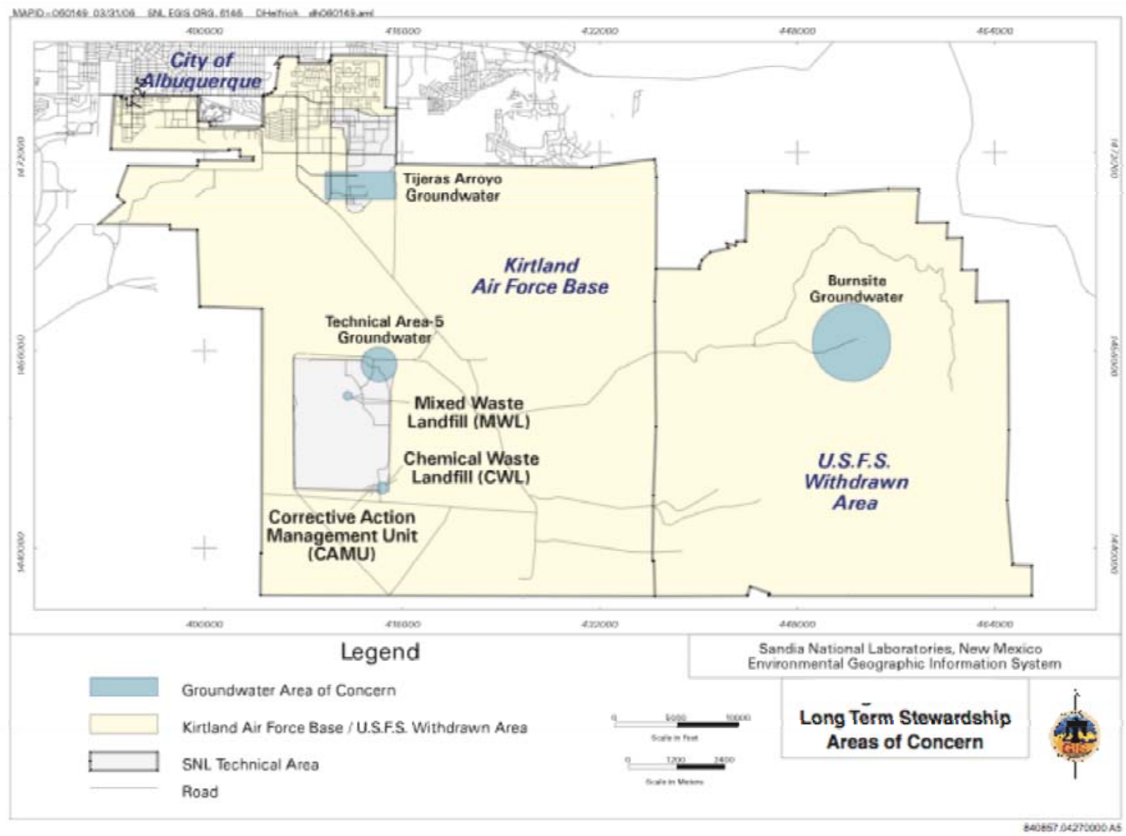
Groundwater Contamination and Remediation Options at the Technical Area Five (TA-V) and the Tijeras Arroyo Groundwater (TAG) Environmental Remediation Sites at Sandia National Laboratories, New Mexico



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Groundwater Contamination and Remediation Options at the Technical Area Five (TA-V) and the Tijeras Arroyo Groundwater (TAG) at Sandia National Laboratories

I. Introduction

This Report summarizes the status of two groundwater contamination sites at Sandia National Laboratories ("SNL") in New Mexico south of the City of Albuquerque in Bernalillo County:

- Technical Area Five ("TA-V") and
- The Tijeras Arroyo Groundwater ("TAG") site.

Sandia National Laboratories is located with the boundaries of Kirtland Air Force Base ("KAFB"). SNL and KAFB are located in a portion of Bernalillo County that has not been incorporated into the city limits of the City of Albuquerque. The City of Albuquerque borders SNL and KAFB on the north and west.

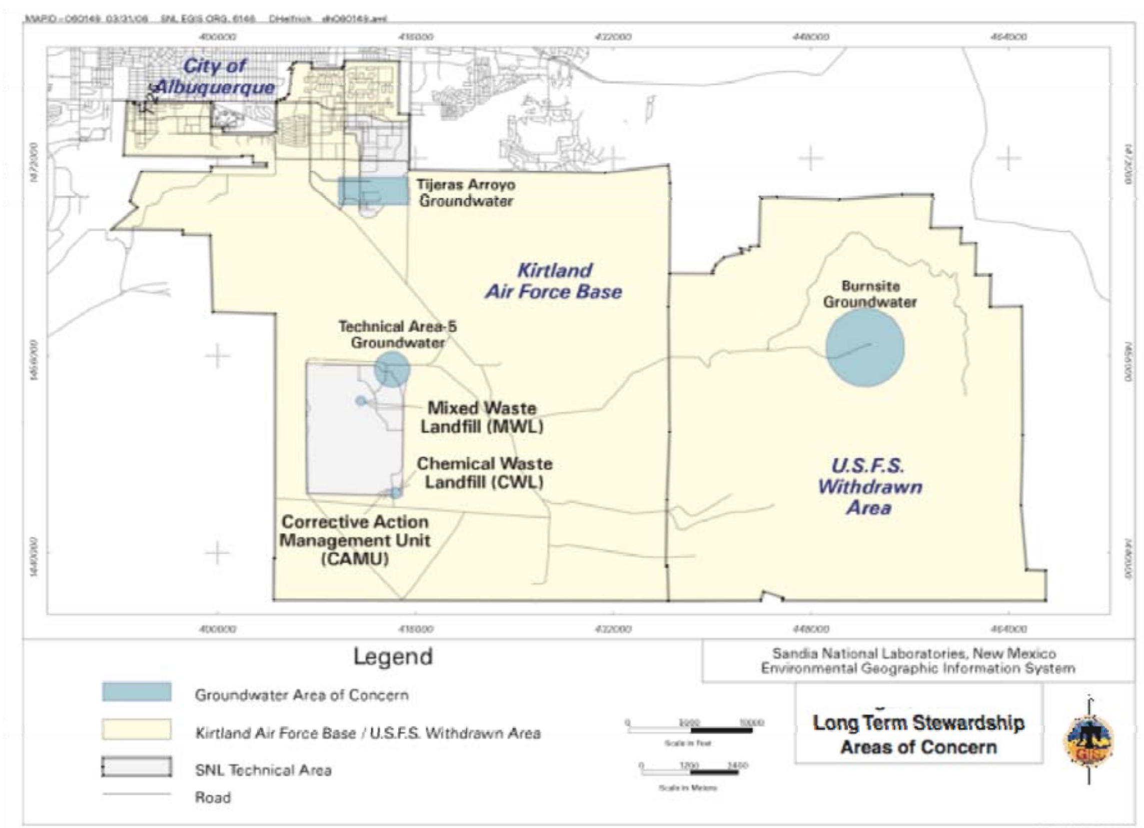


FIGURE 1 – Long-Term Stewardship Areas of Concern at Sandia National Laboratories showing location of Tijeras Arroyo Groundwater (TAG) and Technical Area 5 (TA-V) Groundwater Remediation Sites

Source: SNL 2006, p. 4-5

Water supply wells for the City and surrounding County are operated by the Albuquerque Bernalillo County Water Utility Authority ("ABCWUA") are found within a quarter mile of the northern boundary of SNL. These water supply wells, and water supply wells used by SNL and KAFB, draw water from the regional aquifer beneath the Middle Rio Grande Valley where the City of Albuquerque, SNL and KAFB are located.

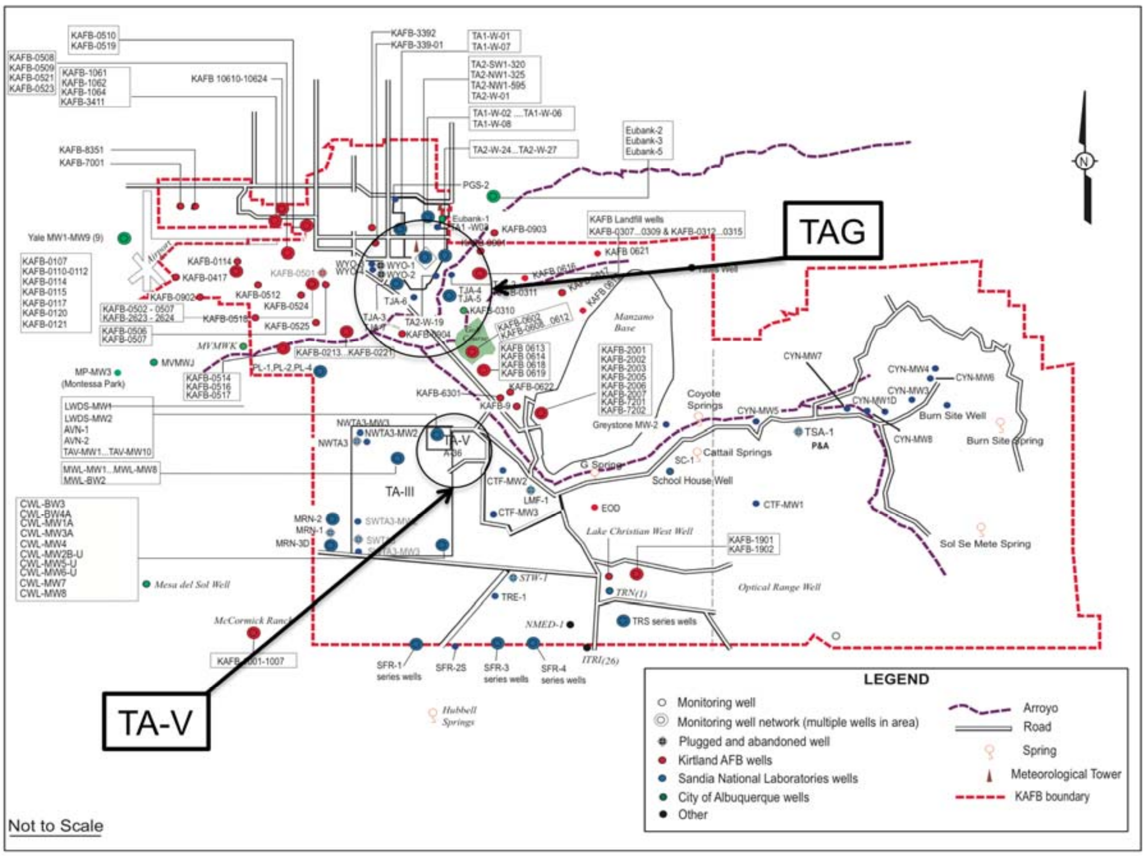


FIGURE 2 - Location of Drinking Water Supply Wells and Groundwater Monitoring Wells in and around Sandia National Laboratories and Kirtland Air Force Base and the TAG and TA-V Groundwater Remediation Sites

Source: SNL 2010a, p. 1-10

The TA-V and TAG site are located in the watershed of Tijeras Arroyo and overlie the Middle Rio Grande Regional Aquifer. Tijeras Arroyo slopes east-to-west as it crosses SNL and KAFB between the Sandia Mountains to the east and the South Valley and Rio Grande to the west. Between the TA-V and TAG sites, Tijeras Arroyo is joined by its largest tributary, Arroyo del Coyote just west of the golf course on Kirtland Base, Tijeras Arroyo Golf Course.

The water table in the Rio Grande regional aquifer located beneath the TA-V and TAG sites has been affected by withdrawals from the aquifer for drinking water uses in the City of Albuquerque and on KAFB. The regional aquifer water table had dropped by 80 – 100 feet during the 1960 – 2002 period. The continuing withdrawals of groundwater for drinking water use continue to influence the regional and perched aquifer water tables at TA-V and TAG.

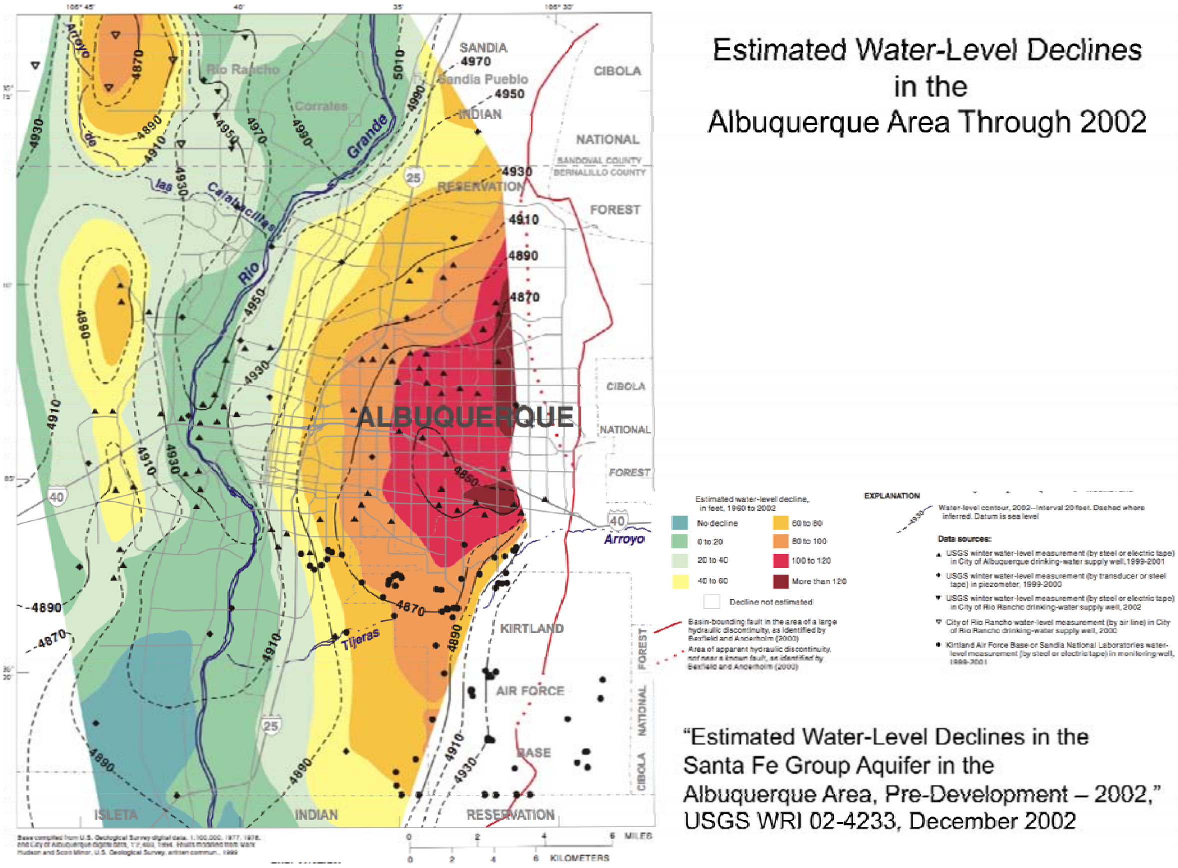


FIGURE 3 - Estimated water level declines in the Santa Fe Group Aquifer in the Albuquerque Area, 1960 - 2002

The TA-V groundwater remediation site is located under Technical Area Five at Sandia National Laboratories about 3.5 miles south of the southern end on Eubank Boulevard SE and south of Tijeras Arroyo. TA-V is the site of the two nuclear reactors at SNL, the Annular Core Research Reactor and the Sandia Pulse Reactor, a Hot Cell Facility and Gamma Ignition Facility.

At TA-V, Tricholoroethene (TCE), Tetrachloroethene (PCE) and Nitrate exceeding allowable maximum contaminant levels (MCLs) have been identified in monitoring wells sampling groundwater beneath the site since 1993 in the deep alluvial aquifer that supplies drinking water to the Albuquerque area. Sources of the TA-V contamination identified by SNL include liquid waste disposal systems that discharged at least 50 million gallons of wastewater between the early 1960s and 1992.

The TAG site is located near the northern boundary of SNL close to drinking water supply wells; it is less than a quarter mile from the City of Albuquerque drinking water wells in the Eubank well field in addition to drinking water wells used at KAFB.

The TAG Remediation Project at SNL includes groundwater in the regional Rio Grande aquifer and in a perched aquifer hydrologically connected to the Rio Grande regional aquifer in the Santa Fe Group geologic structure beneath Tech Areas I, II, and III located at the southern end of Eubank Boulevard north of the Tijeras Arroyo.

At TAG, TCE contamination in the regional aquifer was first identified by SNL in 1994. TCE exceeding the applicable Maximum Contaminant Level ("MCL") has been detected in two wells sampling a perched ground water system connected to the regional aquifer; including exceedences of the applicable MCLs for TCE in all samples from one of the wells. Nitrate exceeding the applicable MCL has been detected in four of the TAG monitoring wells, reaching 3 times the MCL in August 2009 samples.

Table 1 - Summary of Groundwater Contamination at TAG and TA-V Environmental Restoration Sites at SNL

(SNL 2003b p. 9)

Characteristic	Tijeras Arroyo Groundwater (TAG) Site	Technical Area V (TA-V) Site
Nitrate groundwater contamination (EPA MCL = 10 mg/L)	Up to 30 ppm	Up to 25 ppm
TCE groundwater contamination (EPA MCL=5 μg/L=5 ppb)	Up to 10 ppb	Up to 25 ppb
PCE groundwater contamination (EPA MCL=5 μg/L=5 ppb)	None detected	Up to 8 ppb
Other groundwater contaminants	Chlorinated volatile organic compounds (less than 5 ppb)	cis-1,2-DCE 4.5 μg/L; well below EPA MCL of 70 μg/L
Probable source of contamination	Solid-waste management units	Liquid-waste disposal system
Depth to groundwater (ft. below ground surface)	450-475 (regional aquifer) 250-375 (perched aquifer)	+/- 500

Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
ppm = parts per millions = milligrams/liter; ppb = parts per billion = micrograms/liter = μg/l

TCE is identified as "Trichloroethylene" by the Agency for Toxic Substance and Disease Registry (ATSDR) in its Toxicological Profile for TCE at ATSDR 1997a. "Trichloroethene" - the name used by SNL for TCE – is listed as a chemical synonym for the Trichloroethylene in ATSDR 1997a (p. 182, Table 3-1).

PCE is identified as the chemical compound named "Tetrachloroethylene" by the Agency for Toxic Substance and Disease Registry (ATSDR) in its Toxicological Profile for PCE at ATSDR 1997b. "Tetrachloroethene" – the name used by SNL for PCE - is listed as a chemical synonym for the Tetrachloroethylene in ATSDR 1997b (p. 170, Table 3-1).

See Appendix A for summary of health effect information about TCE, PCE and Nitrate.

II. Purpose of this Report

This project is designed to increase public awareness of these sources of contaminants in Albuquerque's aquifer and increase public involvement in decision-making related to those sites. The TA-V and TAG remediation projects have received little public attention compared to other groundwater contamination sites at SNL and KAFB though groundwater contamination in the regional aquifer used for drinking water in the Albuquerque area at both sites was detected in the early 1990s.

Key decisions to address this contamination, including the identification of remedies to be used to clean up the groundwater problems at the sites have yet to be made. The remedies to address groundwater contamination are called "corrective measures" in the New Mexico Hazardous Waste Management Regulations being applied at the sites. NMEIB 1992.

For the TA-V site, the key objective is expanded public participation in the development and implementation of corrective measures to prevent spread of TCE, nitrate and other contaminants, including perchlorate and PCE, detected at the site and clean-up the contaminants that have been identified to prevent future releases.

For the TAG site, the key objective is expanded public participation in the development and implementation of corrective measures to prevent the spread of the TCE, nitrate and other contaminants, including perchlorate, detected at the site and clean-up the contaminants that have been identified to prevent future releases.

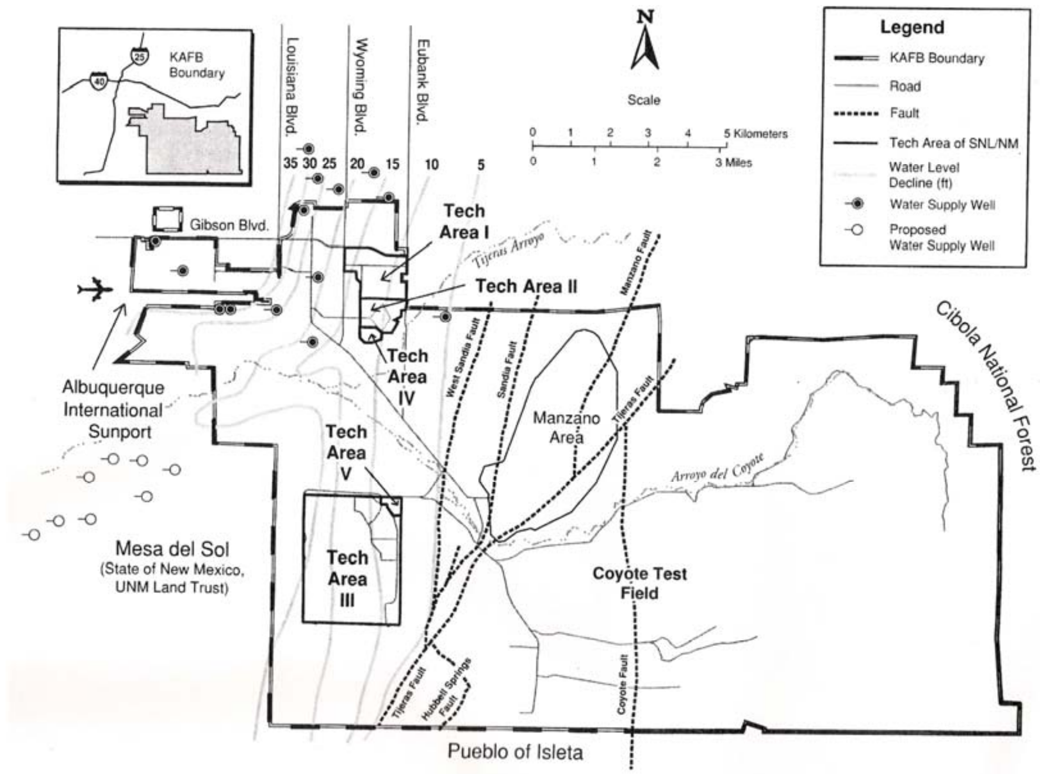


FIGURE 4 - Selected Groundwater Features and Land Uses in the Sandia National Laboratory and Kirtland Air Force Base Area

III. Summary of Groundwater Contamination at the Sites

A. Summary of the Technical Area V Groundwater Contamination Problem

(Documents filed in relation to the TA-V groundwater remediation regulatory process are posted on the "ftp" site at NMED 2011b)

Operations at TA-V include the two reactors at SNL – the Annual Core Cooling Reactor (ACCR) and Sandia Pulse Reactor (SPR), the Gamma Irradiation Facility (GIF), and the Hot Cell Facility (HCF). Between the early 1960s and 1992, SNL used a Liquid Waste Disposal Systems (LWDSs) at TA-V to dispose of millions of gallons reactor coolant water. Groundwater contamination beneath TA-V was confirmed in 1993. 12 groundwater monitoring wells have been installed around the site through 2010 to investigate the nature and extent of groundwater contamination.

TA-V is located on the south side of Tijeras Arroyo, the main surface drainage system across SNL between the Sandia Mountains and the Rio Grande. For decades, groundwater contamination from upstream sources has been a significant concern for the low income, largely-Hispanic communities in the South Valley of Albuquerque located at the base of Tijeras Arroyo downgradient of SNL and KAFB.

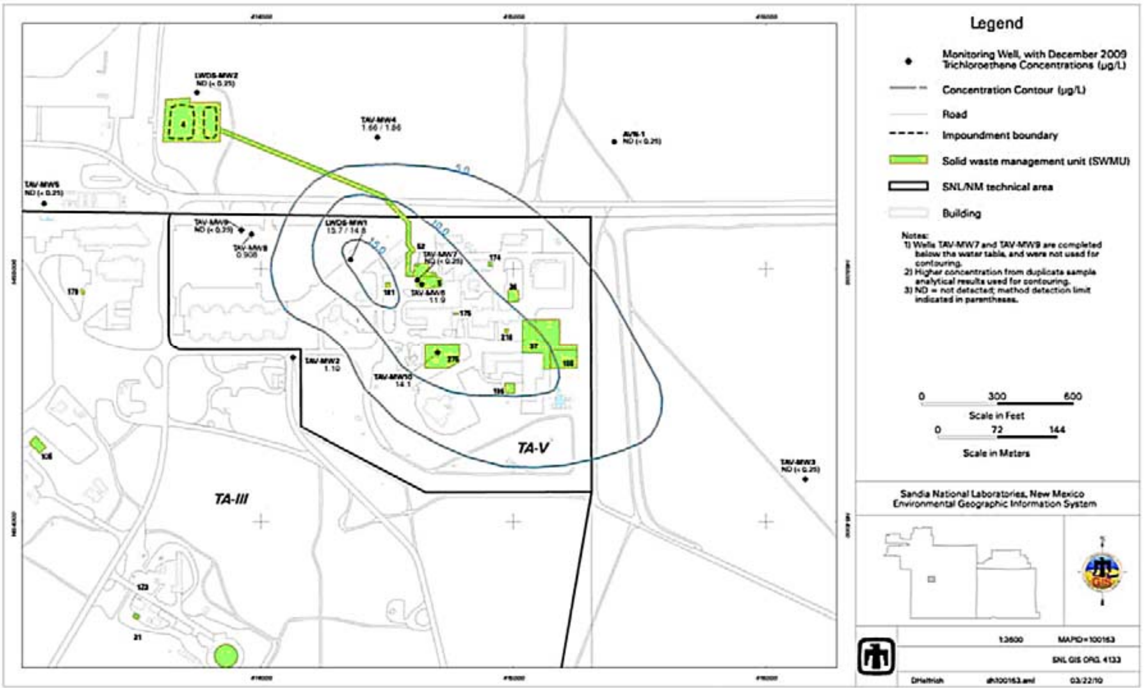


FIGURE 5 - Distribution of TCE in Groundwater at SNL TA-V Environmental Restoration Site, December 2009 Source: SNL 2009a, p. 5-17

Contaminants of Concern at TA-V - Tricholoroethene (TCE) and Nitrate exceeding allowable maximum contaminant levels (MCLs) have been identified in monitoring wells sampling groundwater beneath TA-V since 1993 in the deep alluvial aquifer that supplies drinking water to Albuquerque. In June 2009, TCE levels more than three times higher than applicable MCLs were detected in groundwater beneath TA-V. 2009 groundwater monitoring data shows rising trends in TCE at several TA-V monitoring wells. PCE exceeding allowable maximum contaminant levels have been detected in groundwater samples at TA-V in the past; recent data for PCE in groundwater at TA-V is below MCLs.

Between 2003-2009, nitrate concentrations detected in groundwater beneath TA-V have consistently exceeded applicable MCLs. 2009 groundwater monitoring at TA-V also detected perchlorate in ground water at TA-V at levels that have yet to exceed applicable screening levels (no applicable maximum contaminant level has yet been established for perchlorate).

Status of the Remediation Process at TA-V - SNL is required by the regulations being implemented at the TA-V site to submit and attain approval from NMED-HWB for a Corrective Measure Evaluation Report (CMER") prior to selection and implementation of a remedy to the contamination at the site.

During its review of the TA-V CMER issued in July 2005, NMED issued of series of three Notices of Deficiency to SNL. The first NOD was issued in June 2008, the second NOD was issued August 2008 and a third NOD was issued December 2009 following SNL responses to the previous NODs. SNL's February 2010 response to the third NOD provided the basis for NMED's May 2010 Conditional Approval of SNL Groundwater Investigation Work Plan.

Completion of the SNL Groundwater Investigation Work Plan will provide data necessary for completion of Groundwater Investigation Report (GIR). SNL is required to submit a GIR for approval by NMED-HWB as part of a revised CMER. Characterization of groundwater conditions and the distribution of contaminants of concern at the site are key parts of the GIR. Review and approval of the GIR is required a part of the NMED-HWB review and approval of a TA-V Corrective Measures Evaluation Report (CMER) which will identify options to remedy the contamination at TA-V.

SNL February 2010 reply to the NMED's third NOD proposed a multi-phase Groundwater Investigation Work Plan ("GI Work Plan"). NMED's Hazardous Waste Bureau issued a Conditional Approval for the SNL GI Work Plan in May 2010 to the address deficiencies in the CMER. The revised GI Work Plan for which NMED issued conditional approval includes:

- "Use a licensed well driller and approved materials to install four groundwater monitoring wells
- Use a licensed well driller and approved materials to install three soil vapor monitoring wells;
- Upon completion of the well-installation field activities, submit a report describing the field activities to the NMED;
- Conduct geophysical logging using induction, neutron, and gamma logging techniques of the groundwater monitoring wells through the casing;
- Sample the newly installed groundwater and soil-vapor monitoring wells for eight consecutive quarters;
- Prepare an Investigation Report (revised Current Conceptual Model) and submit to the NMED; and
- Reevaluate the corrective measures and submit a revised CME Report to the NMED."

In November 2010, SNL submitted geophysical logs for all 16 monitoring wells and slug test data for the four new monitoring wells as required in NMED's May 2010 "Conditional Approval." A slug test measures the effects of instantaneous injection or extraction of water into an aquifer to induce stress such as changes in the water level over time as the aquifer returns to equilibrium.

Major milestones in SNL's February 2011 GWI Work Plan as approved by NMED, include:

- February 2012 - completion of eight consecutive quarterly samples for the groundwater and soil vapor monitoring wells;
- May 2013 - submittal of a revised Corrective Measure Evaluation Report;
- May 2014 – NMED approval, disapproval or approval with conditions of revised CMER and make approved CMER available for Public Review;
- December 2014 – NMED selects recommended final remedy; and
- December 2015 – NMED convenes hearing on and selects of final remedy.

B. Summary of the Tijeras Arroyo Groundwater (TAG) Contamination Problem

(Documents filed in relation to the TAG groundwater remediation regulatory process are posted at the "ftp" at NMED 2011a)

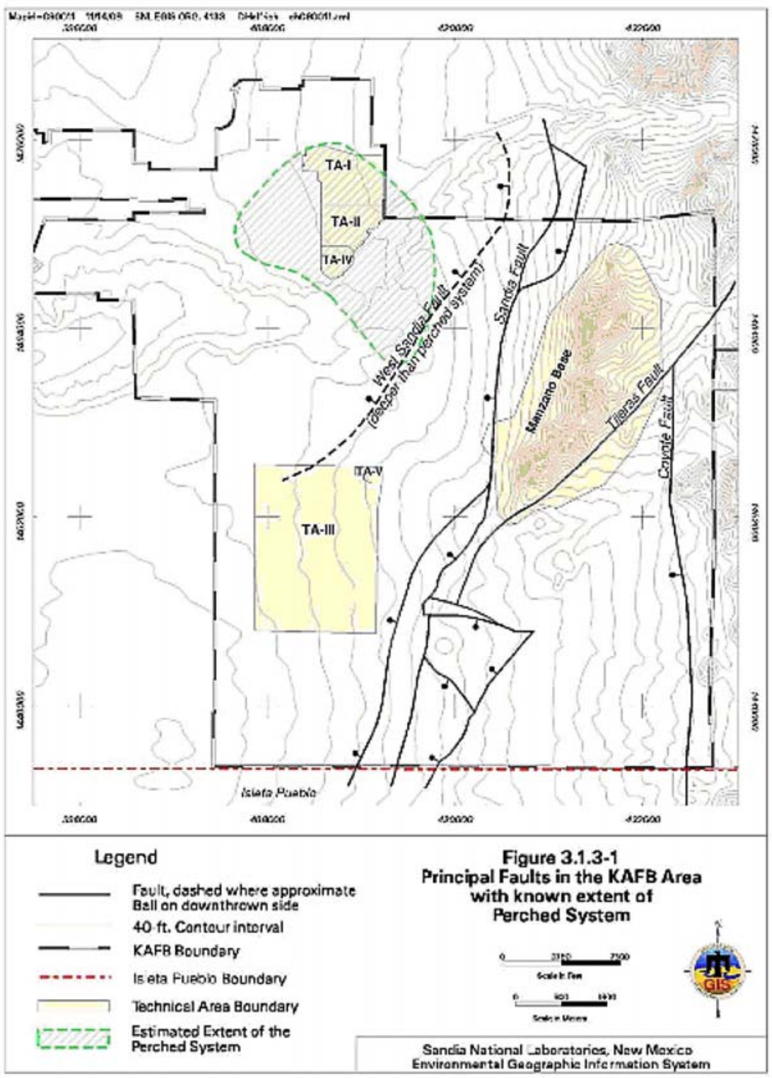


Figure 3.1.3-1
Principal Faults in the KAFB Area with known extent of Perched System

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

FIGURE 6 - Principal Faults in the KAFB Area with known extent of the Perched System at TAG Site Source: SNL 2010 Response to NMED NOD at NMED 2011a

TCE was detected in groundwater samples from the TAG sites in 1994. As of 2009, 21 groundwater monitoring wells had been installed and subject to quarterly sampling in the TAG study area. These wells include 10 that monitor regional aquifer water quality, and 11 that monitor water quality of a perched groundwater system detected at the site that is hydrologically connected to the regional aquifer.

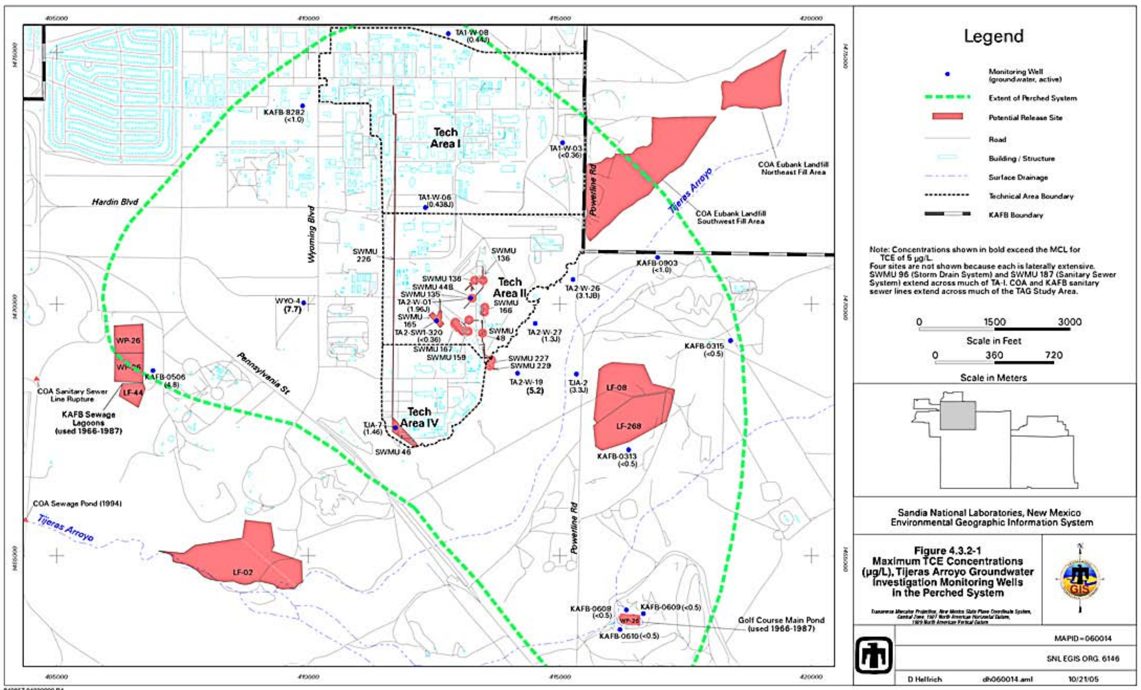


FIGURE 7 - Maximum TCE Concentrations (ug/l), Tijeras Arroyo Groundwater Monitoring Wells Sampled Perched Groundwater System in 2003

Source: SNL 2005c, p. 4-22

Contaminants of Concern at TAG – The contaminants of concern at the TAG site are TCE and Nitrate. TCE exceeding the applicable MCL has been detected in two well sampling perched ground water; including exceedences of the applicable MCLs for TCE in all samples from one of the wells. Nitrate exceeding the applicable MCL has been detected in four of the TAG monitoring wells, reaching 3 times the MCLs in August 2009 samples. Perchlorate has also been detected in TAG monitoring wells samples though the levels detected have yet to exceed applicable screening levels. TCE concentrations exceeding 1 microgram/l were first detected in October 1994.

SNL submitted a TAG Groundwater Investigation Report ("GIR") to NMED-HWB in November 2005. NMED-HWB issued Notices of Disapproval for TAG GIR to SNL in August 2008 and August 2009. In February 2010, NMED approved SNL's November 2005 TAG GIR as modified following review of SNL's January 2010 response to NMED's August 2009 NOD. As noted in the NMED approval letter, NMED has begun review of the TAG CMER submitted by SNL in August 2005. (see 2011a for NMED to SNL letter, February 22, 2010).

While NMED has required SNL to prepared and implement corrective measures at TAG, SNL notes that potential remediation responsibility for groundwater contamination at TAG may include Kirtland Air Force Base and the City of Albuquerque. SNL notes, in its November 2005 TAG GIR, that:

"Characterization and potential remediation responsibilities within the historical TAG boundaries have been tentatively assigned to three parties: SNL/NM, KAFB, and the COA. Of these, only SNL/NM has been issued a COOC (agreed upon by all signatories) by the NMED (NMED April 2004). In order to comply with the COOC and generate a CME Work Plan, it was necessary for SNL/NM to clearly define its contribution to overall TAG contamination and describe the activities that SNL/NM will address through its CME. The SNL/NM CME Work Plan identifies the specific area within the overall TAG boundary for which SNL/NM has responsibility and outlines a process for evaluating remedial alternatives within this area." (TAG GIR P. 1-2)

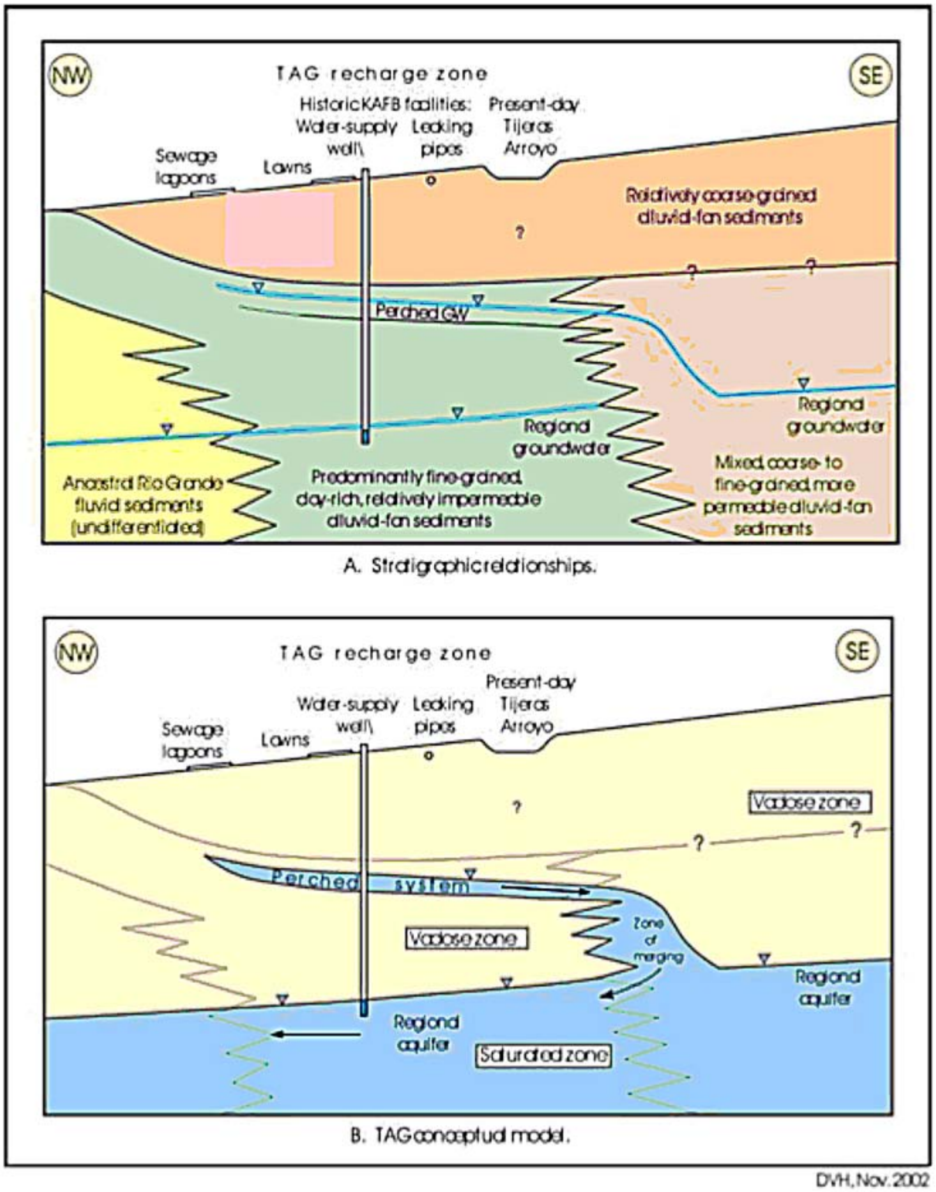


FIGURE 8 - Conceptual Model for Regional Aquifer, Perched Aquifer, and Zone of Merging beneath TAG Groundwater Remediation Sites in 2002

Source: SNL 2003a

Status of the Remediation Process at TAG – SNL is required by the regulations being implemented at the TAG site to submit and attain approval from NMED-HWB for a Corrective Measure Evaluation Report ("CMER") prior to selection and implementation of a remedy to the contamination at the site.

NMED is currently reviewing the August 2005 CMER for the TAG site following approval of the Groundwater Investigation Report (GIR) for the site in February 2010.

NMED-HWB staff have indicated that they will begin review of the 2005 CMER following the Agency's acceptance of SNL responses to two Notices of Disapproval it issued for the GIR. The GIR was submitted to NMED-HWB by SNL in November 2005. The two Notices of Disapproval were provided to SNL on August 1, 2008 and August 12, 2009.

The SNL response to the first NOD in February 2009 was the focus of the second NOD issued in August 2009. The SNL's January 19, 2010 Response to the second NOD provided the basis for NMED's February 22, 2010 approval of the TAG GIR. In that letter notifying SNL of the NMED approval of the January 19, 2010 SNL response to second TAG NOD, NMED notified SNL of its intent to begin review of August 2005 TAG CMER.

NMED has not required SNL to provide a revised version of the GIR incorporating the information provided to the NMED in the SNL Response to the two NODs. Therefore members of public seeking to review the TAG GIR must compile a complete GIR on their own, incorporating part of the November 2005 original GIR, and the two SNL Responses to the NODs.

An extensive body of material has been generated regarding the TAG sites between the August 2005 version of the TAG CMER and the February 2010 start of NMED review of that document. NMED-HWB's February 2010 GIR approval letter does not address the need for, or opportunity to prepare, a consolidated update the August 2005 CMER including all post-2005 groundwater information or remedial technology developments.

In 2009, SNL/NM ER personnel performed groundwater monitoring at the TAG and TA-V sites as well as at the Chemical Waste Landfill (CWL), Mixed Waste Landfill (MWL), and the Burnsite Groundwater (BSG) investigation area. After completion of remediation efforts at these sites, SNL will continue groundwater monitoring as a part of post-remediation Corrective Measures Implementation (CMI) and LTES.

IV. SNL Operations at the Sites and Potential Sources of the Problems

A. Brief Overview of TA-V and TAG Site Activities

TA-V – Facilities located at TA-V include:

- Gamma Irradiation Facility (GIF – Bldg. 6586),
- Hot Cell Facility (HCF – Bldg. 6580),
- Annual Core Research Reactor (ACRR – Bldg. 6588) and
- Sandia Pulse Reactor (SPR – Bldg. 6590).

From 1967 to 1971, a Liquid Waste Disposal System (LWDS) located in TA-V was used to dispose of reactor coolant water in the subsurface.

Groundwater Constituents of Concern (COCs) at the LWDS, nitrate and Volatile Organic Compounds (VOCs) such as TCE, were first detected in the groundwater at TA-V in 1993. There were 12 active monitoring wells at this site that were sampled during CY 2009. The TA-V GI Work Plan conditional approved in May 2010 provides for four more groundwater monitoring wells and three soil vapor monitoring wells.

TAG **–** Facilities located at the Tech Areas overlying the TAG site - TA-I, TA-II, and TA-IV - include, but are not limited to:

- HERMES-III accelerator (the "High Energy Radiation Megavolt Electron Source" - TA-IV – Bldg. 970),
- SATURN facility, a very large x-ray generator (TA-IV – Bldg. 961),
- Explosives Components Facility (ECF – TA-II - Bldg. 905),
- Neutron Generator Test Facility (NGTF – TA-II Bldg. 935), and
- Z facility, a high-energy pulsed power accelerator (TA-IV – Bldg. 983).

As of 2009, an array of 21 groundwater monitoring wells were routinely sampled in the TAG study area. Of these, 10 are regional aquifer monitoring wells, and 11 are perched groundwater system monitoring wells. The perched groundwater system consists of water-bearing sediments located several hundred feet above the regional water table that have insufficient yield to be developed for domestic use. TCE and nitrate are the COCs for TAG. (SNL 2010a p. 7-4). The regional aquifer monitoring wells are constructed to sample the regional aquifer used for drinking water supplies in the Albuquerque area. Wells in the Eubank well field used by the ABCWUA are located less than a mile from the TAG groundwater contamination plume.

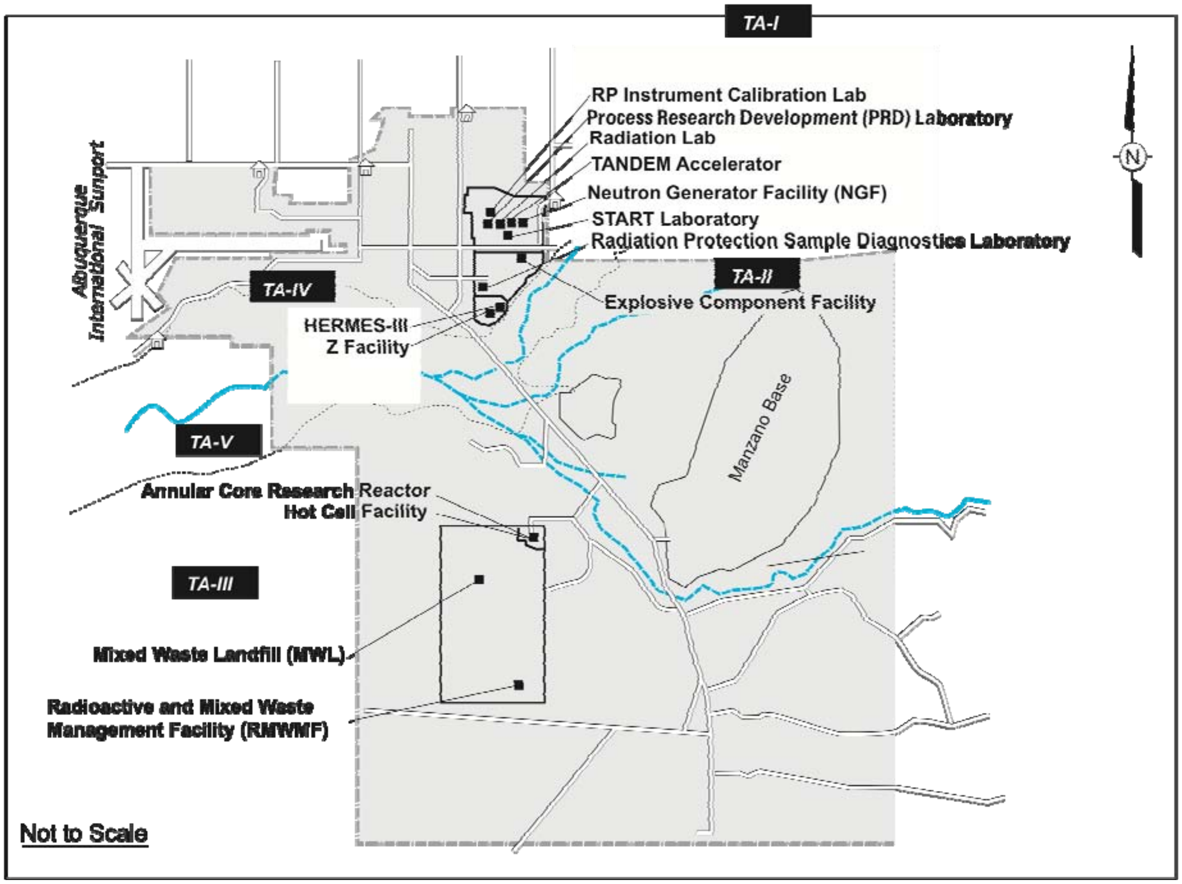


FIGURE 9 - Selected Facilities at Tech Areas at Sandia National Laboratories
Source: SNL 2010a

Brief description of selected facilities at Tech Areas at SNL with emphasis on associated airborne radioactive releases from 2010a is included as Appendix B.

B. Sources of the Groundwater Contamination Problems

1. TA-V

SNL investigations have identified three Solid Waste Management Units (SWMUs), sources of release for 50 – 70 million gallons of wastewater, as the primary sources of the groundwater contamination at TA-V. These are:

TABLE 2 - Wastewater Disposal History at Potential Sources of Contaminants at TA-V Source: SNL 2009b, p. 5-15

Disposal Site	Period of Operation	Estimated Volume of Release – gallons	SWMU Number
TA-V Seepage Pits	1960s - 1992	30 – 50 million	275
Liquid Waste Disposal System (LWDS) Drain Field	1962 - 1967	6.5 million	5
Liquid Waste Disposal System Surface Impoundments	1967 - 1972	12 million	4

According to SNL 2009 Annual Groundwater Monitoring Report,

"In the vicinity of the TA-V seepage pits, trace quantities of TCE, PCE, benzene, toluene, and total xylene were detected in shallow and deep vadose-zone borehole soil-vapor samples and from collected passive, surficial characterization studies conducted during 1994 and 1995. Vapor-phase TCE was detected at 44 parts per billion (by volume) at a depth of 80 ft in [monitoring well] TAV-BH-01. Solvent disposals to the seepage pits were most likely reduced in the early 1980s but wastewater disposal continued. This likely flushed any residual contaminants that may have been present in the vapor and aqueous phase in the vadose zone into the aquifer…

"Because TCE is volatile and the vapors are denser than ambient air, the physical properties of TCE are conducive to vapor transport; therefore, vapor transport in the vadose zone is a possible mechanism for the presence of TCE in the aquifer. Some TCE will typically be retained in the vadose zone due to absorption onto fine-grain materials and capillary forces." (2009 AGWMR, p. 5-15)

2. TAG

SNL investigations identify three Solid Waste Management Units (SMWUs) at SNL as "locations of high concern" as potential sources of groundwater contamination at TAG, two are potential sources of TCE and all three are potential sources of Nitrate. SNL investigations also identify 24 other potential sources of TAG groundwater contaminations including 10 SNL SWMUs and range of Kirtland Air Force Base and City of Albuquerque location as potential sources of groundwater contaminations at the TAG site. The SNL, KAFB and City of Albuquerque potential sources of groundwater contaminations are identified in the four tables below.

TABLE 3 - Wastewater Disposal History at SNL Locations of "High Concern" as Potential Sources of Release at TAG Source: SNL 2009b, p. 6-20

Source	Contaminant of Concern	Period of Operation	Estimated Volume of Release in gallons	SWMU Number
TA-I Old Acid Waste Line Outfall	TCE, Nitrate	1948-1974	1.3 billion	46 (connected to SWMU 226)
TA-II Bldg. 901 Septic System	TCE, Nitrate	1948 – 1992	No estimate identified	165
TA-I Sanitary Sewer System	Nitrate	1948 – Present (as of 2005)	No estimate identified	187

SNL identifies 24 other potential sources of contaminants of concern at TAG that are operated by SNL, KAFB or the City of Albuquerque (Tijeras Arroyo Groundwater Investigation Report, November 2005, p. 2-27). The SNL sites include:

TABLE 4 - SNL Sites Potential Sources of TCE and Nitrate at TAG with "Low and Medium Concern" Source: TAG IR, P. 27

Potential Source	Contaminant of Concern and Level of Concern (L=Low; M=Medium; H=High)	Period of Operation	Estimated Volume of Release in gallons	SNL SWMU Number or other identification
TA-II Bldg. 904 Septic System	TCE (M), Nitrate (M)	1947 – 1992	No estimate provided	48
TA-I Storm Drain System	TCE (L), Nitrate (None)	1950 – Present (as of 2005)	No estimate provided	96
TA-II Bldg. 906 Septic System	TCE (L), Nitrate (L)	1950 – 1992	No estimate provided	135
TA-II Bldg. 907 Septic System	TCE (M), Nitrate (M)	1948 – 1992	No estimate provided	136
TA-II Bldg. 935 Septic System	TCE (L), Nitrate (L)	1963 – 1991	No estimate provided	159
TA-II Bldg. 919 Septic System	TCE (L), Nitrate (M)	1969 – 1990	No estimate provided	166
TA-II Bldg.940 Septic System	TCE (L), Nitrate (L)	1965 – 1990	No estimate provided	167
TA-I Old Acid Waste Line Outfall	TCE (L), Nitrate (None)	1948 – 1974	No estimate provided	226 (Connected to SWMU 46)
TA-II Bunker 904 Outfall	TCE (M), Nitrate (None)	1947 – 1992	No estimate provided	227
TA-II Bldg. 904 Storm Drain System	TCE (M), Nitrate (None)	1947 – 1992	No estimate provided	229

TABLE 5 - KAFB Sites of Potential Sources of TCE and Nitrate at TAG

Source: TAG IR, P. 27

Potential Source	Contaminant of Concern and Level of Concern (L=Low; M=Medium; H=High)	Dates of Operations	Estimate Volume of release (gallons), acreage and/or volume of debris
KAFB Landfill LF-02	TCE (L), Nitrate (M)	1945 - 1967	Storm water (no estimate available); 50 acres of unlined landfill; estimated 1,000,000 cubic yards of waste
KAFB Landfill LF-08	TCE (L), Nitrate (M)	1960 -1989	Storm water (no estimate provided); 30 acres of unlined landfill; estimated 600,000 cubic yards of waste
KAFB Landfill LF-44	(TCE (None); Nitrate (M)	1979 - 1988	Storm water (no estimate provided); 2 acres of unlined landfill; no debris volume estimate
KAFB Landfill LF-268	TCE (None); Nitrate (M)	1989 – Present (as of 2005)	Storm water (no estimated provided); 45 acres of landfill; no liner identified; no debris volume estimate
KAFB Sewage Lagoons	TCE (H); Nitrate (H)	1966 - 1987	Most of 7.3 billion gallons discharged at lagoons; unidentified volume of wastewater piped to golf course pond
KAFB Golf Course Main Pond	TCE (H); Nitrate (H)	1966 - 1987	Unknown volume of wastewater piped from KAFB sewage lagoons; After 1988, pond used to store well water
KAFB Sanitary Sewer Lines	TCE (L); Nitrate (M)	1940s – Present (as of 2005)	No estimate of volume released
KAFB Septic Tank Systems	TCE (L); Nitrate (M)	1940s – Present (as of 2005)	Estimated 30 systems across KAFB; No estimate of volume released
KAFB Manzano Base Blasting	TCE (None); Nitrate (Medium)	1940s – Present (as of 2005)	Dynamite blasting of bunkers may have left explosive material that degrades to nitrate

TABLE 6 - City of Albuquerque (COA) Sites of Potential Sources of TCE and Nitrate at TAG
(TAG IR, P. 27)

Potential Source	Contaminant of Concern and Level of Concern (L=Low; M=Medium; H=High)	Period of Operations	Estimate Volume of release (gallons), acreage and/or volume of debris
COA Eubank Landfill – Northeast Area	TCE (H); Nitrate (H)	1974(?) - 1989	27 acres of landfill area; No liner identified; estimated 1,000,000 cubic yards of municipal and industrial debris dumped; sewer lines associated with residential waste lagoons and septic tanks cross site.
COA Eubank Landfill – Southwest Area	TCE (H); Nitrate (M)	Early 1960s – 1973(?)	60 acres of landfill area; no liner identified; no estimate of volume of municipal and industrial debris dumped
COA Sanitary-Sewer Rupture/Temporary Sewage Pond	TCE (L); Nitrate (H)	1994	100 million gallons spilled; unknown volume of septic water recovered from temporary pond on floodplain
COA Sanitary Sewer Lines	TCE (L); Nitrate (H)	1940s – Present (as of 2005)	Leaking sewer lines may be ongoing problem on KAFB
COA Montessa Park/Tree Farm	TCE (None); Nitrate (H)	1950s – Present (as of 2005)	No volume estimate provided; Sewage lagoon use at Montessa Park Correctional Facility; Irrigation ponds and fertilizer used at US Forest Service Tree Farm

C. Funding for Environmental Management Projects at SNL

Funding for Environmental Management projects at SNL for the next few years is anticipated to be approximately $5,878,000. DOE's Office of Environmental Management reports that SNL projects have received the following funding:

"FY 2010 Enacted Appropriation was $2,864,000, the FY 2011 Operating Plan is $3,014,000, and the FY 2012 Congressional Request is $0. This total funding of $5,878,000, permits the Sandia site to address remaining work scope required under the 2004 regulatory driven Compliance Order on Consent issued by the New Mexico Environment Department.

"The work to be undertaken is:
• administrative activities at the Mixed Waste Landfill and Chemical Waste Landfill;
• characterization of three groundwater areas (i.e. Burn Site Ground Water, Technical Area V, Tijeras Arroyo Groundwater); and,
• characterization of five re-opened soil sites identified.

"Finally, FY 2011 estimated carryover of uncosted balances from the Sandia site indicates a balance of $1,345,000 into FY 2012 to complete the activities referenced above." (Borak 2011)

V. Overview of the Regulations governing the releases at TA-V and TAG and their remediation

Groundwater contamination at the Sandia National Laboratories (SNL) Technical Area Five (TA-V) and the Tijeras Arroyo Groundwater (TAG) sites are two of the five currently active Department of Energy (DOE) Environmental Restoration Projects at SNL located above the Rio Grande Aquifer that provides most of Albuquerque's drinking water. (DOE 2009)

Both site are subject to requirements to address groundwater contamination by the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB). NMED's regulatory program requires a permittee, such as SNL, to receive approval for a Groundwater Investigation Report – "site characterization" before development of a Corrective Measures Evaluation Report – "review and selection of remediation options."

For the TA-V site, SNL provide responses to the three Notice of Deficiency issued by NMED-HWB regarding TA-V Corrective Measures Evaluation Report for TA-V. On May 19, 2010, NMED issued a Notice of Conditional Approval for the SNL TA-V Corrective Measures Evaluation Work Plan to allow geophysical logging and slug testing of newly installed monitoring wells after submittal of well completions reports and before eight quarterly samples of groundwater at those wells.

At the TAG site, "the SNL/NM area of responsibility encompasses approximately 2 square miles in the north-central portion of KAFB, or approximately 25 percent of the entire TAG study area composed of Technical Area (TA)-I, TA-II, and TA-IV, 13 potential release sites are managed by SNL/NM."

The TA-V and TAG groundwater remediation projects at SNL are managed as part of an Environmental Restoration (ER) program by the Department of Energy (DOE). SNL's ER Program was created under the DOE Office of Environmental Management (EM) to identify, assess, and remediate sites potentially contaminated by past spill, release, or disposal activities in accordance with the federal Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984. HSWA requirements apply to ER sites that include Solid Waste Management Units (SWMU) or areas of concern (AOC). A SWMU is any unit "from which hazardous constituents might migrate, irrespective of whether the units were intended for the management of solid and/or hazardous waste" according to EPA regulations. (SNL 2010a p. 3-2)

RCRA regulates the generation, transportation, treatment, storage, and disposal (TSD) of hazardous chemical waste and non-hazardous solid wastes, and the storage of hazardous or petroleum products in underground storage tanks (UST). The NMED administers hazardous waste regulatory programs in New Mexico though Hazardous Waste Management Regulations adopted under the authority of the New Mexico Hazardous Waste Act (NMHWA) with delegated authority from the EPA under RCRA. Hazardous and solid waste management activities at SNL/NM are conducted under NMED regulations though some additional RCRA requirements and EPA regulations also apply. (SNL 2010a, p. 2-6)

NMED-HWB issued Notices of Disapproval for the TAG Groundwater Investigation Report ("GIR") submitted by SNL in February and August 2009. February 22, 2010 NMED informed SNL the November 2005 TAG GIR as modified was approved. As noted in the NMED approval letter, NMED has begun review of the TAG CMER submitted by SNL in August 2005. (NMED to SNL, February 22, 2010).

"Characterization and potential remediation responsibilities within the historical TAG boundaries have been tentatively assigned to three parties: SNL/NM, KAFB, and the [City of Albuquerque ("COA")]. Of these, only SNL/NM has been issued a [Compliance Order on Consent "COOC"] (agreed upon by all signatories) by the NMED (NMED April 2004). In order to comply with the COOC and generate a CME Work Plan, it was necessary for SNL/NM to clearly define its contribution to overall TAG contamination and describe the activities that SNL/NM will address through its CME. The SNL/NM CME Work Plan identifies the specific area within the overall TAG boundary for which SNL/NM has responsibility and outlines a process for evaluating remedial alternatives within this area." (TAG GIR P. 1-2)

VI. Potential Remediation Methods Identified by SNL and NMED

Solutions to the groundwater contamination at the TA-V and TAG sites have yet to be selected or implemented. Technologies with potential to provide solutions were been identified in the Corrective Measures Evaluation Work Plans used by SNL to prepare the Draft Corrective Measures Evaluation Reports (CMERs) developed for the two sites by SNL in 2005. (The documents are available at NMED 2011a for TAG and NMED 2011b for TA-V). The CMERs for TA-V and TAG have yet to be reviewed or accepted as complete by NMED, nor have they been subject to public comment or review at a public hearing.

The proposed solutions in the Draft CMERs were developed based on Draft Groundwater Investigation Reports (GIRs) prepared by SNL and submitted for review and approval to NMED. In the case of both TA-V and TAG, SNL submitted Draft CMERs prior to the approval of the GIRs for the sites. NMED-HWB has deferred its review of the Drafts CMERs until the GIRs for the sites had been accepted as completed and approved.

The revised CMER for TA-V is projected by SNL to be submitted in May 2013 in the schedule provided in the revised Groundwater Investigation Work Plan approved by NMED in May 2010. NMED-HWB staff were unable to provide a projected date for submittal of a revised CMER for TAG. (NMED-2011c)

The Draft CMER for TA-V was submitted to NMED in July 2005 and Notices of Disapproval were received from NMED in August 2009 and December 2009. The CME report for TAG was submitted in September 2005, but no comments have been received from NMED pending NMED-HWD approval of the Groundwater Investigation Report upon which the CMER is to be based.

NMED-HWB's selection of a preferred corrective measure for the sites will follow publication of a revised CMER that will be subject to Agency and public review including opportunity for a public hearing, as was conducted for the CMER for the Mixed Waste Landfill in 2004. After selection of the preferred corrective measure by NMED, SNL will develop proposed Corrective Measure Implementation Plans (CMIP) which will be subject to agency and public review before the corrective measures are used at TAG and TA-V. NMED-HWB review and approval of long-term monitoring and maintenance plans for the sites to be used after Corrective Measure Implementation is completed. Implementation of the CMIP cannot begin until after NMED-HWB has reviewed and approved both the CMER and subsequent CMIP. (SNL 2010a p. 3-6)

Due to the lack of approved Corrective Measure Evaluation Reports for the TAG and TA-V sites, which will provide revisions of the 2005 CMERs prepared for the sites, treatment technology for remediation of the groundwater and vadose zone contamination at those sites has yet to be selected.

In its 2004 TAG CMER Workplan, SNL described a screening evaluation that resulted in the identification of four remediation technologies for review and evaluation in the TAG CMER. SNL 2004. Those technologies include:

1. Groundwater Monitoring
2. Monitored Natural Attenuation (MNA)
3. In-Situ Bioremediation (ISB)
4. Pump and Treat (Ex-situ treatment site to be determined)

SNL reported, in SNL 2004, that "four technologies that passed the screening are listed below; variations within each technology, including which contaminants will be treated and when transitions to other technologies will occur, will be developed during the paper study stage of the CME process:

1. Groundwater Monitoring

A groundwater monitoring remedy would track concentrations, distribution, and transport of TCE and nitrate during the remedial timeframe. A monitoring plan would be written, based on the TAG Investigation Work Plan … and the TAG Continuing Investigation Report …, to identify frequency and duration of sample collection and analysis from an adequate network of monitoring wells. A contingency plan would be developed that could be triggered by unacceptable increases in contaminant distribution and/or concentrations. . Implementation of groundwater monitoring could include either or both COCs (TCE and/or nitrate). In addition, groundwater monitoring could be implemented following a more active treatment such as those identified below.

2. Monitored Natural Attenuation (MNA).

Implementing MNA for TCE and/or nitrate would allow for attenuation of these contaminants in the subsurface to daughter products without active remediation. Prior to MNA implementation, characterization activities may be performed (e.g., identification of indigenous microorganisms and presence of nutrients and electron donors) to determine if intrinsic contaminant degradation is taking place in the subsurface. In addition, an understanding of contaminant transport and/or degradation will be developed, and numerical modeling may be used to predict contaminant transport to potential receptors. This understanding is the primary distinction between MNA and a groundwater monitoring remedy. Because of this, an MNA remedy may provide the basis for reducing the monitoring requirements (e.g., frequency or analytes) during the course of the remedy based on predicted performance or degradation. A contingency plan would be developed that could be triggered by unacceptable increases in contaminant distribution and/or concentrations. Implementation of MNA could include either or both COCs (TCE and/or nitrate). In addition, MNA could be implemented following a more active treatment such as those identified below.

3. In Situ Bioremediation (ISB).
An ISB remedy would be used to remediate TCE and/or nitrate. Following contaminant reduction, ISB would be followed by either MNA or groundwater monitoring. Anaerobic bioremediation techniques can include injection of an electron donor to increase activity of indigenous microorganisms to stimulate anaerobic degradation. TCE and nitrate reduction can occur in the absence of oxygen and the presence of an electron donor where TCE and nitrate can act as electron acceptors in the microbial respiration process. This results in ARD of VOCs to ethene and conversion of nitrate to nitrite and ultimately to nitrogen (N_2).

4. Pump and Treat (Ex Situ Treatment to be Determined).
This remedy would begin with implementation of pump and treat for TCE and/or nitrate. Following concentration reduction, MNA or groundwater monitoring would be implemented for these contaminants to further reduce contaminant concentrations and ensure that sufficient degradation is taking place during the remedial timeframe. Various options for the ex situ treatment technology will be evaluated during the CME process." (SNL 2004, p. 61)

Technologies eliminated during the screening process included:

1. **Source Control Technologies**
2. **Air Sparging**
3. **Permeable Reactive Barriers**
4. **Phytoremediation**
5. **Soil-Vapor Extraction**

The rationale provided for elimination of these candidate technologies included:

"1. Source Control Technologies
ISCO [In situ Chemical Oxidation], in situ flushing, monolithic confinement, nanoscale iron injection, and thermal technologies were all eliminated because they are aggressive technologies designed to target high concentrations of DNAPL/NAPL source zones and are not practical for remediation of low contaminant concentrations in groundwater. Monolithic confinement involves constructing barriers to confine groundwater contamination either by digging a trench or drilling boreholes. Construction of such a barrier around the TAG SNL/NM [Area of Responsibility] AOR perched system at greater than 330 ft [below ground surface] bgs would be an extremely difficult task. Thermal technologies are generally applied as an aggressive removal of high concentrations in source areas. Injection of steam or generation of heat in situ is intended to increase volatilization and decrease viscosity of VOCs. The technology would not be an efficient method for treating the low concentrations of TCE in the perched system. In addition, of these aggressive source control technologies, only monolithic confinement would potentially address nitrate contamination.

“2. Air Sparging

Air sparging is applicable for removing volatile chemicals from groundwater; however, it was determined that air sparging would not be able to remove TCE from the groundwater within the TAG SNL/NM AOR because of the insufficient gradient between the water and air phase due to the low concentrations of TCE. Therefore, it was determined that air sparging is not applicable for attaining media cleanup standards at the TAG SNL/NM AOR.

“3. Permeable Reactive Barriers [PRB]

A PRB would need to be constructed downgradient of each potential contaminant release site, or potentially at the downgradient portion of the perched system, in order to intercept contamination before it reaches the regional aquifer. Construction of such a barrier for the TAG SNL/NM AOR would be an extremely difficult task considering the areal extent of the perched system. Also, due to the depths to groundwater in the perched system (approximately 220 to 330 ft bgs) and the different small contaminant release sources located within the TAG SNL/NM AOR, this would make this technology difficult to implement. Therefore, it was determined that PRBs are not applicable at this site.

“4. Phytoremediation

Phytoremediation is most applicable when the groundwater is within 10 ft of the surface. Implementation of this technology for the TAG SNL/NM AOR would be ineffective considering the depth to groundwater is approximately 220 to 330 ft bgs. In addition, the need for irrigation of plants in this arid environment is difficult. Therefore, it was determined that phytoremediation is not applicable at this site.

“5. Soil Vapor Extraction

Soil vapor extraction is most applicable when contaminants are present in the vadose zone. Although this is the case for portions of the TAG SNL/NM AOR, vapor phase contaminants contribute minimal mass to the perched system ... Although soil vapor extraction may be effective at reducing vadose zone TCE concentrations, this would have little or no impact on the low levels of TCE contamination in the perched system because of the small concentration gradients between the aqueous and vapor phase. Since removal of vapor phase contaminants would have little impact on SNL/NM AOR groundwater, it was determined that soil vapor extraction would not attain media cleanup standards for the TAG SNL/NM AOR.”

VII. Analyze whether the adequacy of the potential solutions to protect the environment including an analysis of regulatory compliance.

Cleanup methods, "Corrective Measures," for groundwater contamination at the TA-V and TAG sites have not been approved or implemented at the sites. The cleanup plans for the sites within the regulatory system being enforced by NMED will be identified in "Corrective Measures Evaluation Reports" ("CMERs") to be prepared for the sites in the next several years. Proposed CMERs were submitted by SNL to NMED for the both TA-V and TAG in 2005, however neither has been approved by NMED and both will be resubmitted in revised form.

For TAG, NMED approved the SNL's Groundwater Investigation Report ("GIR") that characterizes the groundwater conditions and contamination identified at the site but has yet to conduct a review or provide comments on the TAG CMER which was submitted in 2005. No schedule is available from NMED regarding the likely submittal of a revised TAG CMER. (NMED 2011c)

For TA-V, SNL has yet to receive NMED approval for the Groundwater Investigation Report ("GIR") and is implemented a revised Groundwater Investigation Work Plan approved by NMED in February 2010 following review of SNL's Response to the third Notice of Disapproval issued by NMED for report. In its February 2010 Response approved by NMED, SNL projects that a revised GIR will be submitted to NMED as part of a revised CMER in May 2013.

As part of its approved Groundwater Investigation Workplan, SNL submitted a geophysical logs for all the monitoring wells at TA-V and results of "slug tests" – test to measure performance of wells under water injection and water withdrawal conditions – November 2010. NMED staff have not identified when they will provide SNL or the public a response to that report. (NMED2011c)

NMED's response would be one of three options: approval, approval with conditions, or disapproval with areas of deficiency identified.

VIII. References

ATSDR 1997a Agency for Toxic Substances and Disease Registry, Toxicological Profile for Trichloroethylene (TCE), CAS# 79-01-6, September 1997, .pdf version at http://www.atsdr.cdc.gov/ToxProfiles/tp19.pdf, TCE Toxic Substance Portal page at http://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=173&tid=30

ATSDR 1997b Agency for Toxic Substance and Disease Registry, Toxicological Profile for Tetrachloroethylene (PERC), CAS#127-18-4, September http://www.atsdr.cdc.gov/ToxProfiles/tp18.pdf1997, .pdf version, http://www.atsdr.cdc.gov/ToxProfiles/tp18.pdf PERC Toxic Substance Portal page at http://www.atsdr.cdc.gov/ToxProfiles/tp18.pdf

Borak 2011 Borak, D. A., "Re: Two ANA Questions," email from David A. Borak, Intergovernmental Relations Coordinator, Office of Public& Intergovernmental Accountability, Office of Environmental Management, US Department of Energy, Washington, DC to Susan Gordon, Alliance for Nuclear Accountability (ANA), and Don Hancock, Southwest Research and Information Center (SRIC), June 30, 2011

DOE 2009 US Department of Energy (DOE), "Sandia Site Office EM Project Baseline Summary – February 2009, Sandia Site Office, National Nuclear Security Administration (NNSA), February 2009 http://www.em.doe.gov/PDFs/ProjectFiles/Sandia.pdf

NMEIB 1992 New Mexico Environmental Improvement Board (NMEIB), "Hazardous Waste Management Regulations," 20.4.1.1 - .1107 NMAC, 1992 (most recent revision) http://www.nmcpr.state.nm.us/nmac/parts/title20/20.004.0001.htm

NMED 2011a New Mexico Environment Department (NMED) – Hazardous Waste Bureau (HWB), "ftp" site for TAG documents 2005 – 2011 ftp://ftp.nmenv.state.nm.us/hwbdocs/HWB/snl/TAG

NMED 2011b New Mexico Environment Department (NMED) – Hazardous Waste Bureau (HWB), "ftp" site for TA-V documents 2005 – 2011 ftp://ftp.nmenv.state.nm.us/hwbdocs/HWB/snl/TA-V

NMED 2011c William Moats and Syd Brandwein, NMED-HWB, telephone conversation, May 4, 2011.

NMED, 2004 New Mexico Environment Department (NMED), "Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act, § 74-4-10 in the Matter of: The United States Department of Energy and Sandia Corporation, Sandia National Laboratories, Bernalillo County, New Mexico," April 29, 2004 http://www.nmenv.state.nm.us/hwb/SNL/Order_on_Consent/final/SNL_CONSENT_ORDER_April-29-2004_FINAL.pdf

SNL 2010a Sandia National Laboratories, "Annual Site Environmental Report for Sandia National Laboratories, New Mexico Calendar Year 2009," SAND2010-5349P Unlimited Release, September 2010 http://www.sandia.gov/news/publications/environmental/CY09_SNL_ASER_20105349P.pdf

SNL 2010b Sandia National Laboratories (SNL), "Annual Groundwater Monitoring Report Calendar Year 2009, "Groundwater Protection Program Sandia National Laboratories, New Mexico, SAND2010-7245P, October 2010 http://www.sandia.gov/news/publications/environmental/Annual-Ground-Water-Monitoring-2009.pdf

SNL 2006 Sandia National Laboratories, "Long-Term Stewardship Implementation Plans (for Legacy Sites), September 2006, http://www.sandia.gov/ltes/docs/LTS_Implementation_Plan_September_2006_Compiled.pdf

SNL, 2005 Sandia National Laboratories, "Corrective Measures Evaluation Report for Tijeras Arroyo Groundwater," SAND2005-5297, August 2005 http://prod.sandia.gov/techlib/access-control.cgi/2005/055297.pdf

SNL 2005a Sandia National Laboratories, "[Draft] Corrective Measures Evaluation Report for Technical Area-V Groundwater," SAND2005-4492, July 2005 http://prod.sandia.gov/techlib/access-control.cgi/2005/054492.pdf

SNL 2005b Sandia National Laboratories, "[Draft] Corrective Measures Evaluation Report for Tijeras Arroyo Groundwater," SAND2005-5297, August 2005 http://prod.sandia.gov/techlib/access-control.cgi/2005/055297.pdf

SNL 2005c Sandia National Laboratories, Tijeras Arroyo Groundwater Investigation Report, November 2005, available at NMED 2011a

SNL 2003a Sandia National Laboratories (by Dirk Van Hart), "Geologic Investigation: An Update of Subsurface Geology on Kirtland Air Force Base, New Mexico," SAND2003-1869, June 2003 http://prod.sandia.gov/techlib/access-control.cgi/2003/031869.pdf

SNL 2004 Sandia National Laboratories (by Ryan Wymore, et al), "Corrective Measures Evaluation Work Plan Tijeras Arroyo Groundwater Revision 0," SAND2004-6111, December 2004, Supersedes SAND2004-3247P Dated July 2004
http://prod.sandia.gov/techlib/access-control.cgi/2004/046111.pdf

SNL 2003b Sandia National Laboratories (by Clifford Ho, et al), "Survey of Subsurface Treatment Technologies for Environmental Restoration Sites at Sandia National Laboratories, New Mexico," SAND2003-2880, August 2003
http://prod.sandia.gov/techlib/access-control.cgi/2003/032880.pdf

Appendix A

Health Effects Information About TCE and PCE

Appendix A-I

From:

"Drinking Water Contaminants National Primary Drinking Water Standards" at http://water.epa.gov/drink/contaminants/index.cfm

Table A-I - List of Contaminants and their MCLs

Contaminant	Maximum Contaminant Level Goal (MCLG) [1] – mg/l (parts per million)	Maximum Contaminant Level (MCL)[1] – mg/l (parts per million)	Health Effects from Long-term Exposure to Contaminants above MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Tricholorethylene (TCE)	zero	0.005	Liver problems; increased risk of cancer	Discharges from metal degreasing site and other factories
Tetrachloroethylene (PCE)	zero	0.005	Liver problems; increased risk of cancer	Discharges from factories and dry cleaners
Nitrate	10	10	Infants below age of six months who drink water containing nitrate in excess of MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-bay syndrome.	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural features

[1] Definitions:

Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.

APPENDIX A - II

From:

Agency For Toxic Substance and Disease Registry
Toxicological Profiles for TCE and PCE

TCE

"Public Health Statement – How can trichloroethylene affect my health?"
at ATSDR 1997a p. 4 – 5.

"Trichloroethylene was once used as an anesthetic for surgery. People who are exposed to large amounts of trichloroethylene can become dizzy or sleepy and may become unconscious at very high levels. Death may occur from inhalation of large amounts. Many people have jobs where they work with trichloroethylene and can breathe it or get it on their skin. Some people who get concentrated solutions of trichloroethylene on their skin develop rashes. People who breathe moderate levels of trichloroethylene may have headaches or dizziness. It is possible that some people who breathe high levels of trichloroethylene may develop damage to some of the nerves in the face. People have reported health effects when exposed to the level of trichloroethylene at which its odor is noticeable. Effects have also occurred at much higher levels. The effects reported at high levels include liver and kidney damage and changes in heart beat. The levels at which these effects occur in humans are not well characterized. Animals that were exposed to moderate levels of trichloroethylene had enlarged livers, and high-level exposure caused liver and kidney damage.

It is uncertain whether people who breathe air or drink water containing trichloroethylene are at higher risk of cancer, or of having reproductive effects. More and more studies suggest that more birth defects may occur when mothers drink water containing trichloroethylene. People who used water for several years from two wells that had high levels of trichloroethylene may have had a higher incidence of childhood leukemia than other people, but these findings are not conclusive. In another study of trichloroethylene exposure from well water, increased numbers of children were reported to be born with heart defects, which is supported by data from some animal studies showing developmental effects of trichloroethylene on the heart. However, other chemicals were also in the water from this well and may have contributed to these effects. One study reported a higher number of children with a rare defect in the respiratory system and eye defects. Another study reported that the risk for neural tube defects and oral cleft palates were higher among mothers with trichloroethylene in their water during pregnancy. Children listed in the National Exposure Subregistry of persons exposed to trichloroethylene were reported to have higher rates of hearing and speech impairment. There are many questions regarding these reports. There were small numbers of children with defects and trichloroethylene levels at which the effects occurred were not defined well. Thus, it is not possible to make firm conclusions about the exact effects of trichloroethylene from these studies, and more studies need to be done.

We do not have any clear evidence that trichloroethylene alone in drinking water can cause leukemia or any other type of cancer in humans. As part of the National Exposure Subregistry, the Agency for Toxic Substances and Disease Registry (ATSDR) compiled data on 4,280 residents of three states (Michigan, Illinois, and Indiana) who had environmental exposure to trichloroethylene. It found no definitive evidence for an excess of cancers from trichloroethylene exposure. An increase of respiratory cancer was noted in older men, but this effect was thought to result from smoking rather than trichloroethylene exposure. A study in New Jersey found an association between leukemia in women and exposure to trichloroethylene in the drinking water. A study in Massachusetts found that exposure was associated with leukemia in children. In studies with people, there are many factors that are not fully understood. More studies need to be done to establish the relationship between exposure to trichloroethylene and cancer."

PCE

"Public Health Statement - How can Tetrachloroethylene affect my health?"
at ATSDR 1997b p. 6.

"Tetrachloroethylene has been used safely as a general anesthetic agent, so at high concentrations, it is known to produce loss of consciousness. When concentrations in air are high-particularly in closed, poorly ventilated areas-single exposures can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Irritation may result from repeated or extended skin contact with the chemical. As you might expect, these symptoms occur almost entirely in work (or hobby) environments when individuals have been accidentally exposed to high concentrations or have intentionally abused tetrachloroethylene to get a "high." In industry, most workers are exposed to levels lower than those causing dizziness, sleepiness, and other nervous system effects. The health effects of breathing in air or drinking water with low levels of tetrachloroethylene are not definitely known. However, at levels found in the ambient air or drinking water, risk of adverse health effects is minimal. The effects of exposing babies to tetrachloroethylene through breast milk are unknown. Results from some studies suggest that women who work in dry cleaning industries where exposures to tetrachloroethylene can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. However, it is not known for sure if tetrachloroethylene was responsible for these problems because other possible causes were not considered.

"Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that tetrachloroethylene can cause liver and kidney damage and liver and kidney cancers even though the relevance to people is unclear. Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that tetrachloroethylene may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has determined that tetrachloroethylene is probably carcinogenic to humans. Exposure to very high levels of tetrachloroethylene can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant Rats that were given oral doses of tetrachloroethylene when they were very young, when their brains were still developing, were hyperactive when they became adults. How tetrachloroethylene may affect the developing brain in human babies is not known."

APPENDIX B

Brief Description of Selected Facilities at Tech Areas at SNL with Emphasis on Associated Airborne Radioactive Releases

Source: from 2010a, p. 5-11 – 5-13.

"TA-I Facilities

Radiation Protection Instrument Calibration Laboratory (RPICL) – Calibration on radiation detection equipment resulted in small releases of tritium.

Neutron Generator Facility (NGF) – The NGF is the nation's principal production facility for neutron generators. This facility currently emits only tritium. The facility has two stacks, but only utilizes the main stack in the Tritium Envelope North Wing. In 2009, the NGF emitted 7.03 Ci of tritium, based on continuous stack monitoring. Although anticipated tritium releases do not exceed the regulatory threshold requiring continuous monitoring, it is performed voluntarily at NGF as a best management practice (BMP).

Process Research Development (PRD) Laboratory – This laboratory is capable of handling and conducting research on tritium materials. It is currently in standby mode, and has yet to become operational; therefore, there were no emissions from this laboratory in CY 2009.

Radiation Laboratory – Small-scale radiation experiments resulted in the release of air trace amounts activation products and tritium.

Radiation Protection Sample Diagnostics (RPSD) Laboratory – Small-scale radiometric sample analyses on an as-needed basis. In 2009 there were no reportable emissions.

Sandia Tomography and Radionuclide Transport (START) Laboratory – This laboratory is used to perform small-scale experiments.

TANDEM Accelerator – This an ion solid interaction and defect physics accelerator facility. In 2009, the facility reported emissions of tritium.

TA-II Facilities

Explosive Components Facility (ECF) – The ECF conducts destructive testing on neutron generators. In 2009, the facility reported emissions of tritium.

TA-III Facilities

Mixed Waste Landfill (MWL) – The MWL was closed in 1988. Although a diverse inventory of radionuclides is present in the MWL, measurements indicate that tritium is the only radionuclide released into the air. In 1992, 1993, and 2003, special studies were conducted to quantify the tritium emissions (Anderson 2004). The most recent value, from 2003, was used for their annual inventory.

Radioactive and Mixed Waste Management Facility (RMWMF) – The RMWMF primarily handles low-level waste (LLW), mixed waste (MW), and some transuranic (TRU) waste. In 2009, the RMWMF reported tritium releases, americium-241, strontium-90, and cesium-137 as determined by continuous stack monitoring. Although anticipated tritium releases do not exceed the regulatory threshold requiring continuous monitoring, it is performed voluntarily at the RMWMF as a BMP.

TA-IV Facilities

High-Energy Radiation Megavolt Electron Source - III (HERMES-III) – The HERMES-III accelerator is used to test the effects of prompt radiation on electronics and complete military systems. This facility produces air activation products, primarily nitrogen-13 and oxygen-15. In 2009, the facility reported releases of nitrogen-13 and oxygen-15.

Z Facility – The Z Facility is an accelerator used for research on light ion inertial confinement fusion. Large amounts of electrical energy are stored over several minutes and then released as an intense concentrated burst (shot) at a target.

TA-V Facilities

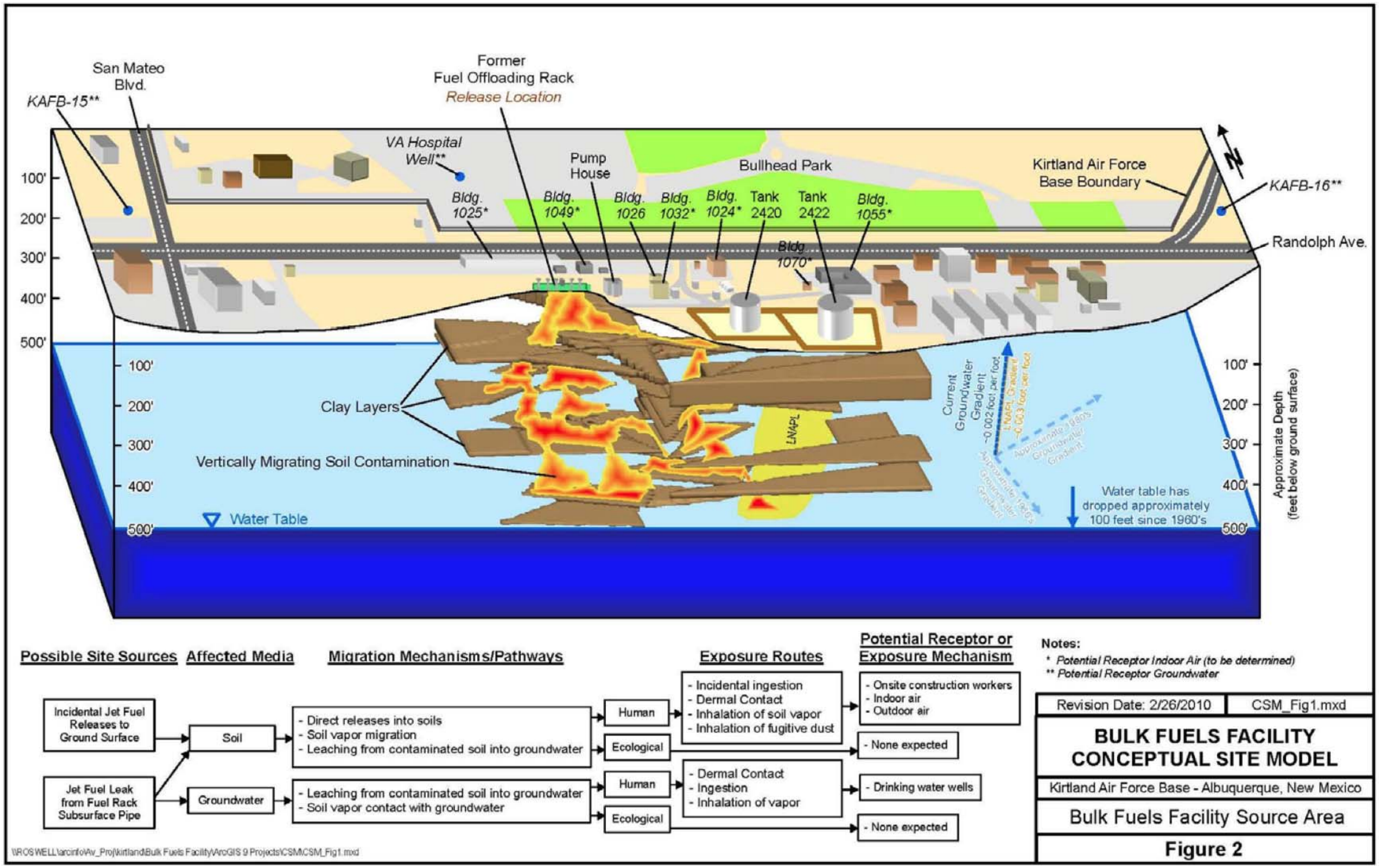
Annular Core Research Reactor (ACRR) – This reactor is used primarily to support defense program projects. If required in the future, the facility also has the capability to support the Medical Isotope Production Project (MIPP). Argon-41, an air activation product, was the only reported release in 2009.

Hot Cell Facility (HCF) – The HCF provides full capability to remotely handle and analyze radioactive materials such as irradiated targets. In 2009 there were no reportable emissions. In 2009 the stack for the HCF was removed. There is no future anticipated use for the HCF and will be removed as a source next reporting year.”

APPENDIX C – Example of a 3-D Conceptual Site for an Groundwater Contamination Site at Kirtland Air Force Base: "Bulk Fuels Facility Conceptual Site Model."

No three-dimensional representation of the conceptual Site Model for TAG or TA-VV has been made available to NMED or the public to date.

Source: Kirtland AFB, "Bulk Fuels Plume Update to Siesta Hills Neighborhood Assoc. and Albuquerque/Bernalillo County Water Authority Citizen Advisory Board, May 2010" available at http://www.kirtland.af.mil/shared/media/document/AFD-100518-057.pdf.


San Mateo Blvd.
KAFB-15**
Former Fuel Offloading Rack
Release Location
VA Hospital Well**
Pump House
Bullhead Park
Kirtland Air Force Base Boundary
KAFB-16**
Randolph Ave.
Bldg. 1025*
Bldg. 1049*
Bldg. 1026
Bldg. 1032*
Bldg. 1024*
Tank 2420
Tank 2422
Bldg. 1055*
Bldg. 1070*
100'
200'
300'
400'
500'
Clay Layers
Vertically Migrating Soil Contamination
Water Table
LNAPL
Current Groundwater Gradient ~0.002 foot per foot
LNAPL Gradient ~0.003 foot per foot
Water table has dropped approximately 100 feet since 1960's
Approximate Depth (feet below ground surface)
Possible Site Sources
Affected Media
Migration Mechanisms/Pathways
Exposure Routes
Potential Receptor or Exposure Mechanism
Incidental Jet Fuel Releases to Ground Surface
Jet Fuel Leak from Fuel Rack Subsurface Pipe
Soil
Groundwater
- Direct releases into soils
- Soil vapor migration
- Leaching from contaminated soil into groundwater
- Leaching from contaminated soil into groundwater
- Soil vapor contact with groundwater
Human
Ecological
Human
Ecological
- Incidental ingestion
- Dermal Contact
- Inhalation of soil vapor
- Inhalation of fugitive dust
- Dermal Contact
- Ingestion
- Inhalation of vapor
- Onsite construction workers
- Indoor air
- Outdoor air
- None expected
- Drinking water wells
- None expected
Notes:
* Potential Receptor Indoor Air (to be determined)
** Potential Receptor Groundwater
Revision Date: 2/26/2010
CSM_Fig1.mxd
BULK FUELS FACILITY CONCEPTUAL SITE MODEL
Kirtland Air Force Base - Albuquerque, New Mexico
Bulk Fuels Facility Source Area
Figure 2
\\ROSWELL\arcinfo\Av_Proj\kirtland\Bulk Fuels Facility\ArcGIS 9 Projects\CSM\CSM_Fig1.mxd