

Environmental Restoration Overview

Mission:

Identify, characterize, and remediate sites where hazardous and/or radioactive materials may have been released to the environment.

Regulation:

- Activities regulated by New Mexico Environment Department (NMED):
 - 2004 Sandia National Laboratories (SNL) Compliance Order on Consent for corrective action under authority of Hazardous Waste Bureau.
 - 2017 Discharge Permit for Technical Area-V Groundwater Area of Concern (AOC) under authority of Ground Water Quality Bureau.

Current Activities:

- Burn Site Groundwater Investigation AOC:
 - Preparing work plan on the installation of additional groundwater monitoring wells that will characterize nitrates in groundwater.
- Technical Area-V Groundwater Investigation AOC:
 - Completed pilot field test of in-situ bio-remediation system to treat nitrate and trichloroethene in groundwater.
 - Preparing for full scale treatability study of in-situ bioremediation.
- Tijeras Arroyo Groundwater Investigation AOC:
 - Proposed three alternatives for remediation of nitrate contamination in perched groundwater.



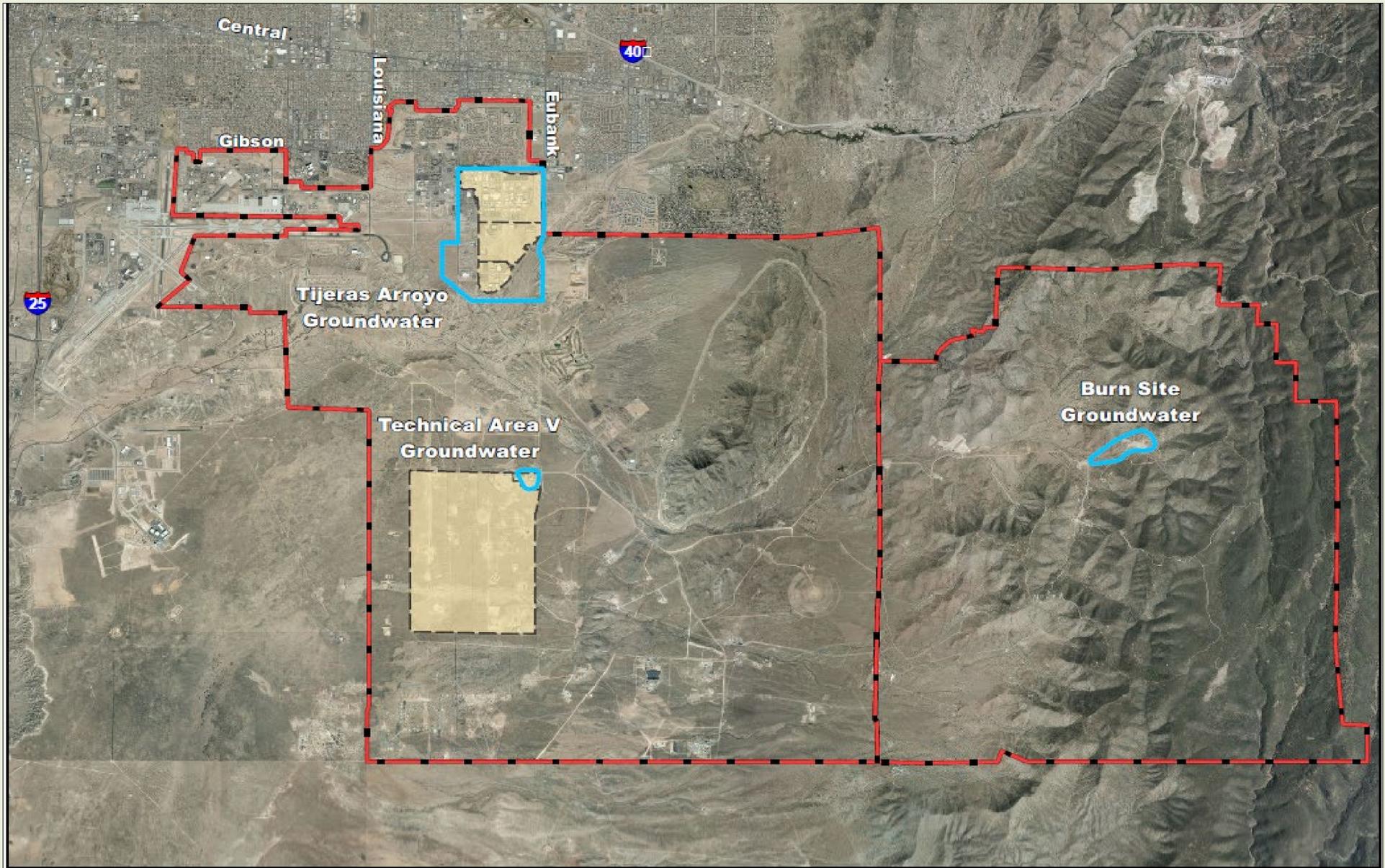
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What are the health risks of contaminated groundwater at SNL?

- There is no known harm to human health because:
 - No one is drinking contaminated groundwater.
 - There are no drinking water wells in or near the contaminated groundwater.
 - Boundaries of groundwater contamination are defined.
 - On-going monitoring of contaminated groundwater continues.
- Drinking water standards serve as groundwater cleanup goals for human health and environmental protection.

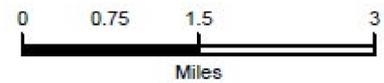
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Legend

- Groundwater Area of Investigation
- SNL Technical Area
- KAFB boundary



Map of Kirtland Air Force Base showing location of 3 Sandia National Laboratories Groundwater Areas of Concern

For more detail, see *Calendar Year 2017 Annual Groundwater Report, June 2018* available at <https://www.env.nm.gov/hazardous-waste/sandia-national-laboratories/#SNLGWMonRpts>



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Burn Site Groundwater Investigation

Site Description

- The Burn Site Groundwater Investigation Area of Concern (AOC) is located in a remote area in the Manzanita Mountains, south of the Tijeras Cement Plant on U.S. Forest Service property that is withdrawn from public access for exclusive use by the U.S. Air Force and U.S. Department of Energy for Sandia National Laboratories (SNL).
- Situated within Lurance Canyon, a west-flowing drainage deeply incised into Paleozoic and Precambrian rocks in moderately- to heavily-wooded pinon-juniper forest.
- SNL activities at the Burn Site began in 1967; early site test activities included explosives testing, current use is fire-survivability studies (i.e., burn testing).
- Corrective action is required only for groundwater at the Burn Site.
- Groundwater occurs in Precambrian-age fractured metavolcanics, quartzite, metasediments (schists and phyllites), and granitic gneiss that is recharged by infiltration of precipitation mostly during summer thundershowers and some winter snowfall.
- Groundwater flow is controlled by the underlying geologic framework such as lithologic changes and structural features (i.e., changes in rock type and faults/fractures).
- Groundwater monitoring began 1996.
 - Depth to groundwater ranges from 100 to 327 feet below ground surface and groundwater flows to the west.
 - The monitoring network consists of 12 monitoring wells, of which 10 are sampled.
- The constituent of concern is nitrate, which has been detected in 7 of the 10 wells that are sampled.
- Groundwater is contaminated with nitrate at concentrations above the maximum contaminant level (MCL); the drinking water standard.
- The nitrate contaminant plume is 79 acres in size.

Constituent of Concern	Maximum Concentration in 2017	MCL
Nitrate	44.9 milligrams per liter (well CYN-MW9)	10.0 milligrams per liter

- Groundwater in this area is not used for any purpose; no one is drinking contaminated groundwater.
- The nearest downgradient drinking-water supply well (KAFB-4) is 8.4 miles to the west.
- Nitrate is derived from both man-made and natural sources, and may include: 1) ammonium nitrate slurry, 2) wastewater discharges, and 3) degradation of HE compounds.

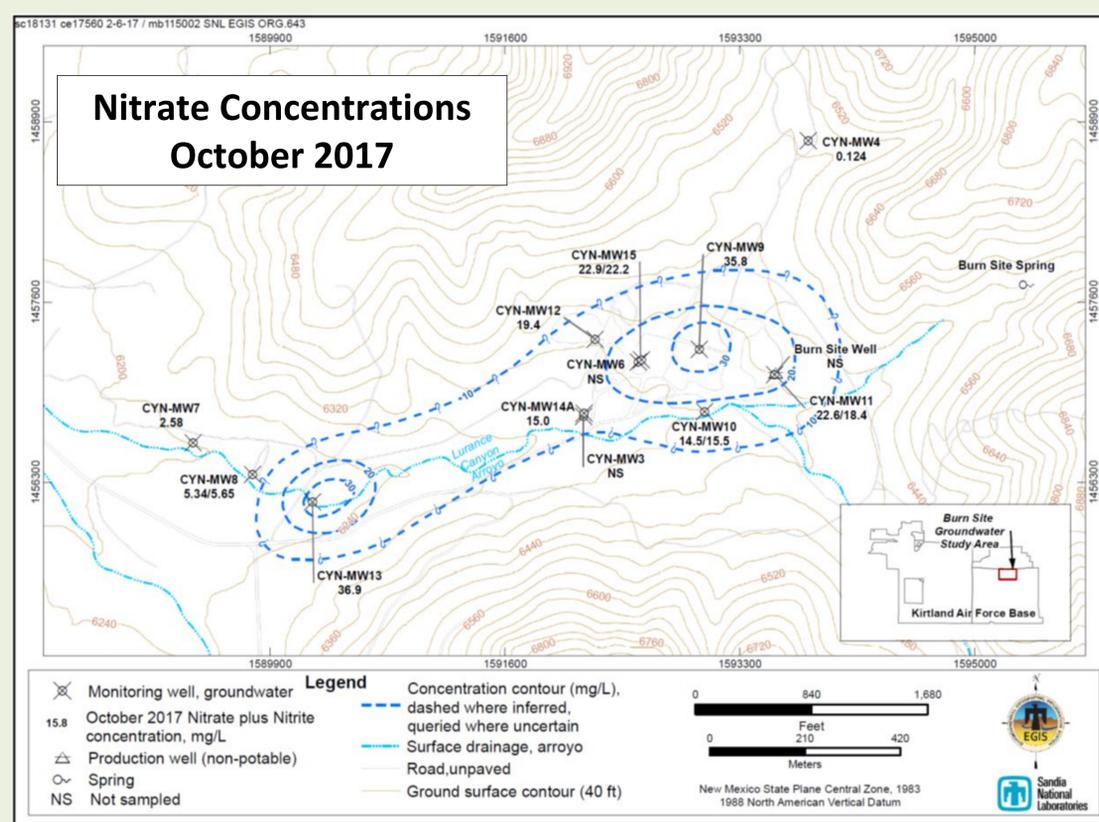
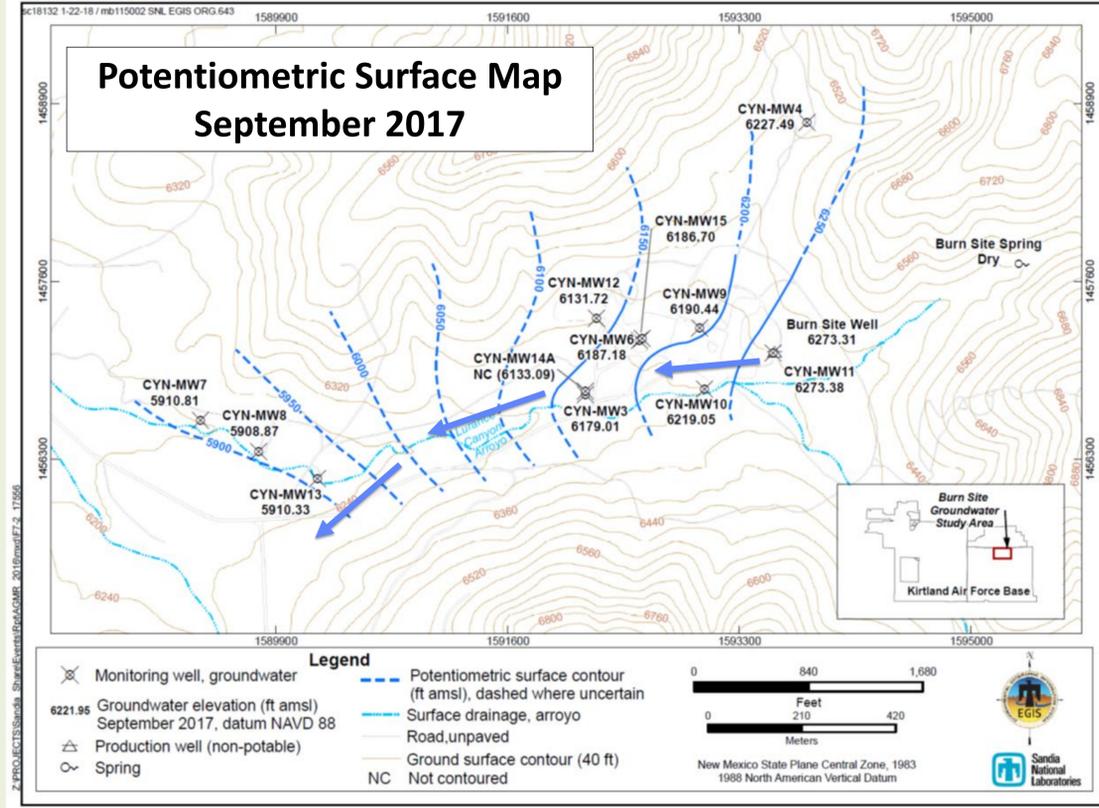
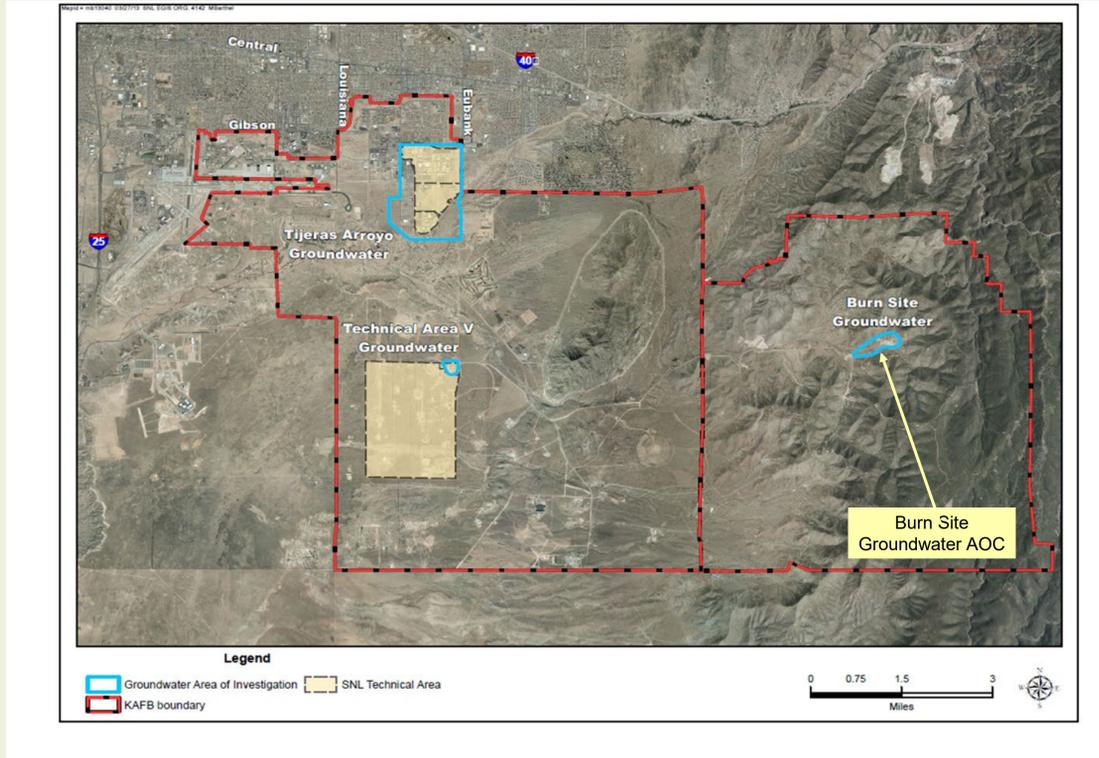
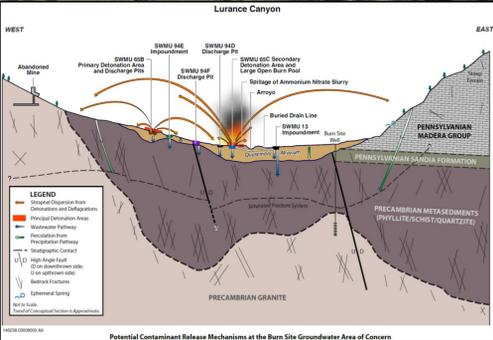
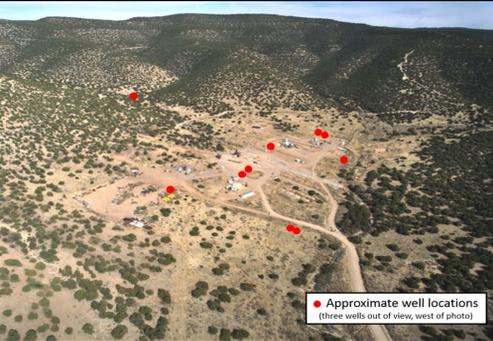


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Burn Site Groundwater Investigation



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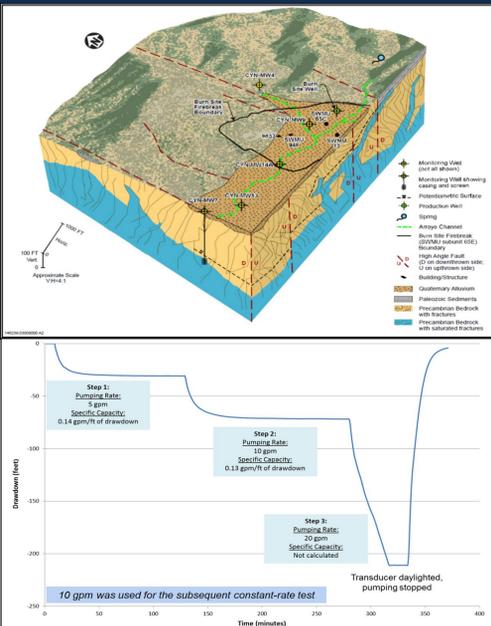
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Burn Site Groundwater Investigation

Current Status and Recent Activities

- Completing characterization of the nature and extent of nitrate contamination before resuming the corrective action process and proposing alternatives for a remedy.
- Recent investigation activities include:
 - Installed monitoring wells CYN-MW14A and CYN-MW15 in 2014 to replace existing wells that had gone dry (CYN-MW3 and CYN-MW6).
 - Performed isotopic analyses to date the groundwater from all monitoring wells.
 - Conducted long-term transducer study to determine aquifer properties.
 - Completed step-drawdown and constant-rate aquifer pumping test.
 - Performed nitrate interval sampling during the constant-rate test.
 - Performed quarterly water level measurements and semiannual groundwater sampling that was presented in the *Annual Groundwater Monitoring Report* submitted to the New Mexico Environment Department (NMED) in June 2018 (approved by NMED July 2018).
- To meet the NMED requirements specified in their April 2016 letter, *Summary of Agreements and Proposed Milestones*, the following activities were completed or are underway:
 - *Aquifer Pumping Test Work Plan* was submitted to the NMED in June 2016, and approved by NMED in June 2016.
 - Field program for the aquifer pumping test was performed in March 2017.
 - *Aquifer Pumping Test Report* was delivered to the NMED in December 2017, and approved by NMED in January 2018.
 - Recommendations for future characterization were submitted to the NMED in June 2018; and NMED responded in June 2018 requesting four wells.
 - Currently preparing a Monitoring Well Installation Work Plan for four wells, plus several contingency wells; Work Plan is due to NMED by January 2019.



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Tijeras Arroyo Groundwater Investigation

Site Description

- The Tijeras Arroyo Groundwater (TAG) Investigation Area of Concern (AOC) covers 1.82 square miles (1,165 acres) within the northern part of Kirtland Air Force Base (KAFB), and extends across Sandia National Laboratories (SNL) Technical Areas I, II, and IV.
- SNL activities at TAG began in 1948 and primarily involve weapons development and energy research.
- Corrective action is required only for the groundwater in the TAG AOC.
- Two water-bearing units, the Perched Groundwater System (PGWS) and the Regional Aquifer, are present in the alluvial fan sediments under the TAG AOC.
 - The PGWS water table occurs at an average depth of approximately 290 feet below the ground surface. The PGWS was created by manmade activities, including recharge from a sewage system, landscape watering, and wastewater outfalls. These activities have been eliminated and the PGWS is naturally dewatering (drying up) at approximately 0.5 feet per year. A thin layer of 7 to 20 feet of saturation remains in the central TAG AOC.
 - Saturated layer thickness is decreasing. Water mostly percolates downward.
 - The Regional Aquifer occurs at an average depth of 410 feet below the ground surface; it is vertically separated from the PGWS by about 200 feet of unsaturated strata.
- In the PGWS, groundwater flows to the southeast at approximately 24 feet per year on average, and merges with the Regional Aquifer along Powerline Road on KAFB. In the Regional Aquifer, groundwater flows to the west and northwest at approximately 64 feet per year.
- Groundwater monitoring began in 1992.
 - The U.S. Department of Energy (DOE) and its prime contractor for SNL have installed 31 monitoring wells in the TAG AOC. KAFB and the City of Albuquerque have installed 70 monitoring wells in the surrounding area.
 - Monitoring wells screened in the PGWS yield very little water (typically about 1 to 2 gallons per minute).
- Groundwater in the PGWS is contaminated with nitrate at concentrations above the maximum contaminant level (MCL); the drinking water standard.
 - The nitrate plume in the PGWS is approximately 280 acres in size and does not pose a threat to drinking water in the Regional Aquifer.

Constituent of Concern	Maximum Concentration in Perched Groundwater System, 2017	Maximum Concentration in Regional Aquifer, 2017	MCL
Nitrate	26.0 milligrams per liter (well TJA-7)	3.84 milligrams per liter (well TA2-NW1-595) 33.1 milligrams per liter (well TJA-4)	10 mg/L
Trichloroethene	4.00 micrograms per liter (well TJA-2)	0.35J micrograms per liter (well TJA-3)	5 ug/L

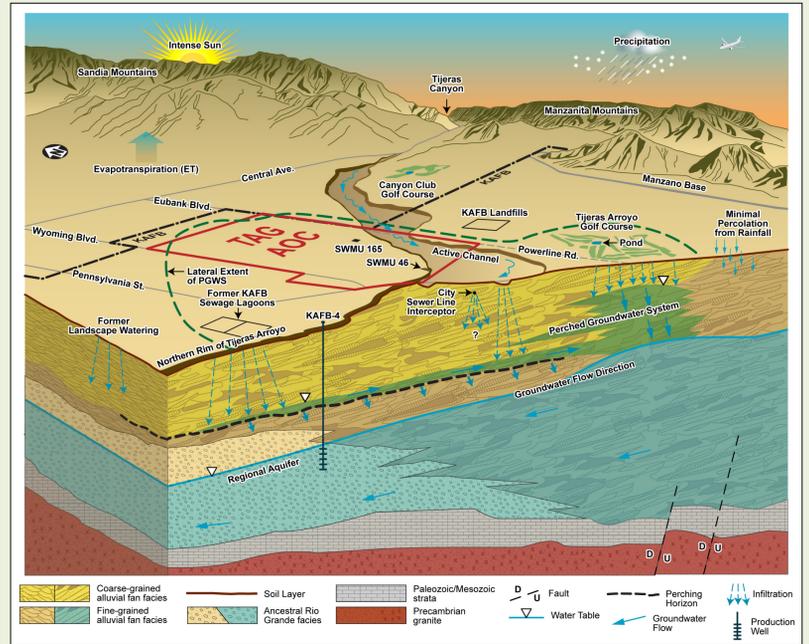
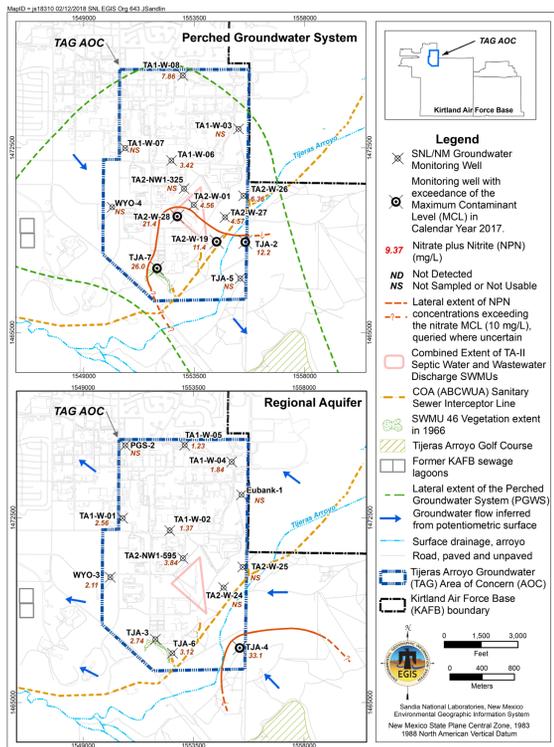
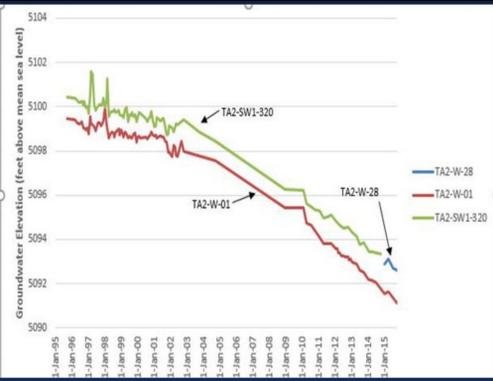
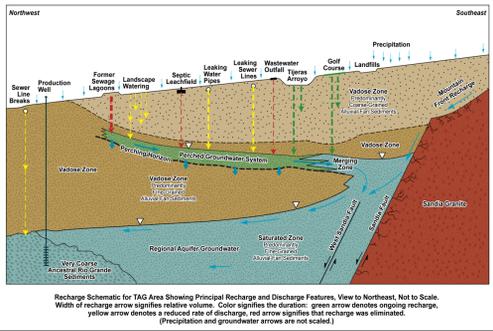


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Tijeras Arroyo Groundwater Investigation

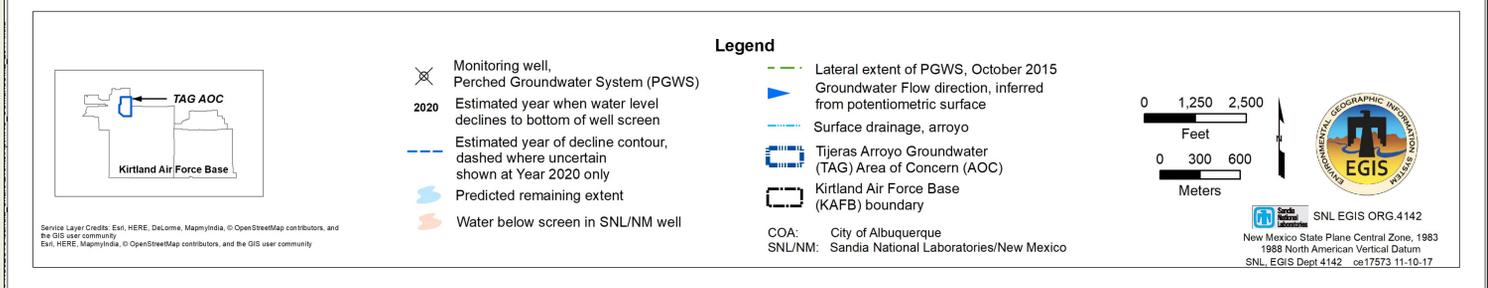
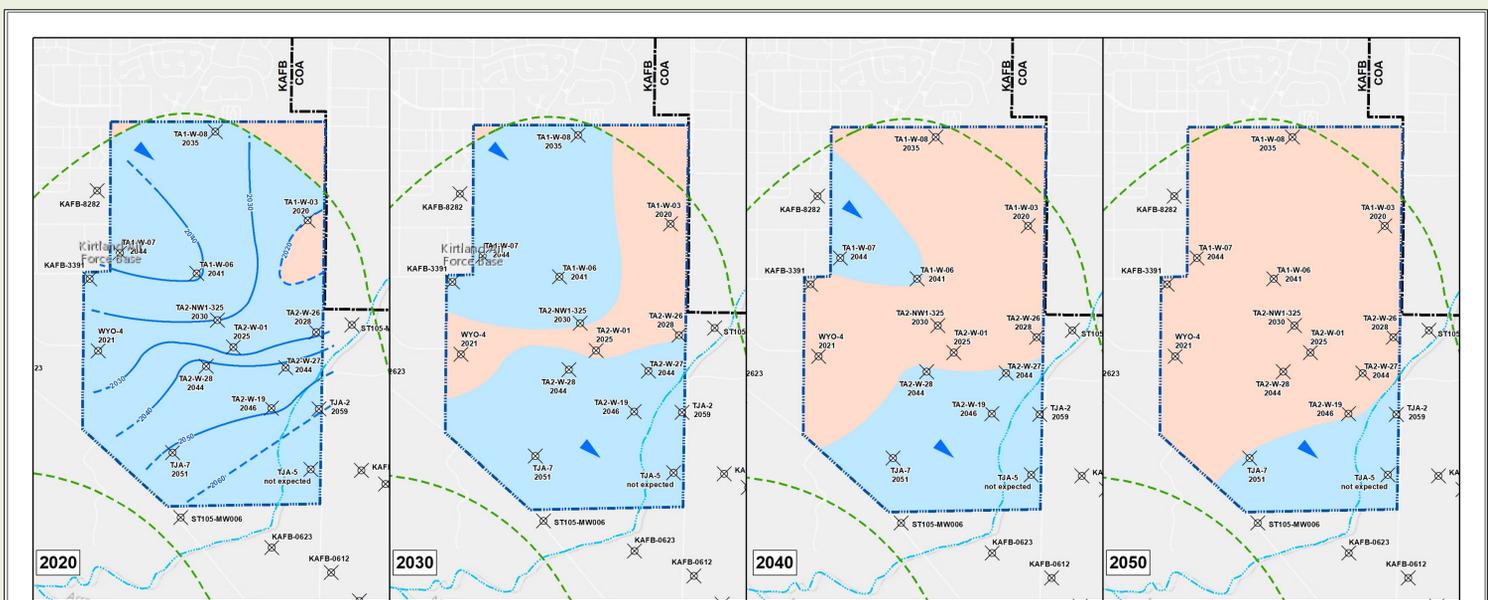


Maximum 2017 Nitrate Concentrations in the Perched Groundwater System and the Regional Aquifer

Conceptual Site Model for the TAG Vicinity



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Declining Water Levels in the Perched Groundwater System from 2020 - 2050

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Tijeras Arroyo Groundwater Investigation

Site Description (continued)

- The groundwater from the Perched Groundwater System is not used for any purpose; no one is drinking contaminated groundwater. Perched groundwater flows to the southeast.
- The nearest downgradient drinking water production well in the Regional Aquifer is KAFB-20, which is located approximately 1 mile to the west of the elevated nitrate concentrations. The nearest Albuquerque Bernalillo County Water Utility Authority well is Ridgecrest 1 which is located approximately 2 miles to the north of the elevated nitrate concentrations.
- Nitrate is typically derived from both man-made and natural sources, and may include: 1) septic leach fields, 2) wastewater discharges, 3) fertilizers, and 4) degradation of minerals in soil.

Current Status and Recent Activities

- Results from ongoing water-level measurements and groundwater sampling will be presented in the next *Annual Groundwater Monitoring Report* that will be submitted to the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) in June 2019.
- The *TAG Current Conceptual Model and Corrective Measures Evaluation (CCM/CME) Report* was submitted to the NMED HWB in December 2016.
- Based on a May 2017 NMED HWB letter requesting more information for the remedial alternatives, a *Revised TAG CCM/CME Report* was submitted to the NMED HWB in February 2018.
- Three remedial alternatives were proposed in the revised CCM/CME report:
 - Monitored Natural Attenuation using the existing well network.
 - In-Situ Bioremediation requiring installation of numerous wells.
 - Groundwater Extraction and Treatment requiring installation of numerous wells.
- All three alternatives require the semiannual monitoring of both water-bearing units.
- NMED HWB is anticipated to select a remedial alternative in early 2019.



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Technical Area-V Groundwater Investigation

Site Description

- Technical Area-V (TA-V) Groundwater Area of Concern (AOC) covers 35 acres of industrial land in central portion of Kirtland Air Force Base (KAFB).
- Sandia National Laboratories (SNL) activities at TA-V began in 1961 for testing the radiation effects on components and operating research reactors.
- Corrective action is required only for groundwater at TA-V.
- Groundwater in the Regional Aquifer occurs approximately 500 feet below ground in alluvial-fan sediments consisting of clays, silts, and sands.
- Groundwater migrates very slowly to the west, southwest, and south on a local scale.
- Groundwater monitoring began in 1993; current monitoring network consists of 18 monitoring wells.
- Groundwater is contaminated with nitrate and trichloroethene (TCE) at concentrations above the maximum contaminant level (MCL); the drinking water standard.
 - The nitrate contaminant plume is 1.4 acres in size.
 - The TCE contaminant plume is 13 acres in size.
 - The two contaminant plumes are not moving.

Constituent of Concern	Maximum concentration, 2017	MCL
Nitrate	12.2 milligrams per liter (well TAV-MW10)	10 milligrams per liter
Trichloroethene (TCE)	17.4 micrograms per liter (well LWDS-MW1)	5 micrograms per liter

- Groundwater in this area is not used for any purpose; no one is drinking contaminated groundwater.
- The nearest drinking water production well (KAFB-4) is located 2.7 miles to the north and downgradient of TA-V.
- No ongoing wastewater release or recharge occurs to groundwater at TA-V.
- Nitrate is typically derived from both man-made and natural sources, and may include: 1) septic leach fields, 2) wastewater discharges, and 3) degradation of minerals in soil.
- TCE is used in industrial processes.



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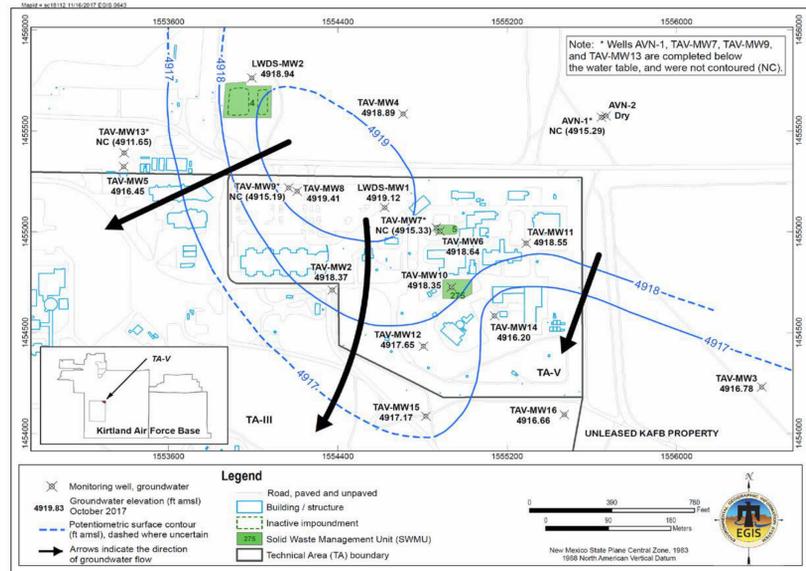
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Technical Area-V Groundwater Investigation

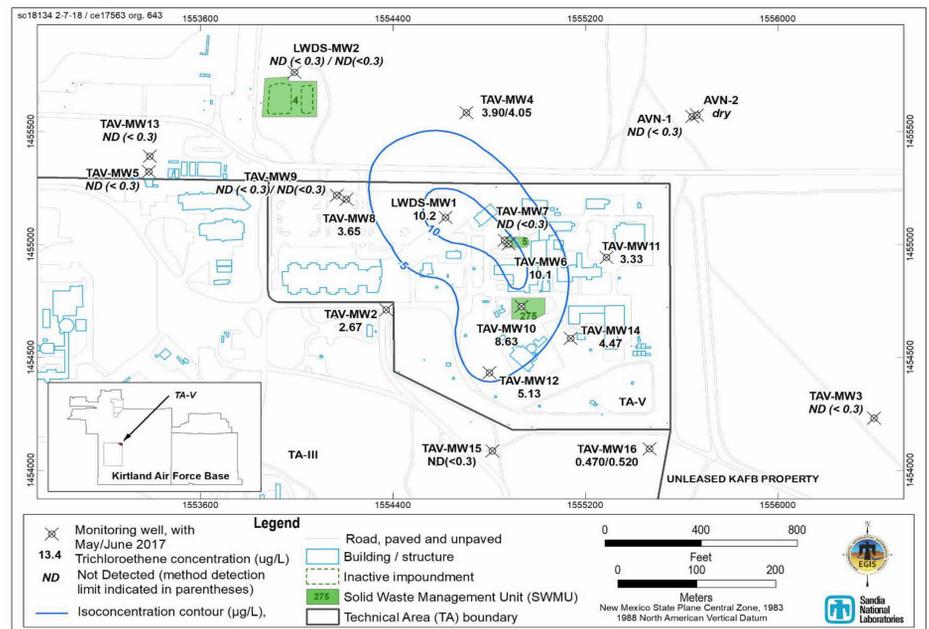
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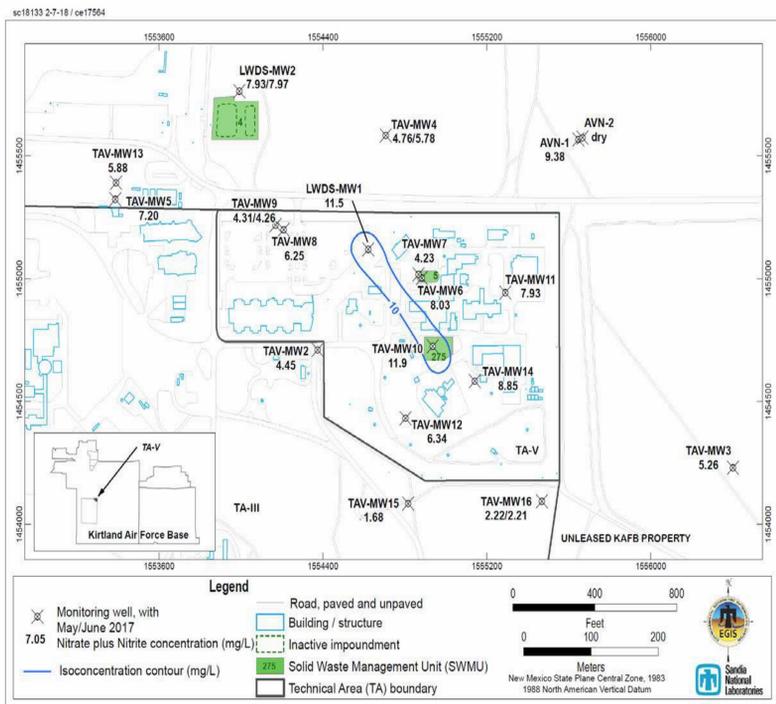
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Potentiometric Surface Map October 2017



TCE Plume Map May/June 2017



Nitrate Plume Map May/June 2017



Injection in Progress: each tank contained 4,500-gallon substrate solution.

Technical Area-V Groundwater Investigation

Treatability Study of In-Situ Bioremediation

- “In-Situ” means treating the contamination in-place (in the sediments).
- “Bioremediation” uses biological processes (natural bacteria) to remediate the groundwater by degrading the nitrate and TCE below drinking water standards.
- In-Situ Bioremediation (ISB) is commonly used to treat contaminated groundwater in the U.S., but not where groundwater is 500 feet deep.
- Deliver bioremediation solution using one injection well; potential for up to three injection wells.
- The New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) approved the Revised Treatability Study Work Plan in May 2016.
- The NMED Ground Water Quality Bureau granted Discharge Permit (DP)-1845 in May 2017 to inject bioremediation solution.

Treatability Study Pilot Test

- First injection well (TAV-INJ1) installed in October 2017.
- Conducted pilot test injections in November 2017.
- Completed seven months of groundwater monitoring at the injection well TAV-INJ1 and two nearby monitoring wells TAV-MW6 and TAV-MW7.
- Major findings of the Pilot Test:
 - The aquifer can take injection at 15 gallons per minute for an extended period of time.
 - Groundwater at TAV-INJ1 has been maintaining optimal conditions for biodegradation.
 - No impact of pilot test injections on wells TAV-MW6 and TAV-MW7.

Treatability Study Full-Scale Test

- Notified NMED HWB in July 2018 of intent to proceed with full-scale Treatability Study at the first injection well TAV-INJ1.
- Plan to inject approximately 530,000 gallons substrate solution with bioaugmentation bacteria over a six-month period.
- Monitor the injection well TAV-INJ1 and well TAV-MW6 for ISB performance for two years.
- Monitor nine surrounding wells for potential impact on groundwater quality caused by the injections for two years.
- Anticipate to start full-scale operation in November 2018.



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