

**Low-Level Perchlorate Contamination and Complex Regulatory Requirements at the Burn Site Groundwater Investigation Study Area, Sandia National Laboratories/New Mexico.  
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**ABSTRACT**

Sandia National Laboratories/New Mexico (SNL/NM) has managed the Lurance Canyon Burn Facility (Burn Site) since 1967 to test the effects of impact, burning, and explosion. The SNL/NM Environmental Restoration (ER) Project has been investigating groundwater contamination in the Burn Site Study Area since 1996. The ER Project has found the groundwater to be contaminated with nitrate and perchlorate. Groundwater occurs as fracture flow through bedrock; alluvium is not saturated. The permeability of bedrock fracture flow is low and well yields are minimal. The New Mexico Environment Department (NMED) Hazardous Waste Bureau has regulatory authority and in 2004 issued a Compliance Order on Consent (the Order) that indentified the Burn site as an area with groundwater contamination. Nitrate has been identified as a contaminant of concern (COC) in groundwater at the Burn Site Groundwater study area based on detections above the U.S. Environmental Protection Agency's (EPA's) Maximum Contaminant Level (MCL) in samples collected from monitoring wells. Since August 1998, the maximum concentration of nitrate detected at the site was 29.3 milligrams per liter (mg/L). Since June 2004, perchlorate has only been detected above the screening level in one of the six monitor wells, CYN-MW6, at concentrations ranging from 5 to 9 micrograms per liter ( $\mu\text{g/L}$ ). The source for the perchlorate in the groundwater at CYN-MW6 is unknown; nearby soil samples did not reveal detectable concentrations of perchlorate. Perchlorate found in the study area may have been derived either from open detonation of perchlorate bearing explosives, burning of rocket motors, or from concentration of naturally-occurring perchlorate via evapotranspiration of rainfall that infiltrated canyon alluvium. Perchlorate could accumulate in alluvial deposits then mobilized by precipitation to infiltrate fractured bedrock. The downgradient extent of the perchlorate-contaminated groundwater has been defined.

**INTRODUCTION**

SNL/NM manages the Coyote Canyon Test Area in the eastern portion of Kirtland Air Force Base (KAFB) directly south of Albuquerque, New Mexico (Figure 1). SNL/NM is a government-owned, contractor-operated, multi-program laboratory overseen by the

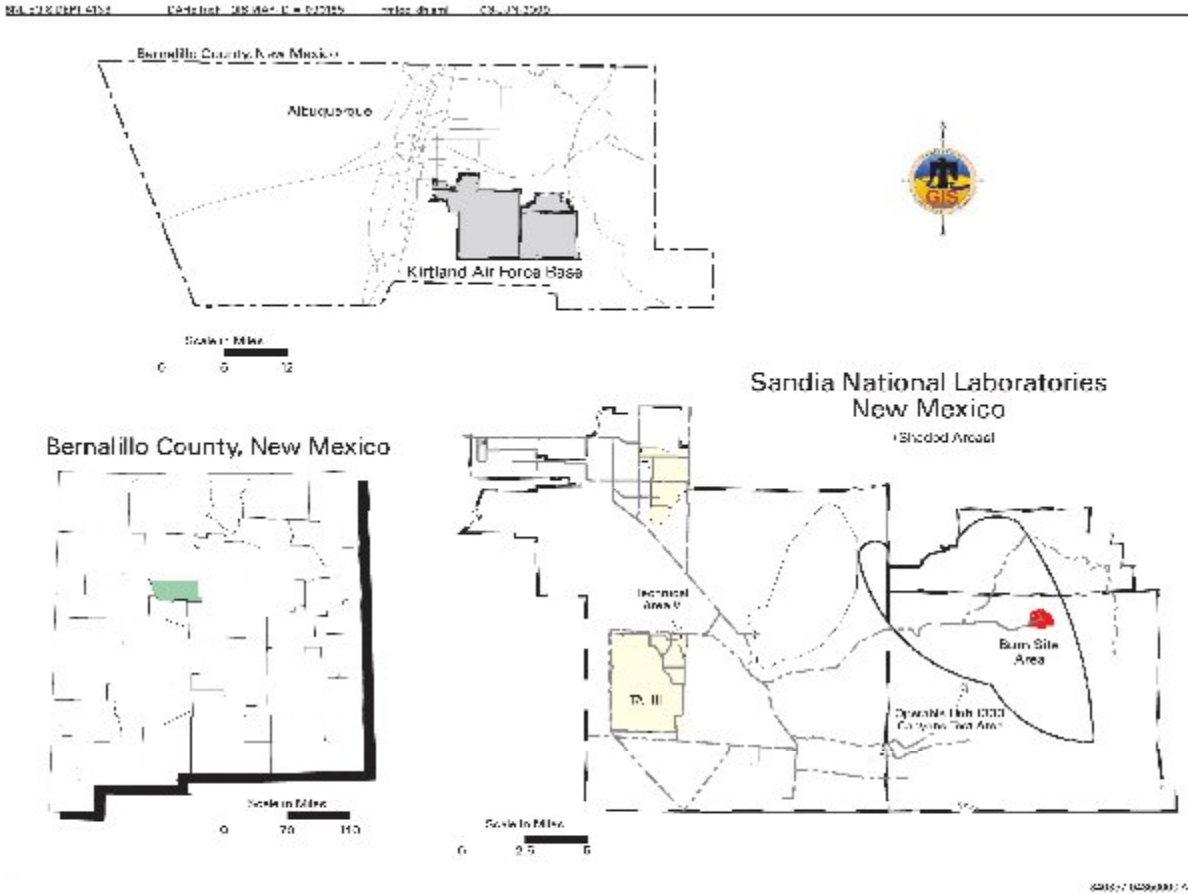


Figure 1. Location of the Burn Site Groundwater Study Area, Sandia National Laboratories, New Mexico

U.S. Department of Energy (DOE), National Nuclear Security Administration through the Sandia Site Office in Albuquerque, New Mexico. Sandia is a multiprogram laboratory managed and operated by Sandia Corporation, a wholly-owned subsidiary of Lockheed Martin Corporation, for the United States Department of Energy’s National Nuclear Security Administration under contract DE-AC04-94AL85000. The Coyote Canyon Test Area consists of multiple test facilities that are located in three large canyons in the Manzanita Mountains (Madera Canyon from the north, Sol se Mete Canyon from the south, and Lurance Canyon from the east). These canyons are the headwaters of the Arroyo del Coyote. One of these facilities, the Lurance Canyon Burn Facility, is located within Lurance Canyon that has operated since 1967.

**GEOLOGIC SETTING**

The Manzanita Mountains include a complex sequence of uplifted Precambrian metamorphic and granitic rocks that were subjected to significant deformation. These rocks are capped by Paleozoic sandstones, shales, and limestones of the Sandia Formation and Madera Group. The Precambrian metamorphic rocks typically are fractured as a result of the long and complex history of regional deformation. Core data and rock outcrops indicate that fractures in the upper portions of these rocks are filled with chemical precipitates. These fracture fillings likely

occurred when the water table was elevated prior to the lowering of the water table by the down cutting of the Rio Grande. As chemical precipitates filled fractures, permeability was effectively reduced, creating a semi-confining unit above underlying rocks with open fractures.

The Burn Site is cut by a north-trending system of faults, consisting locally of several high-angle normal fault zones that are downfaulted to the east. Faults (where exposed) are characterized by zones of crushing and brecciation. The Burn Site fault extends north in the vicinity of the Burn Site well and well CYN-MW4. The estimated displacement of this fault locally is as much as 48 meters based on exposed contacts.

The canyon floor at the Burn Site consists of unconsolidated alluvial fill deposits over bedrock. These deposits typically are sand and gravel derived from erosion of the upstream drainage basin. These alluvial deposits range in thickness from 6 to 16 meters in borings.

## **HYDROLOGIC SETTING**

The fractured rocks of the Manzanita Mountains are recharged by infiltration of precipitation, largely occurring in summer thundershowers and, to a lesser degree, from limited winter snowfall on the higher elevations. Recharge is restricted by high evapotranspiration rates (losses to the atmosphere by evaporation and plant transpiration) and low permeability of the metamorphic rocks.

Generally, groundwater in the western Manzanita Mountains moves to the west from a groundwater flow divide located east of the Burn Site [1]. Westward groundwater flow across the Lurance Canyon Test Facility discharges primarily as direct underflow to the unconsolidated basin-fill deposits of the Albuquerque Basin. Based on field observations, some discharge occurs at springs along the mountain front. Much of the flow that discharges from these springs probably is lost to the atmosphere through evapotranspiration. Some flow from the springs probably infiltrates alluvial deposits. The generally westward flow direction may be locally modified by topographic features. Deeply incised canyons may provide local points of discharge through fault zones where the potentiometric surface intersects the canyon floor.

Annual precipitation in the Manzanita Mountains is in the form of rainfall and minor snowfall. July and August are typically the wettest months, and the average annual precipitation is 30 to 40 centimeters. Annual potential evapotranspiration in the Albuquerque area greatly exceeds annual precipitation. Because much of the rainfall in the Lurance Canyon drainage occurs during the hot summer months, losses to evapotranspiration are high. A small percentage may infiltrate into the exposed bedrock or into alluvial deposits in the canyon.

Streamflow occurs episodically in the Arroyo del Coyote channel in response to precipitation in the drainage basin. Two piezometers were constructed in Lurance Canyon to monitor moisture within the channel deposits, at the contact between the alluvial fill and underlying Precambrian bedrock. No water was detected in either piezometer until September 2, 2004. After a series of rain events, between 2 and 5 centimeters of water was measured in 12AUP-01. The water level remained fairly constant through September 2004. However, more recent water level measurements show no measurable water in 12AUP-01. It is likely that saturation above the bedrock interface is present only after a series of significant rain events. Episodic accumulation of precipitation, as evidenced by

the occurrence of water in the piezometer, may provide a mechanism for recharge through brecciated fault zones and uncemented fractures in the underlying bedrock.

Figure 2 presents the current potentiometric surface for the Burn Site monitoring network wells (October 2008). The depth to groundwater beneath the Burn Site ranges from 35 to 100 meters below ground surface. No water supply wells are located near the Burn Site, except for the Burn Site well that is used only occasionally for non-potable applications. Groundwater levels in the Paleozoic rocks near the Burn Site are not influenced by regional water supply well pumping from the basin-fill deposits of the Albuquerque basin.

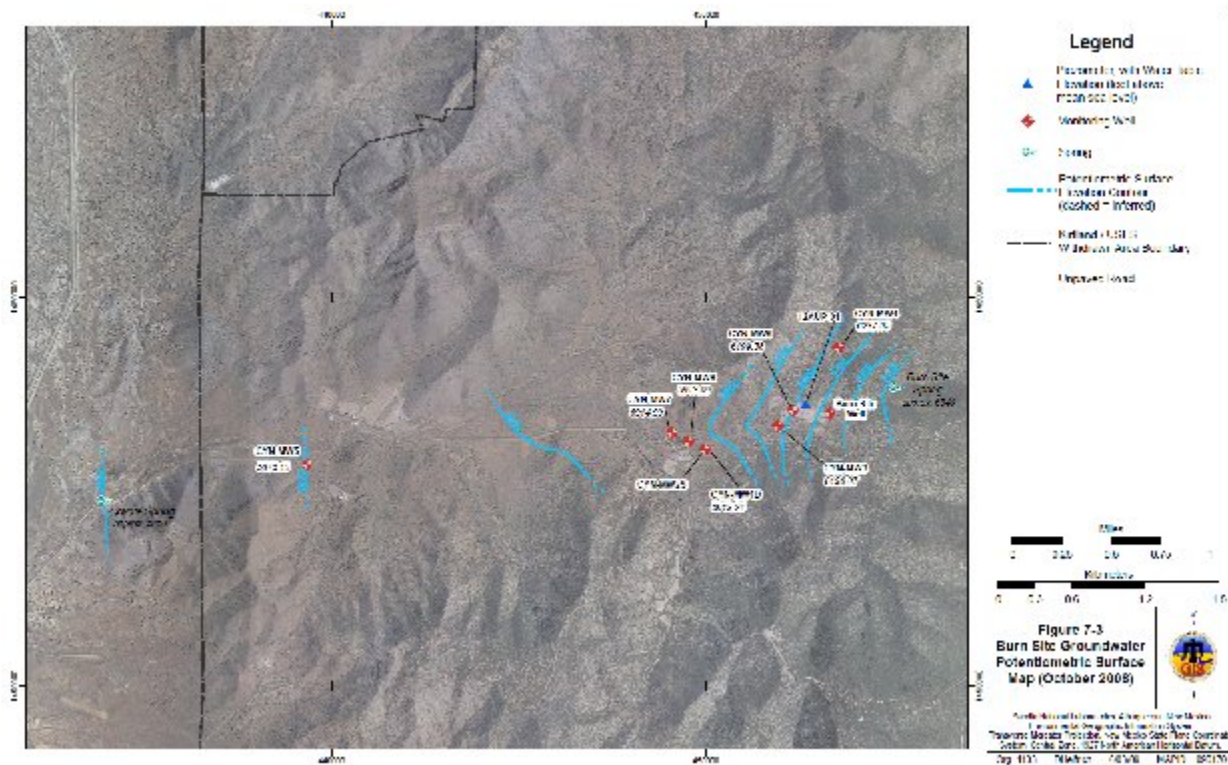


Figure 2. Burn Site Groundwater Potentiometric Surface Map (October 2008)

The apparent horizontal hydraulic gradient based on Burn Site wells, piezometers, and springs varies from approximately 0.004 to 0.14 meters/meter. The hydraulic gradient west of the Burn Site flattens greatly. The wide range of hydraulic gradients in Lurance Canyon indicate that local groundwater systems associated with brecciated fault zones in the low-permeability fractured rock at the Burn Site are poorly connected. Therefore, at the scale of the Burn Site, brecciated fault zones and low-permeability fractures have compartmentalized the aquifer.

Limited flow velocity information includes contaminant first-arrival estimates. Based on contaminant releases from Solid Waste Management Unit (SWMU) 94F arriving at well CYN-MW1D the minimum apparent velocity of the contaminants is estimated to be approximately 48 meters/year [2]. No information is available about vertical flow velocity within the fractured rocks at the Burn Site. However, vertical movement of water to the water table within the brecciated fault zones probably occurs rapidly, under partially saturated to saturated flow conditions. Filled fractures

within the upper portion of metamorphic rock probably act as a semi-confining unit restricting vertical flow.

Water levels have been routinely monitored in Burn Site wells since 1999. No substantial seasonal variation in water levels is evident in these wells; however, longer term (many years) water-level changes have been recorded at the study area. The wide range of hydraulic gradients in Lurance Canyon and the lack of correlation between water-level fluctuations in these wells support the assessment that the low-permeability fractured groundwater system at the Burn Site is poorly connected. Water-level fluctuations may be a result of local heterogeneities in hydraulic properties related to the fractured system.

### **SITE HISTORY**

The Burn Site has been used since 1967 to test the effects of impact, burning, and explosion. Historical operations included open detonation of high explosives (HE). Most HE testing occurred between 1967 and 1975, and was completely phased out by the 1980s. Burn testing began in the early 1970s and has continued to the present. Early burn testing was conducted in unlined pits excavated in native soil. By 1975, portable burn pans were used for open burning using jet fuel composition 4 (JP-4). The Light Air Transport Accident Resistant Container (LAARC) Unit was constructed in 1980 and other engineered burn units were constructed by 1983. These burn units used jet fuel, gasoline, and diesel as fuels for burn tests.

Groundwater samples taken during 1996 from the Burn Site well (a non-potable production well) contained elevated concentrations of nitrate (24.3 mg/L in November 1996). In 1997, the NMED, DOE, and Sandia agreed to investigate the source of this contamination. Later in 1997, monitoring well CYN-MW1D was installed downgradient of the Burn Site well. Samples from this well contained nitrate concentrations above the MCL. Two more wells, CYN-MW3 and CYN-MW4 were installed during 1999-2001; and CYN-MW6, CYN-MW7, and CYN-MW8 were installed in 2006.

Since the initial discovery of nitrate at the Burn Site area, numerous characterization activities have been conducted (Table 1-1). The results of these characterization activities are summarized in two versions of the “*Current Conceptual Model of Groundwater Flow and Contaminant Transport at Sandia National Laboratories/ New Mexico Burn Site*” [3] [2]. These two versions of the Burn Site Conceptual Model provides a comprehensive list of groundwater monitoring data sources used to support the summary of investigations.

There are currently six wells in the Burn Site Groundwater Study Area that are being monitored for water quality: CYN-MW1D, CYN-MW3, CYN-MW4, CYN-MW6, CYN-MW7, and CYN-MW8 (Figure 2). Two shallow piezometers (12AUP-01 and CYN-MW2S) were installed in 1997 to determine if any ephemeral flow was occurring at the alluvium-bedrock interface. Both piezometers have been predominately dry since they were installed.

### **CONTAMINANTS OF CONCERN**

The only COCs identified in groundwater from in the Burn Site study area are nitrate and perchlorate. Organic contaminants associated with fire-suppression wastewater, fuel spills, and high

explosives (HE) used in Burn-Site tests have been detected in groundwater at concentrations below state and EPA standards. For this reason, only nitrate and perchlorate are discussed.

### **Contaminant Distribution in Soils**

Nitrate in the Burn Site groundwater may be derived from both natural and anthropogenic sources. Potential natural sources include concentration of nitrate by evaporation and transpiration of rainwater that has infiltrated canyon alluvial sediments. Potential anthropogenic nitrate sources include the detonation of HE.

Some evidence exists that evaporation and transpiration may concentrate nitrate in sediments beneath ephemeral drainages in the vicinity of the Manzanita Mountains. This evidence includes nitrate concentrations in groundwater beneath these drainages that exceed the MCL and a chloride to nitrate ratio in that groundwater that is similar to the chloride to nitrate ratio in summer rainfall.

SWMU 65 in the center of the Burn Site area contains open detonation areas where nitrate-based explosives were used. Under these conditions, nitrate compounds may have been ejected at the explosive site and disseminated over the adjacent land surface. Subsequent rainfall may have mobilized these soluble compounds. In addition to nitrate in Burn Site area groundwater, petroleum products were detected in area soils, and therefore, the potential for petroleum products in groundwater required evaluation.

In late 2000, the NMED requested to sample soils at select Sandia SWMUs based on historical use of rocket propellants at Sandia. Tests conducted at these SWMUs from the mid-1960s to the mid-1990s used high explosives on weapons components, shipping containers, and other engineered components. There were ten rocket propellant tests conducted at SWMU 65 between January 1984 and August 1993. Although not all rocket propellant contains perchlorate, it seems plausible that the propellant used at SWMU 65 may have contained perchlorate.

In January 2001, NMED selected eight judgmental soil samples within the Burn Site Study Area at specific locations at SWMUs 65 and 94. The soil samples were analyzed by EPA Method 314.0 (Ion Chromatography) with sample-specific MDLs that varied from 10.2 to 15.2 µg/L. The eight soil samples collected by NMED represent the only soil samples collected to date in the Burn Site Groundwater Study Area. All eight samples were nondetect for perchlorate; however the laboratory MDLs for the 2001 sampling event are relatively high compared to detection limits that can be reached with current analytical methods, the results show that there is no gross perchlorate contamination in site soils.

### **Contaminant Distribution and Transport in Groundwater**

Nitrate was first detected above the MCL of 10 mg/L in water from the Burn Site well. Since the completion of wells CYN-MW1D (December 1997), CYN-MW3 (June 1999) and CYN-MW6 (February 2006), nitrate concentrations above the MCL have been consistently detected in these

wells. Nitrate concentrations in water from wells CYN-MW4, CYN-MW7, and CYN-MW8 have not exceeded the MCL.

Nitrate concentrations in water from the Burn Site well have decreased from 24.3 mg/L in 1996 to 5.5 mg/L in 2001, and due to logistical considerations the well has not been sampled since. Concentrations in water from well CYN-MW3, approximately 424 meters downgradient from the Burn Site well, have ranged from less than 5 to 22 mg/L since 1999. Concentrations in water from well CYN-MW6, approximately 300 meters downgradient from the Burn Site well, have ranged from 22.9 to 33.0 mg/L since 2006 (Figure 3). Nitrate concentrations have increased from approximately 10 mg/L to more than 25 mg/L from 1998 to 2008 in water from well CYN-MW1D, located approximately 1030 meters downgradient from the Burn Site well.

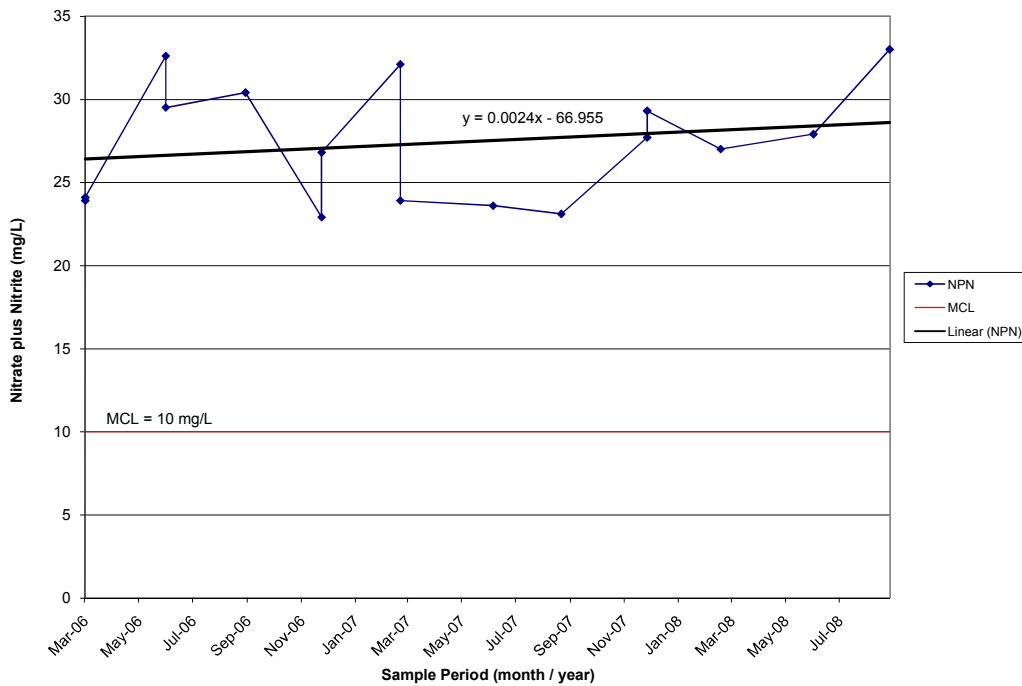


Figure 3. Burn Site Groundwater, Nitrate Plus Nitrite Concentrations over Time at Monitoring Well CYN-MW6

Potential downgradient receptors for the Burn Site groundwater plume are Coyote Springs approximately 5 kilometers west of the study area, and the City of Albuquerque and KAFB well fields approximately 19 kilometers to the west-northwest of the study area. Numerical simulations suggest nitrate concentrations will be decreasing in groundwater to below MCLs at Coyote Springs, and to below detection limits through dispersion and dilution as the plume moves into the more hydraulically conductive Ancestral Rio Grande (ARG) deposits west of Coyote Springs. Numerical simulations also show that that contaminant travel times exceed 600 years from the study area to the COA and KAFB wellfields [4].



Since June 2004 (the start of sampling required by the Order), perchlorate has only been detected above the screening level/MDL (4 µg/L) in one of the wells (CYN-MW6) in the perchlorate-screening monitoring-well network (Figure 4). Due to the detection of perchlorate in the samples from CYN-MW6 in March 2006, DOE/Sandia submitted the “Notification of Release, Perchlorate at Well CYN-MW6, May 2006” [5] to the NMED. DOE and Sandia were required to notify the NMED of the discovery of a previously unknown release under Section V of the Order [6].

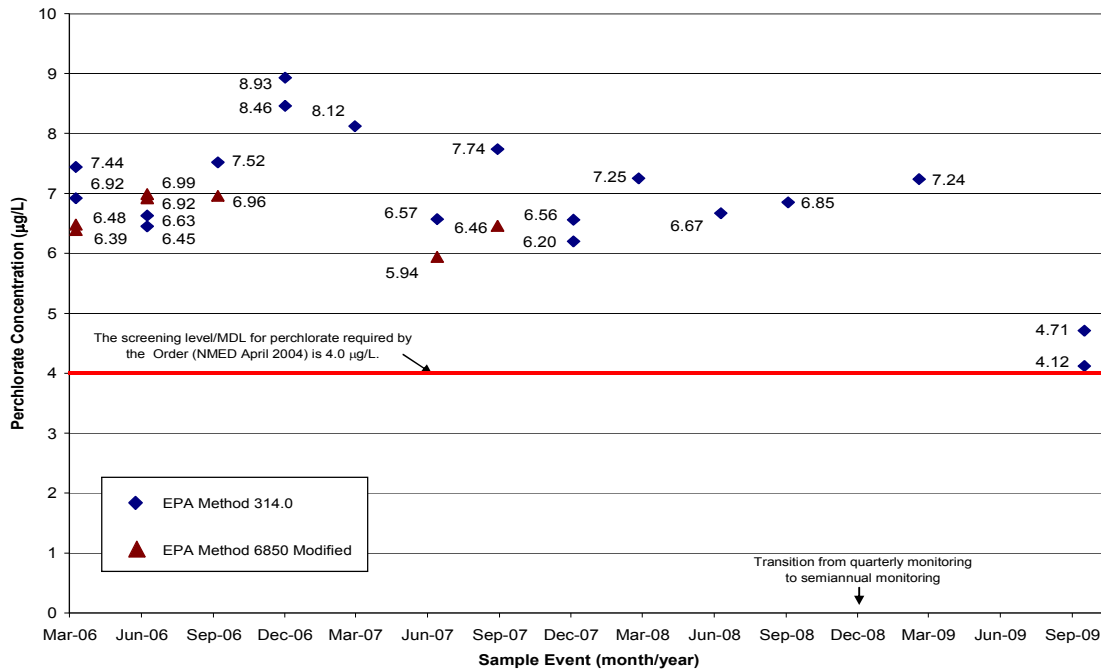


Figure 4. Burn Site Groundwater, Perchlorate Concentrations over Time at Monitoring Well CYN-MW6

Per the requirements of Section VI.K.1.b of the Order [6], a human health risk assessment has been performed to evaluate the potential for adverse health effects from the concentrations of perchlorate detected in CYN-MW6 groundwater. The maximum concentration of perchlorate in CYN-MW6 to date (8.93 µg/L) was used in the assessment. The calculated hazard quotient (HQ) of 0.35 is less than the NMED target level of a Hazard Index (the sum of all HQs) of 1.0 [7] [8].

**REGULATORY REQUIREMENTS**

The regulatory requirements for investigation at the Burn Site study area have been an ever-changing landscape that prohibited the timely selection of a corrective measure. The NMED Hazardous Waste Bureau provides regulatory oversight of the ER Project and implements/enforces federal regulations mandated by the Resource Conservation and Recovery Act (RCRA). All ER SWMUs and Areas of Concern (AOC) are listed in Module IV of the SNL/NM RCRA Part B Operating Permit [9]. More recently, all investigations and corrective action requirements pertaining to SWMUs and AOCs are contained in the Order [6].



Before the finalization of the Order in April 2004 groundwater investigations at the Burn Site had been conducted voluntarily by the ER Project. The Order specified the Burn Site as an area of nitrate and fuel constituent groundwater contamination requiring a Corrective Measures Evaluation (CME). In response, DOE/Sandia submitted a CME Work Plan and a Current Conceptual Model. At that point the NMED concluded that characterization of the extent of nitrate and fuel constituent contamination was not complete enough to proceed with a CME and informed DOE/Sandia that the Burn Site required Interim Measures. Based on requirements stipulated by the NMED, DOE/Sandia submitted the Burn Site Interim Measures Work Plan (IMWP) [4] on May 30, 2005. As detailed in the May 2005 IMWP, three new monitoring wells were installed and quarterly sampling for eight quarters began for the three new monitoring wells.

Based on further requirements of the Order, the newly installed IMWP wells needed to be sampled for perchlorate. At the time there was no promulgated national or state drinking water standard for perchlorate, so the NMED mandated a screening level and minimum detection limit (MDL) of 4 µg/L. NMED did not provide any justification for the 4 µg/L screening level. As perchlorate was detected above the screening level/MDL in CYN-MW6, monitoring continued at that well. DOE/Sandia were also required by the Order to evaluate the nature and extent of perchlorate contamination based on a screening level/MDL of 4 µg/L in the vicinity of CYN-MW6. Section VII.C of the Order clarifies that the CME process will be initiated where there was a release to the environment and where corrective measures are necessary to protect human health or the environment.

Data collected as required by the IMWP were incorporated in an updated version of the conceptual model [2]. The updated conceptual model provided the basis for a technically-defensible remediation program that was developed and documented in the CME Work Plan [10], the results of which will eventually be documented in the CME Report. The work plan included information and data gathered during interim measures, and performance and compliance goals and objectives for the remediation of the Burn Site groundwater.

DOE/Sandia never received any regulatory input from the NMED on the updated conceptual model or the CME Work Plan. However, in April 2009, DOE/Sandia received a letter from the NMED discussing the occurrence of perchlorate in Burn Site groundwater. The letter stated DOE/Sandia must characterize the nature and extent of the perchlorate contamination and must submit to the NMED a plan for such characterization [11].

**Table 1. Regulatory Timeline of the Burn Site Groundwater Study Area**

Date	Event
1967-early 1980s	HE testing at 18 SWMUs within the BSG study area until early 1980s. Burn testing began in 1970s using excavation pits and portable burn pans with JP-4. Wastewater discharged into unlined pits.
1996	DOE/Sandia begin voluntary monitoring program at the Burn Site, existing production well showed nitrate levels (25 mg/L) above the regulatory standard (10 mg/L).
July-1997	NMED and DOE/Sandia agree on installation of deep and shallow monitoring wells one year of quarterly sampling.
Various	BSG study area SWMUs 94 and 65 proposed and approved for NFA/CAC.
Various	Annual Groundwater Monitoring Reports with BSG analytical data submitted to NMED from 1998 to present. No comments received from NMED.
November	Comprehensive BSG Investigation Report documenting hydrogeologic characteristics

Date	Event
2001	of the study area prepared. No comments received from NMED.
April-2004	The Order lists BSG as an Area of Concern that requires a CME.
June-2004	A revised conceptual model of the BSG study area was submitted to NMED.
June-2004	A CME work plan for the BSG study area was submitted to NMED.
February-2005	NMED requires additional site characterization and the preparation of an Interim Measures Work Plan.
May-2005	BSG Interim Measures Work Plan submitted to NMED.
July-2005	NMED requires supplemental information for the Interim Measures Work Plan.
August-2005	DOE/Sandia respond to RSI.
Various	DOE/Sandia submit quarterly reports identifying perchlorate in CYN-MW6 above NMED's 4 µg/L screening level.
March 2007	NMED requires that DOE/Sandia determine the nature and extent of the contamination and complete a CME for the perchlorate-impacted groundwater in the vicinity of CYN-MW6.
April 2007	DOE/Sandia recommend further characterization through continued quarterly monitoring of CYN-MW6 and initiate discussions with NMED for appropriate characterization of perchlorate.
April-2008	BSG Current Conceptual Model resubmitted to NMED. No comments received.
April-2008	BSG CME Work Plan resubmitted to NMED. No comments received.
April 2009	NMED submits letter to DOE/Sandia requesting further characterization of perchlorate in the BSG Study area.
November 2009	DOE/Sandia submits BSG Characterization Work Plan.

**Notes:**

- BSG = Burn Site Groundwater.
- NFA/CAC = No Further Action/Corrective Action Complete.
- RSI = Request for Supplemental Information.

**FUTURE WORK**

A Burn Site Groundwater Characterization Work Plan was prepared in response to a letter received from the NMED to the DOE and Sandia on April 30th, 2009 [11]. The Burn Site Groundwater Characterization Work Plan [12] the activities and procedures to install and sample groundwater monitoring wells and sample soils to comply with NMED's requirements, including:

- Install 3 or 4 groundwater monitoring wells.
- Use soil borings to collect subsurface soil samples for perchlorate analysis at 10 to 20 locations.
- Submit a report describing the field activities.
- Sample the newly installed groundwater wells for eight consecutive quarters.
- Prepare an Investigation Report (revised Current Conceptual Model) describing groundwater and soil analytical results.
- Reevaluate the corrective measures and submit a revised CME Work Plan.

The groundwater monitoring wells (CYN-MW9, CYN-MW10, and CYN-MW11) will be installed upgradient of CYN-MW6 drilled using a combination of Air-Rotary Casing-Hammer (ARCH) and Air-Rotary drilling methods. Two of the proposed wells (CYN-MW9 and CYN-MW10) are upgradient of CYN-MW6 and were specifically requested during negotiations with the NMED [13]. NMED apparently believes a source of perchlorate contamination exists upgradient of CYN-MW6.

NMED also requested that the Burn Site Production Well be sampled. However, due to well construction issues, such as a dedicated high volume production pump, DOE/Sandia herein propose to install a proper groundwater monitoring well (CYN-MW11) to sample in lieu of sampling the

Burn Site Production Well. A fourth well may be required if the revised potentiometric surface map shows that the area downgradient of CYN-MW6 is not sufficiently characterized.

The soil sampling program will provide data regarding vadose-zone perchlorate concentration profiles with depth, and will be completed during two phases, if required. Phase 1 will consist of sampling at 10 locations along two north-south lines that straddle CYN-MW6. The north-south trending lines will contain five locations each. Samples will be collected from unconsolidated deposits (alluvium and colluvium) at approximately 0.5 meters below ground surface (bgs), 1.5 meters bgs, and at approximately 1.5 meter intervals down to the top of bedrock. The unconsolidated deposits are estimated to have a maximum thickness of 12 to 15 meters along the center line of the alluvial basin that contains the Burn Site and these deposits thin rapidly to the north and south. Per NMED requirements, all soil samples will be sampled for NPN, perchlorate, SVOCs, and VOCs. Phase 2, if required, will consist of up to 10 locations to help define any Phase 1 locations that had substantial hits of NPN, perchlorate, SVOCs, and VOCs. The list of analytes during Phase 2 may be narrowed based on Phase 1 findings.

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[8] *Consolidated Quarterly Report, Section III: Perchlorate Screening Quarterly Monitoring Report, Fourth Quarter of Calendar Year 2007 (October, November, and December 2007)*, Sandia National Laboratories, New Mexico Environmental Restoration Project. March 2008.

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[10] *Corrective Measures Evaluation Work Plan, Burn Site Groundwater*, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. April 2008.

[11] *Perchlorate Contamination in Groundwater, Sandia National Laboratories, EPA ID# NM5890110518.* Letter to Kimberly Davis (SSO/NNSA) and Francis Nimick (SNL/NM) from James Bearzi, New Mexico Environment Department, Santa Fe, New Mexico. April 2009.

[12] *Burn Site Groundwater Characterization Work Plan, Installation of Groundwater Monitoring Wells CYN-MW9, CYN-MW10, and CYN-MW11, Collection of Subsurface Soil Samples*, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. November 2009.

[13] *Notes of Meeting—June 15, 2009 Meeting Between NMED, DOE, and SNL/NM to Discuss the April 2009 NMED Letter entitled: Perchlorate Contamination in Groundwater, Sandia National Laboratories*, Internal Memorandum from Michael Skelly (Dept 6765) to John Cochran (Dept. 6765), Sandia National Laboratories/New Mexico. June 2009.