KIRTLAND AIR FORCE BASE, NEW MEXICO

CONTINGENCY PLAN FOR GROUNDWATER PRODUCTION WELLS NEAR THE BULK FUELS FACILITY SPILL AREA

NOVEMBER 2013

377 MSG/CEIR
2050 Wyoming Blvd. SE
Kirtland AFB, New Mexico 87117-5670

ENVIRONMENTAL RESTORATION PROGRAM
KIRTLAND AIR FORCE BASE, NEW MEXICO

CONTINGENCY PLAN FOR GROUNDWATER PRODUCTION WELLS NEAR THE BULK FUELS FACILITY SPILL AREA

NOVEMBER 2013

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Contract No. FA8903-08-D-8769 Task Order No. 0358

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REPORT DOCUMENTATION PAGE		*Form Approved* *OMB No. 0704-0188*
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1. REPORT DATE *(DD-MM-YYYY)* 19/11/2013	**2. REPORT TYPE** Contingency Plan	**3. DATES COVERED *(From - To)*** August to November 2013
4. TITLE AND SUBTITLE Contingency Plan for Groundwater Production Wells near the Bulk Fuels Facility Spill Area Kirtland Air Force Base, New Mexico		**5a. CONTRACT NUMBER** Contract No. FA8903-08-D-8769
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Jarocki, Karen/CH2M HILL LeFevre, William JB /CH2M HILL Clement, Paul/CH2M HILL		**5d. PROJECT NUMBER**
		5e. TASK NUMBER 0358
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES) CH2M HILL 3721 Rutledge Road NE, Suite B-1 Albuquerque, NM 87109		**8. PERFORMING ORGANIZATION REPORT NO.**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFCEC, 772 ESS/PKB 2261 Hughes Avenue, Suite 163 JBSA Lackland AFB, TX 78236-9853 COR: Stephanie Ramon		**10. SPONSOR/MONITOR'S ACRONYM(S)** AFCEC
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT This Contingency Plan identifies and evaluates contingencies that can be implemented should contaminated groundwater approach production wells located near the Bulk Fuels Facility spill site at Kirtland Air Force Base, New Mexico. Trigger points are identified for the contingencies.		
15. SUBJECT TERMS Contingency Plan, production well, Bulk Fuels Facility		

16. SECURITY CLASSIFICATION OF: **Unclassified**			**17. LIMITATION OF ABSTRACT** **UU**	**18. NO. OF PAGES** **69**	**19a. NAME OF RESPONSIBLE PERSON** Karen Jarocki
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER *(include area code)*** 505-855-5244

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

DOCUMENT CERTIFICATION
NOVEMBER 2013

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PREFACE

This Contingency Plan identifies and evaluates contingencies that can be implemented should contaminated groundwater approach groundwater supply wells near the Bulk Fuels Facility spill site at Kirtland Air Force Base, New Mexico. The Contingency Plan addresses the requirements of the U.S. Air Force Statement of Work dated January 29, 2013.

This Contingency Plan was prepared by CH2M HILL in November 2013. Ms. Stephanie Ramon of the Air Force Civil Engineer Center served as the Contracting Officer's Representative.

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ACRONYMS AND ABBREVIATIONS

3-D	three-dimensional
AFB	Air Force Base
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene and xylenes
CSM	conceptual site model
EDB	ethylene dibromide
ERP	Environmental Restoration Program
EPA	U.S. Environmental Protection Agency
ft	foot/feet
GAC	granular activated carbon
HSDB	Hazardous Substances Data Bank
JP4	jet fuel 4
JP8	jet fuel 8
MCL	maximum contaminant level
µg/L	micrograms per liter
mg/L	milligrams per liter
MOA	Memorandum of Agreement
MRGB	Middle Rio Grande Basin
NAPL	non-aqueous phase liquid
NMED	New Mexico Environment Department
TPH	total petroleum hydrocarbons
USAF	U.S. Air Force
USF	Upper Santa Fe
USGS	U.S. Geological Survey
VA	Veterans Administration
VOC	volatile organic compound

EXECUTIVE SUMMARY

The Albuquerque-Bernalillo County Water Utility Authority (Water Authority), Kirtland AFB, and the Veteran's Administration (VA) hospital complex operate production wells near the Bulk Fuels Facility (BFF) spill site at Kirtland Air Force Base (AFB), New Mexico. These wells supply drinking water to the Water Authority distribution system, Kirtland AFB facilities, and VA facilities. The BFF spill site has affected groundwater resources in the Albuquerque Basin. As such, this Contingency Plan was developed to evaluate contingencies that could be implemented to mitigate potential effects to the groundwater supply wells located downgradient of the BFF spill site.

The BFF was constructed in approximately 1953 for storage of fuels and. In 1999, it was determined that fuel leaked from the offloading rack of the BFF. Discharges of fuel from the BFF resulted in groundwater contamination that extends from the BFF spill site into areas of the city of Albuquerque located to the north and east of Kirtland AFB.

The effected groundwater resources lie within the Albuquerque Basin, which is a deep, sediment-filled basin. The groundwater aquifer lies within the Santa Fe group and primarily consists of discontinuous layers of gravels, sands, silts, and clays. Sandy units, including ancestral Rio Grande channel deposits, predominate in the saturated portions of the upper and middle Santa Fe Group beneath the BFF Sill Site. Low-permeability silts, silty sands, and clayey sands are thin and discontinuous in the upper portions of the groundwater aquifer. No aquitards have been identified from local boring logs.

The regional aquifer is an unconfined alluvial aquifer of relatively high yield and good water quality. Groundwater flow in the area of the BFF spill site is northeast toward the Water Authority pumping centers. The groundwater table is relatively flat except in areas of extensive pumping or adjacent to fault zones. In the areas affected by the BFF spill, depths to groundwater typically range from 440 to 515 feet (ft) below ground surface (bgs).

Fuel contamination is currently present as non-aqueous phase liquids (NAPL) near the groundwater table and as chemicals dissolved in the upper portions of the regional groundwater aquifer. The most significant of the detected organic compounds in the dissolved portion of the fuel plume is ethylene dibromide (EDB). It is highly soluble and does not readily degrade and, therefore, is the compound most likely to affect water quality at production wells. The dissolved groundwater plume extends approximately 5,400 ft from the BFF area north-northeast in the direction of Kirtland AFB and Water Authority water supply wells. Water quality has not been affected at any public water supply wells.

The Water Authority provides the water supply for much of the Albuquerque Metropolitan area. Water is withdrawn from Rio Grande surface water and Albuquerque Basin regional groundwater aquifer sources and distributed through an interconnected water distribution system. The distribution system is interconnected in a manner that allows both groundwater and surface water to be provided across the Water Authority service area and for excess production capacity in one area to be moved to areas lacking in production capacity. Kirtland AFB and the VA supply water for their facilities from the Albuquerque Basin regional aquifer. There are three Water Authority, three Kirtland AFB, and one VA production wells located within approximately one mile radius of the BFF dissolved phase fuel plume. Two Water Authority and one Kirtland AFB supply wells have the greatest potential risk for contamination from the BFF spill site due to their proximity to the leading edge of the EDB groundwater plume and groundwater flow direction.

Groundwater modeling was used to provide an estimate of potential future contaminant migration paths and travel times for the contaminant EDB released in the past from the BFF spill site. The U.S. Geological Survey (USGS) Middle Rio Grande Basin groundwater flow model was utilized for the task. This model was updated with recent groundwater pumping rates provided by the Water Authority and Kirtland AFB, and was calibrated so that simulated particle tracks and groundwater elevations closely match the real-world measured distribution of EDB and measured groundwater elevations. Three different scenarios of groundwater pumping rates were used to predict the travel of EDB through 2054. Modeling simulations indicate that EDB may reach one Kirtland AFB and two Water Authority wells. The Kirtland AFB production well may be effected by the BFF EDB plume as soon as 2024. Water Authority production wells may be affected by the BFF EDB plume as soon as 2040, if Water Authority pumping is greater than current pumping rates; however, a more likely plume arrival time is approximately 2054 under the current Water Authority pumping scenario.

Contingencies to address potential future contamination of production wells were evaluated for technical requirements, environmental impacts, protection of human health, intuitional requirements, and cost. The evaluation of the contingencies required substantial value judgments, which have been vetted through the document review process by the Water Authority, Kirtland AFB, and the USGS. The following contingencies were evaluated in this plan:

- Wellhead treatment of affected well;
- Contaminant reduction through blending of water;
- Installation of replacement production well away from contamination areas;
- Additional surface water diversion; and
- System operation modification for the Water Authority distribution system.

Each of these contingencies has strengths and weakness for the areas that were evaluated for this Contingency Plan. A final contingency was not selected as part of this document; selection of a contingency to be implemented remains with the Water Authority based on the needs and circumstances at the time of implementation.

The general process for implementing any contingency is to: install and routinely monitor sentinel wells for evidence of BFF contamination and routinely reevaluate the potential risk to the production wells. If BFF-related contamination is found in a sentinel well, then monitoring frequency is increased and a preferred contingency is selected, planned, and implemented. It is recommended that sentinel wells be installed in upgradient locations for one Kirtland AFB and two Water Authority production wells.

1.0 INTRODUCTION

This Contingency Plan was developed to identify and evaluate contingencies that can be implemented if drinking water resources are threatened by contamination resulting from the Bulk Fuels Facility (BFF) spill site at Kirtland Air Force Base (AFB), New Mexico. The Albuquerque-Bernalillo County Water Utility Authority (Water Authority), Kirtland AFB, and the Veterans Administration (VA) hospital complex all operate groundwater production wells that supply drinking water to their facilities near the BFF spill site. At this time, Kirtland AFB and the VA are developing contingency plans specific to their drinking water systems. This Contingency Plan primarily addresses resources managed by the Water Authority which are near the BFF spill site.

The BFF spill site is located within the western portion of Kirtland AFB. The BFF was constructed in approximately 1953 for fuel storage. Fuels, including aviation gas, jet fuel 4 (JP4), jet fuel 8 (JP8), diesel fuel, and unleaded gasoline, have been stored at the facility since the facilities were constructed. The BFF still serves as the fuel storage facility at Kirtland AFB today. In 1999, it was determined that fuel leaked from the offloading rack of the BFF. Discharges of fuel from the BFF resulted in groundwater contamination that extends from the BFF spill site into areas of the city of Albuquerque located to the north and east of Kirtland AFB. Ethylene dibromide (EDB), a particular contaminant of concern found in the groundwater, has migrated approximately 5,400 feet (ft) from the BFF on Kirtland AFB to the northeast.

Two Kirtland AFB water supply wells are located within 2,300 ft of the east (KAFB-16) and west (KAFB-15) sides of the dissolved phase fuel plume and one water supply well (KAFB-3) is located approximately 2,000 ft downgradient of the dissolved phase fuel plume. The VA well is located approximately 600 ft west of the plume. The Water Authority production wells are located approximately 4,000 ft and 5,300 ft further downgradient of the currently identified leading edge of the EDB groundwater plume (Figure 1-1).

1.1 Objectives and Scope

The objective of this Contingency Plan is to identify and evaluate contingencies that could be implemented to mitigate impacts to the Water Authority groundwater production wells located downgradient of the BFF groundwater plume. This Contingency Plan describes the contingencies and the implementation of them. This Contingency Plan is only applicable to Water Authority groundwater production wells that are located immediately downgradient of the BFF groundwater plume, which could potentially be affected by that groundwater plume. The scope of this Contingency Plan does not include the entire Water Authority water system or other possible contamination sources. Both Kirtland AFB and the VA are developing contingency plans specific to their water systems.

1.2 Approach

Development of the Contingency Plan followed a systematic approach that included evaluation of 1) existing drinking water system infrastructure, 2) the risk to the infrastructure, 3) contingencies, and 4) schedules. Data for both the BFF groundwater contamination and the Water Authority water system were gathered and evaluated. A groundwater flow model with particle tracking was used to assess scenarios under which groundwater contamination might reach the groundwater wells and the timeframe in which that might occur. Results of the modeling effort were used to recommend an early warning system for the wells. Potential contingencies were developed that would appropriately protect, mitigate, or otherwise manage impacts to the water resources at the Water Authority wells as agreed upon by the project team. Each contingency was evaluated for feasibility of implementation, requirements for early warning, and cost.

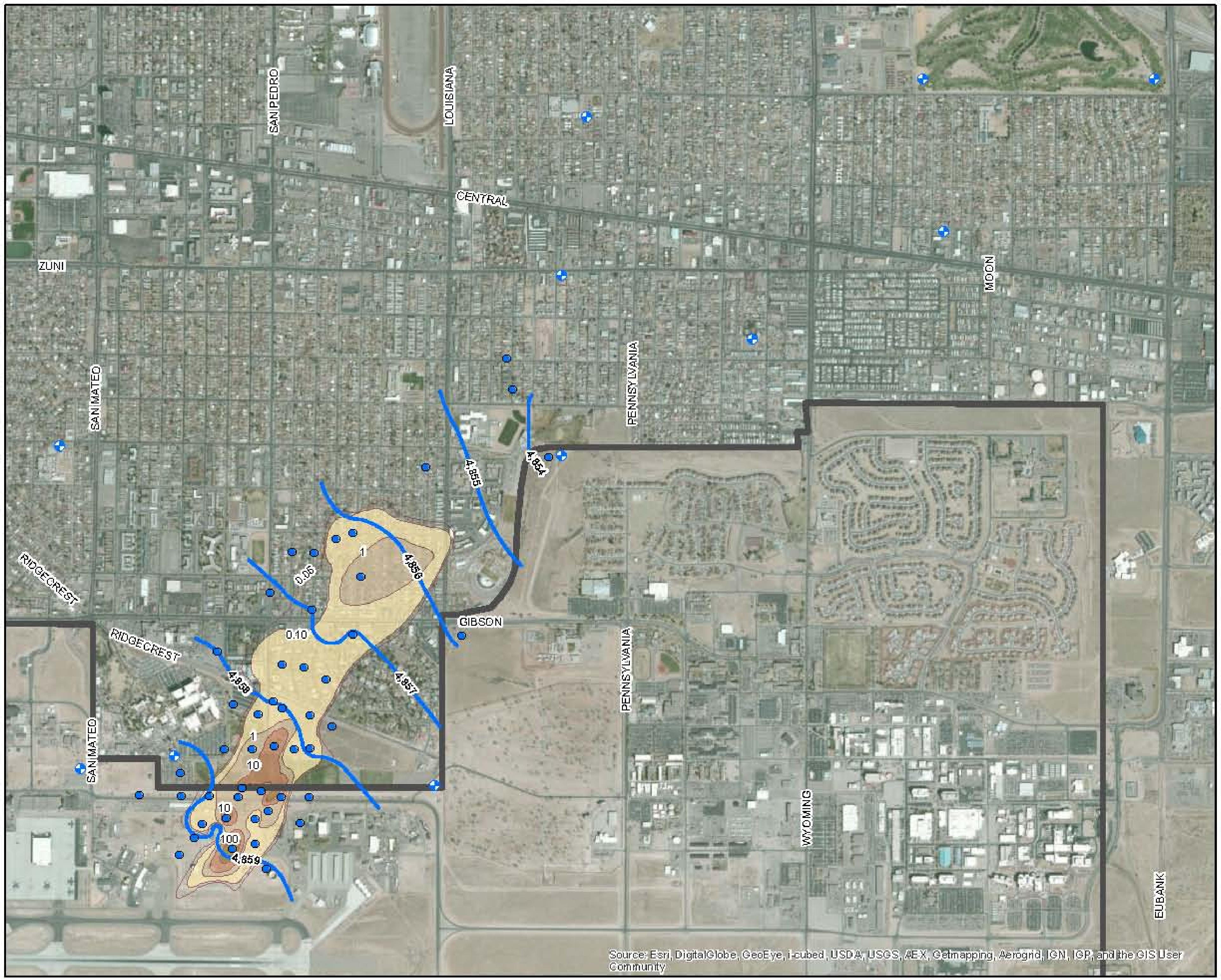
1.3 Background Information

The Contingency Plan was developed as a cooperative effort between the U.S. Air Force (USAF) through Kirtland AFB and the Water Authority. A memorandum of agreement (MOA) was signed between the two parties in December 2012. The MOA identified the purpose, authority, scope, roles and responsibilities, reimbursement, Contingency Plan implementation, liability, notification and coordination, and term and effective date. A signed copy of the MOA is included as Appendix A of this plan.

1.4 Document Organization

The remainder of this Contingency Plan is organized into the following sections:

- Section 2, Conceptual Site Model,
- Section 3, Predictive Modeling;
- Section 4, Contingency Evaluation;
- Section 5, Implementation;
- Appendix A, Memorandum of Understanding; and
- Appendix B, Groundwater Modeling Technical Memorandum.



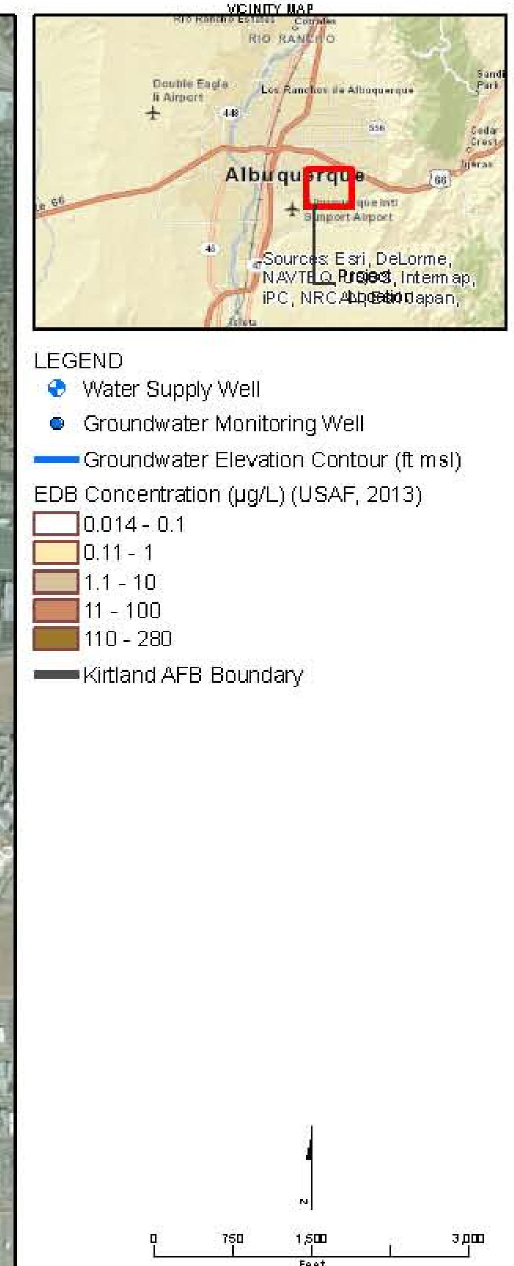


FIGURE 1-1
Ethylene Dibromide (EDB)
Shallow Groundwater Plume and Water Supply Wells near the Kirtland Air Force Base Bulk Fuels Facility

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2.0 CONCEPTUAL SITE MODEL

Fuel releases from the Kirtland AFB BFF spill site have affected groundwater resources that are used for domestic and municipal water supplies. This conceptual site model (CSM) was developed as part of the Contingency Plan for groundwater production wells near the BFF spill site and provides information on the physical setting useful for understanding groundwater properties and plume migration that could influence water quality at nearby production wells. The information presented in this CSM is not comprehensive for the entire BFF spill site and does not provide a detailed description of source area soil and soil vapor contamination, or of the non-aqueous phase liquid (NAPL) hydrocarbon plume. A comprehensive CSM for the BFF spill site can be found in the *Quarterly Pre-Remedy Monitoring and Site Investigation Report for January – March 2013 Bulk Fuels Facility Spill Solid Waste Management Units ST-106 and SS-111*(U.S. Air Force [USAF], 2013).

2.1 Site Specific Geology

The affected groundwater resources lie within the Albuquerque Basin which is a deep, sediment filled basin on which the City of Albuquerque, Kirtland AFB and a portion of the Rio Grande sit. The Albuquerque Basin and mountains to the east were formed as part of the Rio Grande Rift. The bedrock underling the Albuquerque Basin dropped during the Cenozoic Era rift expansion and exposed Paleozoic age sedimentary and Pre-Cambrian age crystalline rock which forms the abutting Sandia and Manzano Mountains (Connell, 2004). A fault network is present between the Sandia Mountain foothills and the Albuquerque Basin (also referred to as the Middle Rio Grande physiographic province) (Connell, 2012).

The groundwater aquifer addressed in this CSM is comprised of unconsolidated sediments of the Santa Fe Group within the Albuquerque Basin, west of the Sandia Mountains, and east of the Rio Grande. Santa Fe Group deposits are present at thicknesses up to 14,000 ft within the Albuquerque Basin (Hawley and Haase, 1992). Santa Fe Group sediments range from about 8,600 to 9,600 ft thick in the vicinity of the BFF spill site. The upper portion of the Santa Fe Group was deposited during development of the ancestral Rio Grande and contains deposits from erosion of Sandia and Manzano Mountain bedrock material (Hawley and Haase, 1992). The lower Santa Fe Group consists of sediments shed from mountains to the east and volcanic rock. Volcanic ash and rock form thin discontinuous layers in the lower portions of the Santa Fe Group and resulted from volcanic activity associated with the Rio Grande rift (Hawley et al., 1994). The Ortiz Gravel lies below the Santa Fe Group with variable thicknesses of coarse mountain front erosion sediments deposited during the initial faulting and spreading of the Albuquerque Basin.

The upper and middle portions of the Santa Fe Group sediments are of particular interest for this CSM. The BFF releases occurred in the upper portion of the Santa Fe Group, and the affected groundwater resources are present in the upper and middle portions of the Santa Fe Group. In the study area, the Santa Fe Group consists primarily of discontinuous layers of gravels, sands, silts, and clays. Sandy units, including ancestral Rio Grande channel deposits, predominate in the saturated portions of the upper and middle Santa Fe Group beneath the BFF Sill Site (Hawley and Haase, 1992). These channel deposits may provide preferential groundwater flow paths that could help determine the flow path of the BFF groundwater plume. Significant thicknesses of continuous and less permeable units are present in the unsaturated zone.

The Upper Santa Fe (USF) has been mapped as two depositional facies called the USF-1 and USF-2, which include the sediments of the unsaturated zone, and the upper portions of the groundwater aquifer in the study area (Hawley et al., 1994). According to recent lithologic logs of the area, the USF-1 and the transition zone between the USF-1 and USF-2 units include interbedded low-permeability silts and clays and higher permeability sandy units to depths of approximately 110 and 170 ft below ground surface (bgs) (USAF, 2013). The water table is present in the USF-2 unit which is dominated by permeable well-graded and poorly-graded sand units. Low-permeability silts, silty sands, and clayey sands are thin and discontinuous in the upper portions of the groundwater aquifer.

2.2 Hydrogeology

The regional groundwater aquifer extends across the Albuquerque Basin and includes the area of the BFF spill site. The regional aquifer has a long history of domestic, agricultural, and municipal use and domestic and municipal water supply wells are located near the BFF spill site. The regional aquifer is an unconfined alluvial aquifer of relatively high yield and good water quality. The aquifer is interconnected with the Rio Grande surface water to the west and is bounded to the east by faults and less permeable bedrock. Recharge to the aquifer occurs primarily from the Rio Grande surface water and from infiltration of precipitation along the mountain front.

Prior to significant groundwater development in the Albuquerque Basin, groundwater flowed from the mountain front recharge areas to the west and southwest toward the Rio Grande. Significant groundwater development in the Albuquerque Basin occurred from the 1960s through the 1980s and groundwater flow directions shifted toward the pumping centers (Bexfield and Anderholm, 2002). Today, groundwater flow in the area of the BFF spill site is toward the northeast (USAF, 2013).

The groundwater table is relatively flat except in areas of extensive pumping or adjacent to fault zones. According to recent monitoring data, the elevation of the water table is between 4,840 and 4,920 above mean sea level across the BFF spill site and areas to the east (USAF, 2013). Although the water table is relatively flat, the depth to water varies considerably due to the variability in surface topography. In general, the depth to water increases eastwards as the land rises from the Rio Grande and distance from the Rio Grande increases. Depth to water is typically less than 50 ft bgs in downtown Albuquerque, west of the BFF sill site (CH2MHILL, 2012) while depths to water can exceed 700 ft bgs east of the BFF spill site and adjacent to fault zones near the mountains (USAF, 2011a). In the areas affected by the BFF spill, depths to groundwater typically range from 440 to 515 ft bgs (USAF, 2013). Historical depth to water measurement data indicate that the water table has declined approximately 120 to 140 ft in this region of the Albuquerque Basin since 1949 due to groundwater pumping. Since 2009, the water table has risen in the BFF monitoring well field between 4 and 8 ft; this trend is attributed to conservation practices implemented by the City of Albuquerque and the use of surface water for the San Juan-Chama Diversion Project completed in December 2008 (USAF, 2013).

The local groundwater flow direction has been mapped using monitoring wells located throughout the BFF spill site and adjacent areas. The current flow direction is to the north-northeast with gradients ranging from 0.004 to 0.0003 ft per ft (USAF, 2013; USAF, 2011a). Groundwater flow direction in the BFF spill site area is heavily influenced by current and recent historical pumping in Kirtland AFB and Water Authority well fields.

Upper portions of the Albuquerque Basin aquifer that are commonly used for water production occur primarily in the upper 500 to 800 ft of saturated zone and occur primarily within the USF-2 of the Santa Fe Group. No continuous low-permeability units that act as significant barriers to horizontal or vertical groundwater flow have been identified in the area affected by the BFF spill. No aquitards have been identified from local boring logs that may act as confining units or barriers between the upper aquifer and lower aquifer units. Local clay and silt deposits have been documented in individual well borings, but have not been mapped across large areas. Based upon available aquifer testing data from Kirtland AFB production wells, hydraulic conductivity values for the upper 500 ft of the Albuquerque Basin aquifer range from 1.5 to 28 ft per day (ft/day). Slug test data from the Water Authority production wells indicate that hydraulic conductivities range from 40 to 200 ft/day (Shean, 2013). Hydraulic conductivities have also been calculated based upon sediment sample permeability testing, with median values of approximately 13 ft/day (USAF, 2013).

The quality of the regional aquifer groundwater is generally good across the Albuquerque Basin. Concentrations of naturally occurring inorganic constituents are generally less than drinking water standards and are consistent with natural conditions. Arsenic can be present at concentrations that exceed drinking water standards due to the presence of volcanic deposits within the Albuquerque Basin. Water quality in the area of the BFF spill site has been affected by fuel-related organic compounds. Additional information on water quality is presented below.

2.3 Groundwater Contamination and Presence of Ethylene Dibromide

Groundwater resources in the northern portion of Kirtland AFB and directly north in southeast Albuquerque have been affected by fuel releases from the BFF. Fuel was released from underground piping at the former off-loading rack until the leak was detected in 1999 and the pipeline and off-loading rack were removed from service. Fuel releases may have occurred from 1953 when the fuel system was constructed, until the releases were detected and stopped in 1999. Fuel released from the BFF spill site may include leaded aviation fuel, JP4, JP8, diesel fuel, and unleaded gasoline. Although the releases have ceased, there continue to be significant quantities of fuel in soils above the groundwater table that may continue to move downward towards groundwater unless intercepted by soil vapor extraction systems installed at the BFF spill site. Fuel contamination is present in unsaturated soils directly beneath and north of the BFF within Kirtland AFB. Fuel contamination is also present as a groundwater plume that extends north-northeast and northeast of the boundaries of Kirtland AFB and beneath the City of Albuquerque (USAF, 2013).

Fuel contamination is currently present as NAPL near the groundwater table and as chemicals dissolved in the upper portions of the regional groundwater aquifer. The NAPLs were previously detected as a plume floating upon the groundwater table extending approximately 1,100 ft north-northeast of the Kirtland AFB boundary. Quarterly monitoring did not indicate that there was significant movement of the NAPL plume downgradient (USAF, 2011b). However, seasonal changes in the groundwater table elevation interfered with the detection of the NAPL. More recently, the 4 to 8 ft rise in the groundwater table has submerged most of the NAPL plume such that it is no longer clearly discernible from the dissolved plume (USAF, 2013). The NAPL contamination continues to act as a source for dissolved phase contamination.

A number of organic compounds have been detected in the dissolved portion of the fuel plume. The most significant of the detected compounds are EDB and benzene due to their chemical properties. The chemical EDB is a volatile organic compound (VOC) used as an anti-knock fuel additive and is considered highly toxic and a probable carcinogen (Hazardous Substances Data Bank [HSDB], 2013). The chemical EDB is highly soluble and does not readily degrade and therefore is the compound most likely to affect water quality at water supply wells (HSDB, 2013). Benzene is a VOC that occurs naturally in petroleum. Benzene is also a highly toxic compound that can act as a neurotoxin, and a carcinogen (HSDB, 2013). Benzene is similar to most organic compounds present in petroleum fuels in that it degrades naturally in the presence of oxygen-rich (aerobic) waters.

The most recent mapped dissolved groundwater plume extends from the BFF area north-northeast in the direction of Kirtland AFB and Water Authority water supply wells, but has not affected water quality at any public water supply well. Groundwater monitoring data from recent years indicate that fuel compounds subject to natural degradation continue to be detected in the same areas, and these constituents of the plume are not migrating closer to water supply wells (USAF, 2011b; USAF, 2013). Although the delineation of the dissolved fuel plume continues to be refined with the installation of additional monitoring wells, the overall pattern of detections for total petroleum hydrocarbons (TPH) and the VOC compounds benzene, toluene, ethylbenzene and xylenes (BTEX) does not indicate continued migration of these compounds beyond current plume boundaries at concentrations above regulatory standards. Currently TPH is detected roughly 3,700 ft north of the BFF (just north of Gibson Street SE) and benzene is detected 2,500 ft north of the BFF (south of Ridgecrest Drive SE) at concentrations above the regulatory standard (U.S. Environmental Protection Agency [EPA] maximum contaminant level [MCL] of 5 micrograms per liter [µg/L]) (USAF, 2013). These detections occur in shallow groundwater within the upper 30 to 40 ft of the aquifer at depths ranging from 470 to 510 ft bgs (USAF, 2013).

Unlike contaminant compounds susceptible to natural degradation processes, EDB appears to be migrating towards downgradient water supply wells (USAF, 2013). The patterns of detections for EDB indicate that this compound is the primary concern for water quality at Kirtland AFB and Water Authority supply wells (USAF, 2011b; USAF, 2013) in part due to its high toxicity and limited natural degradation. The compound EDB is the contaminant most likely to reach downgradient water supply wells first. In 2013, the EDB plume was mapped within 2,000 ft of the nearest water supply well, and concentrations have increased at some downgradient monitoring wells (USAF, 2013).

2.3.1 Fuel Contamination in the Area of Veteran's Affairs Hospital Water Supply Well

Fuel compounds, including EDB and benzene, have been detected at concentrations above regulatory standards in groundwater approximately 800 ft east of the VA Hospital water supply well. This water supply well is closest to the dissolved phase plume from the BFF spill site. Although the proximity of this well to the BFF plume puts the water quality at risk, the groundwater flow pattern indicates contaminants are not currently migrating towards the VA water supply well. Fuel compounds, including EDB, have not been detected in the well; this well is sampled on a monthly basis.

2.3.2 Fuel Contamination in the Area of Water Authority Water Supply Wells

There are two downgradient Water Authority supply wells located approximately 4,400 and 5,000 ft northeast of the leading edge of the EDB plume. EDB has not been detected in any of the Water Authority supply wells.

Other fuel compounds, such as benzene, have not migrated as far from the BFF spill site as EDB. The larger distance of these compounds from nearest downgradient Water Authority supply wells allows for a large amount of dilution and time for degradation within the aquifer. Therefore, most BFF contaminant compounds have not been observed to continue to migrate beyond the current extent of the plume at concentrations above regulatory limits (USAF, 2013).

2.3.3 Fuel Contamination in the Area of Kirtland Air Force Base Water Supply Wells

Two Kirtland AFB water supply wells are located on the east and west sides of the dissolved phase fuel plume and one water supply well is located in the downgradient direction of the dissolved phase fuel plume.

Fuel contaminants, including EDB and benzene, are detected within 2,300 ft of the water supply wells located on the east and west sides of the plume. Water quality at these wells is at risk due to the proximity of the plume, however, the groundwater flow directions and recent monitoring data do not indicate that contaminants are currently migrating towards these wells. Fuel-plume contaminants have not been detected in these wells, which are sampled on a monthly basis.

The Kirtland AFB supply well located downgradient of the dissolved phase fuel plume is at greater risk of water quality effects by EDB due to the well's proximity to the leading edge of the EDB plume. The downgradient edge of the EDB plume is currently detected within approximately 2,000 ft of the water supply well. Monitoring data indicate that EDB continues to move downgradient in the direction of this well (USAF, 2013). Fuel-plume contaminants have not been detected in this well, which is sampled on a monthly basis.

2.4 Kirtland Air Force Base Groundwater Use

The drinking water for Kirtland AFB is pumped from Santa Fe Group sediments in the Albuquerque Basin regional aquifer. Kirtland AFB draws its water from six different wells installed within the boundaries of the base. Groundwater is pumped to a storage tank for distribution throughout Kirtland AFB. The Kirtland AFB water supply system is also connected to the Water Authority supply system and is able to purchase water from the Water Authority, if necessary. Water from the Kirtland AFB water supply wells is of generally good quality.

Kirtland AFB produces roughly 800 million gallons of drinking water per year from their water supply well network. The northwest and north central areas of Kirtland AFB are the most heavily populated areas and contain a majority of water supply wells. The total combined water production from all currently active wells ranged from 750 to 800 million gallons annually between 2008 and 2012. Kirtland AFB has maintained six production wells since 2008 (KAFB, 2013a). Three water supply wells are located in the northwest portion of Kirtland AFB, and are at risk of being affected by BFF contaminants. The three remaining water supply wells are located in the north-central, central, and far northwest portions of the installation, and are of sufficient distance from the BFF plume to indicate that potential risks are minimal.

The Kirtland AFB water supply can be supplemented from the Water Authority supply system. There are multiple connections to the Water Authority distribution system at Kirtland AFB. Water can be purchased in case of a supply failure or to supplement the distribution system during peak usage. Kirtland AFB has not purchased more than one million gallons of water in any year since 2004 (KAFB, 2013a).

Groundwater quality at Kirtland AFB water supply wells is generally of good quality and production capacity if relatively high (KAFB, 2013a; KAFB, 2013b). Organic contaminants have not been detected above regulatory levels at water supply wells. Naturally occurring in-organic chemicals are routinely detected at concentrations below regulatory levels. Elevated arsenic concentrations have been detected from some wells. The overall concentrations of regulated constituents in the blended water supplied to the Kirtland AFB distribution system meets all drinking water regulatory standards (KAFB, 2013b).

2.5 Veteran's Affairs Hospital Groundwater Use

The VA Hospital is located directly north of Kirtland AFB and north-northwest of the BFF spill site. Water supply is provided across the hospital complex and grounds from one well and is used for various purposes including drinking water and irrigation. The well has good production capacity and water from the well meets regulatory standards. The VA Hospital water supply also can be supplemented from the Water Authority distribution system, if necessary.

The VA water supply well provides most of the water needs of the VA Hospital complex. The well is screened in the upper portions of the Albuquerque Basin regional aquifer and produces approximately 760 gallons per minute (Martinez, 2013). Monthly pumping rates range from 1.9 to 10.2 million gallons and fluctuate seasonally, with highest usage occurring in the summer months (Martinez, 2013). Water is pumped to a water tower on site and is gravity fed to all buildings and water systems in the hospital complex. The production well has provided for all water supplies to the VA Hospital over the last three years except during a short period in March and April of 2011.

2.6 Water Authority Groundwater Use

The Water Authority provides the water supply for much of the Albuquerque Metropolitan area. The distribution network covers much of the urbanized areas south of the Bernalillo/Sandoval county line, west of the Sandia Mountains, and north and west of Kirtland AFB. Water is supplied from Rio Grande surface water and Albuquerque Basin regional groundwater aquifer sources and distributed to an interconnected water supply system.

The Water Authority supply system is large and complex and is designed to respond to the needs of the service area. In 2012, 18.9 billion gallons of groundwater were produced from 90 water supply wells while 14.4 billion gallons of purified Rio Grande water was produced (Water Authority, 2013). The distribution network maintains pressure to the system with a series of pumps and tanks. Water is pumped to tanks at higher elevations through a series of main transmission lines referred to as trunks. The trunks are largely oriented east to west, and each trunk feeds local distribution networks. During development of the San Juan-Chama Drinking Water Project infrastructure, the east-west trunks were interconnected with north-south oriented main lines (Water Authority, 2013). The distribution system is interconnected in a manner that allows both groundwater and surface water to be provided across the Water Authority service area and for excess production capacity in one area to be moved to areas lacking in production capacity.

The Water Authority manages the supply system in 20 distribution zones. Each distribution zone includes water supply wells, one or more main trunks, storage tanks, disinfection stations, and pump stations (Figure 2-1). In some areas, water supply wells are plumbed directly into the water distribution system though most water supply wells are plumbed into large capacity holding tanks that act as reservoirs, provide centralized location for disinfection, and provide pressurized supply to local distribution networks. Pump stations are used in areas where gravity forces are insufficient to provide proper pressures to the distribution network, and to move water from well fields to holding tanks. The distribution zones are interconnected by main lines.

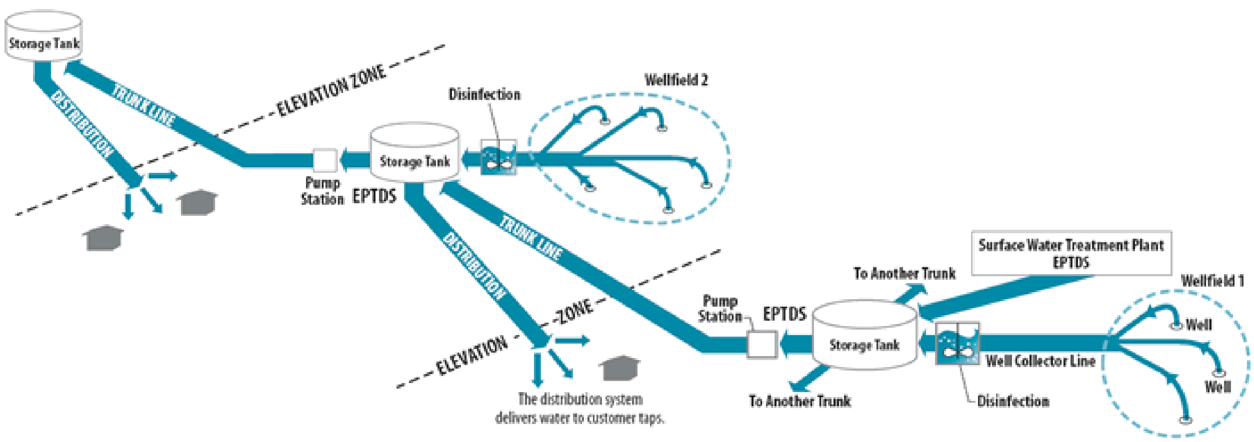

Figure 2-1. Schematic Depiction of the Water Authority Supply System

(courtesy of http://www.abcwua.org/water_quality_by_distribution_zone.aspx)

The Water Authority Distribution Zone No. 3 is located directly adjacent to the Kirtland BFF spill site, and is of particular interest in this Contingency Plan. Zone 3 extends east from the University of New Mexico area (Yale Street) towards the Four Hills area (Tramway Boulevard) and lies largely between Central Avenue and the northern boundary of Kirtland AFB (Figure 2-2). According to 2010 U. S. Census data, Zone 3 provides water to roughly 75,000 people in southeast Albuquerque. There are 13 active water supply wells in Zone 3, including three wells in the Lomas Well Field, five wells in the Burton Well Field, and five wells in the Ridgecrest Well Field. Wells are screened in the upper portions of the Albuquerque Basin regional aquifer from 360 to 1,690 ft bgs. Recent production rates generally ranged from 65 to 350 million gallons per well per year from the Lomas Well Field, from 150 to 870 million gallons per well per year in the Burton Well Field, and from 120 to 860 million gallons per well per year from the Ridgecrest Well Field. Total production from Zone 3 ranged between 3.7 and 6.6 billion gallons from 2008 to 2012.

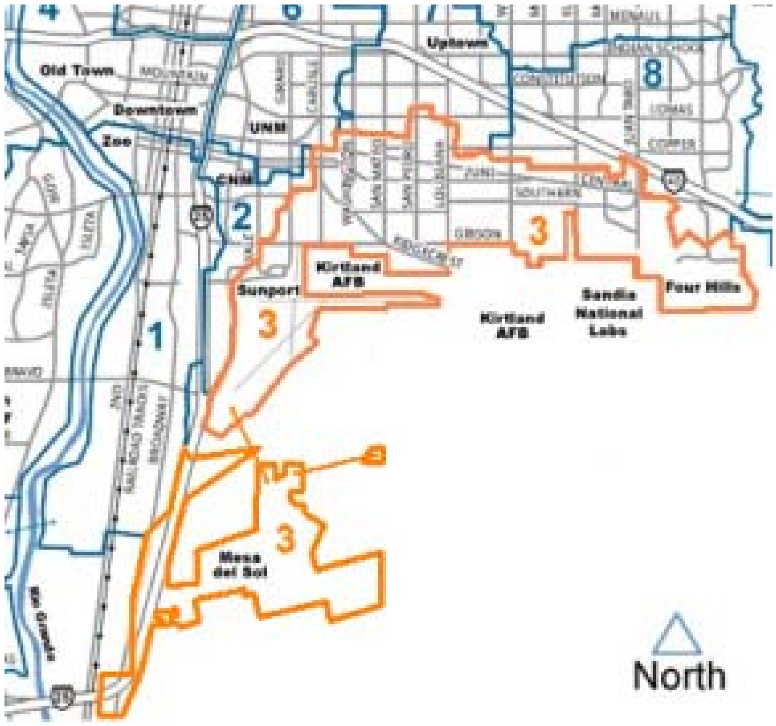

Figure 2-2. Water Authority System Distribution Zones

(courtesy of http://www.abcwua.org/water_quality_by_distribution_zone.aspx)

Water quality in Zone 3 meets all drinking water regulations. No organic compounds have been detected above regulatory standards, and naturally occurring inorganic compounds have been detected at relatively low concentrations. Arsenic has been detected at concentrations between 2 and 5 µg/L in Zone 3 wells in 2012 samples. The EPA MCL for arsenic in drinking water is 10 µg/L. Nitrate concentrations ranged from non-detected to 0.3 milligrams per liter (mg/L), with average concentrations of 0.2 mg/L. Nitrate concentrations were far below the EPA MCL of 10 mg/L. Total dissolved solids were detected at concentrations between 238 and 300 mg/L, below the 500 mg/L New Mexico drinking water standard (Water Authority, 2013).

There are three Water Authority water supply wells located within approximately one mile radius of the BFF dissolved phase fuel plume. One groundwater well within the Burton Well Field is located to the northwest and is not downgradient of the BFF dissolved phase fuel plume. This well produced approximately 512 million gallons of groundwater in 2012. Two groundwater wells within the Ridgecrest Well Field are located northeast of the plume and are in the downgradient direction. These wells produced 206 and 476 million gallons of groundwater in 2012. These wells have the greatest potential risk for contamination from the BFF spill site due to their proximity to the leading edge of the EDB groundwater plume and groundwater flow direction.

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3.0 GROUNDWATER MODELING

Groundwater modeling can provide estimates of potential future contaminant migration paths and travel times for the groundwater contaminant EDB released in the past from the BFF spill site. Of particular interest are possible effects on downgradient public water supply wells belonging to Kirtland AFB, the Water Authority, and the VA. The modeling results provide an estimate of which public water supply wells may be at risk and how long the leading edge of the EDB plume may take to reach those wells. The simulations modeled are described in further detail in Appendix B.

3.1 Modeling Approach

A transient groundwater flow model and particle tracking were used to simulate the past, present, and potential future migration of EDB. The modeling approach included the following:

- Updating the existing United States Geological Survey (USGS) calibrated Middle Rio Grande Basin (MRGB) groundwater flow model (Bexfield et al, 2011) with Water Authority and Kirtland AFB pumping rates from the winter of 2008 through the summer of 2012.
- Generating particle tracks from the EDB plume source area at the BFF off-loading rack from the estimated EDB release date to groundwater through the summer of 2012.
- Comparing the predicted particle tracks and groundwater levels to the three-dimensional (3-D) distribution of EDB and groundwater levels measured in 2012.
- Calibrating the model so that simulated particle tracks and groundwater elevations more closely match the real-world measured distribution of EDB and measured groundwater elevations.
- Selecting three different scenarios to apply to future groundwater pumping rates based on current pumping rate, and.
- Modeling future particle tracks to predict the travel of EDB through 2054.

3.2 Model Description

The starting point for this modeling task is the calibrated MODFLOW-2005 (Harbaugh, 2005) MRGB groundwater flow model. The model code was provided to CH2M HILL by the USGS on July 11, 2013. This model is described in "*Hydrogeologic Setting and Groundwater Flow Simulation of the Middle Rio Grande Basin Regional Study Area, New Mexico, section 2 of Eberts, S.M., ed., Hydrologic settings and groundwater flow simulations for regional investigations of the transport of anthropogenic and natural contaminants to public-supply wells – Investigations begun in 2004*" (Bexfield, L.M., Heywood, C.E., Kauffman, L. J., Rattray, G.W., and Vogler, E.T., 2011). This model will be called the USGS-2011 model for purposes of this Contingency Plan.

The model domain is bounded on the eastern and western sides by normal faults that are thought to form distinct hydrologic boundaries. The northern and southern boundaries correspond to the MRGB boundaries located at Cochiti Lake and San Acacia, respectively. The model domain incorporates the Cenozoic Rio Grande Rift deposits, which range in thickness from 13 ft on the basin margins to approximately 17,300 ft in the deepest parts of the basin, and includes the Santa Fe Group aquifer system. The bottom of the model domain is pre-Santa Fe Group basement rock. The finite-difference model grid is comprised of 9 layers, each containing 312 rows and 160 columns of approximately 1640 ft by 1640 ft cells. Seasonal stress periods used after January 1, 1990, simulate both irrigation seasons that extend from March 16 through October 31 and non-irrigation seasons that extend from November 1 through March 15.

The hydrologic environment in the vicinity of the BFF is complex and dynamic primarily due to the evolving pumping stresses applied to the aquifer from the Water Authority well fields and the Kirtland AFB production wells. From 1900 to the summer of 2008, the simulated water table drops approximately 106 ft in the vicinity of the BFF spill site, and then rises approximately 24 ft by the summer of 2054. The simulated groundwater flow direction reverses from the southwest down the valley and toward the Rio Grande in 1900 to toward the northeast and the center of pumping in the Ridgecrest well field by the mid-1990s.

The BFF spill site is located in the vicinity of a transient groundwater divide that develops between the Water Authority Burton and Ridgecrest well fields. The east-west location of the divide determines if simulated particle tracks migrate more toward Ridgecrest W-5 and Burton W-5, or more toward KAFB-3 and Ridgecrest W-3. The location of the groundwater divide over time is sensitive to the chosen groundwater flow model parameters such as hydraulic conductivity, and horizontal and vertical anisotropy.

As a contaminant, EDB is well suited to a particle tracking advective type of analysis, particularly when the purpose of the analysis is to estimate flow path and time of arrival. EDB is not easily degraded and is only slightly retarded making it a conservative tracer of groundwater flow. Due to the complex and dynamic nature of the groundwater flow field, a particle tracking analysis is warranted and gives results with an appropriate level of confidence. A contaminant transport analysis including hydrodynamic dispersion, retardation and degradation would give little added benefit and would introduce more uncertainty into the analysis due to the uncertainty in the chosen contaminant transport parameters.

The model was updated with actual Water Authority and Kirtland AFB pumping rates from the summer and winter seasons of 2008 through the summer of 2012. All other model input parameters such as pumping rates for commercial and domestic wells, and the recharge, evapotranspiration, river, and drain packages were updated by copying forward the summer and winter seasons of 2008.

3.3 Model Refinement

A comparison of the particle tracks and groundwater levels predicted by the updated USGS-2011 model to the 3-D distribution of EDB and groundwater levels measured in 2012 illustrated several areas where modifications should be made so that modeled results more closely matched real-world measurements. The following areas were identified:

- The predicted particle tracks veered too far to the west and didn’t extend far enough downgradient when compared to the current extent of the EDB plume.
- The predicted particle tracks remain approximately 18-ft too shallow when compared to the deepest 2012 EDB detections at the BFF spill site.
- The predicted groundwater levels were approximately 2 to 10 ft below the measured water levels and the hydraulic gradient toward the ease was too steep.

The following adjustments were made to the USGS-2011 model so that simulated particle tracks and groundwater elevations more closely matched the measured distribution of EDB and measured groundwater elevations:

- The extent of the axial channel deposits was increased to the east to include model rows which include the BFF, the conductivity was increased in that portion of the model, and
- Vertical anisotropy, specific yield, and aquifer recharge from City of Albuquerque water and sewer system were decreased for limited portions of the model that include the BFF.

These changes resulted in improvements to the particle tracks and predicted water levels when compared to site conditions. The particle tracks migrate more toward the northeast and less toward the northwest and the particle tracks migrate further and deeper within the aquifer. The summer 2012 simulated water levels also more closely match the summer 2012 measured water levels. Comparisons of the predicted particle tracks to the 3-D distribution of EDB and predicted water levels to measured water levels show that the tracks and water levels are in better agreement as of the summer of 2012 because of these changes. The resulting new model is referred to in this plan as the modified USGS-2011 model.

3.4 Model Simulations

With the simulated 2012 particle tracks comparing well to the boundary of the 2012 3-D distribution of EDB, the modified USGS-2011 model was used to predict future possible EDB plume migration. As a sensitivity analysis, three different pumping scenarios were developed to simulate the future migration of the EDB plume. The scenarios are 1) a 3-year average of actual pumping rates from 2010, 2011, and 2012, 2) drought conditions based on actual pumping rates from July 2012 through June 2013, and 3) a conservative higher pumping rate where actual irrigation-season 2013 pumping rates are applied to year around pumping. Pumping rates for each scenario are calculated based on all groundwater production wells operated by the Water Authority and Kirtland AFB. Pumping rates are broken down into two seasons: 1) the irrigation season from March 16 through October 31 of each year and 2) the non-irrigation season from November 1 through March 15 of each year (Table 3-1). A graph of relative pumping rates is shown in Figure 3-1.

Table 3-1. Future Groundwater Pumping Scenarios

Groundwater Pumping Scenario	**Season**	
	Irrigation Season March 16 – October 31	Non-Irrigation Season November 1 – March 15
3-Year Average	Average Water Authority and Kirtland AFB pumping rates, measured for each well, during the irrigation seasons of 2010, 2011, and 2012	Average Water Authority and Kirtland AFB pumping rates, measured for each well, during the non-irrigation seasons of 2010, 2011, and 2012
Drought Conditions	Actual Water Authority and Kirtland AFB pumping rates, measured for each well, during the irrigation seasons for 2012 and 2013	Actual Water Authority and Kirtland AFB pumping rates, measured for each well, during the non-irrigation seasons for 2012 and 2013
Year Around Pumping	Actual Water Authority and Kirtland AFB pumping rates, measured for each well, during the irrigation seasons of 2012 and 2013	

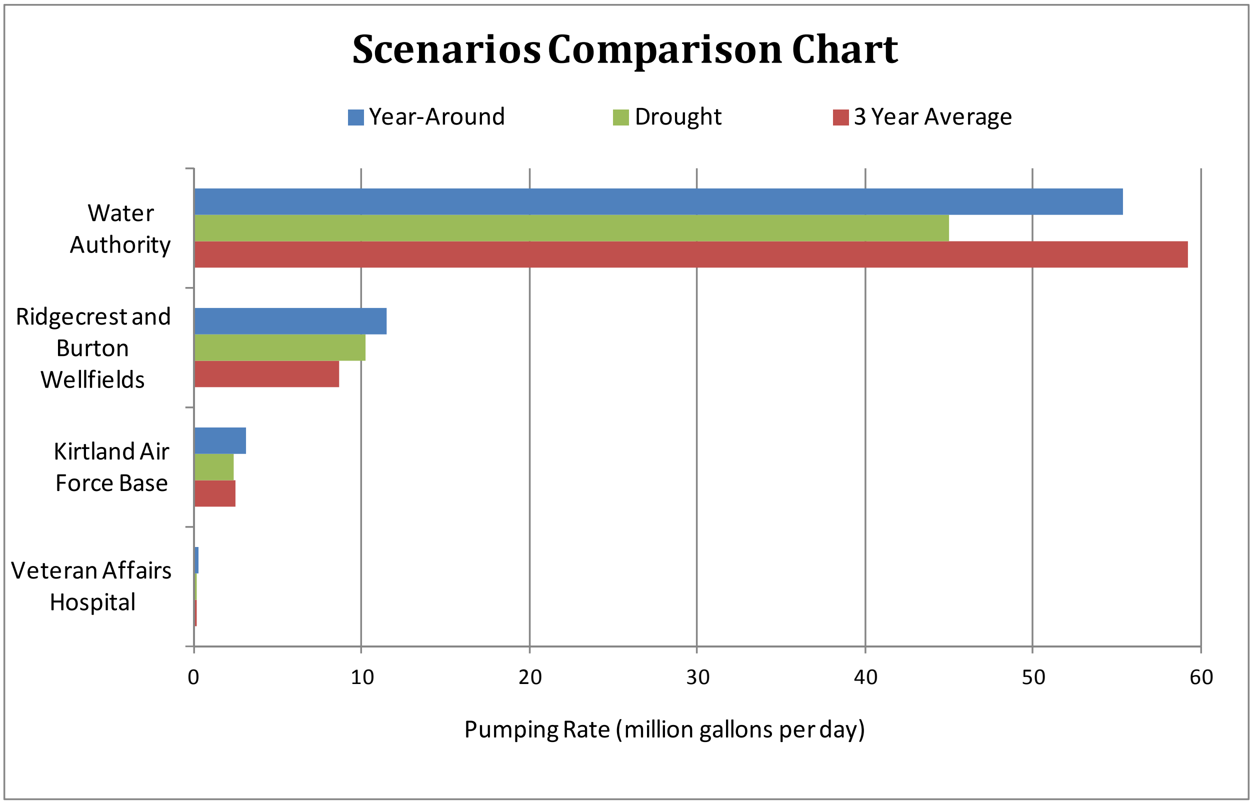

Figure 3-1. Pumping Scenarios Comparison Chart for Water Authority, Kirtland Air Force Base, and Veteran's Administration Production Wells

3.5 Model Simulation Results

The model simulation results indicate that EDB plume migration is expected to be heavily influenced by the pumping stress from Kirtland AFB and Water Authority production wells. Based on the modeling results for each scenario, the EDB plume is predicted to first reach the vicinity of KAFB-3 in approximately 11 to 15 years (2024 to 2028). If production well KAFB-3 does not fully intercept the EDB plume, the plume is predicted to continue to migrate toward two Water Authority wells (Ridgecrest W-3 and Ridgecrest W-5) in approximately 27 to 41 years (Table 3-2). Figures 3-2, 3-3, and 3-4 show predicted EDB plume migration based on particle tracks generated for the three groundwater pumping scenarios.

Comparison of the simulated particle migration tracks produced by the three pumping scenarios shows that there is enough uncertainty in the modified USGS-2011 groundwater flow model that it should be assumed that Water Authority production wells Ridgecrest W-3 and Ridgecrest W-5 may both be potential downgradient EDB plume receptors in addition to Kirtland AFB production well KAFB-3. The hydrologic environment in the vicinity of the BFF spill site is complex and dynamic, and any predictions of potential production well impacts should be treated as estimations. For the purposes of this Contingency Plan, it is assumed that EDB may reach production wells KAFB-3, Ridgecrest W-3, and Ridgecrest W-5 in the future.

Table 3-2. Estimated Year of Impact to Drinking Water Production Wells for Each Groundwater Pumping Scenario

Groundwater Pumping Scenario	Estimated Year of Impact for Drinking Water Production Wells		
	KAFB-3	**Ridgecrest W-3**	**Ridgecrest W-5**
3-Year Average	2028-2036	2054	NA
Drought Conditions	2028-2036	NA	2054
Year Around Pumping	2024-2032	NA	2040-2042

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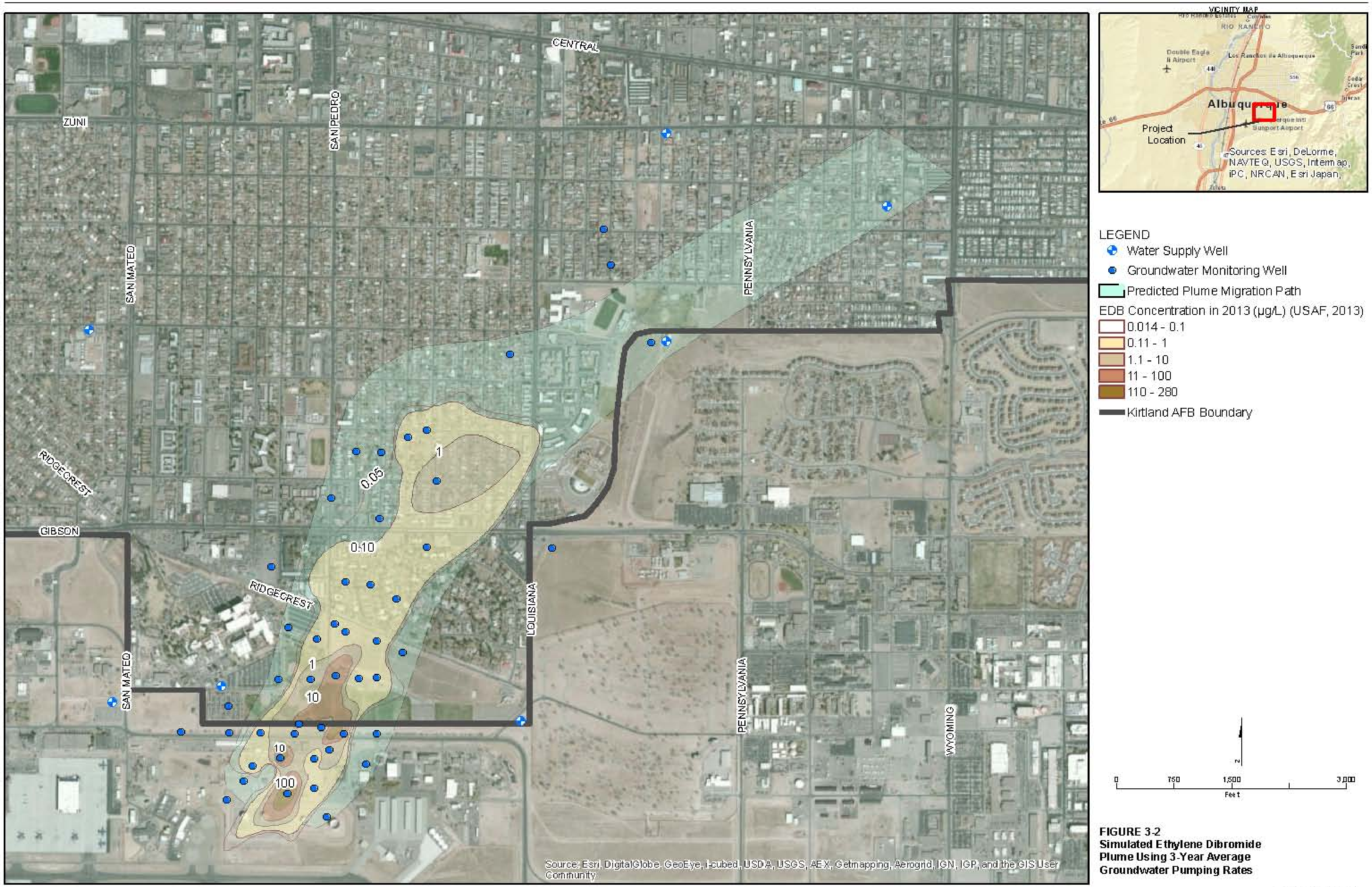

FIGURE 3-2
Simulated Ethylene Dibromide Plume Using 3-Year Average Groundwater Pumping Rates

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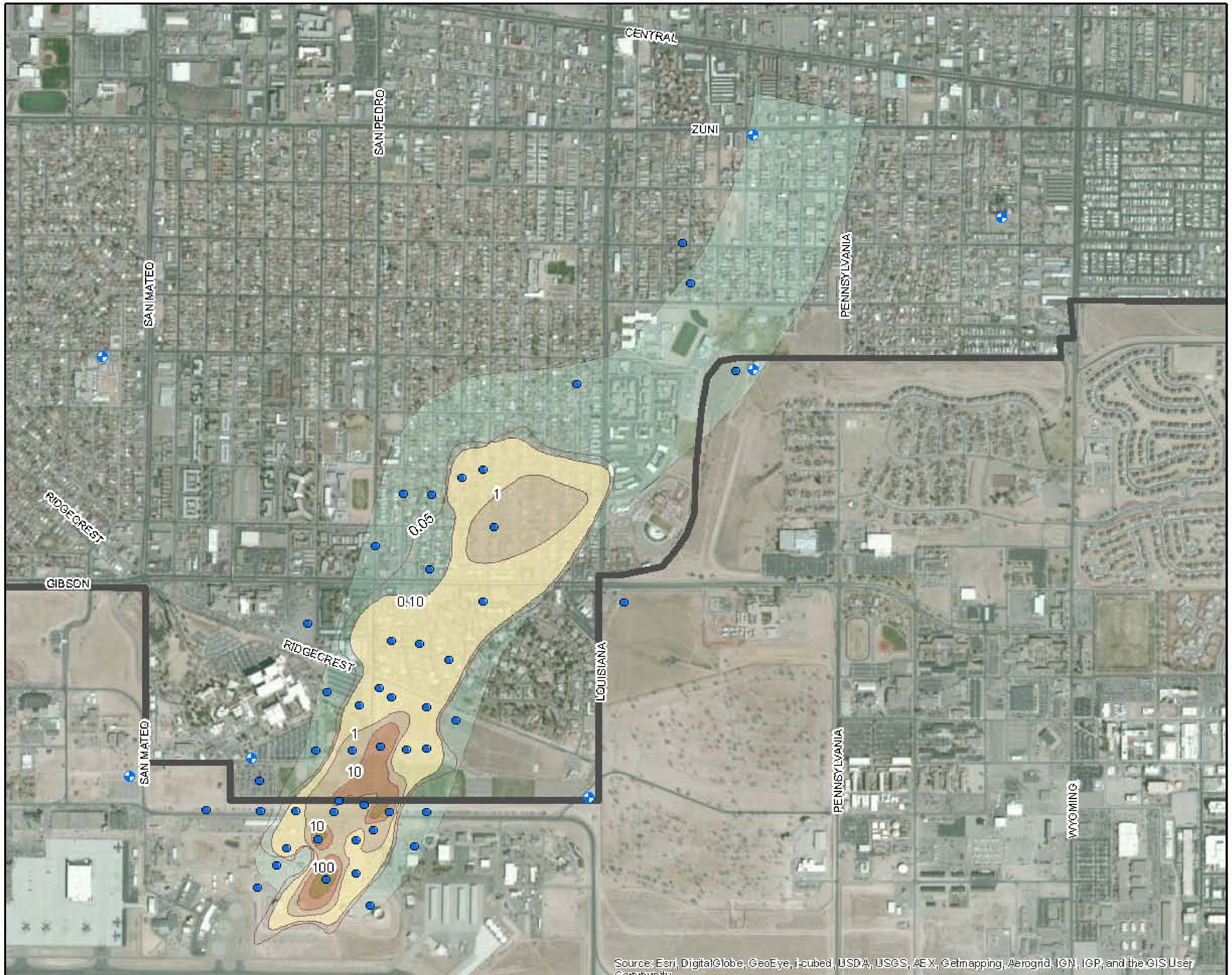

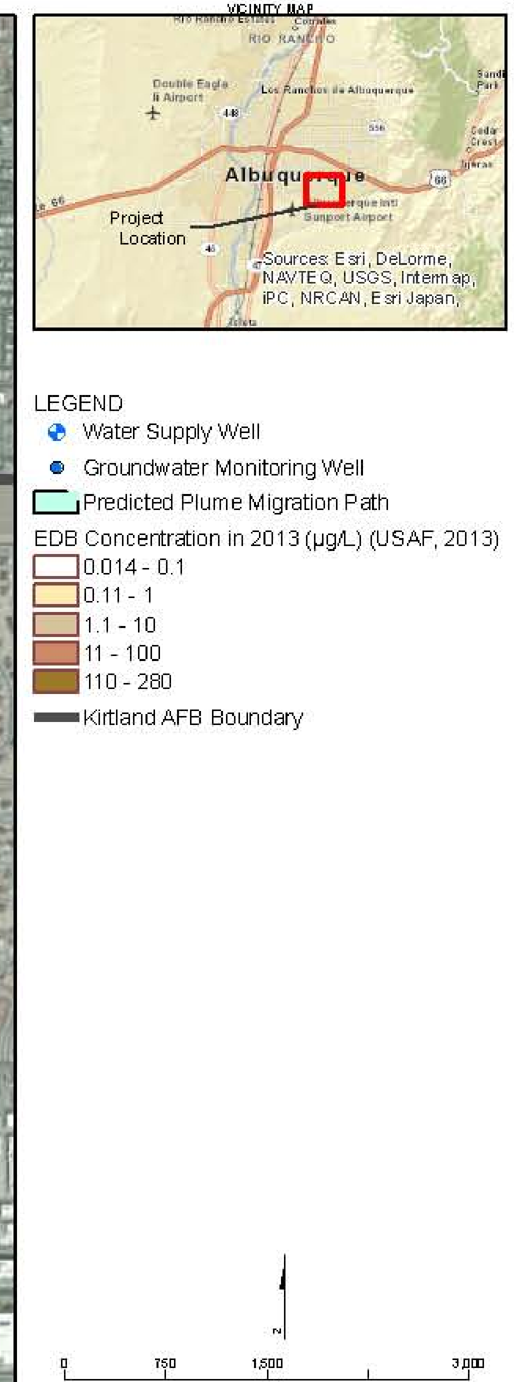

FIGURE 3-3
Simulated Ethylene Dibromide Plume Using Drought Conditions Groundwater Pumping Rates

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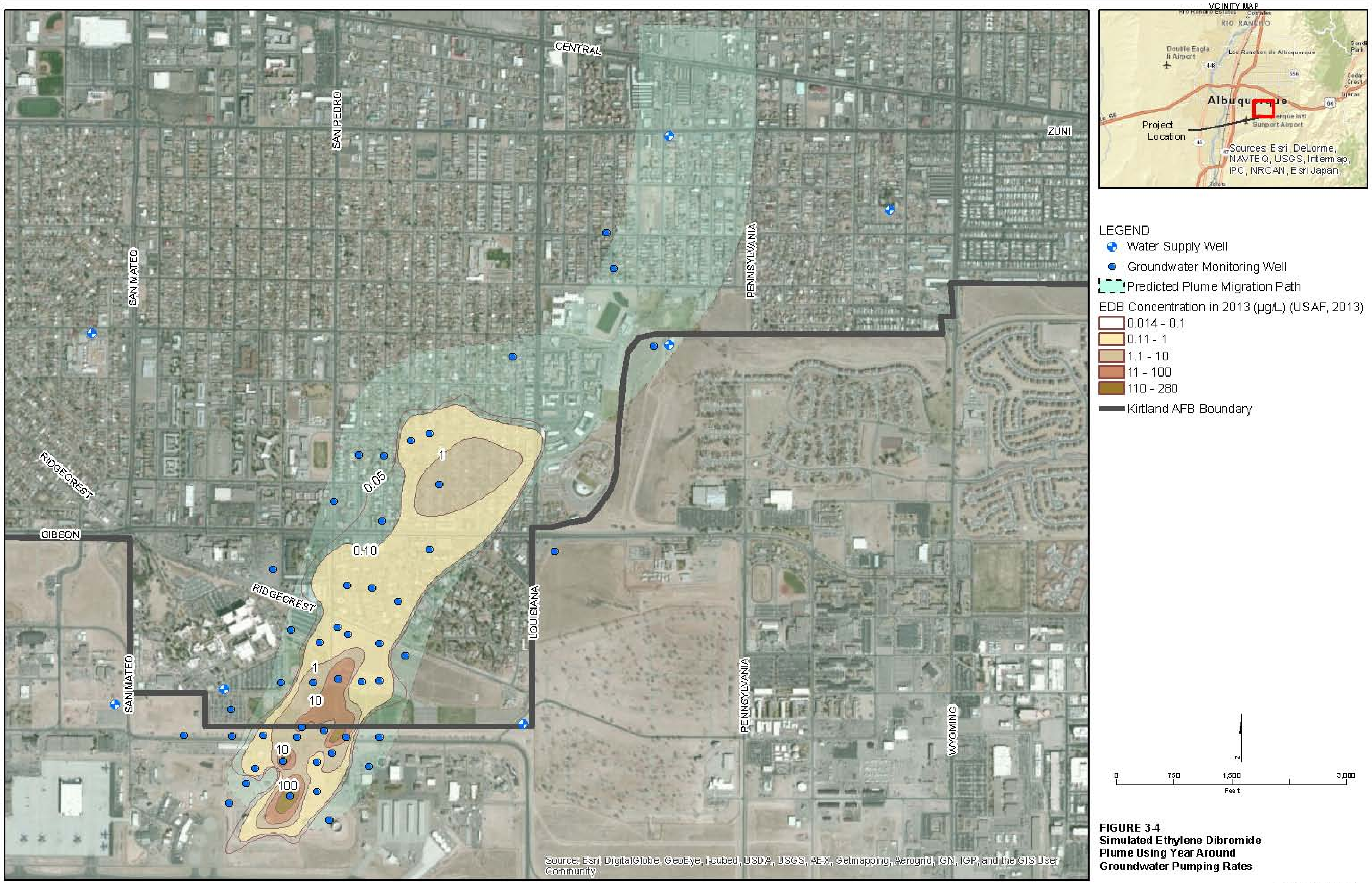

FIGURE 3-4
Simulated Ethylene Dibromide Plume Using Year Around Groundwater Pumping Rates

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4.0 CONTINGENCIES

This Contingency Plan was developed with input from the Water Authority, Kirtland AFB, and the USGS. Potential contingencies were discussed between CH2M HILL, Kirtland AFB, and the Water Authority prior to beginning preparation of the Contingency Plan.

This Contingency Plan addresses the contingencies that can be implemented for Water Authority groundwater production wells. The VA is preparing a Source Water Protection Plan with support from the New Mexico Environment Department (NMED) Source Water Protection Program. The VA Source Water Protection Plan will evaluate contingencies that meet their drinking water needs and may include using water supplied by the Water Authority or Kirtland AFB, installation of groundwater production wells away from potential contamination, and treatment of contaminated groundwater. The Bioenvironmental Engineering group at Kirtland AFB developed a Contingency Plan for production wells at the base. The Kirtland AFB Contingency Plan includes using water supplied by the Water Authority, installation of groundwater production wells away from potential contamination, and treatment of contaminated groundwater. The plans prepared by the VA and Kirtland AFB are incorporated by reference into this plan.

4.1 Contingency Descriptions

This plan evaluates two types of contingencies for the Water Authority production wells: 1) continued use of affected wells with wellhead treatment or blending, and 2) replacement of the lost production capacity with other drinking water sources. These contingencies are developed to address the possible future outcomes predicted by the conceptual site model and the groundwater modeling described in previous sections of this plan. The contingencies evaluated in this plan are:

- Wellhead treatment using carbon filtration;
- Contaminant reduction through water blending;
- Replacement groundwater production wells;
- Additional surface water diversion and treatment; and
- System operation modifications.

4.2 Evaluation Process and Criteria

Each of the contingencies is evaluated for preliminary requirements, technical requirements, environmental impacts, protection of human health, institutional requirements, and cost. The evaluation of the contingencies requires substantial value judgments, which have been vetted through the document review process by the Water Authority, Kirtland AFB, and the USGS. The evaluation criteria for the proposed contingencies are described below. Weighting of each criterion was not performed because priorities are expected to change over time. In addition, a single contingency is not selected as part of this plan for the same reason.

4.2.1 Preliminary Evaluation

All contingencies must meet the following preliminary criteria: 1) provide sufficient water to service connections, and 2) provide drinking water that meets EPA drinking water standards. Each contingency listed above meets these preliminary criteria.

4.2.2 Technical Evaluation

Technical aspects including performance, reliability, implementability, and safety are evaluated.

Performance was evaluated based on the effectiveness and useful life of the contingency. Effectiveness was evaluated in terms of the ability to perform intended functions (such as containment, diversion, or removal). The effectiveness of each contingency was estimated either through evaluating design specifications or by performance evaluation. Specific site characteristics that could potentially impede effectiveness were considered. Useful life is defined as the length of time the level of effectiveness of the contingency can be maintained. Each contingency was evaluated in terms of the projected service lives of its components.

The reliability of each contingency including operation and maintenance requirements and demonstrated reliability were evaluated. Contingencies requiring frequent or complex operation and maintenance activities were regarded as less reliable than contingencies requiring little or straightforward operation and maintenance. The demonstrated and expected reliability was determined based on the contingency being used effectively under analogous conditions; whether failure of the contingency had an immediate impact on receptors; and whether the contingency had the flexibility to deal with uncontrollable changes at the site.

Both short-term and long-term reliability were evaluated. Short term reliability is the ability of the contingency to meet basic criteria without interruption, during a short time frame (such as, 1 year), especially during construction and startup. Long-term reliability is the ability of the contingency to meet basic criteria without interruption over longer time frames (such as, 10 years), for example the possible response to long-term drought, dropping groundwater levels, or migration of groundwater contaminant plumes.

The implementability of each contingency including the relative ease of installation (constructability) and the time required to achieve a given level of response was estimated. Constructability was determined by conditions both internal and external to the site. External factors that could affect implementation include the need for special permits or agreements and equipment availability. The evaluation of time has two components that were addressed: the time it takes to implement a contingency, and the time it takes to see beneficial results. Beneficial results are defined as the reduction of contaminants to an acceptable, pre-established level (at a minimum below the EPA drinking water standard).

Each contingency was evaluated with regards to safety. This evaluation included threats to the safety of nearby communities and environments as well as those to workers during implementation. Considered factors were fire, explosion, and exposure to hazardous substances.

4.2.3 Environmental Evaluation

An evaluation of environmental conditions was performed for each contingency. The evaluation focused on the site conditions and exposure pathways addressed by each contingency. The environmental evaluation included an assessment of short-term beneficial and adverse effects of the contingency, adverse effects on environmentally sensitive areas, long-term analysis of measures to mitigate adverse effects; and sustainability. The environmental evaluation investigated the energy requirements, impacts on water resources, air emissions, impacts on land and ecosystems, and material consumption and waste generation.

4.2.4 Human Health Evaluation

Each contingency was assessed in terms of the extent to which it protects human health both during and after implementation of the contingency. The assessment describes the levels and characterizations of contaminants, possible exposure routes, and potentially affected populations.

4.2.5 Institutional Requirements

The relevant institutional needs were assessed for each contingency. Specifically, the effects of federal, state, and local environmental and public health standards, regulations, guidance, advisories, ordinances, or community relations on the design, operation, and timing of each contingency was evaluated.

4.2.6 Cost Estimates

A rough order of magnitude cost estimate of each contingency was developed. The cost estimate includes both capital and operation and maintenance costs. Capital costs include construction costs for materials, labor, and equipment required to install the contingency; site development costs including expenses associated with purchase of land or development of an existing property; buildings and services costs including utility connections. Indirect capital costs include construction supervision, drafting, and testing; administrative and technical costs necessary to obtain licenses and permits for installation and operation; and startup and shakedown costs. Operation and maintenance costs are post-construction costs necessary to ensure continued effectiveness of the contingency. The following operation and maintenance cost components were considered: labor costs for operations; maintenance materials for routine maintenance of facilities and equipment; utilities; disposal and treatment costs for waste materials, such as treatment residues; and other costs that do not fit any of the above categories.

4.3 Contingency-Specific Evaluations

In this section, each contingency is described and evaluated according to the process and criteria described above. Table 3-1 below summarizes the evaluation.

4.3.1 Wellhead Treatment using Carbon Filtration

Wellhead treatment includes the continued use of the affected well and a treatment system to remove EDB or other BFF contaminants to safe drinking water levels prior to addition of the treated drinking water to the distribution system. This contingency includes installation, operation, and maintenance of a treatment system located at the affected well. Should more than one well be affected, treatment systems could be installed at each affected well head or at the reservoir serving the affected wells. Carbon filtration is the selected treatment process.

Carbon filtration is a process that passes contaminated groundwater through granular activated carbon (GAC). The GAC adsorbs organic contaminants, including EDB and other BFF contaminants. A carbon filtration system can be designed for the required well production capacity and contaminant concentrations that will remove contaminants to below drinking water standards. Carbon filtration can be combined with air stripping technology if additional contaminant reduction is needed. Carbon filtration systems are commonly used to treat contaminated groundwater prior to use.

Performance – Wellhead treatment using carbon filtration can meet the preliminary objectives of providing sufficient water and meeting drinking water standards. The projected service life of a wellhead treatment system is 15 years before significant equipment replacement is needed. The GAC used in the treatment system is considered consumable equipment and needs to be regenerated or replaced at regularly specified intervals. Site-specific conditions, such as unusual groundwater chemistry, may make carbon filtration ineffective. Higher contaminant concentrations may require more frequent replacement of the GAC or require that air stripping technology be added to the treatment system.

Reliability – This contingency, when properly maintained, provides sufficient reliability to meet the preliminary objectives. This contingency requires regularly scheduled maintenance and monitoring of pretreatment and post-treatment water samples to confirm that the system is working efficiently. The GAC needs to be regenerated and replaced at routine intervals. Failure of this contingency (that is, overloading the GAC) could result in delivery of contaminants with concentrations in excess of the drinking water standards to drinking water customers. Such a failure would likely be short-lived as routine post-treatment sampling would identify the failure condition. To mitigate a failure, drinking water would be provided from other areas of the drinking water distribution system until this contingency could be repaired and restarted.

Implementability – This contingency can be implemented to meet the preliminary objectives. Design and construction of this contingency may take as long as three years. Beneficial results can be realized after a commissioning period estimated to be approximately one month. The treatment system footprint can be designed to fit within the available space at the individual wellhead or reservoir. Suitable construction contractors are available locally and regionally.

Safety – This contingency has safety issues related to initial construction and long-term operation, including increased vehicular traffic at the well head. Construction of the carbon filtration system will require the use of heavy equipment. Fire, explosion, and exposure to hazardous substances are not expected to be significant safety hazards associated with this contingency.

Environmental Evaluation – This contingency requires little additional on-site energy to operate, as it is primarily powered by the groundwater pump. Materials and energy requirements for initial construction are substantial, but less than other contingencies requiring construction. Additional disruption of the urban well head site is minimal. Transportation and recycling the GAC requires energy and materials, suggesting that this contingency may be less sustainable than other contingencies. However, this contingency includes the continued use of existing infrastructure that may offset some of the additional energy and material requirements.

Human Health Evaluation – Exposure (dermal contact) of site workers to contaminated groundwater and GAC could occur during initial construction and operations, including sampling of groundwater prior to treatment. Exposure of site workers can be mitigated through the use of personnel protection equipment, such as gloves and safety glasses. Exposure to the general public is unlikely.

Institutional Requirements – Implementation of this contingency would not require special permits. Treated groundwater would be required to meet all drinking water standards prior to being added to the water distribution system. Public perception may be an impediment to implementing this contingency, requiring a substantial community relations effort.

Cost – This contingency requires construction of treatment facilities at the affected wellhead or reservoir if more than one well is affected, long-term operation, long-term sampling, and ongoing costs for recycling GAC. Such facilities are expected to cost more than $1M to implement and $100K per year to operate.

4.3.2 Contaminant Reduction

The contaminant reduction contingency includes the continued use of the affected well along with transfer of drinking water from other portions of the distribution system (blending) to reduce EDB or other BFF contaminant concentrations to safe drinking water levels prior to delivery of the blended drinking water to the water distribution system. This contingency includes installation, operation, and maintenance of monitoring and metering equipment located at the affected reservoir. This contingency also includes installation of an estimated ½ mile of piping to connect the affected well to the collector lines leading to the reservoir site.

Performance – Blending of groundwater can meet the preliminary objectives of providing sufficient water and meeting drinking water standards. The projected service life of monitoring and metering equipment located at the affected reservoir is 15 years before significant equipment replacement may be needed. Underground piping is expected to have a 30-year effective lifetime. This contingency has no significant consumable equipment. This contingency may be useful for reducing other non-BFF-related contaminant concentrations, such as arsenic, produced by other wells if those wells are used for blending.

Reliability – This contingency, when properly operated provides sufficient reliability to meet the preliminary objectives. This contingency requires routine monitoring (that is, sampling of water entering and leaving the reservoir) and control to ensure that the system is meeting contaminant reduction goals. Failure of this contingency (that is, cessation of blending with continued production by the contaminated well) may result in immediate delivery of contaminants with concentrations in excess of drinking water standards to drinking water customers. Such failure would be likely short-lived as routine sampling would identify the failure condition.

Implementability – This contingency can be implemented to meet the preliminary objectives. Design and construction of this contingency may take as long as three years. Beneficial results can be realized after a commissioning period estimated to be approximately one month. The need for an underground pipeline from the affected production well to the reservoir will result in short-term disruptions to traffic during construction. Suitable construction contractors are available locally and regionally.

Safety – This contingency has safety issues related to initial construction and long-term operation, including increased vehicular traffic at the reservoir. Construction of the underground pipeline will require the use of heavy equipment. Fire, explosion, and exposure to hazardous substances are not expected to be significant safety hazards associated with this contingency.

Environmental Evaluation – This contingency requires some additional on-site energy to operate monitoring and metering equipment and valve controls. Materials and energy requirements for initial construction are substantial, primarily due to construction of the underground pipeline. Disruption of urban reservoir and wellhead sites are minimal. Temporary disruption of a public roadway during construction will be substantial, but short-lived. This contingency may be more sustainable than other contingencies because it includes the continued use of existing infrastructure.

Human Health Evaluation – Exposure (dermal contact) of site workers to contaminated groundwater could occur during initial construction and operations, including sampling of groundwater prior to blending. Exposure of site workers can be mitigated through the use of personnel protection equipment, such as gloves and safety glasses. Exposure to the general public is unlikely.

Institutional Requirements – Permits would be required for the construction of the underground pipeline connecting the affected well and reservoir. Blended water would be required to meet all drinking water standards prior to being added to the water distribution system. Public perception may be an impediment to implementing this contingency, requiring a substantial community relations effort.

Cost – This contingency requires construction of flow-control facilities at the reservoir, construction of an underground pipeline from the affected well to the reservoir, and long-term operation of monitoring and metering equipment. Such facilities are expected to cost more than $3.5M to implement and $50K per year to operate.

4.3.3 Replacement Groundwater Wells

A replacement groundwater well may be used to replace the lost production capacity at an affected well. A new production well would be installed in an area away from the BFF groundwater contamination. This contingency includes plugging and abandonment of the affected well, installation of a new groundwater production well, installation of all required pumping equipment, and connection of the well to the drinking water distribution system. It is assumed that existing cross-trunk system interconnects are sufficient to distribute drinking water to the portion of the system potentially affected by the BFF contamination so that the new groundwater wells could be installed in a different part of the system.

Performance – Replacement groundwater wells can meet the preliminary objectives of providing sufficient water and meeting drinking water standards. The projected service life of new groundwater wells, associated wellhead equipment, and pipelines is 30 years. This contingency has consumable equipment associated with operation of a drinking water production well, but these are offset by the reduction in consumables at the affected well. This contingency also may be useful for increasing the overall performance of the water distribution system by increasing production near a portion of the system that is underserved.

Reliability – This contingency provides sufficient reliability to meet the preliminary objectives. This contingency requires no additional operation or maintenance beyond standard operations of a groundwater production well. Failure of this contingency (such as, pump failure or screen collapse) may result in immediate reduction in the quantity of water available, however such failures are rare and are not more likely at the replacement well than at any other production well within the water distribution system. The fact that groundwater wells are ubiquitous across the basin points to the overall reliability of this contingency.

Implementability – This contingency can be implemented to meet the preliminary objectives. Design and construction of this contingency may take as long as five years. Beneficial results can be realized after a commissioning period estimated to be approximately one month. The facility footprint is expected to be less than ¼ acre but may require land purchase or development of a previously undeveloped site. The need for an underground pipeline from the replacement well to a reservoir will result in short-term disruptions to traffic during construction. Suitable drilling and construction contractors are available locally and regionally.

Safety – The safety issues associated with operation of this contingency are the same as operation of any other production well. There are additional safety issues related to the initial drilling and construction of the replacement well and construction of the underground pipeline. Although great strides have been made in improving safety during well drilling, this contingency has the greatest safety concerns. There are also safety issues related to the abandonment of the affected well which requires the use of heavy equipment at the wellhead site. Fire, explosion, and exposure to hazardous substances are not expected to be significant safety hazards associated with this contingency.

Environmental Evaluation – This contingency requires no additional on-site energy compared to use of the existing wells. Materials and energy requirements for initial construction of the well and pipeline are substantial. Temporary disruption of a public roadway during construction will be substantial, but short-lived. This contingency includes plugging and abandonment of the affected well, which will require some short-term energy use and disposal of the affected well as waste. This contingency could require the development of an undeveloped site for installation of the replacement well.

Human Health Evaluation – The likelihood of exposure of site workers to contaminated groundwater is reduced by site selection. Exposure to the general public is unlikely. This contingency is expected to have the least negative effects on human health.

Institutional Requirements – This contingency will require permits for the installation of the groundwater production well and construction of the underground pipeline. There may be some challenges associated with changing the point of diversion associated with a water right. This contingency is expected to have public acceptance.

Cost – This contingency requires drilling and construction of a new groundwater production well, construction of an underground pipeline from the replacement wellhead to the reservoir, and plugging and abandonment of the affected well. Such facilities are expected to cost more than $6M to implement; no additional operation costs are anticipated.

4.3.4 Additional Surface Water Diversion

Surface water may be used to replace the lost production capacity. Drinking water may be added to the drinking water distribution system by increasing the diversion and treatment of surface water. This contingency includes the plugging and abandonment of the affected well and increasing water diversion from the Rio Grande and the operation rate of the San Juan-Chama water treatment plant. It is assumed that existing cross-trunk system interconnects are sufficient to move drinking water from the drinking water plant to the portion of the system potentially affected by the BFF contamination.

Performance – Additional surface water diversion may not be able to meet the preliminary objective of providing sufficient water quantity but can meet drinking water standards. Surface water diversions are limited and are controlled by interstate stream commission rules, which include in-stream flow limitations. Naturally occurring conditions, such drought, may result in restrictions to the volume of water that may be diverted from the Rio Grande. The projected service life of this contingency is the same as the existing diversion and treatment plant.

Reliability – The reliability of this contingency may have seasonal or permit limitations. The level of additional operation and maintenance effort required by this contingency is comparable to the marginal additional diversion volume over current surface water diversion. Failure of this contingency is no more likely than failure of the surface water diversion and treatment system.

Implementability – Impediments to implementing this contingency are primarily administrative because the surface water diversion dam and water treatment plant are already in place and operating. This contingency may not be implementable to meet the preliminary objectives due to potential restriction of water diversion from the Rio Grande. As in other contingencies, it is assumed that existing cross-trunk connections are in place to facilitate distribution of sufficient water supply.

Safety – The safety issues associated with operation of this contingency are the same as operation of the existing surface water diversion and treatment plant, primarily exposure of workers to industrial environments. There are also safety issues related to the abandonment of the affected well which requires the use of heavy equipment at the wellhead site. Fire, explosion, and exposure to hazardous substances are not expected to be significant safety hazards associated with this contingency.

Environmental Evaluation – This contingency requires additional ongoing energy use at the existing surface water diversion and water treatment plant, proportional to the marginal increase in water flow at the plant. This contingency includes plugging and abandonment of the affected well, which will require some short-term energy use and disposal of the affected well as waste.

Human Health Evaluation – Human health risk is expected to be the same as is expected for the existing surface water diversion and water treatment plant. Exposure is limited to worker exposure to industrial products and equipment. This contingency is expected to have the least negative effects on human health.

Institutional Requirements – Permits would be required to expand the diversion capacity and obtain additional water rights, if needed. Because the volume of surface water diversion allowed from the Rio Grande is not controlled by the Water Authority, intuitional requirements may not be met with this contingency. There may be some challenges associated with changing the point of diversion associated with a water right.

Cost – Cost for this contingency may be substantial if additional water rights, permits, and water treatment plant expansion are required to implement this contingency. If existing water rights and treatment plant capacity are sufficient for operation of this contingency then operating and maintaining the existing surface water diversion and water treatment plant would be similar to existing costs. Plugging and abandonment of the affected well is a one-time cost. Plugging and abandonment is expected to cost approximately $150K.

4.3.5 System Operation Modifications

Existing sources of groundwater may be used to replace the lost production capacity at an affected well. This contingency includes the plugging and abandonment of the affected well and increasing the groundwater production from other wells or other well fields. No additional construction is anticipated. It is assumed that existing cross-trunk system interconnects are sufficient to move drinking water from distal parts of the system to the portion of the system potentially affected by the BFF contamination.

Performance – System operation modifications can meet the preliminary objectives providing sufficient water and meeting drinking water standards. The projected service life of this contingency is the same as continued use of groundwater production wells, associated wellhead equipment, and pipelines. This contingency has consumable equipment associated with operation of a drinking water production well, but these are offset by the reduction in consumables at the affected well.

Reliability **–** This contingency provides sufficient reliability to meet the preliminary objectives. This contingency requires no additional operation or maintenance beyond operating existing groundwater production wells. Failure of this contingency (such as, pump failure or screen collapse) may result in immediate reduction in the quantity of water available, however such failures are rare. The fact that groundwater wells are ubiquitous across the basin points to the overall reliability of this contingency.

Implementability – This contingency can be implemented to meet the preliminary objectives. Beneficial results can be realized after a planning and commissioning period estimated to be less than two months.

Safety **–** The safety issues associated with operation of this contingency are the same as with operation of other groundwater production wells. There are additional safety issues related to abandonment of the affected well.

Environmental Evaluation – This contingency requires no additional on-site energy or construction materials compared to use of the existing wells. This contingency includes plugging and abandonment of the affected well, which will require some short-term energy use and disposal of the affected well materials as waste.

Human Health Evaluation **–** Human health risk is expected to be the same as that incurred by operating other groundwater production wells (no additional risk). This contingency is expected to have the fewest negative effects on human health.

Institutional Requirements – Permits would not be required to implement this contingency. This contingency is expected to have public acceptance. There may be some challenges associated with changing the point of diversion associated with a water right.

Cost – This contingency requires no additional operation and maintenance; additional operation costs are anticipated to be negligible at the scale of this evaluation. Plugging and abandonment of the affected well is a one-time cost. Plugging and abandonment is expected to cost approximately $150K.

4.4 Summary Evaluation

The advantages and disadvantages of each contingency are tabulated below (Table 4-1). The summary evaluations are relative to each other with each criterion and no weighting of the criteria is attempted.

Table 4-1. Summary Evaluation of Contingencies

Contingency	Performance	Reliability	Implementation	Safety	Environmental	Human Health	Institutional	Cost
Wellhead Treatment	positive	positive	neutral	neutral	neutral	neutral	negative	neutral
Contaminant Reduction	neutral	neutral	neutral	neutral	positive	neutral	negative	neutral
Replacement Groundwater Well	positive	positive	neutral	negative	negative	positive	positive	negative
Additional Surface Water Diversion	negative	negative	negative	neutral	positive	positive	negative	positive
System Operation Modifications	positive	positive	positive	neutral	neutral	positive	positive	neutral

(thumbs up) = positive (thumbs down) = negative (neutral hand) = neutral

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5.0 IMPLEMENTATION

The process for implementing any contingency is intended to be protective of human health and drinking water production facilities, and to permit sufficient time implement the preferred contingency.

5.1 General Process

The general process for implementing any contingency is to:

1) Routinely monitor sentinel wells for evidence of BFF contamination;
2) Routinely reevaluate the potential risk to production wells;
3) If BFF-related contamination is found in a sentinel well, then increase monitoring frequency;
4) Select the preferred contingency; and
5) Plan and implement the final selected contingency.

5.1.1 Routine Monitoring of Sentinel Well

Routine monitoring of sentinel wells requires the drilling and construction of new groundwater wells. This Contingency Plan recommends that sentinel wells be installed upgradient of one Kirtland AFB and two Water Authority groundwater production wells. Each sentinel well location should consist of three or more screened intervals. The proposed sentinel well nests should be located a sufficient distance from a production well to provide a minimum of five to ten years of advanced warning (upgradient) of impending contamination. Recommended wells locations are shown on Figure 5-1. Recommended screen elevations are as follows:

- 4840 to 4850 feet above mean sea level (near the water table and maximum currently detected EDB concentrations);
- 4805 to 4815 feet above mean sea level (near the bottom of the predicted depth of contamination based on the groundwater modeling results; and
- 4765 to 4775 feet above mean sea level (near the top of the Water Authority production wells screened intervals).

Actual screen elevations should be evaluated for each location prior to installation of the sentinel wells.

This Contingency Plan recommends that sentinel wells along with the groundwater production wells located downgradient of the sentinel wells should be sampled on an annual basis until the data indicate that sampling should increase. Water samples should be analyzed for BFF contaminants including EDB. Low-flow and/or no-flow sampling methods are recommended for use at the sentinel wells to reduce the generation of waste water. Analytical results should be evaluated as described below.

5.1.2 Annual Reevaluation

The potential risk to production wells should be evaluated annually. The evaluation should be quantitative, to the extent possible, and include:

1) Evaluation of contaminant concentrations from sentential wells, if present, for trends and comparison with drinking water standards;
2) Estimation of the extent of the contaminant plume based on groundwater data collected as part of the BBF site investigation, monitoring, and remediation;

3) Evaluation of the remediation efforts on plume migration;
4) Estimated time that BFF contaminants could reach sentinel wells, and
5) Estimated time between BFF contaminants reaching sentinel wells and production wells.

The annual evaluation should be published as part of an annual long-term monitoring report. It is recommended that the groundwater flow and particle tracking model be updated every five years. The groundwater model should be updated with current groundwater production rates and remediation efforts, as applicable. The model refinement could include a finer grid spacing for a more localized modeling domain near a potentially affected production well as contaminants migrate closer to the well.

5.1.3 Contingency Selection

When a sentinel well is contaminated (upon first detection of BFF-related contamination, even if below drinking water standards), it is recommended that sampling at that sentinel well be increased in frequency to quarterly. In addition, contaminant migration should be reevaluated to provide an estimate of the time remaining until a production well is affected, including updated modeling. If modeling predicts imminent impact to a production well, a detailed plan should be prepared to implement the preferred contingency. It may be necessary to implement System Operation Modifications on an accelerated schedule, prior to implementing the final preferred contingency. Figure 5-2 shows recommended the implementation process.

It should be noted that a final contingency was not selected as part of this document; selection of a contingency to be implemented remains with the Water Authority based on the needs and circumstances at the time of implementation.

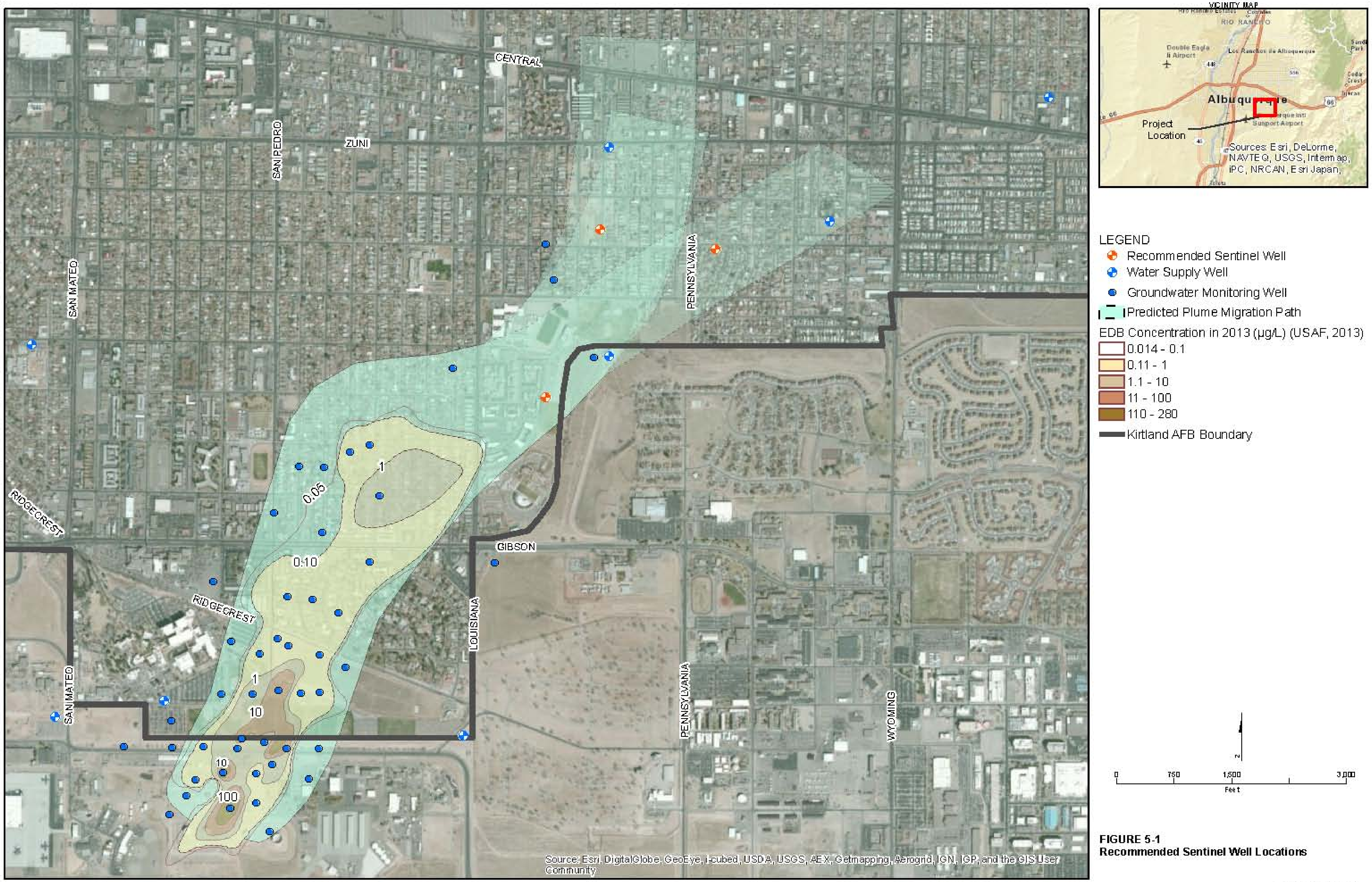

FIGURE 5-1
Recommended Sentinel Well Locations

CH2MHILL.

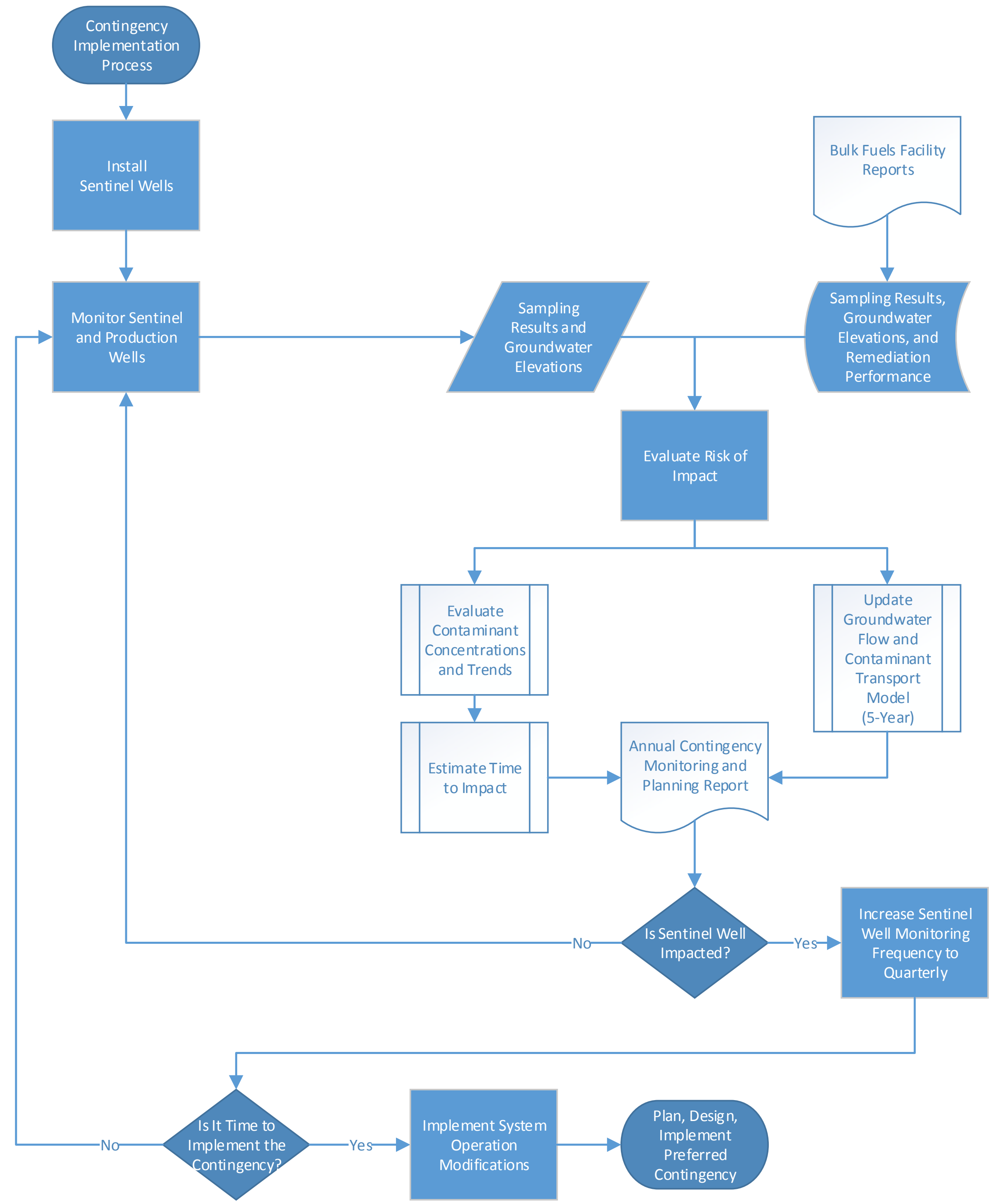

Figure 5-2. Contingency Implementation Process Diagram

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APPENDIX A
MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF AGREEMENT
BETWEEN THE
DEPARTMENT OF THE AIR FORCE, KIRTLAND AIR FORCE BASE
AND THE
ALBUQUERQUE BERNALILLO COUNTY WATER UTILITY AUTHORITY

1. PURPOSE

This Memorandum of Agreement (MOA) sets forth the agreement between the United States Air Force, by and through Kirtland Air Force Base, hereinafter referred to as Kirtland AFB, and the Albuquerque Bernalillo County Water Utility Authority, hereinafter referred to as the Water Authority, for development of a water-supply contingency plan.

2. AUTHORITY

10 USC §§ 2701 et seq., Environmental Restoration;
DoDI 4000.19, Inter-service and Intra-governmental Support (9 Aug 1995);
Air Force Instruction 25-201, Support Agreement Procedures (1 May 2005, as amended);
Air Force Instruction 32-7020, The Environmental Restoration Program (7 Feb 2001); and
Air Force Policy Directive 25-2, Support Agreements (1 Nov 2001).

3. SCOPE

This MOA sets forth the general terms and conditions under which Kirtland AFB and the Water Authority (the Parties) will jointly support the development of a contingency plan(s) for maintaining the safety of drinking water supplies potentially placed at risk by groundwater contamination associated with the Kirtland Bulk Fuels site.

The Parties acknowledge that Kirtland AFB's participation will depend on the ability of the Air Force Civil Engineering Center (AFCEC) to award and administer an engineering services contract. The services contract statement of work used during contract acquisition will be jointly developed by AFCEC with the Water Authority with the goal of awarding a contract to a technically qualified engineering services firm that demonstrates experience with and understanding of Water Authority infrastructure by Jan 28, 2013 .

The contingency plan will be a contract deliverable and will include the following:

a. Current water supply system characteristics and existing plans and procedures,
b. Evaluation of new or alternative water supplies,
c. Ranking of proposed alternative water supplies based on cost and feasibility. Feasibility of proposed alternative water supplies will be evaluated in the context of the recommended early warning system (i.e. trigger points), and hydrogeological modeling and EDB fate/transport predictions developed as part of Kirtland AFB's characterization of the bulk fuels plume,
d. Implementation schedule for contingency actions based on the early warning system and trigger points

After Kirtland AFB and the Water Authority mutually agree upon its adequacy, the draft contingency plan shall be made available for public review and comment. The final plan may incorporate comments received from the public and other State and Federal agencies.

4. ROLES AND RESPONSIBILITIES
   a. WATER AUTHORITY
      Under the terms of this MOA, the Water Authority will have the following roles and responsibilities:
      i. Participate in scoping activities leading to a contract for engineering services. Participation will focus on mutually agreed recommendations in conjunction with the Air Force for the contract scope of work, and ensuring that contract deliverables adequately incorporate both Air Force and Water Authority inputs.
      ii. Provide the contractor with access to Water Authority operational data relevant to the contract scope of work.
      iii. Assure that Kirtland Bulk Fuels site data and remedial action plans provided by the Air Force are not released to the public prior to public release by the Air Force.
      iv. Organize and hold public meetings related to development of the contingency plan.
      v. Coordinate with Kirtland AFB, USGS and contractor during the development of the draft and final contingency plans and provide timely review comments.
      vi. Review the contractor scope of work, draft and final contingency plan and provide comments to ensure that Water Authority concerns are adequately addressed.

   b. KIRTLAND AFB
      Under the terms of this MOA, Kirtland AFB will have the following roles and responsibilities:
      i. Participate in scoping activities leading to a contract for engineering services. Participation will focus on mutally agreed recommendations in conjunction with the Water Authority for the contract scope of work, and ensuring that contract deliverables adequately incorporate both Air Force and Water Authority inputs.
      ii. Acquire engineering services through an appropriate contract vehicle to support development of mutally agreed upon contingency plan(s).
      iii. Incorporate all mutually agreed upon comments provided by the Water Authority as the result of collaborative reviews of the contract statement of work .
      iv. Provide the Water Authority and contractor with access to Kirtland Bulk Fuels site data and remedial action plans relevant to the contract scope of work.
      v. Provide fate and transport model to the USGS for review and comment.

vi. Require the contractor to ensure that proprietary Water Authority operational data used by the contractor is appropriately protected from disclosure to third parties.
vii. Provide technical review and comments on contract deliverables and reports. Obtain Water Authority concurrence on the content of the deliverables and reports and incorporate mutually agreed upon Water Authority comments.
viii. Participate in public meetings and provide technical review of public comments, recommendations and revisions of the contingency plan.

c. Coordination
In addition to email and other informal exchanges of information, regular progress and coordination meetings or teleconferences will be held, at least, on a monthly basis. Participation in progress/coordination meeting will include technical staffs of the Water Authority, Kirtland AFB, United States Geologic Service (USGS) and the contractor.

5. REIMBURSEMENT
The Water Authority will be reimbursed for expenditures related to water supply contingency planning described in this Memorandum of Agreement as mutually agreed upon by the Water Authority and Kirtland AFB. For example, the Water Authority may install a new ground water monitoring well in advance of the final early warning system that could be reimbursed if the location and type of the well can be utilized as part of the final agreed upon early warning system.

6. CONTINGENCY PLAN IMPLEMENTATION
It is anticipated that subsequent to the approval and adoption of this contingency plan, a separate MOA between the parties will be prepared to address plan implementation and identify response action implementation requirements.

7. LIABILITY
This MOA is not intended to and does not create any right, benefit or trust obligation, substantive or procedural, enforceable at law or in equity by any party against the Water Authority or the United States, their departments, agencies, instrumentalities, or entities, their officers, employees, or agents, or any other person. As between the parties in performance of this MOA, each party shall be responsible for liability arising from personal injury, loss or damage to person or property occasioned by its own actions or those of its agents or employees.

8. NOTIFICATION AND COORDINATION
The Kirtland AFB points of contact for water supply contingency planning shall be:
Primary: Mr. Brent Wilson, Base Civil Engineer
377 Mission Support Group (MSG)

505-846-7911
505-846 -8025 FAX
Brent.Wilson@kirtland.af.mil

Alternate: Wayne Bitner, Chief, Environmental Restoration
377 Mission Support Group (MSG)
505-853-3484
505-853-1647 FAX
Ludie.bitner

The Water Authority points of contact for water supply contingency planning shall be:

Primary: Mr. John M. Stomp III, Chief Operating Officer
Albuquerque Bernalillo County Water Utility Authority
Commercial phone: 505-768-3650
DSN phone: 505-768-3627
FAX number: 505-768-3629

Alternate: Mr. Rick Shean, Water Quality Hydrologist
Albuquerque Bernalillo County Water Utility Authority
Commercial phone: 505-768-3650
DSN phone: 505-768-3634
FAX number: 505-768-3629

9. TERM AND EFFECTIVE DATE

This MOA shall remain in effect for a term of one (1) year beginning December 1, 2012 and ending November 30, 2013. Kirtland AFB and the Water Authority shall review the term of this MOA by September 30, 2013 to determine whether the MOA should be extended to facilitate completition of the contingency plan. If the term of the MOA is extended, it shall be reviewed by September 30 of each subsequent year and extended upon written supplement to this agreement approved by both parties.

SIGNATURES ON FOLLOWING PAGES

IN WITHNESS WHEREOF, I have hereunto signed this Memorandum of Agreement this 19th day of December 2012.

MARK S. SÁNCHEZ
Executive Director, Albuquerque Bernalillo County Water Utility Authority

IN WITHNESS WHEREOF, I have hereunto signed this Memorandum of Agreement this 19th day of DEC, 2012.

JOHN C. KUBINEC, Colonel, USAF
Commander

APPENDIX B
GROUNDWATER MODELING TECHNICAL MEMORANDUM