New Mexico Environment Department

2015 Strategic Plan

Kirtland Air Force Base Fuel Spill

Project Collaborators:

City of Albuquerque, Environmental Health Department

Albuquerque-Bernalillo County Water Utility Authority

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New Mexico Bureau of Geology

New Mexico Environment Department

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U.S. Air Force Civil Engineering Center

U.S. Air Force, Kirtland Air Force Base

U.S. Environmental Protection Agency

U.S. Geological Survey

Version 2.1; April 8, 2015

minor edits made to V 2.0

A Message from NMED Cabinet Secretary Ryan Flynn:

Cleaning up the Kirtland Air Force Base fuel spill is one of the highest priorities of the New Mexico Environment Department (NMED) and I am certain we will be able to prevent the spill from threatening the health and safety of Albuquerque's citizens. As Cabinet Secretary, I have committed to working with the City of Albuquerque and the Albuquerque-Bernalillo County Water Utility Authority to ensure Albuquerque's drinking water supply is not endangered by the fuel spill. Designing and implementing a successful cleanup is an ongoing process and this 2015 Strategic Plan is an important part of that process.

Over the past year, NMED has worked closely with the Air Force, Albuquerque-Bernalillo County Water Utility Authority, City of Albuquerque, and U.S. Environmental Protection Agency to design effective measures for cleaning up the fuel spill based on sound science and engineering. We developed productive working groups with top technical experts from our project partner organizations and other entities and are beginning to see meaningful progress. Although I will not be satisfied until we have successfully cleaned up the entire spill, I am very pleased with the progress we are making and feel confident that we are on the right path.

This document describes remediation activities we expect the Air Force to complete in 2015 including:

- Installation of 16 new, strategically placed monitoring wells.
- Installation and operation of up to 4 extraction wells. Extracted groundwater will be treated to drinking water standards, re-injected back into the aquifer and/or reused for non-potable purposes.
- Vadose zone remediation will be optimized to effectively reduce fuel contamination to be more protective of groundwater.
- Continuation of laboratory and field tests of various technologies that might be used to clean up the light non-aqueous phase liquid (LNAPL).

We appreciate all the comments and constructive feedback we received on the draft version of our 2015 Strategic Plan. This final version serves as a guide for the extensive work that is being conducted this year. We hope many of you will continue to participate in the quarterly public meetings, periodic field trips, and other opportunities to stay informed and to make your voice heard as this important project progresses.

Sincerely,

Ryan Flynn

Ryan Flynn, Secretary of Environment

What is the Strategic Plan?

The 2015 Strategic Plan is our roadmap for aggressively cleaning up soil and groundwater at the Kirtland Air Force Base fuel spill site throughout this year.

The New Mexico Environment Department (NMED) developed this Strategic Plan to provide a clear compilation of our vision on how to advance the fuel cleanup during 2015. This reference document is a guide to the various strategies currently in place, being actively implemented, or being considered as potential options by the technical working groups. Strategies presented in this document (some of which are in process) represent the continuation of an accelerated remediation process initiated by NMED and the Air Force in the summer of 2014.

The guide also contains information NMED and KAFB presented during numerous public presentations in the 2nd half of 2014 and links to current enforceable regulatory documents related to those strategies in progress. NMED values public involvement and comments. A draft of the 2015 Plan was voluntarily issued for public comment in December 2014, and any comments and suggestions were incorporated into the final document released March 23, 2015. A new draft for calendar year 2016 will be issued in December 2015.

Enforcement for Strategies in the Plan

The Strategic Plan is not an element required by the Resource Conservation and Recovery Act (RCRA) process; we developed it as a reference and planning document. As such, it is not an enforceable document under RCRA or any other regulatory authority.

Enforcement for the strategies presented in the Plan stems from the RCRA permit held by KAFB and enforced by NMED. Under RCRA, KAFB is required to submit work plans, schedules, and other documents for each remediation activity. There are many approved documents already in place and as work proceeds, additional regulatory documents will be submitted to NMED by the Air Force, and subject to NMED approval. Failure to meet the requirements of approved documents will result in enforcement actions, such as the Notice of Violation (NOV) issued to KAFB on January 15th, 2015.

2015 Strategic Plan

Reference guide for remediation Goals & Strategies

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Implementation of Strategies in Strategic Plan

- KAFB must continue to formally submit to NMED: Work plans, schedules, and other documents.

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Enforcement Mechanisms for Elements in Strategic Plan

- NMED issues approval / denial letters for formally submitted Work plans, schedules, and other documents.
- KAFB must comply with formally approved documents or face enforcement actions by NMED.

Table of Contents:

Commonly used acronyms and abbreviations:

AFCEC	Air Force Civil Engineer Center
EDB	Ethylene dibromide
EPA	U.S. Environmental Protection Agency
KAFB	Kirtland Air Force Base
LNAPL	Light Non-Aqueous Phase Liquid (in this case, aviation gasoline & jet fuel)
MCL	Maximum Contaminant Level
NMED	New Mexico Environment Department
RCRA	Resource Conservation and Recovery Act (federal)
SDWA	Safe Drinking Water Act (federal)
SVE	Soil Vapor Extraction

Project Accomplishments in 2014

In 2014, NMED and the technical working groups made progress to identify and fill data gaps, and increase the robustness of interim corrective measures. The following progress was accomplished in 2014:

On-Site Activities

- The soil vapor extraction system, which has already removed more than 500,000 gallons of fuel from the subsurface, was upgraded.
- An air sparging pilot test well was drilled and put into operation.

Work Plans and Other Documents Submitted

- A work plan to drill an additional 16 monitoring wells to fill data gaps in the horizontal and vertical plume definition was approved, and drilling commenced in early December.
- A work plan to drill the first groundwater extraction well and treatment system, which will begin to collapse the dissolved phase contamination plume and pull it away from the City of Albuquerque's water supply wells, was recently approved.

Technical Work Groups:

Multidisciplinary working groups were established during the summer of 2014 to provide detailed review and analysis of highly technical issues pertaining to the investigation and cleanup of the Kirtland Air Force Base fuel spill. These working groups are comprised of experts from the entities with regulatory and public resource oversight for the project. (See Appendix B for additional information)

Public Outreach and Participation:

- An e-mail Listserv to keep the public better informed of site developments and opportunities for involvement was created.
- Quarterly public meetings were modified to include poster sessions that allow members of the public to speak directly with NMED and Air Force technical experts.
- A geological field trip was held to discuss the hydrogeology and geochemistry of the site with members of the public.

To track activities and progress during 2015, plan to attend public meetings, sign up for the NMED email list serve (link on website), and check project websites:

New Mexico Environment Department

⇒ Home page: Update tab under "NM Environment Issues" www.nmenv.state .nm.us

⇒ KAFB Jet Fuel Plume Remediation Web Page: www.nmenv.state.nm.us/NMED/Issues/KirtlandFuelPlume

Kirtland Air Force Base

⇒ Project website: http://www.kirtlandjetfuelremediation.com

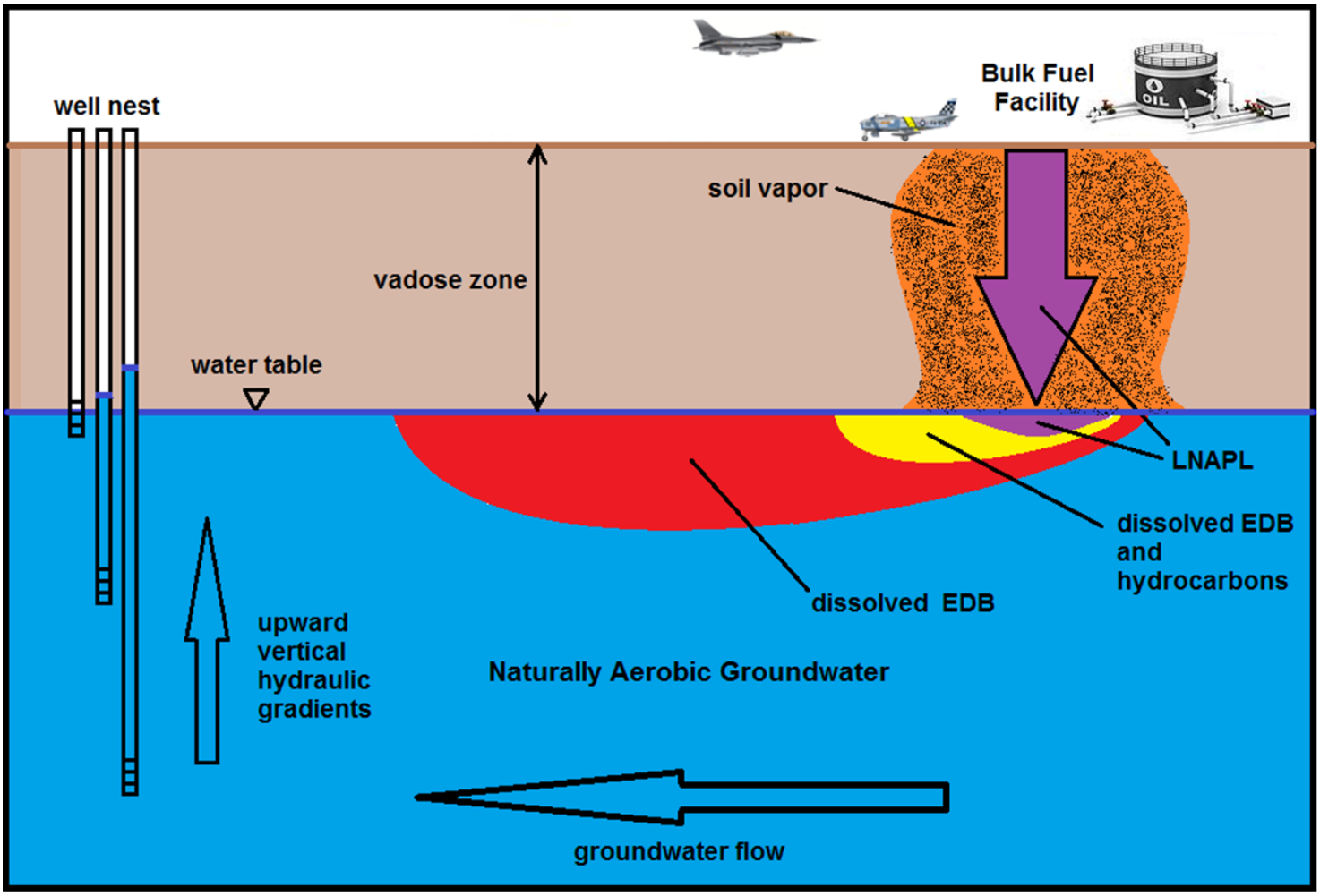
Leakage of aviation gasoline and jet fuel from the Kirtland Air Force Base (KAFB) bulk fuel facility migrated through ~500 feet of soil (vadose-zone), and into the underlying aquifer.

During migration, the LNAPL partitioned into dissolved, vapor and adsorbed phases.

Initially, the LNAPL floated on the groundwater surface. Beginning in 2009, the water table began to rise and the LNAPL became submerged and trapped within the groundwater. This "drowned" LNAPL continues to release dissolved EDB and other contaminants into the groundwater.

Benzene and other hydrocarbons are readily biodegraded by native groundwater bacteria. EDB is biodegrading only in the presence of biodegrading hydrocarbons. Once the EDB has migrated beyond the area of hydrocarbon contamination, there is no evidence of EDB biodegradation.

The aquifer contains naturally occurring upward vertical hydraulic gradients. These upward gradients mean that deep groundwater, such as in the zones tapped by drinking water wells, has the potential to migrate upwards into shallower aquifer zones. The upward gradients work in favor of helping to prevent downward migration of the fuel contamination, and offer some protection of the drinking water wells.

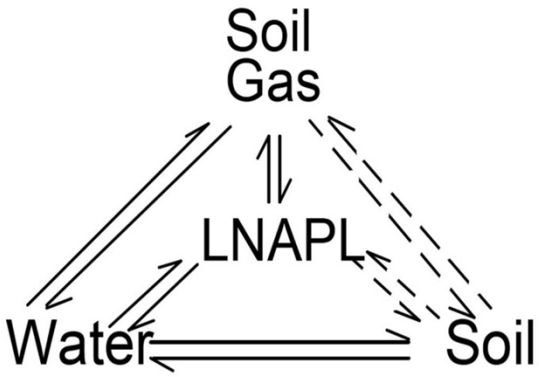


Schematic Diagram of the KAFB Fuel Spill

The four phases of partitioned jet fuel in the soil and groundwater are:

- Light non-aqueous phase liquid (LNAPL) residual fuel;
- Soil vapor (lighter fuel constituents that have volatilized to the vapor phase in soil);
- Adsorbed contaminants (attached to soil particles and aquifer matrix);
- Dissolved contaminants (fuel constituents dissolved in groundwater).

Four Phase Contaminant System



LNAPL = light non-aqueous phase liquid

The jet fuel and aviation gasoline leaked into the ground.

Contaminants transfer between phases

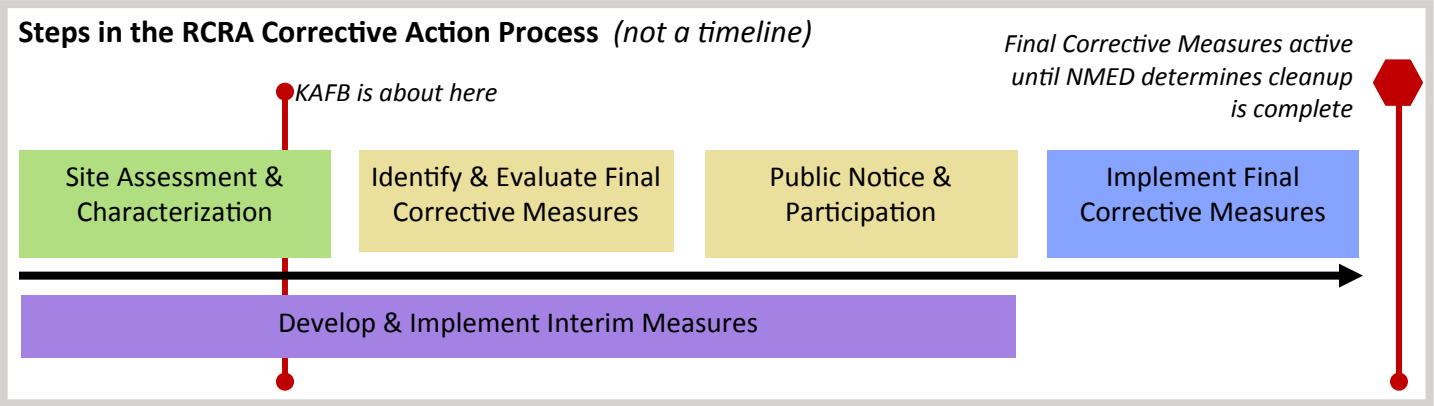
- LNAPL constituents vaporize into "soil gas" and dissolve into groundwater
- Extracting contaminated soil gas can cause some of the contaminants in other phases to vaporize.

LNAPL initially floating on top of the aquifer has become submerged in groundwater by a rising water table.

Dissolved ethylene dibromide (EDB, an additive of aviation gasoline) has migrated in groundwater about 6,000 feet away from the source area, but has not contaminated any drinking water supply well.

References for additional technical information are attached in Appendix A. Detailed engineering plans, specifications, and schedules are contained in the individual work plans approved by NMED.

New Mexico has primacy granted by the U.S. Environmental Protection Agency (EPA) to administer the federal Resource Conservation and Recovery Act (RCRA) hazardous waste program. NMED implements the program. Kirtland Air Force Base must comply with their RCRA Hazardous Waste Permit, including the Corrective Action Process.



Some interim measures have been put into place and additional measures are scheduled. Site assessment and characterization activities are ongoing and, upon completion, RCRA Facilities Investigation (RFI) reports will be submitted to NMED. The RFI reports, after approval by NMED, will be used to support the Corrective Measures Evaluation. Teams of multi-disciplinary technical experts (Appendix B) have been created to provide the following support for the corrective action process:

- Identify, and make recommendations to fill data gaps;
- Identify and resolve data quality issues;
- Define and evaluate the physical, chemical, and biological processes that affect the migration and fate of fuel constituents in the vadose zone and groundwater;
- Establish mass balance equations to calculate the amounts of fuel recovered by engineered cleanup actions, destroyed by biodegradation, and remaining in the aquifer and vadose zone.
- Develop a conceptual site model;
- Develop recommendations for cleanup technologies and strategies.

For more information about RCRA see the EPA's RCRA Orientation manual (link in Appendix A)

PROJECT GOAL:

Protect Albuquerque's aquifer and the drinking water supply wells in the area of the fuel spill.

STRATEGIES TO ACHIVE THE GOAL:

1) Implement a robust groundwater and wellhead monitoring program.
2) Collapse the dissolved EDB plume.
3) Remediate LNAPL and associated dissolved phases in LNAPL area.
4) Clean up soil in the spill area.
5) Meet or exceed all requirements for providing public information and involvement.

Details of these strategies are outlined in the following pages.

Due to the nature of clean-up activities, some of which are dependent of the outcomes of others, it is difficult to present a detailed timeline in a static document such as this.

As the Air Force submits work plans to NMED for the various project activities, specific schedules and enforceable deadlines will be set. These work plans will also include much greater detail and technical specifications for the activities. Approved work plans and other project documents will be posted on NMED's project website as they become available. Check this website, as well as the KAFB project website, for project updates and information.

NMED: KAFB Jet Fuel Plume Remediation Web Page: www.nmenv.state.nm.us/NMED/Issues/KirtlandFuelPlume

KAFB: Project website: http://www.kirtlandjetfuelremediation.com

General timeline of current and expected project activities:

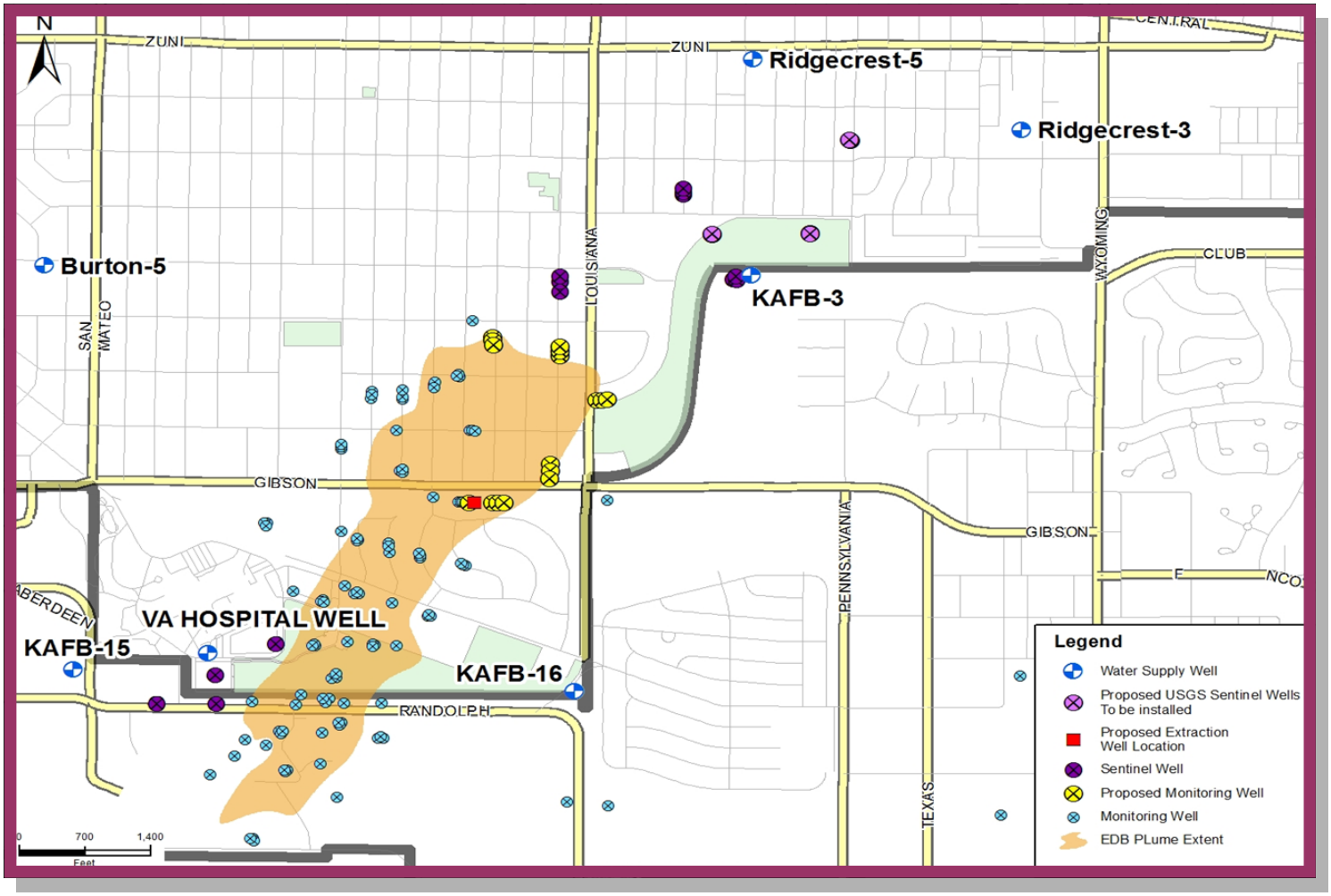
Winter/ Spring 2015	Strategy 1: Robust Monitoring • Continue monthly sampling of drinking water wells. • Continue quarterly sampling of sentinel wells. Strategy 2: Collapse Dissolved EDB Plume • Drill additional monitoring wells and 1st EDB extraction well (well 106228). • Conduct aquifer pilot test for extraction well 106228. • Develop of conveyance system for extracted water. • Develop of plan for non-potable, beneficial-reuse of treated water. • Develop of carbon filtration system for treating extracted water. Strategy 4: Soil Remediation • SVE rebound testing. • Biorespiration testing.
Summer 2015	Strategy 1: Robust Monitoring • Continue monthly sampling of drinking water wells. • Continue quarterly sampling of sentinel wells. Strategy 2: Collapse Dissolved EDB Plume • EDB Pump & Treat system installed and fully functioning - DEADLINE June 30, 2015.
Fall / Winter 2015	Strategy 1: Robust Monitoring • Continue monthly sampling of drinking water wells. • Continue quarterly sampling of sentinel wells. • Develop sentinel well indicator parameters and action levels. Strategy 2: Collapse Dissolved EDB Plume • Complete drilling and connection to treatment system for the 3 additional EDB wells. Strategy 3: LNAPL Remediation • Develop list of potentially suitable technologies for LNAPL interim measure. Strategy 4: Soil Remediation • Drill additional SVE/LNAPL wells. • Complete rebound respiration and testing report.

Strategy 1

Implement a robust groundwater and wellhead monitoring program

As fuel plume cleanup proceeds, the following plan is being implemented to protect drinking water wells:

- Test for fuel contaminants at drinking water wellheads monthly. (current requirements are for testing every 3 years).
- Drill nests of sentinel wells (minimum of 3 wells per nest) located between the fuel plume and drinking water supply wells.
- Test sentinel wells quarterly to provide early detection of any contaminant migration towards the drinking water wells.
- Establish geochemical indicator parameters and action levels for sentinel wells, attainment of which would trigger a review of current hydrogeological conditions, increased monitoring, or intervention.
- Public water system coordination on water well pumping rates, groundwater monitoring, and contamination plume migration.



Drinking Water Standards

NMED has primacy granted by the U.S. EPA to administer the federal Safe Drinking Water Act (SDWA) program. One of NMED's SWDA responsibilities is to require that public water systems supply drinking water to consumers that complies with the EPA Primary (human health based) Maximum Contaminant Levels (MCLs).

Constituent	Primary MCL* (µg/L)
Ethylene dibromide (EDB)	0.05
Ethylene dichloride (EDC)	5
Benzene	5
Toluene	1,000
Ethylbenzene	700
Xylenes (total)	10,000

*EPA Maximum Contaminant Levels (MCLs) adopted by NM as part of our primacy.
(http://water.epa.gov/drink/contaminants/)

- **The goal of this strategic plan is to collapse the contamination plume and pull it back towards the boundary of KAFB before it ever reaches a drinking water well.**
- **Monthly testing of public water supply wells in the area continues to show no detections of fuel contaminants.**
- **Dissolved EDB will not be allowed to impact any drinking water supply system at detectable concentrations**

Performance Measures and Timeline

The success of strategy 1 will be measured by:

- Development of sentinel well indicator parameters and action levels by fall 2015; and
- Continued non-detectable test results in all sentinel wells and drinking water wells; or
- Increased monitoring or intervention if contaminants are detected in any sentinel or drinking water wells.

Strategy 2

Collapse the dissolved EDB plume

Strategy

Develop a robust monitoring and pump and treat system. NMED will oversee the following actions to be performed by the Air Force and their contractors:

Phase 1 (Interim measures)

- Define the horizontal and vertical extent of EDB contamination in groundwater by the drilling of at least 16 additional monitoring wells.
- Install a pilot extraction well at the KAFB-106035 well nest location.
- Construct a pipeline to convey water from the KAFB-106035 well nest location.
- Construct a granular activated carbon filtration system to treat the approximately 100 gallons per minute of extracted water to at least the EPA drinking water MCL of 0.05 µg/L. System will be designed to handle the capacity from the maximum number of extraction wells to be installed.
- Construct an infiltration gallery, permitted by the NMED Groundwater Quality Bureau, to disperse the treated water into the subsurface and allow it to recharge groundwater.
- Explore other options for the beneficial use of treated water such as landscape irrigation and dust control.

Phase 2 (Interim measures)

- Use hydrogeological data and numerical modeling simulations, as appropriate, to locate and design up to 7 additional extraction wells located throughout the dissolved-phase EDB plume.
- Drill up to 7 additional extraction wells.
- Upgrade conveyance, treatment and infiltration systems, as necessary, to accommodate up to approximately 600-800 gallons per minute of extracted water.

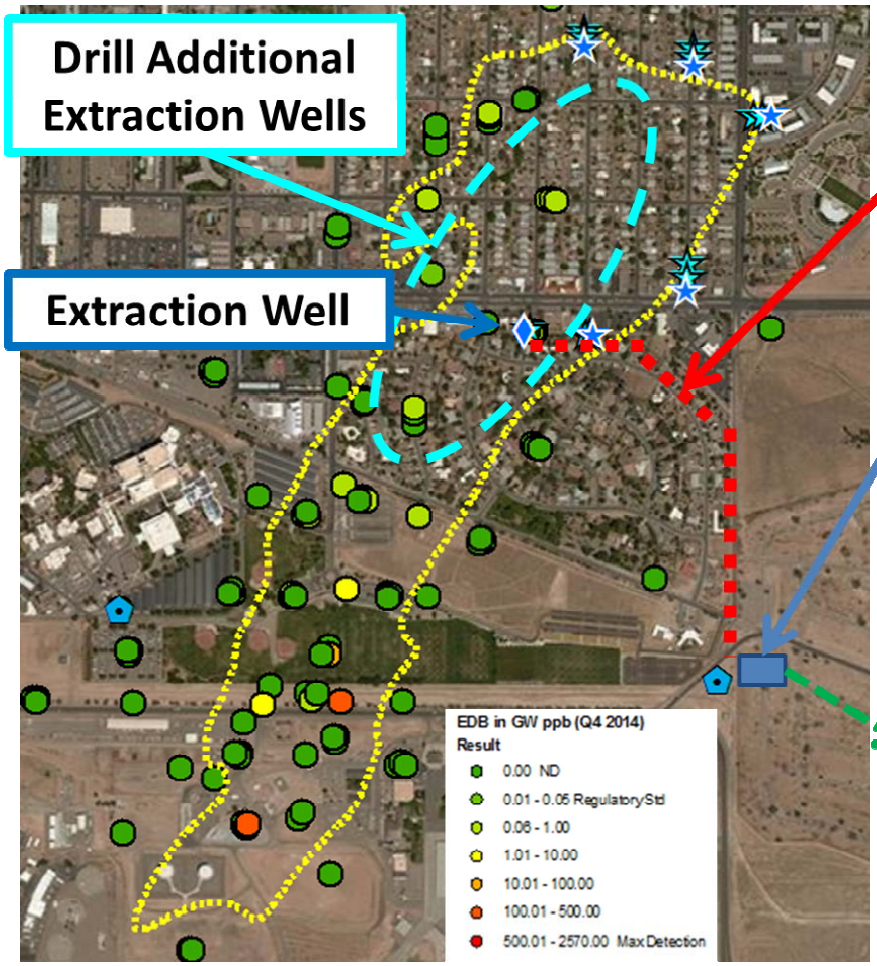
Phase 3 (Final measures)

- In accordance with the requirements of the federal Resource Recovery and Conservation Act, evaluate, select and implement a final corrective measure for dissolved-phase EDB.
- Implement long-term operation, maintenance and optimization of pump-and-treat system to collapse plume and pull it back towards the boundary of KAFB.

Performance Measures and Timeline

The success of strategy 2 will be measured by:

- Installation of 16 new monitoring wells by summer 2015;
- Activation of the pump-and-treat system utilizing the first extraction well by June 30, 2015; and
- The installation of three additional extraction wells by December 31, 2015.

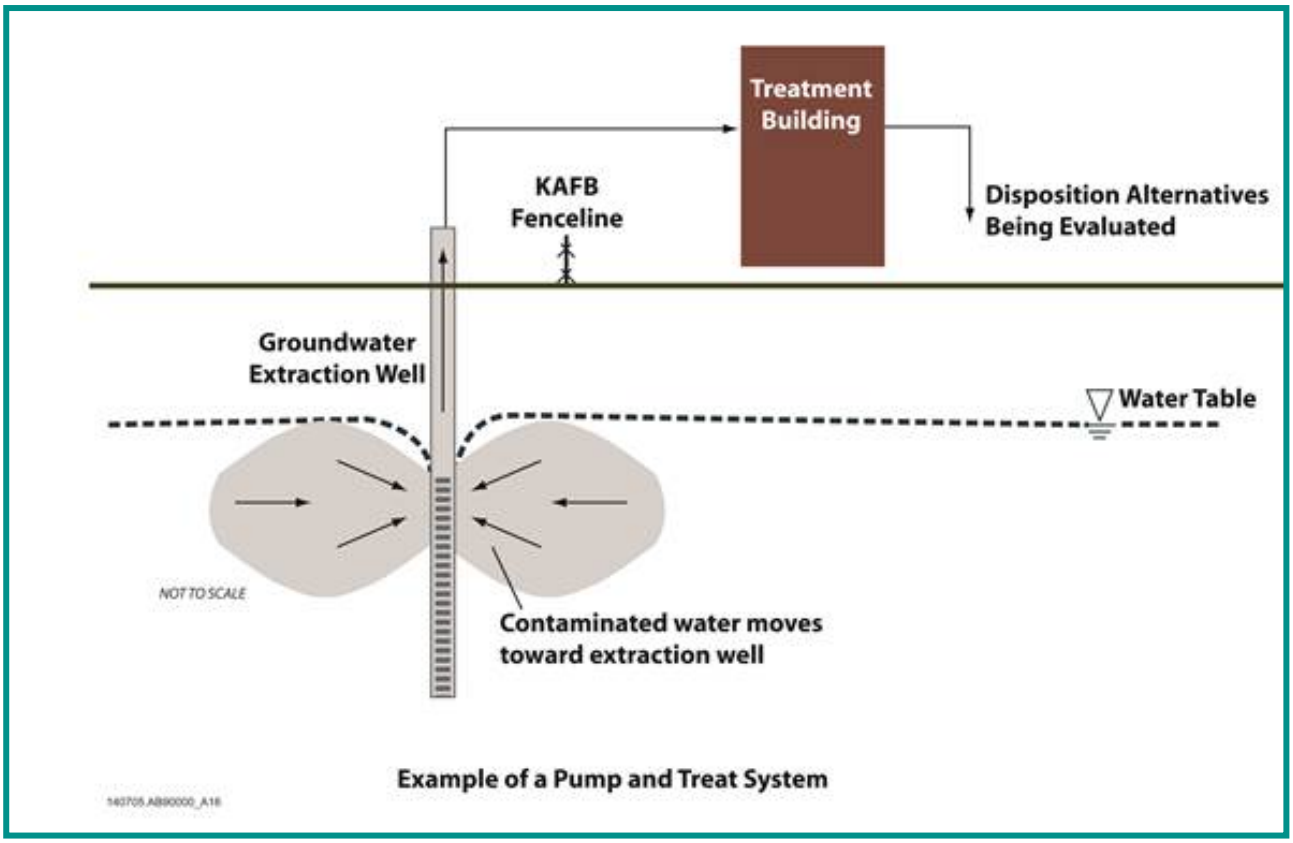


EDB Extracted Water Conveyance Line

EDB Treatment System Using Granular Activated Carbon

Treated Water:

- Infiltration Gallery for Aquifer Recharge
- Landscape Irrigation
- Non-potable Reuse



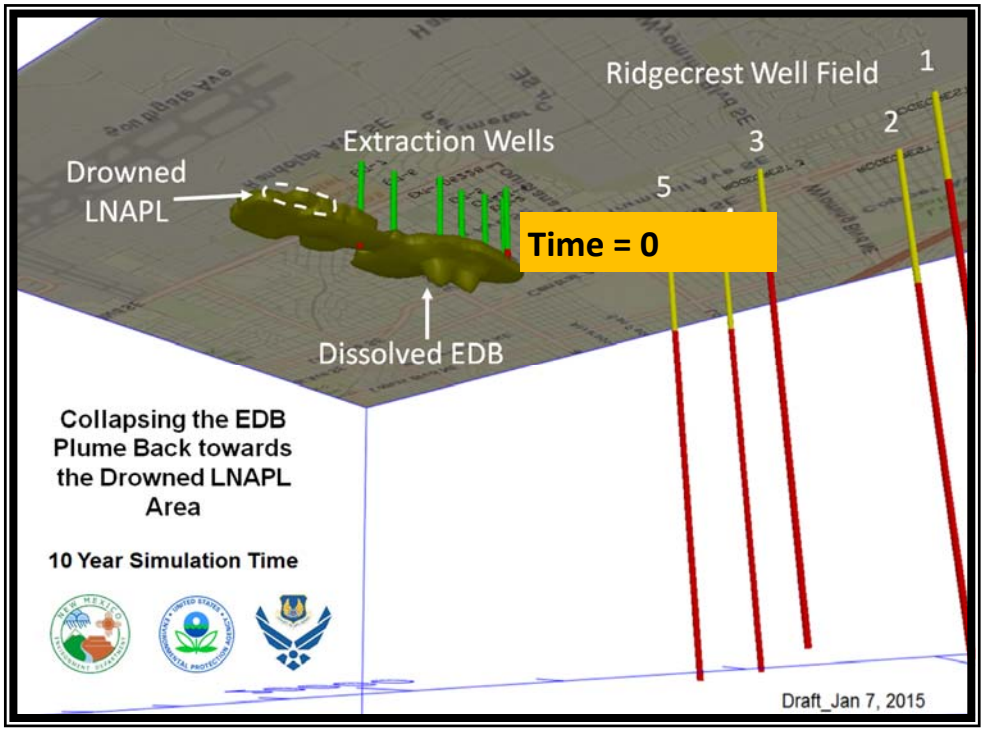
Example of a Pump and Treat System

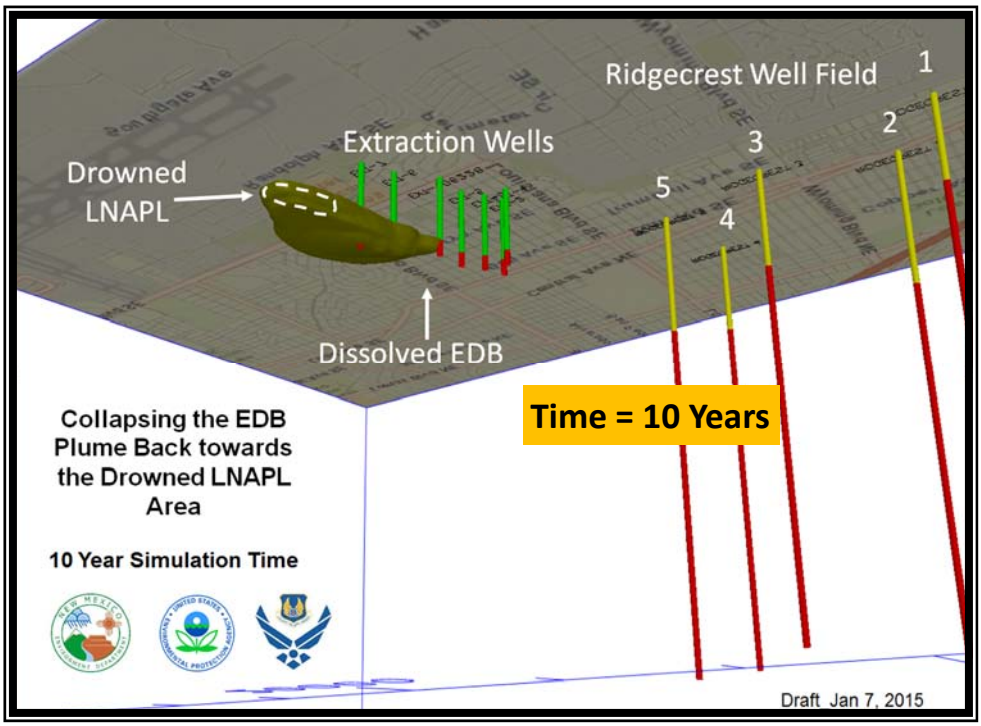
Collapsing the EDB Plume

"Collapsing the plume" refers to the collective actions of an extraction well system that will locally reverse ground water flow gradients, pulling the EDB contamination south and away from Water Utility Authority drinking water wells. The system will contain, capture, and extract the EDB plume, reducing its area and eliminating its potential for threatening clean drinking water wells.

An animated model produced by scientists at EPA can be found on the NMED website:
http://www.nmenv.state.nm.us/NMED/Issues/KirtlandFuelPlume/KAFBProjectDocs.html

Below are two still images from the animated model.





Strategy 3

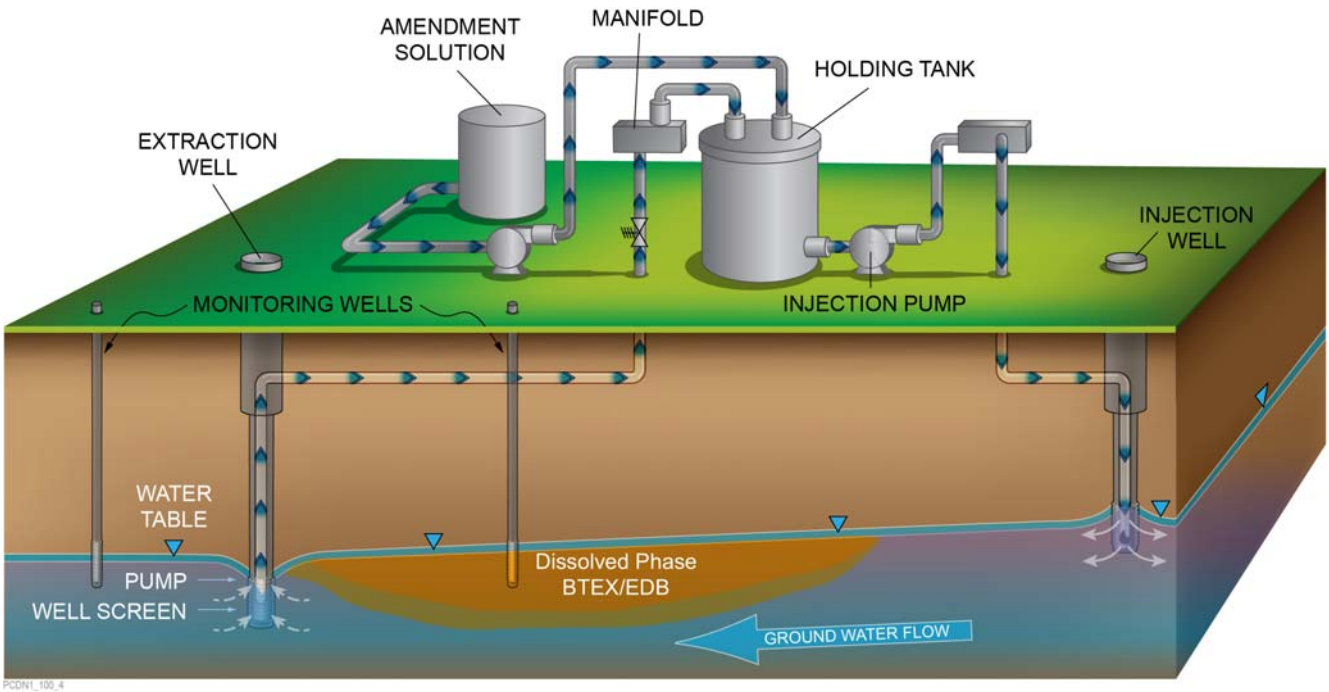
Remediate LNAPL and associated dissolved phases in LNAPL area

Pilot Tests

NMED will oversee evaluations performed by the Air Force and their contractors to explore the feasibility and effectiveness of a variety of interim measures. Remediation technologies under consideration include, but are not limited to, the following:

- Air sparging (blowing air into the groundwater to strip out contaminants, followed by vacuuming the stripped contaminants from soil);
- Steam sparging (blowing steam into the groundwater to strip out contaminants, followed by vacuuming the stripped contaminants from soil);
- Surfactant flushing (injection of surfactant into the LNAPL zone to mobilize the LNAPL to facilitate fuel recovery);
- Bio-stimulation (introducing amendments to stimulate native aquifer bacteria into doing a better job of biodegrading contaminants);
- Bio-augmentation (introducing specialized bacteria into the aquifer to biodegrade the contaminants even faster).

Scaled-up laboratory and field pilot tests will be conducted for critical evaluation of remediation technologies that are deemed to be potentially feasible. Numerical modeling simulations will be performed, as needed, to assist with the evaluation of these technologies. A final list of technologies to be evaluated as interim measures will be developed using groundwater geochemistry, contaminant, and soil core data.



One option that is being explored is to mix amendments into the groundwater to stimulate natural bacteria to do a better job of biodegrading contaminants.

LNAPL Measurement Techniques

Evaluations and tests of non-invasive methods of detecting and measuring submerged LNAPL will be conducted in parallel with the remediation pilot tests. Techniques to be considered include, but are not necessarily limited to:

- Borehole geophysics;
- Contaminant concentration gradients;
- Environmental Tracers.

Final Corrective Measure Evaluation, Selection, and Implementation

- In accordance with the requirements of the federal Resource Recovery and Conservation Act, interim measure performance data (e.g. pump and treat capture zones) and other information will be evaluated to select and implement final corrective measure(s) for LNAPL remediation. This may include a combination of different treatments.
- Establish LNAPL metrics to determine when LNAPL remediation is complete.
- Operation, maintenance, and optimization of the remediation system until LNAPL metrics approved by NMED are met.

Laboratory studies are evaluating the effects that various amendments may have on stimulating abiotic and biotic degradation under aerobic and anaerobic conditions.

Performance Measures and Timeline

The success of strategy 3 will be measured by:

- Development by fall 2015 of a list of technologies that are potentially suitable as an interim measure to remediate the drowned LNAPL; and
- Preparations of work plans by winter 2015-16 for scaled up laboratory and field-scale pilot tests of those technologies that are deemed to be potentially suitable.

Strategy 4

Clean up soil in the spill area

Strategy

Interim Measures

Soil vapor extraction (SVE) has been operating since 2003 and has removed more than 500,000 gallons of fuel from the vadose zone.

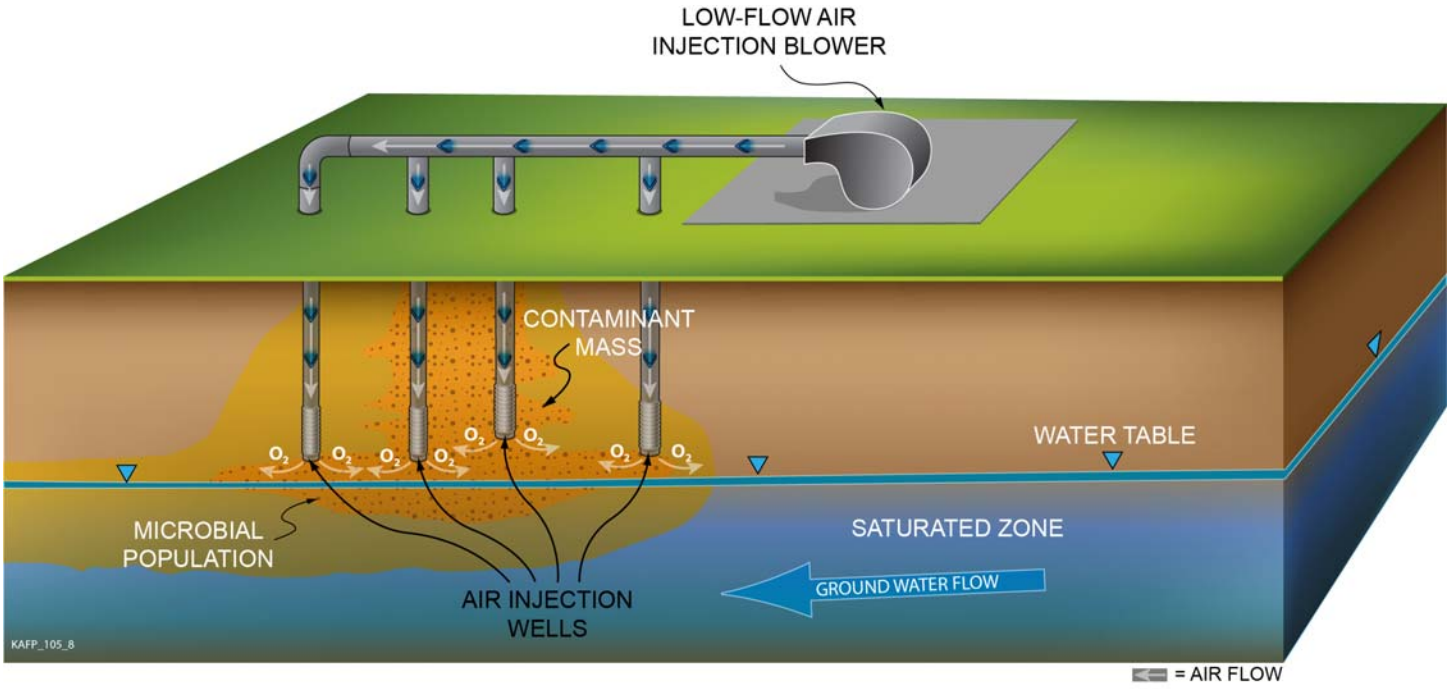
NMED will oversee the following additional actions by the Air Force to increase the robustness of SVE:

- SVE testing to observe rebound of contaminant levels to locate areas where residual contamination exists and to design and place additional SVE wells if needed.
- Conduct *in-situ* microbiological respiration tests during the SVE shutdown period to evaluate the biodegradation capacity of the vadose zone.
- Drill additional SVE wells into identified LNAPL and hotspot areas, and collect soil cores to locate, quantify and characterize residual LNAPL in the subsurface.
- Terminate the current air quality permit, and apply to the Albuquerque Environmental Health Department (AEHD) for a new permit for pilot testing of the new SVE wells.
- Conduct pilot testing using both the current catalytic oxidation (CATOX) and/or internal combustion engine (ICE) treatment systems at identified hotspot areas.
- Use the results of the pilot testing to design a new robust SVE system that optimizes the extraction and treatment of the remaining vadose zone contamination. Apply for an AEHD air permit for the system.
- Construct the new robust SVE system, operate, maintain and optimize as necessary in accordance with the permit.
- Evaluate the potential benefits of bioventing to remediate the remaining vadose zone contamination. If justified, a bioventing pilot test will be performed.

Final Corrective Measure Evaluation, Selection and Implementation

- In accordance with the requirements of the federal Resource Recovery and Conservation Act, interim measure performance data (e.g. SVE radius of influence) and other information will be evaluated to select and implement final corrective measure(s) for the vadose zone. This may include a combination of different treatments.
- Establish soil vapor cleanup concentrations that will not be capable of contaminating groundwater.
- Operation, maintenance, and optimization of the SVE system until soil vapor cleanup concentrations approved by NMED are met.

- Vapor contamination is treated in accordance with City of Albuquerque Air Quality Permit requirements
- Volatile fuel contaminants can be vacuumed out of the soil
- Less-volatile contaminants will need to be destroyed by bioventing
- Bioventing is accomplished by blowing air into the soil to stimulate soil bacteria with an ongoing source of oxygen to support biodegradation.



Performance Measures and Timeline

The success of strategy 4 will be measured by:

- Successful completion of the SVE rebound and bio-respiration testing by summer 2015;
- Rebound and biorespiration testing report submitted in fall 2015.
- Installation of additional SVE and LNAPL monitoring wells by winter 2015.

Strategy 5

Meet or exceed all requirements for providing public information and involvement

Our continued goal is to communicate accurate, comprehensive information to the public. We hold poster sessions to make our experts directly available to the public, offer field trips to educate the public on the geology and remediation activities of the area, coordinate public meetings with the Air Force, and post information on our website.

Strategy

- Maintain a KAFB fuel spill cleanup website on the NMED server to make correspondence and technical information readily available to the public. Documents to be posted include, but will not necessarily be limited to, proposed and final work plans, quarterly reports, technical working group meeting minutes, RFI reports, and NMED approval letters.
- Maintain a KAFB fuel spill cleanup Listserv to send out periodic messages informing the public of important news and opportunities for involvement.
- Participate in quarterly public meetings hosted by the Air Force, to include poster sessions and presentations.
- Make presentations, as requested, to neighborhood associations, city and county governmental agencies, legislative committees, and to other organizations interested in the KAFB fuel cleanup.
- Host occasional field trips, in coordination with other stakeholders, to inform the public about site geology, hydrology, geochemistry, and cleanup actions.
- Explore potential for facilitated public working groups to address various components of site investigation and cleanup. Host working group sessions, in coordination with other stakeholders, if public interest exists.
- Conduct a robust public outreach and involvement program for evaluation and selection of final corrective measures in compliance with statutory RCRA requirements.
- Continually identify additional opportunities for constructive public outreach and communication
- Update this Strategic Plan on an annual basis.

Performance Measures and Timeline

The success of strategy 5 will be measured by:

- Participation in three public meetings, spring, summer and fall/winter, 2015;
- Participation in one listening/question-and-answer session, spring 2015;
- Participation in at least one field trip, spring 2015;
- Issuance in December 2015 of a draft NMED Strategic Plan for calendar year 2016.

INFORMATION ON THE WEB

New Mexico Environment Department

⇒ Home page: Update tab under "NM Environment Issues" www.nmenv.state .nm.us

⇒ KAFB Jet Fuel Plume Remediation Web Page: www.nmenv.state.nm.us/NMED/Issues/KirtlandFuelPlume

Kirtland Air Force Base

⇒ Project website: http://www.kirtlandjetfuelremediation.com

References for Additional Technical Information

New Mexico Environment Department:

⇒ KAFB Jet Fuel Plume Remediation web section: www.nmenv.state.nm.us/NMED/Issues/KirtlandFuelPlume

- **Project Documents Page: Groundwater Extraction Pilot and Additional Characterization**
  - KAFB workplan, August 1, 2014 Link to PDF on NMED website
  - NMED approval letter, August 20, 2014 Link to PDF on NMED website

- **Public Outreach Archive Page: Public Meeting Presentations and Field Trip Handouts**

- **Site also includes:** additional documents, modeling videos, biographies of technical working group members

- **Historical Reports and Correspondence** (dating back to 1999)
  - NMED Hazardous Waste Bureau Webpage link http://www.nmenv.state.nm.us/HWB/kafbperm.htm

Kirtland Air Force Base:

⇒ Project website: http://www.kirtlandjetfuelremediation.com

- **Project Documents Page: Quarterly Monitoring and Site Investigation Reports** (full text, figures and tables)

- **Site also includes:** past meeting materials, maps & photos, frequently asked questions, contacts

U.S. Environmental Protection Agency :

- **EPA's RCRA Orientation Manual** http://www.epa.gov/osw/inforesources/pubs/orientat/

KAFB Technical Working Group Mission Statements

Multidisciplinary working groups have been established to provide detailed review and analysis of highly technical issues pertaining to the investigation and cleanup of the Kirtland Air Force Base fuel spill. The groups consist of staff scientists and engineers from the New Mexico Environment Department, Kirtland Air Force Base, the Air Force Civil Engineering Center, Air Force consultant CB&I, the Albuquerque Bernalillo County Water Utility Authority (ABCWUA), ABCWUA consultant INTERA, the City of Albuquerque Environmental Health Department, and U.S. Environmental Protection Agency (EPA). Each working group shall prepare minutes documenting the attendance, discussion, and homework assignments from each meeting, and the minutes shall be posted on the NMED web site.

Hydrogeology Working Group

The hydrogeology working group will review published maps and reports, lithologic logs, well records, core samples, drill cuttings, airborne, surface and borehole geophysical data, water level data and other information. The hydrogeology group will use this information to define stratigraphy, structural features, and aquifer hydraulics in the vicinity of the fuel contamination. The hydrogeology group also will define background aquifer geochemistry, but will not address geochemical alterations caused by fuel contamination as that subject will be addressed by the biogeochemistry/LNAPL working group.

The hydrogeology group will have the following specific responsibilities:

1. Assembly or, if necessary, preparation of maps, cross sections, fence diagrams, graphs, Stiff diagrams, trilinear plots, time trends, interpretations and other material as appropriate to document site hydrogeologic conditions.
2. Provide detailed stratigraphic and other geotechnical information to the SVE, biogeochemistry/LNAPL and modeling work groups for their consideration and use in their areas of responsibility.
3. Field oversight of drilling operations, including review and approval of lithologic logs and proposed well completions.
4. Oversee borehole geophysical logging; analysis of logging data.
5. Oversee the design, implementation and interpretation of aquifer performance testing.
6. Develop a conceptual site model in coordination with other technical work groups.
7. Identify and resolve field and laboratory QA/QC issues.
8. Review water-level and water-quality monitoring data from the hydrodynamic dissolved-phase EDB extraction system.
9. Coordinate with ABCWUA, KAFB and NMVAHCS on protection of public drinking water wells.
10. Define background conditions for dissolved oxygen, nitrate, alkalinity, bromide and other parameters of concern.
11. Develop indicator parameter concentrations for sentinel wells that, if observed, would trigger additional review, increased monitoring, or intervention.
12. Plan and host occasional geological field trips for the general public, in coordination with other working groups.
13. Optimize the current groundwater monitoring program including the wells sampled and the laboratory analyses.

Biogeochemistry/LNAPL Working Group

The biogeochemistry/LNAPL working group will investigate and define the physical, microbial, geochemical, and hydrogeological processes that control the fate and transport of dissolved, non-aqueous liquid, gaseous and adsorbed phase contaminants, and evaluate potential remediation options. Dissolved phase contaminants of concern include: ethylene dibromide (EDB), benzene, toluene, ethylbenzene, and xylene isomers (BTEX), polynuclear aromatic and aliphatic hydrocarbons, and 1,2-dichloroethane. Parameters of interest regarding natural and engineered degradation processes include dissolved oxygen, oxidation reduction potential, nitrate, manganese, iron, sulfate, methane, carbon dioxide, alkalinity, bromide, chloride, and stable isotopes of various elements.

The biogeochemistry/LNAPL group will have the following specific responsibilities:

1. Characterize the physical and chemical properties of light non-aqueous phase liquids (LNAPLs) that are submerged within or floating atop groundwater.
2. Identify specific chemical and biological mechanisms that have transformed or degraded contaminants, along with reaction rates and byproducts.
3. Make recommendations for additional sampling and analysis as needed.
4. Use stoichiometric equations to calculate the amounts of contaminants that have been transformed or degraded in the vadose zone and in groundwater.
5. Maintain a running quantification of the amount of EDB that has been removed by the pump-and-treat system.
6. Evaluate potential remediation options for additional removal or destruction of fuel contaminants. Such options may include, but may not necessarily be limited to, pump and treat, air or steam sparging, soil vapor extraction, biostimuation, bioaugmentation, bioventing, surfactant flooding, and monitored natural attenuation.
7. Make recommendations for scaled up laboratory and field-scale pilot tests of potentially viable remediation technologies.

Vadose Zone Working Group

The vadose zone working group will review lithologic data, soil vapor concentrations, and performance data from historical and ongoing SVE operations to make recommendations on increasing the robustness of SVE activities.

The Vadose Zone group will have the following specific responsibilities:

1. Identify soil vapor hotspots needing additional treatment.
2. Recommend locations and completion specifications for additional extraction wells.
3. Identify areas where biodegradation is ongoing and would benefit from active bioventing.
4. In coordination with the biogeochemistry/LNAPL group, maintain a running quantification of the amounts of hydrocarbons that have been removed by SVE and by biodegradation in the vadose zone.

Modeling Working Group

The modeling working group will design, run and calibrate numerical simulations of contaminant transport and fate.

The modeling group will be responsible for the following types of simulations:

1. EDB transport times to drinking water wells in the area under various scenarios.
2. Hydrodynamic capture zones for various configurations of extraction wells with various pumping rates for pump-and-treat remediation.

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