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**ENVIRONMENTAL  
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A Department of Energy  
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# **Characterization Well R-15 Geochemistry Report**

 **Los Alamos**  
NATIONAL LABORATORY

Los Alamos NM 87545

Produced by the Groundwater Investigations Focus Area

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**List of Acronyms and Abbreviations**

am	amorphous
C	colorimetry
°C	degrees Celsius
CVAA	cold vapor atomic absorption
DOC	dissolved organic carbon
DOM	dissolved organic matter
E°	standard electrode potential in volts
Eh	oxidation-reduction potential
EPA	Environmental Protection Agency
ER	environmental restoration
HE	high explosive
HSA	hollow-stem auger
IC	ion chromatography
ICPOES	inductively coupled argon plasma optical emission spectroscopy
ICPMS	inductively coupled argon plasma mass spectrometry
IRMS	isotope ratio mass spectrometry
ISE	ion selective electrode
J values	estimated values
JMML	Jemez Mountains meteoric line
LANL	Los Alamos National Laboratory
MCL	maximum contaminant level
MCOBT	Mortandad Canyon Observation Bandelier Tuff
MDA	minimum detectable activity

MEQ	milliequivalents
μS/cm	microSiemens per centimeter
MWL	(worldwide) meteoric water line
NTU	nephelometric turbidity unit
pH	negative log <sub>10</sub> activity of the hydrogen ion
ppt	precipitate
SI	saturation index
TA	technical area

**Metric to English Conversions**

<b>Multiply SI (Metric) Unit</b>	<b>by</b>	<b>To Obtain US Customary Unit</b>
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (μm)	0.000394	inches (in.)
square kilometers (km <sup>2</sup> )	0.3861	square miles (mi <sup>2</sup> )
hectares (ha)	2.5	acres
square meters (m <sup>2</sup> )	10.764	square feet (ft <sup>2</sup> )
cubic meters (m <sup>3</sup> )	35.31	cubic feet (ft <sup>3</sup> )
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm <sup>3</sup> )	62.422	pounds per cubic foot (lb/ft <sup>3</sup> )
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (μg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)



# CHARACTERIZATION WELL R-15 GEOCHEMISTRY REPORT

by

Patrick Longmire

## ABSTRACT

This report provides analytical results for groundwater obtained during four characterization sampling rounds conducted at regional aquifer well R-15 from February 2000 through May 2001 (February 24, 2000; October 11, 2000; February 15, 2001; and May 22, 2001). A geochemical evaluation of the analytical results is also presented. The goal of the characterization effort at R-15 is to assess the hydrochemistry and to determine if any contaminants are in the regional aquifer in the vicinity of the well. Characterization well R-15 is located in Mortandad Canyon southeast of the sediment traps within Technical Area (TA)-5, Los Alamos National Laboratory (LANL or the Laboratory). Well R-15 is downgradient of multiple contaminant source areas that include release sites in the Mortandad Canyon watershed. R-15 is completed with a single-screen well (958.6 to 1020.3 ft) with a dedicated submersible pump set in the Puye Formation. The regional water table was at a depth of 964 ft at well R-15 during characterization sampling.

Four rounds of groundwater characterization samples collected from a depth of 1018.6 ft were chemically characterized for radionuclides, metals and trace elements, major ions, high explosive (HE) compounds, dissolved organic carbon, organic compounds, and stable isotopes (H, N, and O). Analytical results for R-15 show that contaminant concentrations are presently below maximum contaminant levels (MCLs) within the regional aquifer at this well location. Analytical methods recommended by both the Environmental Protection Agency (EPA) and Environmental Restoration (ER) Project laboratories external to the Laboratory were followed for groundwater (filtered and nonfiltered) samples. Americium-241, cesium-137, plutonium-238, and plutonium-239,240 were not detected in groundwater samples collected from well R-15. These radionuclides adsorb onto aquifer material and migrate in groundwater to a limited extent beneath the alluvium. Strontium-90, however, was detected ( $1.51 \pm 0.91$  pCi/L,  $3 \sigma$  error) in a filtered groundwater sample collected from the regional aquifer on February 15, 2001. Strontium-90 was not detected, however, in the first, second, and fourth sampling rounds. Activities of uranium-234, uranium-235, and uranium-238 were only detected at concentrations less than 1 pCi/L. Gross alpha and gross beta activities were generally less than detection. Measurable gross gamma was attributed to isotopes within the natural uranium-238, uranium-235, and thorium-232 decay chains.

Groundwater from the regional aquifer in well R-15 is dominantly a calcium-sodium-bicarbonate type. This groundwater was found to contain an average of 2.1 pCi/L tritium, 0.000350 milligrams/liter (mg/L) (0.350 micrograms per liter [ $\mu\text{g/L}$ ]) dissolved uranium, 4.3 mg/L dissolved chloride, 0.00271 mg/L (2.71  $\mu\text{g/L}$ ) dissolved perchlorate, 0.18 mg/L dissolved fluoride, 5.6 mg/L dissolved sulfate, and 2.3 mg/L nitrate plus nitrite (as N). Nitrate is the dominant nitrogen species present in groundwater collected from R-15. Current analytical reporting and detection limits for perchlorate are 0.004 and 0.001 mg/L (4 and 1  $\mu\text{g/L}$ ), respectively, with the ion chromatography method. Stable isotope ratios of  $\delta\text{D}$  and  $\delta^{18}\text{O}$  imply that the sampled groundwater was derived from a local meteoric source, consisting of precipitation and surface water. Low activities of tritium suggest that most of sampled groundwater is greater than 60 years in age and predated nuclear testing. Results of  $\delta^{15}\text{N}$  ( $\text{NO}_3$ ) analyses suggest that nitrate plus nitrite is derived from treated nitric acid discharges, which vary in isotopic composition in the alluvium, Cerros del Rio basalt, and Puye Formation in Mortandad Canyon.

Geochemical calculations using the computer program MINTEQA2 were performed to evaluate solute speciation and mineral equilibrium in assessing groundwater chemistry and refining the geochemical conceptual model for R-15. Results suggest that the regional aquifer at well R-15 is in close equilibrium with amorphous silica phases or volcanic glass and is undersaturated with respect to  $\text{CaCO}_3$  and  $\text{SrCO}_3$ . This suggests that the mobility of strontium-90 is controlled by cation exchange rather than mineral equilibrium. Smectite and silica glass identified in core samples within the regional aquifer would adsorb strontium-90 if it were present. Such adsorption results in decreasing activities of this fission product in groundwater. Adsorption processes are considered to dominate over mineral equilibrium, for strontium-90 at R-15. Major cations and anions are calculated to occur as free or uncomplexed solutes. Alkalinity ( $\text{HCO}_3^-$ ) provides ligands for complexing with uranium(VI). Uranium(VI) is calculated to be stable as  $\text{UO}_2(\text{CO}_3)_2^{2-}$  and  $\text{UO}_2(\text{CO}_3)_3^{4-}$  complexes under oxidizing conditions. Calculation results agree well with observed mineralogy and groundwater analytical results.

## **1.0 INTRODUCTION**

This report provides analytical results for four groundwater sampling rounds conducted at characterization well R-15. The goal of the characterization effort at R-15 is to assess the hydrochemistry and to determine if any contaminants are in the regional aquifer in the vicinity of the well. This well is located in middle Mortandad Canyon, in TA-5, within the Laboratory (Figure 1.0-1) (Longmire et al. 2001, 70103). Well R-15 was installed by the ER Project as part of groundwater investigations required by the Mortandad Canyon Work Plan (LANL 1997, 56835). It also satisfies requirements to install a well in this part of the regional aquifer as part of the "Hydrogeologic Workplan" (LANL 1998, 59599) in support of the Laboratory's "Groundwater Protection Management Program Plan" (LANL 1995, 50124). Well R-15 primarily is designed to provide geochemical or water quality and hydrogeologic data for the regional aquifer downgradient of potential release sites in the Mortandad Canyon watershed (LANL 1997, 56835). A geochemical evaluation of the analytical results is also presented.

Hydrogeochemical interpretations are presented using validated analytical results for groundwater samples collected at well R-15. Discussion of other hydrogeochemical data collected within the Mortandad Canyon watershed, however, is deferred until they can be evaluated in the context of site-wide information collected from other ER Project and hydrogeologic work plan characterization wells [Mortandad Canyon Observation Bandelier Tuff (MCOBT)-4.4, R-13, and R-14]. Once all deep groundwater investigations in Mortandad Canyon are completed, geochemical and hydrogeologic conceptual models for the watershed may be included in a groundwater risk analysis. These models will include an evaluation of potential contaminant transport pathways.

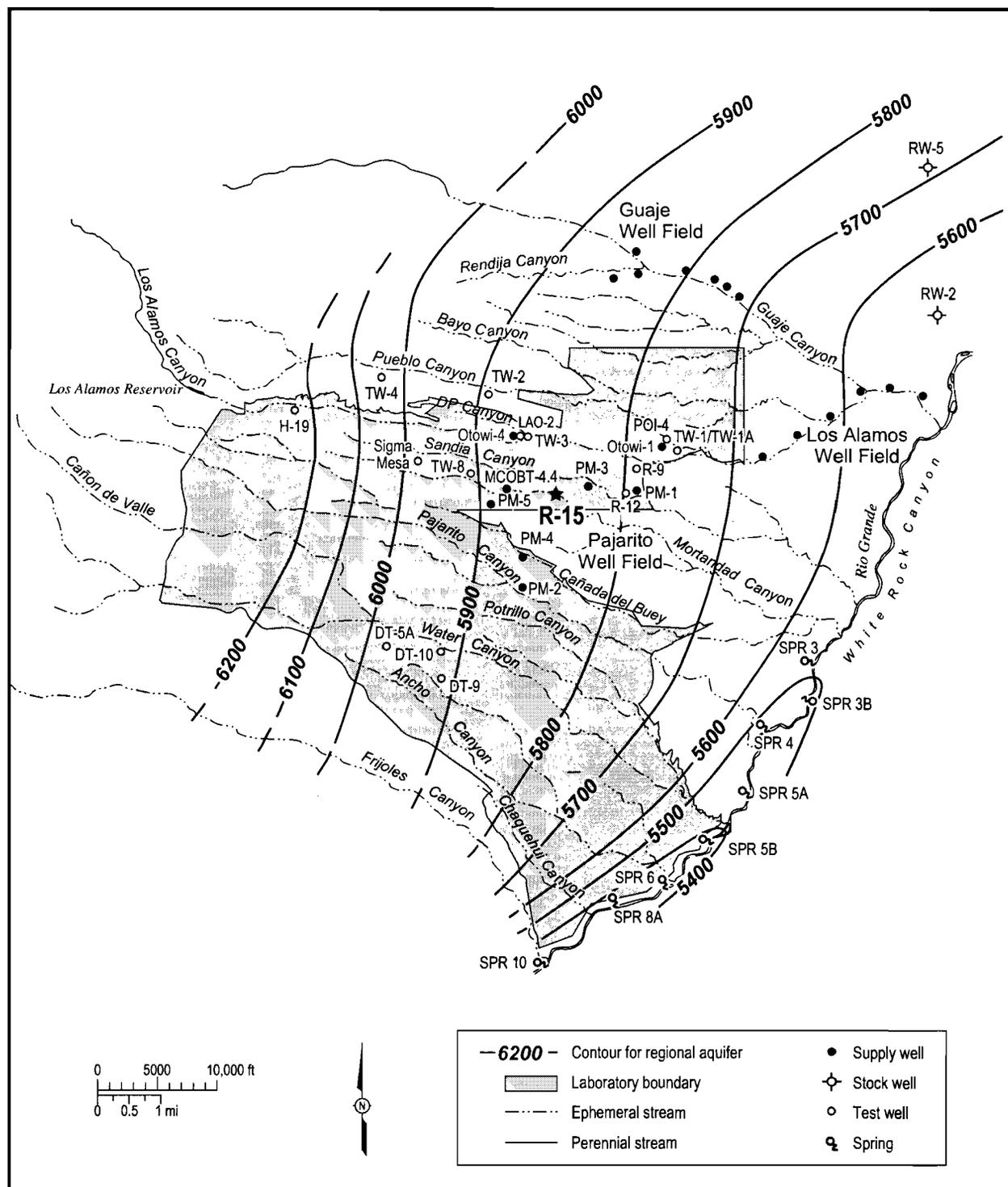
Although R-15 is primarily a characterization well, its design also meets the requirements of a monitoring well as defined in Module VIII of the Laboratory's Hazardous Waste Facility Permit. Incorporation of this well into a Laboratory-wide groundwater monitoring program will be evaluated at a later date when the results of this characterization activity are integrated with other groundwater investigations in the "Hydrogeologic Workplan" (LANL 1998, 59599).

## **2.0 DRILLING METHODS AND WELL DESIGN**

### **2.1 Drilling Methods**

Drilling of R-15 was conducted in two phases during 1998 and 1999. Phase I utilized the hollow-stem auger (HSA) drilling technique to drill a total of 420 ft during September 1998. The HSA method provided dry core samples for evaluating moisture and anion profiles below the canyon floor. The HSA borehole below the surface casing then was backfilled with cuttings and the casing sealed at the surface at the conclusion of Phase I drilling. R-15 Phase II drilling from June 8 through September 7, 1999, utilized an air rotary casing-advance drilling technique to drill to a total borehole depth of 1107 ft (Longmire et al. 2001, 70103). The casing-advance drilling method was assisted by the use of drilling mud behind the casing for lubrication.

TORKease® polymer and EZ-MUD® bentonite slurries, mixed with community water obtained from Laboratory fire-protection hydrant number 64 located at TA-52, were utilized for 69% of the total borehole depth. These additives were used to lubricate the outside of the casing system during drilling and to prevent binding the casing string to the borehole wall or another casing string. Footage intervals for which lubricating slurry was used are provided by Longmire et al. (2001, 70103).



Source: Purtymun 1984, 6513.

F1.0-1/ R-15 WELL COMPLETION RPT / 062900 / PTM

**Figure 1.0-1. Locations of well R-15, selected water supply wells, test wells, springs near the Rio Grande, and generalized water-level contours for the regional aquifer**

## 2.2 Well Design

Characterization well R-15 was designed as a single-completion well with a wire-wrapped, stainless steel screen. Figure 2.2-1 shows final construction information for well R-15. The screen, with a nominal length of 61.7 ft, is located across the top of the regional zone of saturation. The screen extends from 5 ft above the regional water table to approximately 56 ft into saturation. This screen length ensures that the well can continue to function even if the regional water table declines because of extraction of water from nearby supply wells.

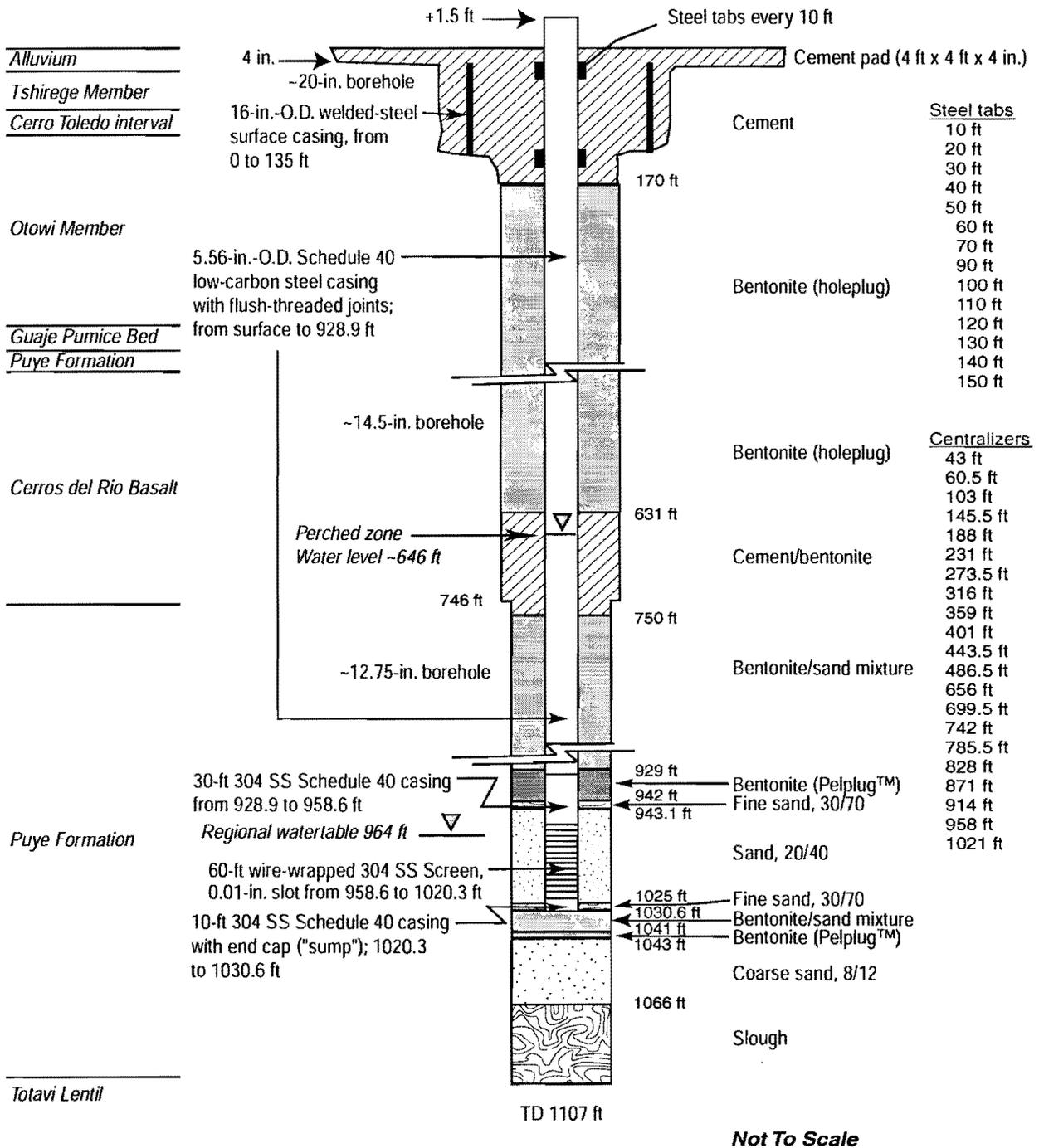
A submersible pump was installed in well R-15 by Rio Grande Well Supply of Santa Fe, New Mexico. The pump is a 3-horsepower Grunfos™ Model 10S30-34, 4-in.-outer diameter, submersible pump that operates on a 460-volt, 3-phase power supply provided by a portable diesel generator. The pump intake was set at 1018.6 ft below the top of the 5-in. well casing; this location places the intake approximately 55 ft below the static water level in the well. The pump was installed with a check valve and weep hole drilled in the riser pipe at a point near the static water level in the well to allow water to drain from the piping. The pump capacity is approximately 10 gal./min at 700-ft depth. The depths to static water table (regional) were 986.15 and 986.09 ft, measured on February 15 and May 22, 2001, respectively. Static water-level measurements were not recorded at R-15 on February 24 and October 11, 2000.

Before each groundwater sampling event at well R-15, approximately three casing volumes of groundwater were pumped from the well. Field parameters including pH, specific conductance, turbidity, and temperature were recorded during each well sampling event.

## 3.0 HYDROGEOLOGY

### 3.1 Hydrostratigraphy

The principal hydrogeologic units penetrated in well R-15, in descending order, consist of alluvium, the Tshirege Member of the Bandelier Tuff, tephra and volcanoclastic sediments of the Cerro Toledo interval, the Otowi Member of the Bandelier Tuff, the fanglomerate facies of the Puye Formation, basaltic rocks of the Cerros del Rio volcanic field, more Puye fanglomerate, and the axial Rio Grande facies of the Puye Formation (Totavi Lentil) (Longmire et al. 2001, 70103). No perched groundwater was encountered in the Cerro Toledo interval or Guaje Pumice Bed. However, a single perched zone of saturation was found to occur between the depths of approximately 646 and 740 ft in the Cerros del Rio basalt. A clay-rich zone at the base of the basalt appears to be the perching layer. A slug test of this interval yielded a value for hydraulic conductivity of  $2.54E-07$  cm/sec, which is at the lower end of the range typical of silt (Longmire et al. 2001, 70103). The top of the regional zone of saturation lies at a depth of 964 ft in the Puye Formation. A 46-hr aquifer pumping test was conducted at well R-15 on February 19 and 20, 2000 (Longmire et al. 2001, 70103). From the aquifer performance tests, average transmissivity, storage coefficient, and hydraulic conductivity were calculated as  $123.4$  ft<sup>2</sup>/day, 0.0025, and  $0.00117$  cm/sec (2.06 ft/day), respectively.



F8.0-1 / R-15 WELL COMPLETION RPT / 072500 / PTM

Figure 2.2-1. As-built well completion diagram of well R-15

## 4.0 FIELD SAMPLING AND ANALYTICAL METHODS

### 4.1 Field Sampling Methods

Groundwater samples analyzed for inorganic and organic chemicals and radionuclides were collected using a dedicated submersible pump at well R-15. Temperature, turbidity, pH, and specific conductance were determined onsite from an aliquot collected during field sampling. Both filtered and nonfiltered samples were collected for chemical and radiochemical analyses. Groundwater samples were collected for analyses of dissolved organic carbon (DOC); total organic carbon; stable isotopes of hydrogen, oxygen, and nitrogen; major cations and anions; metals; organic compounds; and radionuclides. Aliquots of the samples were filtered through a 0.45- $\mu\text{m}$  Gelman filter and acidified with analytical-grade  $\text{HNO}_3$  to a pH of 2.0 or less for metal and radionuclide analyses. DOC samples were filtered with a special 0.45- $\mu\text{m}$  silver filter to eliminate biodegradation of organic solutes. All groundwater samples collected in the field were stored at 4°C until they were analyzed.

### 4.2 Field Parameters

Field-measured parameters for the groundwater samples, including pH, temperature, specific conductance, and turbidity, are provided in Table 4.2-1. These parameters were measured at the time of sample collection when groundwater was in contact with the atmosphere. Temperature, specific conductance, and pH were measured with an Orion meter (model no. 1230); and turbidity was measured with a Hach meter (model no. 53600-00). Both meters were calibrated daily using buffer solutions (pH 4 and 7) and known standards for turbidity. Field measurements were recorded with daily activity logs submitted to the ER Project and are included with the analytical results.

**Table 4.2-1**  
**Field-Measured Parameters for Groundwater Samples Collected at Well R-15**

Geologic Unit	Puye Formation	Puye Formation	Puye Formation	Puye Formation
Depth (ft)	1018.6	1018.6	1018.6	1018.6
Date sampled (mo/dy/yr)	02/24/00	10/11/00	02/15/01	05/22/01
pH (standard units)	8.06	7.90	8.15	7.87
Temperature (°C)	20.6	16.9	19.0	21.5
Specific conductance ( $\mu\text{S}/\text{cm}^{\text{a}}$ )	126	130	146	150
Turbidity (NTU <sup>b</sup> )	4.7	3.0	2.6	1.2

<sup>a</sup>  $\mu\text{S}/\text{cm}$  = microSiemens per centimeter.

<sup>b</sup> NTU = nephelometric turbidity unit.

### 4.3 Analytical and Validation Methods

#### 4.3.1 Analytical Methods

Groundwater samples were analyzed using techniques specified in EPA method SW-846 including ion chromatography (IC) for bromide, chloride, fluoride, oxalate, nitrate, nitrite, perchlorate, phosphate, and sulfate. Inductively coupled argon plasma optical emission spectroscopy (ICPOES) was the analytical method for trace elements (aluminum, arsenic, barium, boron, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, selenium, silicon (silica), silver, sodium,

strontium, vanadium, and zinc). Total cyanide was analyzed by colorimetry (C) and mercury was analyzed by cold vapor atomic absorption (CVAA). Ammonium was analyzed by ion selective electrode (ISE). Antimony, beryllium, cadmium, lead, thallium, and uranium were analyzed by inductively coupled argon plasma mass spectrometry (ICPMS). This work was performed by contract laboratories including Paragon Analytics, Inc. (IC, C, ISE, CVAA, and ICPOES methods) and General Engineering Laboratory (ICPMS and perchlorate-IC). Alkalinity was determined in the laboratory (Paragon) using standard titration techniques. Laboratory blanks were analyzed in accordance with EPA and Laboratory procedures. The precision limits for major ions and trace elements were generally  $\pm 10\%$ .

Tritium activity in groundwater was determined by electrolytic enrichment. Radiometric methods included alpha spectrometry for americium, plutonium, and uranium isotopes; gamma spectrometry for cesium-137 and other gamma-emitting isotopes; and gas proportional counting for strontium-90. These analyses were performed by contract laboratories including Paragon Analytics, Inc. (radionuclides) and the University of Miami (low-level tritium).

Stable isotope ratios of oxygen ( $\delta^{18}\text{O}$ ) and hydrogen ( $\delta\text{D}$ ) were analyzed by Geochron Laboratories (Cambridge, Massachusetts) using isotope ratio mass spectroscopy (IRMS). Nitrogen isotope ratios ( $\delta^{15}\text{N}$ ) were analyzed by Coastal Science Laboratories, Inc. (Austin, Texas) using IRMS.

Volatile and semivolatile organic compounds, HE compounds, polychlorinated biphenyls, and pesticides were analyzed by high pressure liquid chromatography and gas chromatography-mass spectrometry. Paragon Analytics, Inc. performed these analyses.

#### 4.3.2 Validation Methods

Data quality validation was performed on chemical and radiochemical analytical results (electronic format) for groundwater samples collected from well R-15 during February 2000 through May 2001. There were no deficiencies associated with the analytical results. Groundwater samples were analyzed within required holding times. Laboratory blanks, percent tracer recovery, laboratory duplicate samples, laboratory control samples, internal standards, spike recovery, and analyte concentrations relative to instrument detection and reporting (quantitation) limits were evaluated as part of the validation procedure. Charge balance errors for analytical results were calculated for major and trace ions using the computer program MINTEQA2. Charge balance is defined as:

$$(100)[(\sum \text{milliequivalents cations} - \sum \text{milliequivalents anions}) \text{ divided by } (\sum \text{milliequivalents cations} + \sum \text{milliequivalents anions})].$$

Detection of a chemical in groundwater is defined as an analyte concentration that exceeds the instrument detection limit. A nondetect is defined as an analyte concentration that is recorded but is less than the instrument detection limit. The reporting limit is defined as the instrument quantitation limit.

## 5.0 GROUNDWATER ANALYTICAL RESULTS

This section presents analytical results obtained during four sampling rounds conducted at well R-15 on February 24, 2000, October 11, 2000, February 15, 2001, and May 22, 2001. Analyte suites include major ions, trace elements-trace metals, radionuclides, stable isotopes, organic compounds, and DOC. Analytical results for R-15 show that contaminant concentrations are presently below MCLs within the regional aquifer at this well location.

## 5.1 Major Ions, Metals, Radionuclides, Organic Compounds, and Stable Isotopes

Selected results of inorganic and organic analytes measured at well R-15 are provided in Table 5.1-1 and complete analytical results are provided in Appendix A. Groundwaters sampled at well R-15 generally had charge balance errors less than  $\pm 10\%$ . Negative charge balance errors in Table 5.1-1 indicate excess anions from analytical results, a finding which probably is due to measurement of alkalinity off-site at Paragon Analytics, Inc. Distributions of dissolved major ions and silica are shown in Figure 5.1-1. Groundwater at well R-15 is characterized by a calcium-sodium-bicarbonate ionic composition with calculated total dissolved solids ranging between 155 and 172 mg/L (Figure 5.1-1). Average concentrations of dissolved chloride, nitrate plus nitrite (as nitrogen), and sulfate are 4.3 mg/L, 2.3 mg/L, and 5.6 mg/L, respectively. Dissolved silica is the most abundant solute, a finding consistent with the ubiquitous volcanic glass present in the Puye Formation from 979 to 1099 ft (Longmire et al. 2001, 70103).

**Table 5.1-1**  
**Hydrochemistry of Well R-15, Upper Mortandad Canyon (Validated Results)**

Depth of Pump Intake (ft)	1018.6	1018.6	1018.6	1018.6
Geologic Unit	Puye Formation	Puye Formation	Puye Formation	Puye Formation
Sample Treatment	Filtered	Filtered	Filtered	Filtered
Date Sampled (mo/dy/yr)	02/24/00	10/11/00	02/15/01	05/22/01
Alkalinity (Lab)(CaCO <sub>3</sub> mg/L)	51.0	54.9	56.0	58.0
Ca (mg/L)	12.0	12.0	12.0	13.0
Mg (mg/L)	3.4	3.2	3.4	3.5
Na (mg/L)	9.1	6.8	8.7	8.5
K (mg/L)	1.9	1.6	1.7	1.8
Cl (mg/L)	3.7	4.0	4.9	4.7
SiO <sub>2</sub> (mg/L)	70.62	63.90	72.76	72.73
SO <sub>4</sub> (mg/L)	5.2	4.8	6.4	6.1
NH <sub>4</sub> (mg/L)	<0.5, U <sup>a</sup>	0.16	<0.50, U	<0.1, U
B (mg/L)	0.019	<0.011, U	0.015	0.010
ClO <sub>4</sub> (mg/L)	0.00241	<0.0028, U	0.00154	0.00419
F (mg/L)	0.209	0.220	0.170	0.140
Fe (mg/L)	0.210	0.020	<0.048	0.060
Mn (mg/L)	0.018	0.0012	0.0004	0.00024
NO <sub>3</sub> + NO <sub>2</sub> (as N) (mg/L)	2.20	2.30	2.40	2.40
Sr (mg/L)	0.055	0.051	0.055	0.056
DOC (mgC/L)	0.370	6.10	not reported	not reported
TOC (mgC/L) <sup>b</sup>	13.00	not reported	1.20	not reported
TKN (mg/L)	<0.1, U	0.55	<0.1, U	<0.1, U
U (mg/L)	0.000342	0.000355	0.000354	0.000375
MEQ <sup>c</sup> cations	1.291	1.206	1.309	1.357
MEQ <sup>c</sup> anions	1.399	1.485	1.570	1.597
Charge Balance (%)	-4.03	-10.34	-9.06	-8.12

Table 5.1-1 (continued)

Depth of Pump Intake (ft)	1018.6	1018.6	1018.6	1018.6
Geologic Unit	Puye Formation	Puye Formation	Puye Formation	Puye Formation
Sample Treatment	Non-Filtered	Non-Filtered	Non-Filtered	Non-Filtered
Date Sampled (mo/dy/yr)	02/24/00	10/11/00	02/15/01	05/22/01
Sr-90 (pCi/L)	-0.03, U	-0.026, U	1.51	-0.10, U
Tritium (pCi/L)	<0.606, U	0.77	2.17	3.29
Gross alpha (pCi/L)	<0.66, U	<1.02, U	<1.3, U	<-0.19, U
Gross beta (pCi/L)	3.1	<1.57, U	<1.2, U	<0.8, U
Gross gamma (pCi/L)	not measured	not measured	173	240
$\delta D$ (‰)	-82	-79	-77	-79
$\delta^{15}N$ (NO <sub>3</sub> ) (‰)	-0.8	+0.9	-0.4	+1.3
$\delta^{18}O$ (‰)	-11.2	-10.9	-11.3	-11.2

- <sup>a</sup> U = not detected.
- <sup>b</sup> TOC is non-filtered.
- <sup>c</sup> MEQ = milliequivalents.

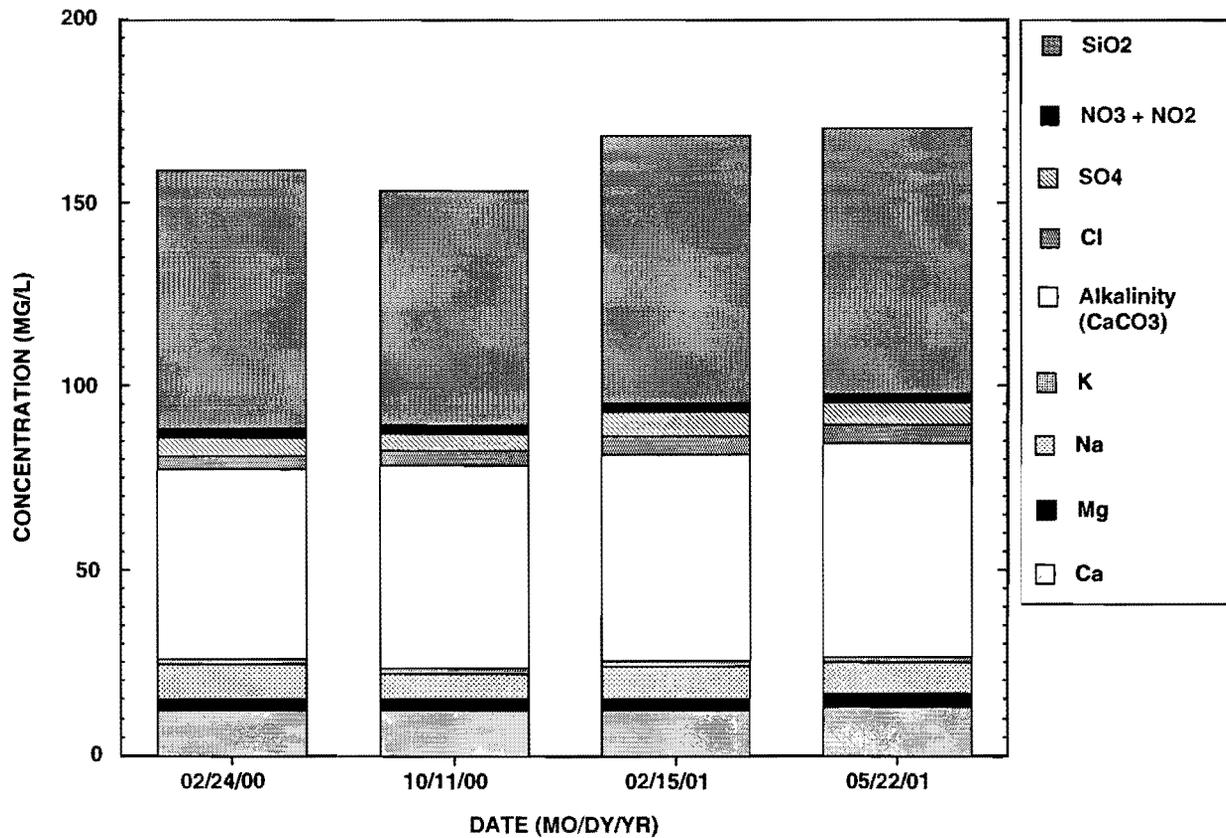


Figure 5.1-1. Major ion chemistry for well R-15 (regional aquifer), upper Mortandad Canyon

Distributions of chloride, nitrate plus nitrite, and perchlorate at well R-15 are shown in Figure 5.1-2. These solutes are stable as anions and are generally conservative (mobile) in aqueous systems under oxidizing conditions (Langmuir 1997, 56037). Detection of nitrate plus nitrite at well R-15 suggests that surface water and alluvial groundwater have provided recharge to the regional aquifer within Mortandad Canyon. Nitrate occurs in alluvial groundwater within upper Mortandad Canyon in the 10- to 60-mg/L range (LANL 1997, 56835). Nitrate is stable under oxidizing conditions and can be reduced to nitrite, ammonium, and nitrogen gas in the presence of denitrifying and other (ammonifying) bacteria and electron donors such as reduced manganese [Mn(II)] and iron [Fe(II)] and DOC (Langmuir 1997, 56037). Ammonium is less mobile in groundwater relative to nitrate and nitrite because of cation exchange.

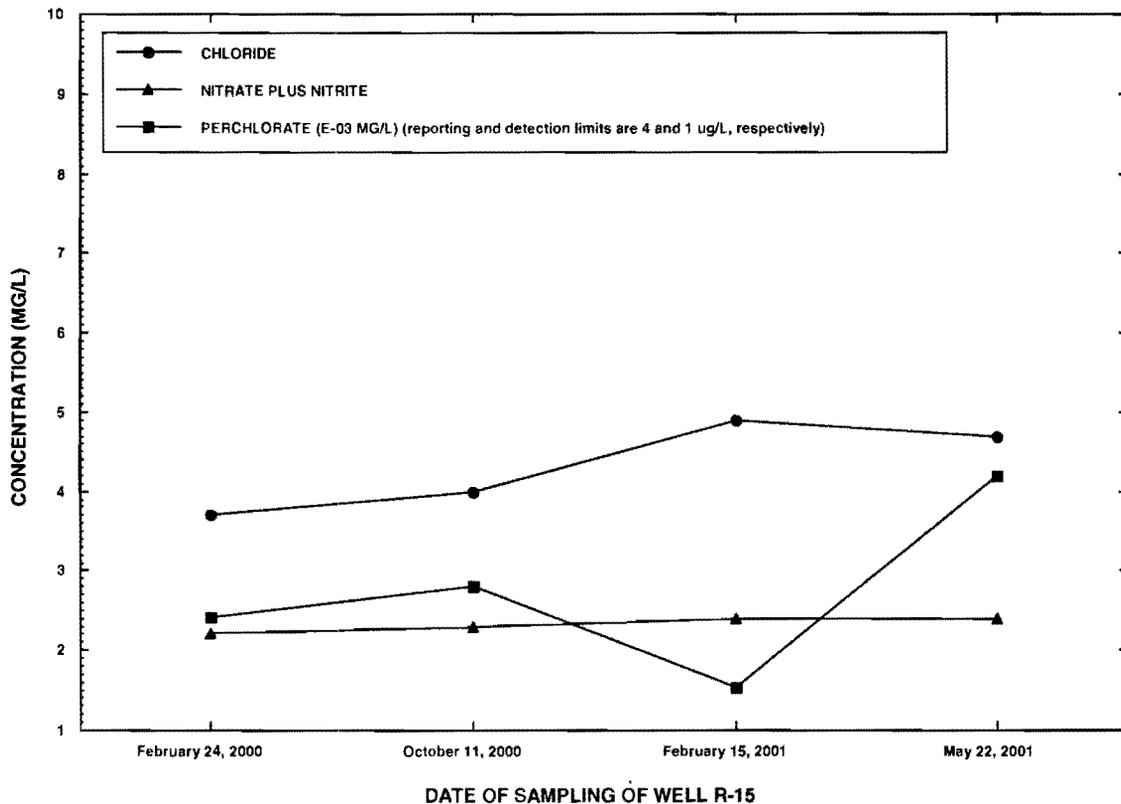


Figure 5.1-2. Anion distributions in well R-15 (regional aquifer), upper Mortandad Canyon

Elevated concentrations of nitrate have been observed within alluvial groundwater in Mortandad Canyon since the early 1960s (LANL 1997, 56835). Sources of nitrate include discharges from dissociated nitric acid, treated sewage effluent (Ten Site Canyon), and urine produced from bioassay analyses. Organic forms of nitrogen (total Kjeldahl nitrogen) are also observed in alluvial groundwater within Mortandad Canyon (Kendrick 1999, 66141). Concentrations of chloride ranged from 3.7 to 4.9 mg/L, whereas concentrations of nitrate plus nitrite showed less variation, ranging from 2.2 to 2.4 mg/L (Figure 5.1-2).

Concentrations of nitrate (as N) at MCOBT-4.4 in groundwater samples that represent both the Cerros del Rio basalt and the Puye Formation are 12.7 mg/L (Longmire 2001, 70103). This well is upgradient (west) of well R-15, and the perched groundwater at MCOBT-4.4 may be a local source of recharge to the regional aquifer. It is possible that this saturated zone is hydraulically connected to the perched zone

(646 ft) encountered during the drilling of R-15. Other recharge pathways may occur west of R-15 and MCOBT-4.4 in Mortandad Canyon.

Estimated concentrations (J values) of perchlorate at well R-15 range from <0.00280 to 0.00419 mg/L (<2.80 to 4.19 µg/L) (Table 5.1-1). The detection limit for this analyte is 0.0010 mg/L (1.0 µg/L) with a reporting limit of 0.0040 mg/L (4.0 µg/L) with the IC method. The limits may be raised to higher concentrations (4 µg/L for the detection limit and 12 µg/L for the reporting limit) based on recent results of an investigation conducted by LANL. Concentrations of perchlorate at well R-15 are very close to both limits and should be judged as estimates or J values. The only detect for perchlorate at well R-15 is at a concentration of 0.00419 mg/L (4.19 µg/L) measured during the fourth sampling round conducted on May 22, 2001.

Perchloric acid (HClO<sub>4</sub>) is used in actinide research conducted at the Laboratory and is a constituent of the treated effluent discharged from TA-50. Perchloric acid is a strong oxidizing acid. Perchloric acid dissociates to perchlorate at negative pH values ranging from -4.8 to -2.12, depending on the hydration state of the acid. Perchlorate (ClO<sub>4</sub><sup>-</sup>) was detected at 0.012 mg/L (12 µg/L) in a groundwater screening sample collected from the 646-ft perched zone during drilling of R-15 (Longmire et al. 2001, 70103). Perchlorate was also detected in alluvial groundwater in 1999 and 2000 within Mortandad Canyon, ranging from <1 to 440 ppb (Kendrick 1999, 66141, ESP 2002, 71301). This anion was recently detected in a screening sample collected from perched groundwater at MCOBT-4.4 at 0.145 mg/L (145 µg/L) at a sample depth ranging from 494 to 532 ft (Longmire e-mail 2001). Perchlorate is mobile in groundwater, and this anion does not adsorb onto aquifer material under near-neutral pH conditions. Perchlorate is not easily reduced to chloride (Cl<sup>-</sup>) under aerobic conditions typical of the groundwater. Oxidation of the chloride ion to perchlorate in aqueous solution is given by the following half reaction (Longmire et al. 2001, 70103):



This oxidation reaction is represented by:

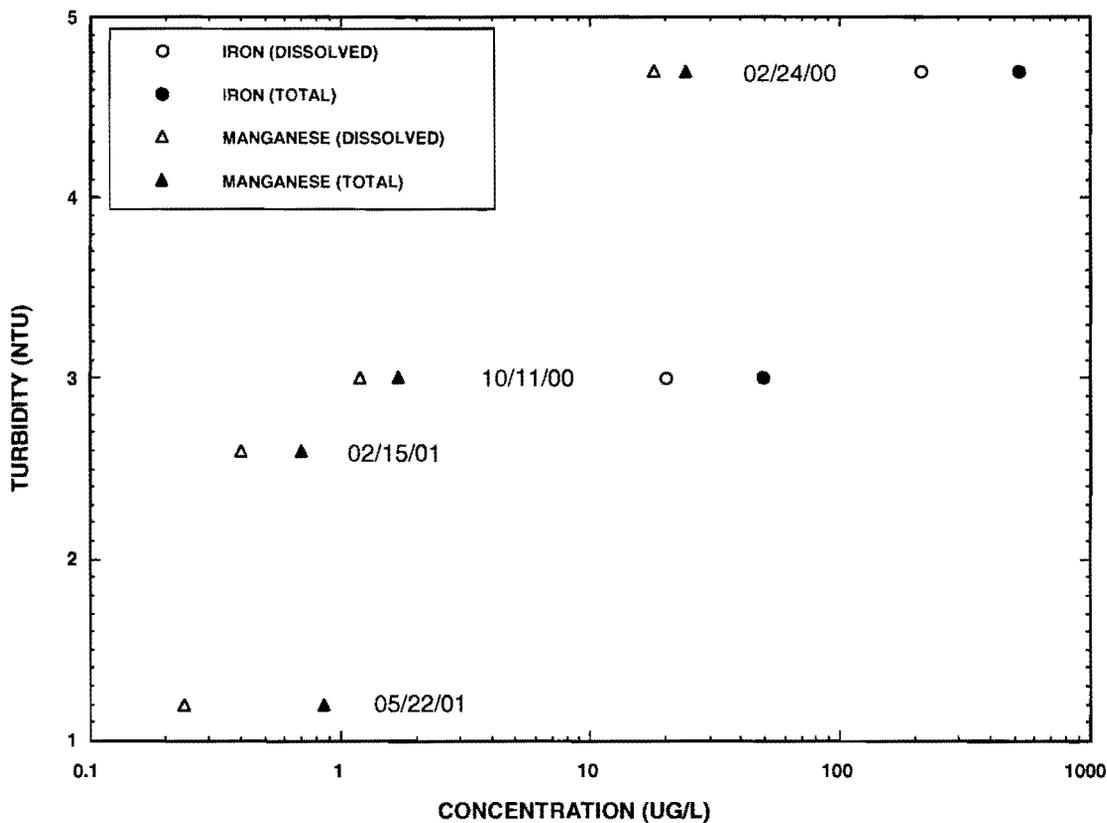
$$\text{Eh (volts)} = 1.39 - 0.0592\text{pH},$$

where Eh is the oxidation-reduction potential for the half reaction, and activity of Cl<sup>-</sup> is equal to the activity of ClO<sub>4</sub><sup>-</sup>.

At a pH value of zero, the chloride ion is stable relative to perchlorate ion at an E<sup>o</sup> (standard electrode potential) value less than 1.39 volts; perchlorate and chloride are at equilibrium at an E<sup>o</sup> value of 1.39 volts; and perchlorate is stable above an Eh value of 1.39 volts. This oxidation is also dependent on pH, and at pH7, chloride is stable below an Eh of 0.98 volt. Due to four strong covalent bonds between the oxygen and chlorine atoms within the tetrahedral perchlorate molecule, this species does not become easily reduced to chloride. Subsequently, perchlorate may persist in aerobic surface water and groundwater environments for an indefinite period of time. Strong reducing agents, such as reactive organic matter and hydrogen sulfide, however, are capable thermodynamically of reducing perchlorate to chloride under anaerobic conditions (Langmuir 1997, 56037; Longmire et al. 2001, 70103).

Figure 5.1-3 shows dissolved and total (suspended plus dissolved fractions) concentrations of iron and manganese versus turbidity for groundwater samples collected from well R-15. Turbidity decreases from the first to the fourth sampling round (Table 4.2-1). Turbidity values for these samples are less than 5 NTUs (Table 4.2-1); however, some colloidal/suspended material possibly is present. Concentrations of dissolved and total iron and manganese at well R-15 differ by up to 41% (Appendix A), a fact which suggests that these two analytes contribute to turbidity. Concentrations of total and dissolved iron were

less than detection for two sampling rounds conducted on February 15 and May 22, 2001. The colloids and suspended material may consist of ferric and manganic oxyhydroxides and/or oxides. Colloidal SiO<sub>2</sub> dominantly contributes to turbidity based on highest concentration differences (mg/L range) between suspended and dissolved fractions (Appendix A). Volcanic glass (pumice) was observed (21.3 to 52.7 wt %) in cutting samples collected from R-15 at depths ranging from 979 to 1099 ft (Table 3.1-2, Longmire et al. 2001, 70103). This volcanic glass is dacitic to rhyolitic and hence high in silica; the solubility of the glass is comparable to that of amorphous silica. Alkali metal- and alkali earth-bearing glasses are characterized by higher solubilities (Ca >> Na > K) than that of silica glass, and, therefore, they are more reactive in aqueous systems (Lindsay 1979). However, groundwater analytes including Ca, K, Na, and Al do not show significant differences in concentration between filtered and nonfiltered samples. Based on this observation, it is possible that colloidal clay minerals are not as abundant as silica, manganese, and iron colloids or suspended material in the regional aquifer at R-15. Mineralogy, charge density, point-of-zero charge (pH<sub>pzc</sub>), and surface area of colloids (clay minerals, ferric oxyhydroxide, and manganic oxyhydroxide) influence adsorption of solutes onto colloids/suspended material (Langmuir 1997, 56037).



**Figure 5.1-3. Dissolved and total concentrations of iron and manganese versus turbidity at well R-15 (regional aquifer), upper Mortandad Canyon**

Activities of tritium measured in groundwater samples collected from the regional aquifer at well R-15 range from <0.61 to 3.29 pCi/L. These values are consistent with the value (1.12 pCi/L) measured during

drilling of R-15 (Longmire et al. 2001, 70103). Activities of tritium, however, have increased over time at well R-15 (Table 5.1-1 and Appendix A).

Activities of selected radionuclides measured at well R-15 are provided in Table 5.1-1 and Appendix A. Americium-241, cesium-137, plutonium-238, and plutonium-239,240 (Appendix A) were not detected in the groundwater samples collected from well R-15. These radionuclides adsorb onto aquifer material and, therefore, migrate in groundwater probably only to a limited extent beneath the alluvium. Strontium-90, however, was detected in a filtered groundwater sample, collected on February 15, 2001, with an activity of  $1.51 \pm 0.91$  pCi/L ( $3 \sigma$  error). The minimum detectable activity (MDA) for strontium-90 measured in this sample is 0.87 pCi/L. This reported activity for strontium-90 is very close to the sample MDA. Strontium-90 was not detected during the first, second, and fourth sampling rounds.

Gross alpha and gross beta activities were generally less than detection. Measurable gross gamma is attributed to isotopes within the natural uranium-238, uranium-235, and thorium-232 decay chains (Langmuir 1997, 56037) (Table 5.1-1). Nondetect activities of gross alpha are consistent with concentrations of nonisotopic uranium less than  $0.5 \mu\text{g/L}$ . Activities of uranium-238, uranium-235, and uranium-234 are less than 1 pCi/L in groundwater samples collected from R-15 (Appendix A).

Analyses of  $\delta^{18}\text{O}$  and  $\delta\text{D}$  were performed on groundwater samples collected from well R-15 and other wells and springs, and results are shown in Figure 5.1-4. The Jemez Mountains meteoric line (solid) and the worldwide meteoric water line (dashed) are denoted by JMML and MWL, respectively, in Figure 5.1-4.

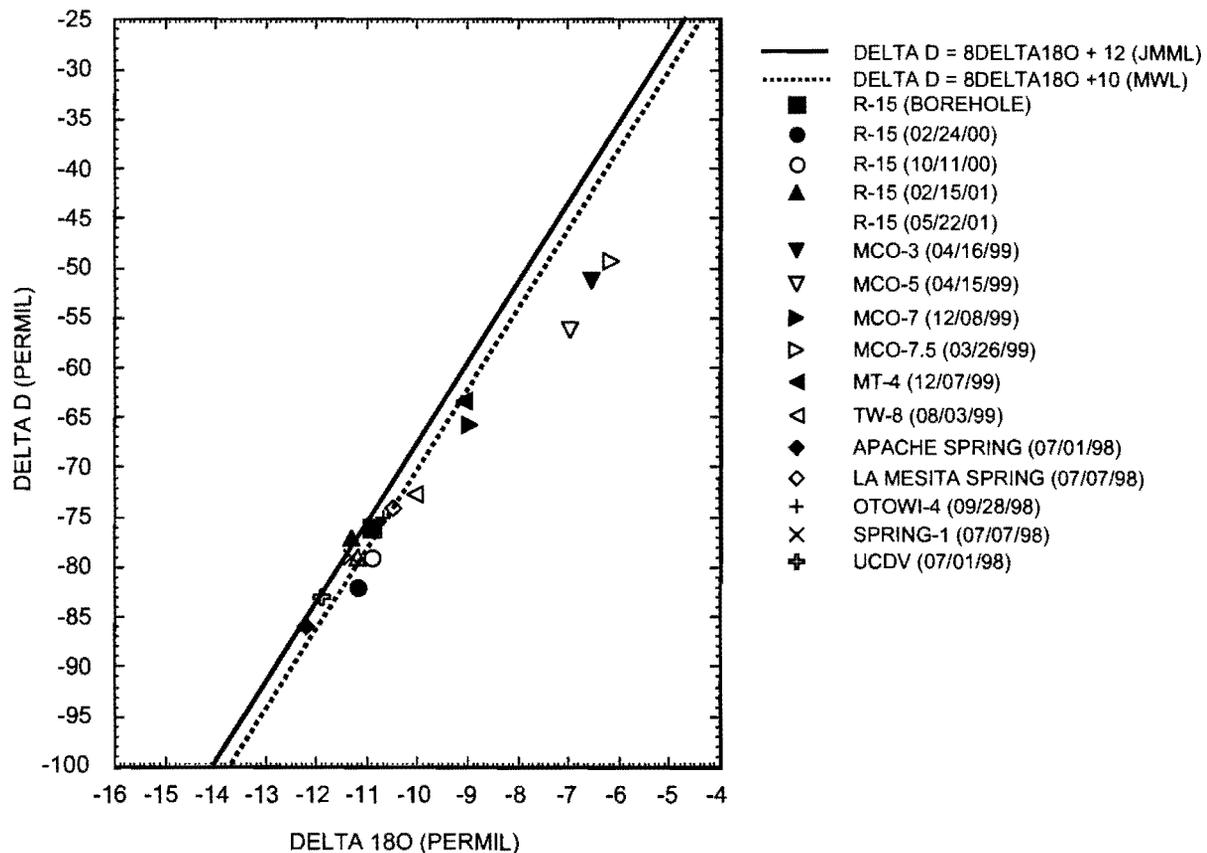


Figure 5.1-4. Stable isotope results for well R-15 and other wells and springs near Los Alamos, New Mexico

Interpretation of the  $\delta^{18}\text{O}$  and  $\delta\text{D}$  results are similar for the four groundwater samples collected from R-15. The results for well R-15 and other waters, excluding MCO-3, MCO-5, and MCO-7.5, indicate a meteoric source in which the groundwater samples plot close to both the Jemez Mountain and worldwide meteoric water lines (Blake et al., 1995, 49931) (Figure 5.1-4). Isotopic variations in  $\delta^{18}\text{O}$  and  $\delta\text{D}$  are minimal at well R-15, which indicates a long residence time for regional aquifer groundwater and a small amount of local recharge to the regional aquifer at the well site. This finding is also consistent with anion profiles in the vadose zone presented by Longmire et al. (2001, 70103) for borehole R-15. Groundwater samples collected from MCO-3, MCO-5, and MCO-7.5 are isotopically heavier in  $\delta^{18}\text{O}$ , which suggests that evaporation has taken place. This physical process results in enrichment of  $^{18}\text{O}$ .

Groundwater samples collected from well R-15 were analyzed for  $\delta^{15}\text{N}$  ( $\text{NO}_3$ ), with results of -0.8, -0.4, +0.9, and +1.3‰ (Table 5.1-1). These values are consistent with dissociated and nonfractionated  $\text{HNO}_3$  (Broxton et al. 2001, 71252, and Longmire et al. 2001, 70103) discharged to Mortandad Canyon. From 1986 through 1989, isotopically-light nitrate from nitric acid, which is enriched in nitrogen-14, was discharged from TA-50; that history may account for the average negative  $\delta^{15}\text{N}$  value (-6.2‰) measured in the perched zone at R-15 (Longmire et al. 2001, 70103). Delta ( $\delta$ )  $^{15}\text{N}$  values as low as -37.9‰ have been observed in alluvial groundwater within Mortandad Canyon (Kendrick 1999, 66141). Nitrate within the regional aquifer at R-15 is isotopically heavier than the nitrate observed in the perched zone (Longmire et al. 2001, 70103). This fact implies, based on the observed isotopic fractionation, that the sources of nitrate discharged into Mortandad Canyon vary in nitrogen chemistry as well as isotopic composition. A nitrate plume characterized by isotopically light  $\delta^{15}\text{N}$  within alluvial groundwater has not reached the regional water table at well R-15. Alluvial groundwater probably acts as a line-source of recharge for the perched zone within the Cerros del Rio basalt. Evidence for this type of recharge includes elevated activities of tritium and concentrations of nitrate and perchlorate observed in the Cerros del Rio basalt at R-15 and MCOBT-4.4.

Volatile and semivolatile organic compounds generally were not detected at well R-15, except for toluene (0.69  $\mu\text{g/L}$ ) and bis(2-ethylhexyl)phthalate (5.9  $\mu\text{g/L}$ ) detected during the October 11, 2000 (second), sampling round. Bis(2-ethylhexyl)phthalate is a constituent of plastics, and its occurrence probably is not due to contaminants released to Mortandad Canyon. The occurrence of toluene at well R-15 is probably not related to petroleum products because of its single presence without benzene, ethylbenzene, and xylene isomers that are common constituents of gasoline and diesel fuel. HE compounds or their degradation products were not detected at well R-15.

Analysis of the DOC fractionation (also termed humic substances), which includes both hydrophobic and hydrophilic fractions, was performed on a single groundwater sample collected during the second round from well R-15 (Appendix A). Both fractions contain acid-, neutral-, and base-organic substances. Hydrophobic acids are considered to include humic and fulvic acids (carboxylic acids and phenols), whereas the hydrophobic neutral fraction includes aliphatic organic compounds (Vilks and Bachinski 1996). Hydrophobic bases include aromatic amines and other nitrogen-containing compounds. The hydrophilic fraction contains low-molecular weight ( $\leq 5$  carbon atoms) polyelectrolytic and aliphatic acids (acid fraction), aliphatic amines and amino acids (base fraction), and alcohols, esters, aliphatic amides, and carbohydrates (neutral fraction) (Vilks and Bachinski 1996). These two DOC fractions are naturally occurring in groundwater (Vilks and Bachinski 1996) with a median concentration of 0.7 mgC/L (Thurman 1985). Anthropogenic sources including refined petroleum products and high-molecular weight organic compounds are also possible.

A DOC concentration of 6.10 mgC/L was measured in a groundwater sample collected from well R-15 on October 11, 2000. This sample contained 4.70 mgC/L hydrophobic fraction consisting of 1.20 mgC/L acid fraction and 3.50 mgC/L neutral fraction with the base fraction less than detection ( $<0.1$  mgC/L). The

groundwater also contained 1.40 mgC/L hydrophilic fraction, which consisted of 1.00 and 0.30 mgC/L acid and neutral fractions, respectively. Approximately 31% of the humic and fulvic acids (hydrophobic acid fraction) is calculated to form a complex with calcium with the majority of humic and fulvic acids stable as noncomplexed anions. Formation of calcium-humate and/or calcium-fulvate complexes does not influence the stability of  $\text{CaCO}_3$  (calcite) according to MINTEQA2 simulations. The origin of DOC in groundwater at well R-15 includes natural sources and/or residual fluids from drilling and/or well completion. The neutral and base fractions may consist of residual EZ-MUD® copolymer and petroleum hydrocarbons (aliphatic compounds).

## 5.2 Comparison to Sierra de los Valles Springs and Supply Well PM-5

Nitrate plus nitrite concentrations at well R-15 exceed those reported by Blake et al. (1995, 49931) for springs discharging west of the Laboratory and by Adams et al. (1995, 47192) in precipitation. Nitrate and/or this combined parameter is also elevated in alluvial groundwater (LANL 1997, 56835, and ESP 2002, 71301) and in the Cerros del Rio basalt (Longmire e-mail 2001) within upper Mortandad Canyon as compared to concentrations observed in the Sierra de los Valles springs and supply well PM-5. Concentrations of nitrate plus nitrite at several of the springs range from 0.01 to 0.35 mg/L, with a mean concentration of 0.16 mg/L (Blake et al. 1995, 49931). Occurrence of nitrate plus nitrite at well R-15 is consistent with the hydrochemical conceptual model for this canyon, which attributes these constituents to treated nitric acid discharges.

Concentrations of nitrate and nitrate plus nitrite in supply well PM-5, south of Mortandad Canyon, were 0.30 and 0.35 mg/L during 1999 and 2000, respectively (ESP 2000 and 2001). These concentrations reported for PM-5 are consistent with nitrate measured in previous years.

Perchlorate is an anthropogenic chemical. It has estimated J values during three of the four sampling rounds at well R-15. Concentrations of perchlorate observed at the well, however, are generally below the analytical reporting limit of 0.004 mg/L (4  $\mu\text{g/L}$ ) using the ion chromatography (IC) method.

Concentrations of other trace elements and trace metals observed at well R-15 are within concentration ranges for samples collected from springs discharging in the Sierra de los Valles (Blake et al. 1995, 49931). All chemicals analyzed at well R-15 are below their respective MCLs (Appendix A).

## 6.0 GROUNDWATER GEOCHEMICAL CALCULATIONS

### 6.1 Computer Program Selection

Geochemical calculations of groundwater samples collected from R-15 are conducted to evaluate speciation of solutes (dissolved species) and to quantify the state of saturation of solid phases that control groundwater composition under equilibrium conditions. These calculations provide insight to processes that control water/rock interactions, including mineral precipitation and adsorption, occurring in both natural and anthropogenic waters. Geochemical calculations of water are conducted to evaluate geochemical processes influencing water composition and remediation strategies.

Calculations of solute speciation,  $\text{PCO}_2$  gas, and solid phase saturation indices were made using the computer program MINTEQA2 (Allison et al. 1991, 49930), with single ion activity coefficients calculated using the Davies equation. MINTEQA2 was developed by Battelle Northwest for the EPA for use at Resource Conservation and Recovery Act and Superfund sites. The model is constrained by solute concentrations and involves silicate and iron (oxy)hydroxides-oxides identified by Longmire et al. (2001, 70103) at R-15. MINTEQA2 quantifies possible rock-water and water-atmosphere reactions, but

calculation results should be interpreted with caution and are limited by the scope of our understanding of hydrologic flow conditions (saturated and unsaturated), possible reaction mechanisms, and kinetic constraints in a disequilibrium-dominated system. A source of error with the computer program is the accuracy of the thermochemical data contained in the data base. Errors are greater for trace solutes in which experimental data are lacking including thallium, beryllium, and cadmium. The uranium data base contained in MINTEQA2 has been critically evaluated by Grenthe et al. (1992). There are fewer errors associated with the major ions and solid phases consisting of carbonate, silicate, and oxyhydroxide minerals (Langmuir 1997, 56037).

## 6.2 Speciation Calculations

Speciation calculations using the computer program MINTEQA2 (Allison et al. 1991, 49930) were performed to evaluate stable forms of dissolved solutes, which influence mineral precipitation and adsorption reactions occurring in natural and contaminated waters. Input files for the calculations are provided in Appendix B. Solutes of importance at well R-15 include major ions, iron(II), strontium, and uranium(VI), which are naturally occurring. Results of the speciation calculations are provided in Table 6.2-1.

**Table 6.2-1**  
**Results of Speciation Calculations Using MINTEQA2 for Well R-15, Upper Mortandad Canyon**

Solute	Dominant Speciation	Percentage	Sample Date (mo/dy/yr)
Fe(II)	Fe <sup>2+</sup>	95.6	02/24/00
Fe(II)	Fe <sup>2+</sup>	97.0	10/11/00
Fe(II)	Fe <sup>2+</sup>	95.2	02/15/01
Fe(II)	Fe <sup>2+</sup>	96.1	05/22/01
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>2</sub> <sup>2-</sup>	67.5	02/24/00
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> <sup>4-</sup>	30.8	02/24/00
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>2</sub> <sup>2-</sup>	68.7	10/11/00
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> <sup>4-</sup>	28.7	10/11/00
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>2</sub> <sup>2-</sup>	58.8	02/15/01
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> <sup>4-</sup>	40.0	02/15/01
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>2</sub> <sup>2-</sup>	73.5	05/22/01
U(VI)	UO <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> <sup>4-</sup>	24.1	05/22/01
Sr(II)	Sr <sup>2+</sup>	98.0	02/24/00
Sr(II)	Sr <sup>2+</sup>	98.2	10/11/00
Sr(II)	Sr <sup>2+</sup>	97.7	02/15/01
Sr(II)	Sr <sup>2+</sup>	97.7	05/22/01
DOM <sup>a</sup>	DOM	67.4	10/11/00
DOM	Ca-DOM	31.2	10/11/00

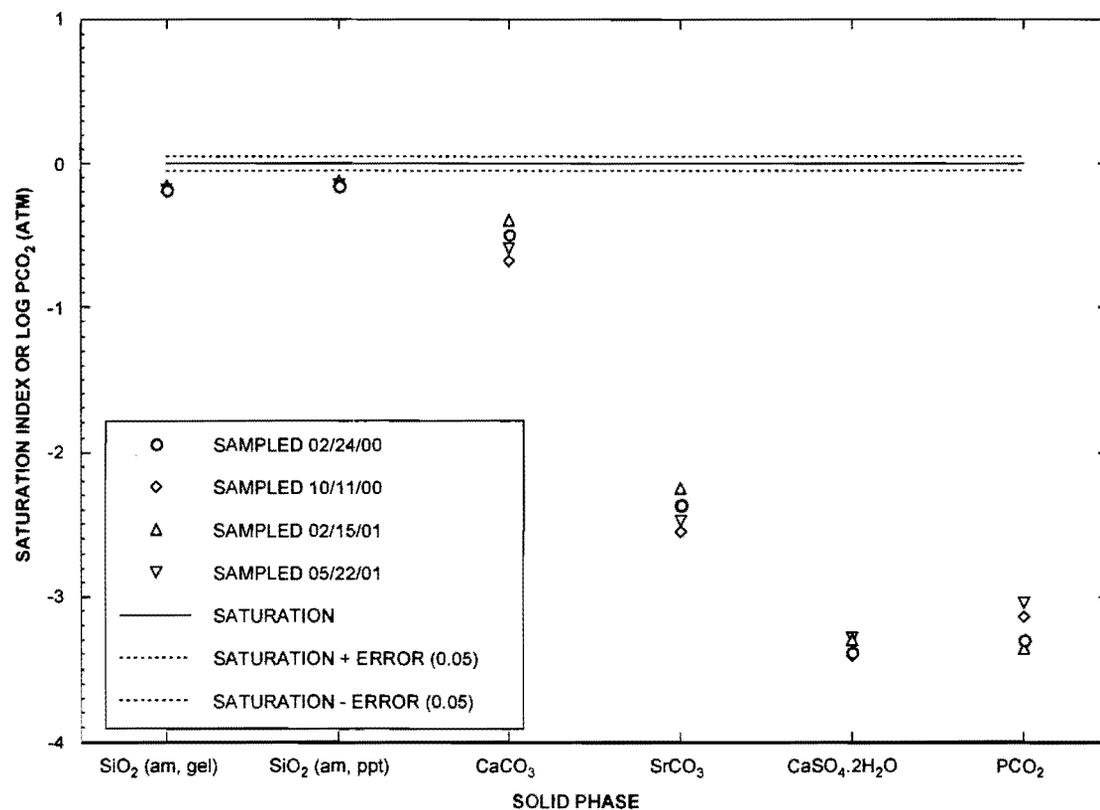
<sup>a</sup> DOM = dissolved organic matter.

Ferrous iron is predicted to be stable as dissolved Fe<sup>2+</sup>, and the hydrolysis species FeOH<sup>+</sup> is a minor component. The free or uncomplexed Fe<sup>2+</sup> cation is available for adsorption and precipitation reactions. Uranium(VI) is predicted to be stable as UO<sub>2</sub>(CO<sub>3</sub>)<sub>2</sub><sup>2-</sup> and UO<sub>2</sub>(CO<sub>3</sub>)<sub>3</sub><sup>4-</sup>, and these complexes are

semisorbing onto mineral surfaces (Langmuir, 1997, 56037). Concentrations of total and dissolved uranium are less than 1 µg/L at well R-15. Strontium is predicted to be stable as Sr<sup>2+</sup>, and this species can undergo cation exchange with other divalent cations (Longmire et al. 1996, 54168). Increasing concentrations of natural strontium occur in the regional aquifer and correlate well with dissolved calcium. Major ions consisting of Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, and HCO<sub>3</sub><sup>-</sup> (not shown in Table 6.2-1) are calculated to be stable as free or uncomplexed solutes at well R-15. Dissolved organic matter (DOM), consisting of humic and fulvic acids (hydrophobic acid fraction), is calculated by MINTEQA2 to include mainly noncomplexed solutes and a calcium-DOM complex (Table 6.2-1).

### 6.3 Saturation Index Calculations

Solid-solution phase calculations were performed with MINTEQA2 (Allison et al. 1991, 49930) using analytical results obtained from filtered (less than 0.45 µm membrane) groundwater samples collected at well R-15. The purpose of the calculations was to assess the importance of precipitation reactions. Figure 6.3-1 shows the values of the saturation index (SI) for several key phases. The SI is a measure of the degree of saturation, undersaturation, or oversaturation of a solid phase in water [SI = log<sub>10</sub> {activity product/solubility product}]; at equilibrium SI = 0 ± 0.05 (Langmuir 1997, 56037). Well R-15 groundwater is calculated to be slightly undersaturated with respect to both silica glass (precipitate) and silica gel (Figure 6.3-1). Siliceous glass is abundant in the Puye Formation (Longmire et al. 2001, 70103).



**Figure 6.3-1. Results of saturation index calculations using MINTEQA2 for well R-15 (regional aquifer), upper Mortandad Canyon**

Calculations also show that the groundwater is undersaturated with respect to reactive minerals including CaCO<sub>3</sub> (calcite), SrCO<sub>3</sub> (strontianite), and CaSO<sub>4</sub>·H<sub>2</sub>O (gypsum) (Figure 6.3-1). These results are

consistent with observed mineralogy (abundance of volcanic glass and absence of calcium and strontium carbonate) in the Puye Formation at R-15. Calculated  $\log_{10} \text{PCO}_2$  gas varies from -3.36 to -3.04 atmosphere for the well R-15 groundwater. Variation in the SI values for  $\text{CaCO}_3$  and  $\text{SrCO}_3$  and  $\text{PCO}_2$  gas is due to differing temperature, carbonate alkalinity, pH, and activities of calcium and strontium in groundwater at well R-15.

Mixed-cation smectite has been observed within the Puye Formation at R-15 (Longmire et al. 2001, 70103), and this clay mineral has a high adsorption capacity for cations ( $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ , and  $\text{UO}_2^{2+}$ ) (Langmuir 1997, 56037). The stability of calcium smectite is evaluated by considering activities of silicic acid ( $\text{H}_4\text{SiO}_4^0$ ), calcium ion, and hydrogen ion as depicted in Figure 6.3-2. This activity diagram for part of the  $\text{Ca}^{2+}$ - $\text{H}^+$ - $\text{H}_4\text{SiO}_4^0$ - $\text{CO}_2$  system suggests that calcium smectite is the stable clay mineral in R-15 groundwater. The four groundwater samples are oversaturated with respect to  $\text{CaCO}_3$  (calcite) at a  $\text{PCO}_2$  equal to  $10^{-3.5}$  atmosphere according to Figure 6.3-2. The groundwaters, however, are undersaturated with respect to  $\text{CaCO}_3$  at a  $\text{PCO}_2$  equal to  $10^{-2.0}$  atmosphere. This range of  $\text{PCO}_2$  gas bounds calculated  $\text{PCO}_2$  gas calculated with MINTEQA2 for well R-15. The mineral calcite ( $\text{CaCO}_3$ ) was not detected above 0.2 wt % in the Puye Formation at R-15 (Longmire et al. 2001, 70103). Figure 6.3-2 also suggests that the R-15 groundwaters are oversaturated with respect to  $\text{SiO}_2$  soil (log  $K_{sp} = -3.10$ , Lindsay 1979) and undersaturated with respect to  $\text{SiO}_2$  glass, which is in agreement with SI calculations performed by MINTEQA2.

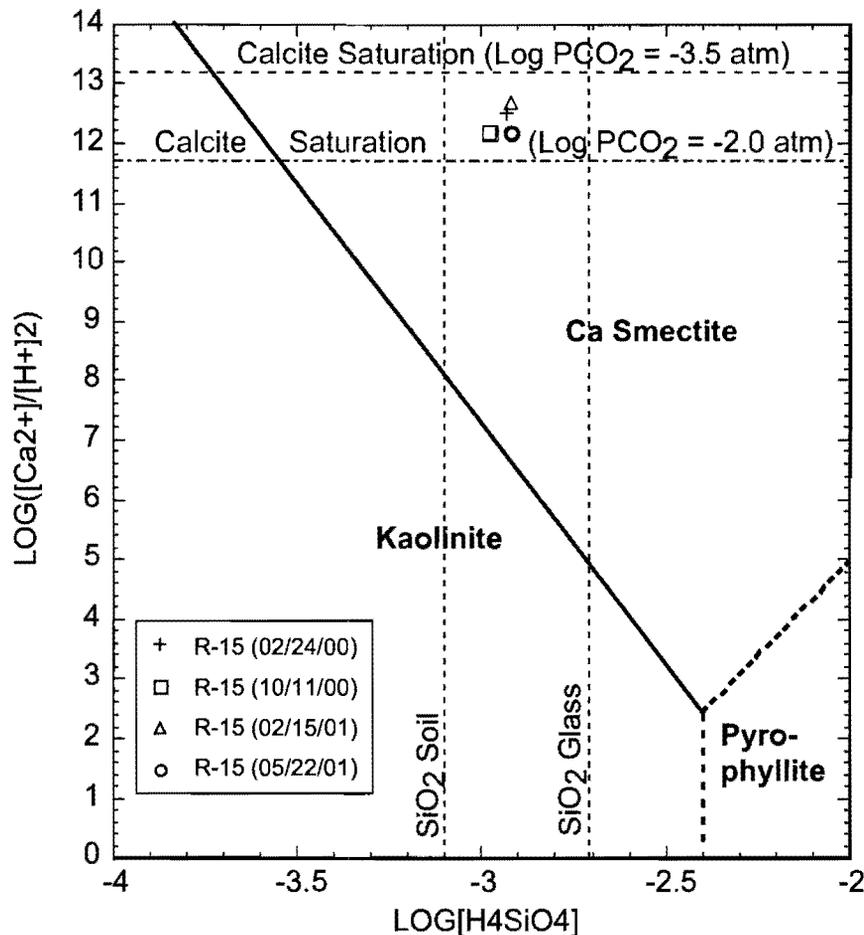


Figure 6.3-2. Activity diagram of  $\log[\text{H}_4\text{SiO}_4]$  versus  $\log([\text{Ca}^{2+}]/[\text{H}^+]^2)$  at 25C for well R-15, upper Mortandad Canyon

## 7.0 CONCLUSIONS

Four rounds of groundwater characterization samples were collected at well R-15 at a pump intake depth of 1018.6 ft. These samples were chemically characterized for radionuclides, metals and trace elements, major ions, high explosive compounds, dissolved and total organic carbon, organic compounds, and stable isotopes. Analytical results for R-15 show that contaminant concentrations are presently below MCLs within the regional aquifer at this well location. Americium-241, cesium-137, plutonium-238, and plutonium-239,240 were not detected in the groundwater samples collected from well R-15. Strontium-90 was detected ( $1.51 \pm 0.91$  pCi/L,  $3 \sigma$  error) in a filtered groundwater sample collected from the regional aquifer on February 15, 2001. Strontium-90 was not detected, however, during the first, second, and fourth sampling rounds. Activities of uranium-234, uranium-235, and uranium-238 were detected at concentrations less than 1 pCi/L. Gross alpha and gross beta activities were generally less than detection. Measurable gross gamma was attributed to isotopes within the natural uranium-238, uranium-235, and thorium-232 decay chains.

Groundwater from the regional aquifer in well R-15 is dominantly a calcium-sodium-bicarbonate type. This groundwater was found to contain an average of 2.1 pCi/L tritium, 0.00271 mg/L (2.71  $\mu$ g/L) dissolved perchlorate, 0.350  $\mu$ g/L dissolved uranium, 4.3 mg/L dissolved chloride, 0.18 mg/L dissolved fluoride, 5.6 mg/L dissolved sulfate, and 2.3 mg/L nitrate plus nitrite (as N). Concentrations of nitrate plus nitrite were elevated above those observed at springs in the Sierra de los Valles and at supply well PM-5. Current analytical reporting and detection limits for perchlorate in groundwater are 0.004 and 0.001 mg/L (4 and 1  $\mu$ g/L), respectively, with the IC method. These limits may be raised to higher concentrations (4  $\mu$ g/L for the detection limit and 12  $\mu$ g/L for the reporting limit) based on recent results of investigations conducted by LANL. The highest concentration of perchlorate detected at well R-15 was 0.00419 mg/L (4.19  $\mu$ g/L) measured during the fourth sampling round. Stable isotope ratios of  $\delta$ D and  $\delta^{18}$ O imply that most of the sampled groundwater was derived from a local meteoric source (precipitation and surface water). Low activities of tritium suggest that most of sampled groundwater is greater than 60 years old (prenuclear testing). Results of  $\delta^{15}$ N ( $\text{NO}_3$ ) analyses suggest that nitrate plus nitrite could be derived from treated nitric acid discharges.

Geochemical calculations, using the computer program MINTQA2, suggest that the regional aquifer at well R-15 is close to equilibrium with amorphous silica phases and is undersaturated with respect to reactive minerals  $\text{CaCO}_3$  and  $\text{SrCO}_3$ . This implies that the mobility of strontium-90 is controlled by cation exchange rather than mineral equilibrium. Major cations and anions are calculated to occur as free or uncomplexed solutes. Alkalinity ( $\text{HCO}_3^-$ ) provides ligands for complexing with uranium(VI). Uranium(VI) is calculated to be stable as  $\text{UO}_2(\text{CO}_3)_2^{2-}$  and  $\text{UO}_2(\text{CO}_3)_3^{4-}$  complexes under oxidizing conditions. Calculation results agree well with observed mineralogy and groundwater analytical results.

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# **Appendix A**

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## *Groundwater Analytical Results*



**Table A-1**  
**Regional Well R-15 Screen 1 First Round Sample Results: Data Summary for Inorganic Chemicals**

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
<b>Field Parameter</b>												
Field Alkalinity (total as CaCO <sub>3</sub> )	1	1020	02/23/00	NF	0	0	—	—	—	—	—	—
pH	1	1020	02/23/00	NF	0	0	—	—	>6 & <9	0/1	>6 & <9	0/1
Specific Conductance (µS/cm)	1	1020	02/23/00	NF	0	0	—	—	—	0/1	—	0/1
Temperature (°C)	1	1020	02/23/00	NF	0	0	—	—	—	0/1	—	0/1
Turbidity (NTU) <sup>g</sup>	1	1020	02/23/00	NF	0	0	—	—	—	0/1	—	0/1
<b>Analyte</b>												
Alkalinity	1	1018.6	2/23/00	F <sup>e</sup>	1	1	51000	— <sup>f</sup>	—	—	—	—
Alkalinity	1	1018.6	2/23/00	NF <sup>g</sup>	1	1	58000	—	—	—	—	—
Aluminum	1	1018.6	2/23/00	F	1	0	—	[61]	50	0/1	5000	0/1
Aluminum	1	1018.6	2/23/00	NF	1	0	—	[96]	—	—	—	—
Ammonia (expressed as N)	1	1018.6	2/23/00	F	1	0	—	[500]	—	—	—	—
Ammonia (expressed as N)	1	1018.6	2/23/00	NF	1	0	—	[500]	—	—	—	—
Antimony	1	1018.6	2/23/00	F	1	0	—	[0.683]	6	0/1	—	—
Antimony	1	1018.6	2/23/00	NF	1	0	—	[0.683]	—	—	—	—
Arsenic	1	1018.6	2/23/00	F	1	0	—	[2.3]	50	0/1	100	0/1
Arsenic	1	1018.6	2/23/00	NF	1	0	—	[2.3]	—	—	—	—
Barium	1	1018.6	2/23/00	F	1	1	24	—	2000	0/1	1000	0/1
Barium	1	1018.6	2/23/00	NF	1	1	25	—	—	—	—	—

Table A-1 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Beryllium	1	1018.6	2/23/00	F	1	1	0.025	—	4	0/1	—	—
Beryllium	1	1018.6	2/23/00	NF	1	1	0.05	—	—	—	—	—
Boron	1	1018.6	2/23/00	F	1	1	19	—	—	—	750	0/1
Boron	1	1018.6	2/23/00	NF	1	1	20	—	—	—	—	—
Bromide	1	1018.6	2/23/00	F	1	0	—	[16]	—	—	—	—
Bromide	1	1018.6	2/23/00	NF	1	0	—	[16]	—	—	—	—
Cadmium	1	1018.6	2/23/00	F	1	0	—	[0.162]	5	0/1	10	0/1
Cadmium	1	1018.6	2/23/00	NF	1	0	—	[0.145]	—	—	—	—
Calcium	1	1018.6	2/23/00	F	1	1	12000	—	—	—	—	—
Calcium	1	1018.6	2/23/00	NF	1	1	12000	—	—	—	—	—
Chloride	1	1018.6	2/23/00	F	1	1	3700	—	250000	0/1	250000	0/1
Chloride	1	1018.6	2/23/00	NF	1	1	3670	—	—	—	—	—
Chromium	1	1018.6	2/23/00	F	1	1	2.6	—	100	0/1	50	0/1
Chromium	1	1018.6	2/23/00	NF	1	1	4.6	—	—	—	—	—
Cobalt	1	1018.6	2/23/00	F	1	0	—	[0.39]	—	—	50	0/1
Cobalt	1	1018.6	2/23/00	NF	1	0	—	[0.39]	—	—	—	—
Copper	1	1018.6	2/23/00	F	1	0	—	[0.42]	1300	0/1	1000	0/1
Copper	1	1018.6	2/23/00	NF	1	1	1.3	—	—	—	—	—
Cyanide (total)	1	1018.6	2/23/00	NF	1	0	—	[10]	—	—	—	—
Fluoride	1	1018.6	2/23/00	F	1	1	209	—	4000	0/1	1600	0/1
Fluoride	1	1018.6	2/23/00	NF	1	1	271	—	—	—	—	—
Iron	1	1018.6	2/23/00	F	1	1	210	—	300	0/1	1000	0/1
Iron	1	1018.6	2/23/00	NF	1	1	520	—	—	—	—	—
Lead	1	1018.6	2/23/00	F	1	1	0.126	—	15	0/1	50	0/1

Table A-1 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Lead	1	1018.6	2/23/00	NF	1	1	0.477	—	—	—	—	—
Magnesium	1	1018.6	2/23/00	F	1	1	3400	—	—	—	—	—
Magnesium	1	1018.6	2/23/00	NF	1	1	3400	—	—	—	—	—
Manganese	1	1018.6	2/23/00	F	1	1	18	—	50	0/1	200	0/1
Manganese	1	1018.6	2/23/00	NF	1	1	24	—	—	—	—	—
Mercury	1	1018.6	2/23/00	F	1	0	—	[0.011]	2	0/1	—	—
Mercury	1	1018.6	2/23/00	NF	1	0	—	[0.011]	—	—	2	0/1
Molybdenum	1	1018.6	2/23/00	F	1	0	—	[3.3]	—	—	—	—
Molybdenum	1	1018.6	2/23/00	NF	1	0	—	[3.3]	—	—	—	—
Nickel	1	1018.6	2/23/00	F	1	1	1.9	—	100	0/1	200	0/1
Nickel	1	1018.6	2/23/00	NF	1	1	2.8	—	—	—	—	—
Nitrate + Nitrite (expressed as N)	1	1018.6	2/23/00	F	1	1	2200	—	10000	0/1	—	—
Nitrate + Nitrite (expressed as N)	1	1018.6	2/23/00	NF	1	1	2000	—	—	—	—	—
Oxalate	1	1018.6	2/23/00	F	1	0	—	[113]	—	—	—	—
Oxalate	1	1018.6	2/23/00	NF	1	0	—	[113]	—	—	—	—
Perchlorate	1	1018.6	2/23/00	F	1	1	2.41	—	—	—	—	—
Perchlorate	1	1018.6	2/23/00	NF	1	1	3.45	—	—	—	—	—
Phosphorus (total)	1	1018.6	2/23/00	F	1	1	65	—	—	—	—	—
Phosphorus (total)	1	1018.6	2/23/00	NF	1	1	78	—	—	—	—	—
Potassium	1	1018.6	2/23/00	F	1	1	1900	—	—	—	—	—
Potassium	1	1018.6	2/23/00	NF	1	1	2000	—	—	—	—	—

Table A-1 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Selenium	1	1018.6	2/23/00	F	1	0	—	[3.8]	50	0/1	50	0/1
Selenium	1	1018.6	2/23/00	NF	1	0	—	[3.8]	—	—	—	—
SiO <sub>2</sub>	1	1018.6	2/23/00	F	1	1	70620	—	—	—	—	—
SiO <sub>2</sub>	1	1018.6	2/23/00	NF	1	1	72760	—	—	—	—	—
Silver	1	1018.6	2/23/00	F	1	0	—	[0.202]	100	0/1	50	0/1
Silver	1	1018.6	2/23/00	NF	1	0	—	[0.201]	—	—	—	—
Sodium	1	1018.6	2/23/00	F	1	1	9100	—	—	—	—	—
Sodium	1	1018.6	2/23/00	NF	1	1	9200	—	—	—	—	—
Strontium	1	1018.6	2/23/00	F	1	1	55	—	—	—	—	—
Strontium	1	1018.6	2/23/00	NF	1	1	55	—	—	—	—	—
Sulfate	1	1018.6	2/23/00	F	1	1	5200	—	250000	0/1	600000	0/1
Sulfate	1	1018.6	2/23/00	NF	1	1	5170	—	—	—	—	—
Thallium	1	1018.6	2/23/00	F	1	1	0.966	—	2	0/1	—	—
Thallium	1	1018.6	2/23/00	NF	1	1	1.51	—	—	—	—	—
Total Kjeldahl Nitrogen	1	1018.6	2/23/00	F	1	0	—	[100]	—	—	—	—
Total Kjeldahl Nitrogen	1	1018.6	2/23/00	NF	1	0	—	[100]	—	—	—	—
Uranium (by ICPMS <sup>h</sup> )	1	1018.6	2/23/00	F	1	1	0.342	—	—	—	5000	0/1
Uranium (by ICPMS)	1	1018.6	2/23/00	NF	1	1	0.34	—	—	—	—	—
Uranium (by KPA <sup>i</sup> )	1	1018.6	2/23/00	F	1	1	0.39	—	—	—	5000	0/1
Uranium (by KPA)	1	1018.6	2/23/00	NF	1	1	0.39	—	—	—	—	—

Table A-1 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Vanadium	1	1018.6	2/23/00	F	1	1	5.9	—	—	—	—	—
Vanadium	1	1018.6	2/23/00	NF	1	1	5.9	—	—	—	—	—
Zinc	1	1018.6	2/23/00	F	1	0	—	[2.8]	5000	0/1	10000	0/1
Zinc	1	1018.6	2/23/00	NF	1	0	—	[4.9]	—	—	—	—
<b>Stable Isotopes (‰)</b>												
δD/H	1	1018.6	2/23/00	NF	1	1	-82	—	—	—	—	—
δ <sup>15</sup> N/ <sup>14</sup> N	1	1018.6	2/23/00	NF	1	1	-0.8	—	—	—	—	—
δ <sup>18</sup> O/ <sup>16</sup> O	1	1018.6	2/23/00	NF	1	1	-11.2	—	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from *National Primary Drinking Water Regulations*, 40 CFR Part 141. US E.P.A. secondary MCLs are from *National Secondary Drinking Water Regulations*, 40 CFR Part 143. State of New Mexico MCLs are from *Drinking Water Regulations*, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from *New Mexico Water Quality Control Commission Regulations, Ground and Surface Water Protection*, 20 NMAC 6.2.

<sup>e</sup> F = Filtered.

<sup>f</sup> — = not applicable or not available.

<sup>g</sup> NF = Nonfiltered.

<sup>h</sup> Kinetic phosphorescence analysis.

<sup>i</sup> Inductively coupled plasma mass spectrometry.

**Table A-2**  
**Regional Well R-15 Screen 1 First Round Sample Results: Data Summary for Radionuclides**

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (pCi/L)	Non-detected Value (pCi/L)	Drinking Water MCL <sup>b</sup> (pCi/L)	Frequency of Detects > Drinking Water MCL
Americium-241	1	1018.6	2/23/00	F <sup>c</sup>	1	0	— <sup>d</sup>	[0.019]	—	—
Americium-241	1	1018.6	2/23/00	NF <sup>e</sup>	1	0	—	[0.018]	—	—
Cesium-134	1	1018.6	2/23/00	F	1	0	—	[1.3]	—	—
Cesium-134	1	1018.6	2/23/00	NF	1	0	—	[-0.1]	—	—
Cesium-137	1	1018.6	2/23/00	F	1	0	—	[-0.5]	—	—
Cesium-137	1	1018.6	2/23/00	NF	1	0	—	[-0.2]	—	—
Cobalt-60	1	1018.6	2/23/00	F	1	0	—	[-0.4]	—	—
Cobalt-60	1	1018.6	2/23/00	NF	1	0	—	[0]	—	—
Europium-152	1	1018.6	2/23/00	F	1	0	—	[-3.8]	—	—
Europium-152	1	1018.6	2/23/00	NF	1	0	—	[-1.8]	—	—
Gross Alpha Radiation	1	1018.6	2/23/00	F	1	0	—	[0.51]	15	0/1
Gross Alpha Radiation	1	1018.6	2/23/00	NF	1	0	—	[0.66]	—	—
Gross Beta Radiation	1	1018.6	2/23/00	F	1	1	1.98	—	—	—
Gross Beta Radiation	1	1018.6	2/23/00	NF	1	1	3.1	—	—	—
Gross Gamma Radiation <sup>f</sup>	1	1018.6	10/11/00	NF	1	0	—	—	—	—
Plutonium-238	1	1018.6	2/23/00	NF	1	0	—	[0.003]	—	—
Plutonium-239	1	1018.6	2/23/00	F	1	0	—	[0.004]	—	—
Plutonium-239	1	1018.6	2/23/00	NF	1	0	—	[0.03]	—	—
Ruthenium-106	1	1018.6	2/23/00	F	1	0	—	[-3]	—	—
Ruthenium-106	1	1018.6	2/23/00	NF	1	0	—	[0]	—	—
Sodium-22	1	1018.6	2/23/00	F	1	0	—	[0.3]	—	—
Sodium-22	1	1018.6	2/23/00	NF	1	0	—	[1.9]	—	—
Strontium-90	1	1018.6	2/23/00	F	1	0	—	[-0.03]	8	0/1

Table A-2 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (pCi/L)	Non-detected Value (pCi/L)	Drinking Water MCL <sup>b</sup> (pCi/L)	Frequency of Detects > Drinking Water MCL
Strontium-90	1	1018.6	2/23/00	NF	1	0	—	[0.14]	—	—
Tritium	1	1018.6	2/23/00	NF	1	0	—	[0.606]	20000	0/1
Uranium-234	1	1018.6	2/23/00	F	1	1	0.279	—	—	—
Uranium-234	1	1018.6	2/23/00	NF	1	1	0.311	—	—	—
Uranium-235	1	1018.6	2/23/00	F	1	1	0.048	—	—	—
Uranium-235	1	1018.6	2/23/00	NF	1	1	0.076	—	—	—
Uranium-238	1	1018.6	2/23/00	F	1	1	0.143	—	—	—
Uranium-238	1	1018.6	2/23/00	NF	1	1	0.148	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from *National Primary Drinking Water Regulations*, 40 CFR Part 141. US E.P.A. secondary MCLs are from *National Secondary Drinking Water Regulations*, 40 CFR Part 143. State of New Mexico MCLs are from *Drinking Water Regulations*, 20 NMAC 7.1.

<sup>c</sup> F = Filtered.

<sup>d</sup> — = Not applicable or not available.

<sup>e</sup> NF = Nonfiltered.

<sup>f</sup> The results for gross gamma radiation are not available.

**Table A-3**  
**Regional Well R-15 Screen 1 First Round Sample Results: Data Summary for Detected Organic Chemicals**

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Dissolved Organic Carbon	1	1018.6	2/23/00	F <sup>e</sup>	1	1	370	— <sup>f</sup>	—	—	—
Total Organic Carbon	1	1018.6	2/23/00	NF <sup>g</sup>	1	1	13000	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 40 CFR Part 143. State of New Mexico MCLs are from Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from New Mexico Water Quality Control Commission Regulations, Ground and Surface Water Protection, 20 NMAC 6.2.

<sup>e</sup> F = Filtered.

<sup>f</sup> — = Not applicable or not available.

<sup>g</sup> NF = Nonfiltered.

<sup>h</sup> High explosive compounds and associated degradation products were less than instrument detection limits, and, therefore, are not reported in this table.

**Table A-4**  
**Regional Well R-15 Screen 1 Second Round Sample Results: Data Summary for Inorganic Chemicals**

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Aluminum	1	1018.6	10/11/00	F <sup>e</sup>	1	0	— <sup>f</sup>	[49.5]	50	0/1	5000	0/1
Aluminum	1	1018.6	10/11/00	NF <sup>g</sup>	1	0	—	[53]	—	—	—	—
Ammonia (expressed as N)	1	1018.6	10/11/00	F	1	1	160	—	—	—	—	—
Ammonia (expressed as N)	1	1018.6	10/11/00	NF	1	1	110	—	—	—	—	—
Antimony	1	1018.6	10/11/00	F	1	0	—	[0.485]	6	0/1	—	—
Antimony	1	1018.6	10/11/00	NF	1	0	—	[0.431]	—	—	—	—
Arsenic	1	1018.6	10/11/00	F	1	0	—	[1.8]	50	0/1	100	0/1
Arsenic	1	1018.6	10/11/00	NF	1	0	—	[1.3]	—	—	—	—
Barium	1	1018.6	10/11/00	F	1	1	22	—	2000	0/1	1000	0/1
Barium	1	1018.6	10/11/00	NF	1	1	22	—	—	—	—	—
Beryllium	1	1018.6	10/11/00	F	1	0	—	[0.01]	4	0/1	—	—
Beryllium	1	1018.6	10/11/00	NF	1	0	—	[0.035]	—	—	—	—
Bicarbonate (as CaCO <sub>3</sub> )	1	1018.6	10/11/00	F	1	1	44000	—	—	—	—	—
Bicarbonate (as CaCO <sub>3</sub> )	1	1018.6	10/11/00	NF	1	1	45000	—	—	—	—	—
Boron	1	1018.6	10/11/00	F	1	0	—	[11]	—	—	750	0/1
Boron	1	1018.6	10/11/00	NF	1	0	—	[21]	—	—	—	—
Bromide	1	1018.6	10/11/00	F	1	0	—	[20000]	—	—	—	—
Bromide	1	1018.6	10/11/00	NF	1	1	21000	—	—	—	—	—
Cadmium	1	1018.6	10/11/00	F	1	0	—	[0.059]	5	0/1	10	0/1
Cadmium	1	1018.6	10/11/00	NF	1	0	—	[0.059]	—	—	—	—

Table A-4 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Calcium	1	1018.6	10/11/00	F	1	1	12000	—	—	—	—	—
Calcium	1	1018.6	10/11/00	NF	1	1	12000	—	—	—	—	—
Carbonate (as CaCO <sub>3</sub> )	1	1018.6	10/11/00	F	1	0	—	[10000]	—	—	—	—
Carbonate (as CaCO <sub>3</sub> )	1	1018.6	10/11/00	NF	1	0	—	[10000]	—	—	—	—
Chloride	1	1018.6	10/11/00	F	1	1	4000	—	250000	0/1	250000	0/1
Chloride	1	1018.6	10/11/00	NF	1	1	4300	—	—	—	—	—
Chromium	1	1018.6	10/11/00	F	1	1	5.3	—	100	0/1	50	0/1
Chromium	1	1018.6	10/11/00	NF	1	1	5.2	—	—	—	—	—
Cobalt	1	1018.6	10/11/00	F	1	0	—	[0.2]	—	—	50	0/1
Cobalt	1	1018.6	10/11/00	NF	1	0	—	[0.2]	—	—	—	—
Copper	1	1018.6	10/11/00	F	1	0	—	[2]	1300	0/1	1000	0/1
Copper	1	1018.6	10/11/00	NF	1	0	—	[3.7]	—	—	—	—
Cyanide (total)	1	1018.6	10/11/00	NF	1	0	—	[10]	—	—	—	—
Fluoride	1	1018.6	10/11/00	F	1	1	220	—	4000	0/1	1600	0/1
Fluoride	1	1018.6	10/11/00	NF	1	1	250	—	—	—	—	—
Iron	1	1018.6	10/11/00	F	1	1	20	—	300	0/1	1000	0/1
Iron	1	1018.6	10/11/00	NF	1	1	49	—	—	—	—	—
Lead	1	1018.6	10/11/00	F	1	0	—	[0.014]	15	0/1	50	0/1
Lead	1	1018.6	10/11/00	NF	1	1	0.654	—	—	—	—	—
Magnesium	1	1018.6	10/11/00	F	1	1	3200	—	—	—	—	—
Magnesium	1	1018.6	10/11/00	NF	1	1	3100	—	—	—	—	—
Manganese	1	1018.6	10/11/00	F	1	1	1.2	—	50	0/1	200	0/1
Manganese	1	1018.6	10/11/00	NF	1	1	1.7	—	—	—	—	—

Table A-4 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Mercury	1	1018.6	10/11/00	F	1	0	—	[0.05]	2	0/1	—	—
Mercury	1	1018.6	10/11/00	NF	1	0	—	[0.05]	—	—	2	0/1
Molybdenum	1	1018.6	10/11/00	F	1	0	—	[10.2]	—	—	—	—
Molybdenum	1	1018.6	10/11/00	NF	1	0	—	[10.2]	—	—	—	—
Nickel	1	1018.6	10/11/00	F	1	0	—	[1]	100	0/1	200	0/1
Nickel	1	1018.6	10/11/00	NF	1	0	—	[1]	—	—	—	—
Nitrate + Nitrite (expressed as N)	1	1018.6	10/11/00	F	1	1	2300	—	10000	0/1	—	—
Nitrate + Nitrite (expressed as N)	1	1018.6	10/11/00	NF	1	1	2400	—	—	—	—	—
Perchlorate	1	1018.6	10/11/00	F	1	0	—	[2.8]	—	—	—	—
Phosphorus (total)	1	1018.6	10/11/00	F	1	0	—	[100]	—	—	—	—
Phosphorus (total)	1	1018.6	10/11/00	NF	1	0	—	[100]	—	—	—	—
Potassium	1	1018.6	10/11/00	F	1	1	1600	—	—	—	—	—
Potassium	1	1018.6	10/11/00	NF	1	1	1200	—	—	—	—	—
Selenium	1	1018.6	10/11/00	F	1	1	0.956	—	50	0/1	50	0/1
Selenium	1	1018.6	10/11/00	NF	1	1	0.889	—	—	—	—	—
SiO <sub>2</sub>	1	1018.6	10/11/00	F	1	1	63900	—	—	—	—	—
SiO <sub>2</sub>	1	1018.6	10/11/00	NF	1	1	66030	—	—	—	—	—
Silver	1	1018.6	10/11/00	F	1	0	—	[1.2]	100	0/1	50	0/1
Silver	1	1018.6	10/11/00	NF	1	0	—	[0.03]	—	—	—	—
Sodium	1	1018.6	10/11/00	F	1	1	6800	—	—	—	—	—
Sodium	1	1018.6	10/11/00	NF	1	1	6800	—	—	—	—	—

Table A-4 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Strontium	1	1018.6	10/11/00	F	1	1	51	—	—	—	—	—
Strontium	1	1018.6	10/11/00	NF	1	1	52	—	—	—	—	—
Sulfate	1	1018.6	10/11/00	F	1	1	4800	—	250000	0/1	600000	0/1
Sulfate	1	1018.6	10/11/00	NF	1	1	4800	—	—	—	—	—
Thallium	1	1018.6	10/11/00	F	1	1	0.355	—	2	0/1	—	—
Thallium	1	1018.6	10/11/00	NF	1	1	0.337	—	—	—	—	—
Total Kjeldahl Nitrogen	1	1018.6	10/11/00	F	1	1	550	—	—	—	—	—
Total Kjeldahl Nitrogen	1	1018.6	10/11/00	NF	1	1	3700	—	—	—	—	—
Uranium by KPA <sup>h</sup>	1	1018.6	10/11/00	F	1	1	0.33	—	—	—	—	—
Uranium by KPA	1	1018.6	10/11/00	NF	1	1	0.33	—	—	—	—	—
Vanadium	1	1018.6	10/11/00	F	1	1	6.4	—	—	—	—	—
Vanadium	1	1018.6	10/11/00	NF	1	1	6.4	—	—	—	—	—
Zinc	1	1018.6	10/11/00	F	1	0	—	[6.9]	5000	0/1	10000	0/1
Zinc	1	1018.6	10/11/00	NF	1	0	—	[15]	—	—	—	—

Table A-4 (continued)

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
<b>Stable Isotopes (‰)</b>												
δ <sup>15</sup> N/ <sup>14</sup> N	1	1018.6	10/11/00	NF	1	1	+0.9	—	—	—	—	—
δ <sup>18</sup> O/ <sup>16</sup> O	1	1018.6	10/11/00	NF	1	1	-10.9	—	—	—	—	—
δD/H	1	1018.6	10/11/00	NF	1	1	-79	—	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 40 CFR Part 143. State of New Mexico MCLs are from Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from New Mexico Water Quality Control Commission Regulations, Ground and Surface Water Protection, 20 NMAC 6.2.

<sup>e</sup> F = Filtered.

<sup>f</sup> — = Not applicable or not available.

<sup>g</sup> NF = Nonfiltered.

<sup>h</sup> KPA = Kinetic phosphorescence analysis.

**Table A-5**  
**Regional Well R-15 Screen 1 Second Round Sample Results: Data Summary for Radionuclides**

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (pCi/L)	Nondetected Value (pCi/L)	Drinking Water MCL <sup>b</sup> (pCi/L)	Frequency of Detects > Drinking Water MCL
Americium-241	1	1018.6	10/11/00	F <sup>c</sup>	1	0	— <sup>d</sup>	[0.00585]	15 <sup>e</sup>	0/1
Americium-241	1	1018.6	10/11/00	NF <sup>f</sup>	1	0	—	[0.00236]	—	—
Gross Alpha Radiation	1	1018.6	10/11/00	F	1	0	—	[2.28]	15	0/1
Gross Alpha Radiation	1	1018.6	10/11/00	NF	1	0	—	[1.02]	—	—
Gross Beta Radiation	1	1018.6	10/11/00	F	1	0	—	[2.25]	—	—
Gross Beta Radiation	1	1018.6	10/11/00	NF	1	0	—	[1.57]	—	—
Gross Gamma Radiation <sup>g</sup>	1	1018.6	10/11/00	NF	1	0	—	—	—	—
Plutonium-238	1	1018.6	10/11/00	F	1	0	—	[0.00315]	15 <sup>e</sup>	0/1
Plutonium-238	1	1018.6	10/11/00	NF	1	0	—	[-0.00129]	—	—
Plutonium-239	1	1018.6	10/11/00	F	1	0	—	[0]	15 <sup>e</sup>	0/1
Plutonium-239	1	1018.6	10/11/00	NF	1	0	—	[0.00515]	—	—
Strontium-90	1	1018.6	10/11/00	F	1	0	—	[-0.026]	8	0/1
Strontium-90	1	1018.6	10/11/00	NF	1	0	—	[0.1]	—	—
Tritium	1	1018.6	10/11/00	NF	1	1	0.77	—	20000	0/1
Uranium-234	1	1018.6	10/11/00	F	1	1	0.2	—	—	—
Uranium-234	1	1018.6	10/11/00	NF	1	1	0.234	—	—	—
Uranium-235	1	1018.6	10/11/00	F	1	0	—	[0.00925]	—	—
Uranium-235	1	1018.6	10/11/00	NF	1	0	—	[0.00253]	—	—
Uranium-238	1	1018.6	10/11/00	F	1	1	0.104	—	—	—
Uranium-238	1	1018.6	10/11/00	NF	1	0	—	[0.113]	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 40 CFR Part 143. State of New Mexico MCLs are from Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> F = Filtered.

<sup>d</sup> — = Not applicable or not available.

<sup>e</sup> Based on an MCL of 15 pCi/L (including radium-226, but excluding radon and uranium).

<sup>f</sup> NF = Nonfiltered.

<sup>g</sup> The results for gross gamma radiation are not available.

**Table A-6**  
**Regional Well R-15 Screen 1 Second Round Sample Results: Data Summary for Detected Organic Chemicals**

Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Bis(2-ethylhexyl)phthalate	1	1018.6	10/11/00	NF <sup>e</sup>	1	1	5.9	6	0/1	— <sup>f</sup>	—
Toluene	1	1018.6	10/11/00	NF	1	1	0.69	1000	0/1	750	0/1
Dissolved Organic Carbon	1	1018.6	10/11/00	F <sup>g</sup>	1	1	6100	—	—	—	—
Humic Substances, Hydrophilic Acids	1	1018.6	10/11/00	F	1	1	1000	—	—	—	—
Humic Substances, Hydrophilic Bases	1	1018.6	10/11/00	F	1	1	0	—	—	—	—
Humic Substances, Hydrophilic Neutrals	1	1018.6	10/11/00	F	1	1	300	—	—	—	—
Humic Substances, Hydrophilic Total	1	1018.6	10/11/00	F	1	1	1400	—	—	—	—
Humic Substances, Hydrophobic Acids	1	1018.6	10/11/00	F	1	1	1200	—	—	—	—
Humic Substances, Hydrophobic Bases	1	1018.6	10/11/00	F	1	1	0	—	—	—	—
Humic Substances, Hydrophobic Neutrals	1	1018.6	10/11/00	F	1	1	3500	—	—	—	—
Humic Substances, Hydrophobic Total	1	1018.6	10/11/00	F	1	1	4700	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 40 CFR Part 143. State of New Mexico MCLs are from Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from New Mexico Water Quality Control Commission Regulations, Ground and Surface Water Protection, 20 NMAC 6.2.

<sup>e</sup> NF = Nonfiltered.

<sup>f</sup> — = Not applicable or not available.

<sup>g</sup> F = Filtered.

<sup>h</sup> High explosive compounds and associated degradation products were less than instrument detection limits, and, therefore, are not reported in this table.

**Table A-7**  
**Regional Well R-15 Screen 1 Third Round Sample Results: Data Summary for Inorganic Chemicals**

Parameter and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
<b>Field Parameter</b>												
Field Alkalinity (total as CaCO <sub>3</sub> )	1	1018.6	02/15/01	NF	1	0	—	—	—	—	—	—
pH	1	1018.6	02/15/01	NF	1	1	8.15	—	>6 & <9	0/1	>6 & <9	0/1
Specific Conductance (µS/cm)	1	1018.6	02/15/01	NF	1	1	146	—	—	0/1	—	0/1
Temperature (°C)	1	1018.6	02/15/01	NF	1	1	19	—	—	0/1	—	0/1
Turbidity (NTU) <sup>g</sup>	1	1018.6	02/15/01	NF	1	1	2.6	—	—	0/1	—	0/1
<b>Analyte</b>												
Lab Alkalinity (total as CaCO <sub>3</sub> )	1	1018.6	02/15/01	F	1	1	56000	—	—	—	—	—
Aluminum	1	1018.6	02/15/01	F	1	0	—	[47]	50	0/1	5000	0/1
Aluminum	1	1018.6	02/15/01	NF	1	0	—	[55]	—	—	—	—
Ammonia (as N)	1	1018.6	02/15/01	F	1	0	—	[500]	—	—	—	—
Antimony	1	1018.6	02/15/01	F	1	0	—	[0.182]	6	0/1	—	—
Antimony	1	1018.6	02/15/01	NF	1	0	—	[0.153]	—	—	—	—
Arsenic	1	1018.6	02/15/01	F	1	0	—	[1.5]	50	0/1	100	0/1
Arsenic	1	1018.6	02/15/01	NF	1	0	—	[1.5]	—	—	—	—
Barium	1	1018.6	02/15/01	F	1	1	26	—	2000	0/1	1000	0/1
Barium	1	1018.6	02/15/01	NF	1	1	26	—	—	—	—	—
Beryllium	1	1018.6	02/15/01	F	1	1	0.017	—	4	0/1	—	—
Beryllium	1	1018.6	02/15/01	NF	1	0	—	[0.012]	—	—	—	—

Table A-7 (continued)

Parameter and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Boron	1	1018.6	02/15/01	F	1	1	15	—	—	—	750	0/1
Boron	1	1018.6	02/15/01	NF	1	1	14	—	—	—	—	—
Bromide	1	1018.6	02/15/01	F	1	0	—	[200]	—	—	—	—
Cadmium	1	1018.6	02/15/01	F	1	0	—	[0.2]	5	0/1	10	0/1
Cadmium	1	1018.6	02/15/01	NF	1	0	—	[0.2]	—	—	—	—
Calcium	1	1018.6	02/15/01	F	1	1	12000	—	—	—	—	—
Calcium	1	1018.6	02/15/01	NF	1	1	12000	—	—	—	—	—
Chloride	1	1018.6	02/15/01	F	1	1	4900	—	250000	0/1	250000	0/1
Chromium (total)	1	1018.6	02/15/01	F	1	1	3.8	—	100	0/1	50	0/1
Chromium (total)	1	1018.6	02/15/01	NF	1	1	4.1	—	—	—	—	—
Cobalt	1	1018.6	02/15/01	F	1	0	—	[0.4]	—	—	50	0/1
Cobalt	1	1018.6	02/15/01	NF	1	0	—	[0.4]	—	—	—	—
Copper	1	1018.6	02/15/01	F	1	0	—	[0.66]	1300	0/1	1000	0/1
Copper	1	1018.6	02/15/01	NF	1	0	—	[0.86]	—	—	—	—
Cyanide (total)	1	1018.6	02/15/01	NF	1	0	—	[10]	—	—	—	—
Fluoride	1	1018.6	02/15/01	F	1	1	170	—	4000	0/1	1600	0/1
Iron	1	1018.6	02/15/01	F	1	0	—	[48]	300	0/1	1000	0/1
Iron	1	1018.6	02/15/01	NF	1	0	—	[87]	—	—	—	—
Lead	1	1018.6	02/15/01	F	1	0	—	[0.65]	15	0/1	50	0/1
Lead	1	1018.6	02/15/01	NF	1	0	—	[0.65]	—	—	—	—
Magnesium	1	1018.6	02/15/01	F	1	1	3400	—	—	—	—	—
Magnesium	1	1018.6	02/15/01	NF	1	1	3400	—	—	—	—	—
Manganese	1	1018.6	02/15/01	F	1	1	0.4	—	50	0/1	200	0/1
Manganese	1	1018.6	02/15/01	NF	1	1	1.3	—	—	—	—	—

Table A-7 (continued)

Parameter and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Mercury	1	1018.6	02/15/01	F	1	0	—	[0.016]	2	0/1	—	—
Mercury	1	1018.6	02/15/01	NF	1	0	—	[0.016]	—	—	2	0/1
Molybdenum	1	1018.6	02/15/01	F	1	0	—	[0.45]	—	—	—	—
Molybdenum	1	1018.6	02/15/01	NF	1	0	—	[4.5]	—	—	—	—
Nickel	1	1018.6	02/15/01	F	1	1	1.1	—	100	0/1	200	0/1
Nickel	1	1018.6	02/15/01	NF	1	1	1.2	—	—	—	—	—
Nitrate + Nitrite (as N)	1	1018.6	02/15/01	F	1	1	2400	—	10000	0/1	—	—
Perchlorate	1	1018.6	02/15/01	F	1	1	1.54	—	—	—	—	—
Phosphorus (total)	1	1018.6	02/15/01	F	1	0	—	[50]	—	—	—	—
Potassium	1	1018.6	02/15/01	F	1	1	1700	—	—	—	—	—
Potassium	1	1018.6	02/15/01	NF	1	1	1700	—	—	—	—	—
Selenium	1	1018.6	02/15/01	F	1	0	—	[2.5]	50	0/1	50	0/1
Selenium	1	1018.6	02/15/01	NF	1	0	—	[2.5]	—	—	—	—
SiO <sub>2</sub>	1	1018.6	02/15/01	F	1	1	72760	—	—	—	—	—
SiO <sub>2</sub>	1	1018.6	02/15/01	NF	1	1	70620	—	—	—	—	—
Silver	1	1018.6	02/15/01	F	1	0	—	[0.48]	100	0/1	50	0/1
Silver	1	1018.6	02/15/01	NF	1	0	—	[0.48]	—	—	—	—
Sodium	1	1018.6	02/15/01	F	1	1	8700	—	—	—	—	—
Sodium	1	1018.6	02/15/01	NF	1	1	8500	—	—	—	—	—
Strontium	1	1018.6	02/15/01	F	1	1	55	—	—	—	—	—
Strontium	1	1018.6	02/15/01	NF	1	1	54	—	—	—	—	—
Sulfate	1	1018.6	02/15/01	F	1	1	6400	—	250000	0/1	600000	0/1
Thallium	1	1018.6	02/15/01	F	1	1	0.55	—	2	0/1	—	—

Table A-7 (continued)

Parameter and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Thallium	1	1018.6	02/15/01	NF	1	1	0.591	—	—	—	—	—
Total Kjeldahl Nitrogen	1	1018.6	02/15/01	F	1	0	—	[100]	—	—	—	—
Uranium	1	1018.6	02/15/01	F	1	1	0.354	—	20	0/1	5000	0/1
Uranium	1	1018.6	02/15/01	NF	1	1	0.367	—	—	—	—	—
Vanadium	1	1018.6	02/15/01	F	1	1	6.4	—	—	—	—	—
Vanadium	1	1018.6	02/15/01	NF	1	1	6.1	—	—	—	—	—
Zinc	1	1018.6	02/15/01	F	1	1	7.1	—	5000	0/1	10000	0/1
Zinc	1	1018.6	02/15/01	NF	1	1	3.6	—	—	—	—	—
<b>Stable Isotope (‰)</b>												
δD/H	1	1018.6	02/15/01	NF	1	1	-77	—	—	—	—	—
δ <sup>18</sup> O/ <sup>16</sup> O	1	1018.6	02/15/01	NF	1	1	-11.3	—	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15, when the well was sampled, was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from New Mexico Quality Control Commission Regulations, Ground and Surface Water Protection, 20 NMAC 6.2.

<sup>e</sup> NF = Nonfiltered.

<sup>f</sup> — = Not applicable or not available.

<sup>g</sup> NTU = Nephelometric turbidity unit.

<sup>h</sup> F = Filtered.

**Table A-8**  
**Regional Well R-15 Screen 1 Third Round Sample Results: Data Summary for Radionuclides**

Parameter and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (pCi/L)	Nondetected Value (pCi/L)	Drinking Water MCL <sup>b</sup> (pCi/L)	Frequency of Detects > Drinking Water MCL
Americium-241	1	1018.6	02/15/01	F <sup>c</sup>	1	0	— <sup>d</sup>	[0.007]	15 <sup>e</sup>	0/1
Cesium-134	1	1018.6	02/15/01	F	1	0	—	[0]	—	—
Cesium-137	1	1018.6	02/15/01	F	1	0	—	[-0.4]	—	—
Cobalt-60	1	1018.6	02/15/01	F	1	0	—	[0.7]	—	—
Europium-152	1	1018.6	02/15/01	F	1	0	—	[0.3]	—	—
Gross Alpha Radiation	1	1018.6	02/15/01	NF <sup>f</sup>	1	0	—	[1.3]	—	—
Gross Beta Radiation	1	1018.6	02/15/01	NF	1	0	—	[1.2]	—	—
Gross Gamma Radiation	1	1018.6	02/15/01	NF	1	1	173	—	—	—
Plutonium-238	1	1018.6	02/15/01	F	1	0	—	[-0.015]	15 <sup>e</sup>	0/1
Plutonium-239	1	1018.6	02/15/01	F	1	0	—	[0]	15 <sup>e</sup>	0/1
Ruthenium-106	1	1018.6	02/15/01	F	1	0	—	[-18]	—	—
Sodium-22	1	1018.6	02/15/01	F	1	0	—	[-0.2]	—	—
Strontium-90	1	1018.6	02/15/01	F	1	1	1.51	—	8	0/1
Tritium	1	1018.6	02/15/01	NF	1	1	2.17	—	20000	0/1
Uranium-234	1	1018.6	02/15/01	F	1	1	0.229	—	—	—
Uranium-235	1	1018.6	02/15/01	F	1	0	—	[0.001]	—	—
Uranium-238	1	1018.6	02/15/01	F	1	1	0.125	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15, when the well was sampled, was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> F = Filtered.

<sup>d</sup> — = Not applicable or not available.

<sup>e</sup> Based on an MCL of 15 pCi/L for gross alpha particle activity (including radium, but excluding radon and uranium).

<sup>f</sup> NF = Nonfiltered.

**Table A-9  
Regional Well R-15 Screen 1 Third Round Sample Results: Data Summary for Detected Organic Chemicals**

Parameter and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Date	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Dissolved Organic Carbon	1	1018.6	02/15/01	F <sup>e</sup>	1	1	1200	— <sup>f</sup>	—	—	—	—
Total Organic Carbon	1	1018.6	02/15/01	NF <sup>g</sup>	1	1	1200	—	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15, when the well was sampled, was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from New Mexico Quality Control Commission Regulations, Ground and Surface Water Protection, 20 NMAC 6.2.

<sup>e</sup> F = Filtered.

<sup>f</sup> — = Not applicable or not available.

<sup>g</sup> NF = Nonfiltered.

<sup>h</sup> High explosive compounds and associated degradation products were less than instrument detection limits, and, therefore, are not reported in this table.

**Table A-10**  
**Regional Well R-15 Screen 1 Fourth Round Sample Results: Data Summary for Inorganic Chemicals**

Parameters and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Dates	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
<b>Field Parameters</b>												
Field Alkalinity (total as CaCO <sub>3</sub> )	1	1018.6	05/22/01	NF <sup>e</sup>	1	1	— <sup>f</sup>	—	—	—	—	—
pH	1	1018.6	05/22/01	NF	1	1	7.87	—	>6 & <9	0/1	<6 & >9	0/1
Temperature (°C)	1	1018.6	05/22/01	NF	1	1	21.5	—	—	0/1	—	0/1
Turbidity (NTU <sup>g</sup> )	1	1018.6	05/22/01	NF	1	1	1.2	—	—	0/1	—	0/1
Specific Conductance (µS/cm)	1	1018.6	05/22/01	NF	1	1	150	—	—	0/1	—	0/1
<b>Analytes</b>												
Lab Alkalinity (total)	1	1018.6	05/22/01	F <sup>h</sup>	1	1	58000	—	—	—	—	—
Aluminum	1	1018.6	05/22/01	F	1	0	—	[7.6]	50	0/1	5000	0/1
Aluminum	1	1018.6	05/22/01	NF	1	0	—	[7.6]	—	—	—	—
Ammonia (as N)	1	1018.6	05/22/01	F	1	0	—	[100]	—	—	—	—
Antimony	1	1018.6	05/22/01	F	1	0	—	[0.153]	6	0/2	—	—
Antimony	1	1018.6	05/22/01	NF	1	0	—	[0.193]	—	—	—	—
Arsenic	1	1018.6	05/22/01	F	1	0	—	[1.5]	50	0/1	100	0/1
Arsenic	1	1018.6	05/22/01	NF	1	0	—	[1.5]	—	—	—	—
Barium	1	1018.6	05/22/01	F	1	1	25	—	2000	0/1	1000	0/1
Barium	1	1018.6	05/22/01	NF	1	1	25	—	—	—	—	—
Beryllium	1	1018.6	05/22/01	F	1	0	—	[0.074]	4	0/1	—	—
Beryllium	1	1018.6	05/22/01	NF	1	0	—	[0.074]	—	—	—	—
Boron	1	1018.6	05/22/01	F	1	0	—	[5.4]	—	—	750	0/1

Table A-10 (continued)

Parameters and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Dates	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Boron	1	1018.6	05/22/01	NF	1	1	10	—	—	—	—	—
Bromide	1	1018.6	05/22/01	F	1	0	—	[200]	—	—	—	—
Cadmium	1	1018.6	05/22/01	F	1	0	—	[0.084]	5	0/1	10	0/1
Cadmium	1	1018.6	05/22/01	NF	1	0	—	[0.084]	—	—	—	—
Calcium	1	1018.6	05/22/01	F	1	1	13000	—	—	—	—	—
Calcium	1	1018.6	05/22/01	NF	1	1	13000	—	—	—	—	—
Chloride	1	1018.6	05/22/01	F	1	1	4700	—	250000	0/1	250000	0/1
Chromium (total)	1	1018.6	05/22/01	F	1	1	3.8	—	100	0/1	50	0/1
Chromium (total)	1	1018.6	05/22/01	NF	1	1	3.6	—	—	—	—	—
Cobalt	1	1018.6	05/22/01	F	1	0	—	[0.37]	—	—	50	0/1
Cobalt	1	1018.6	05/22/01	NF	1	0	—	[0.37]	—	—	—	—
Copper	1	1018.6	05/22/01	F	1	0	—	[0.27]	1300	0/1	1000	0/1
Copper	1	1018.6	05/22/01	NF	1	0	—	[0.27]	—	—	—	—
Cyanide, Total	1	1018.6	05/22/01	NF	1	0	—	{10}	—	—	—	—
Fluoride	1	1018.6	05/22/01	F	1	1	140	—	4000	0/1	1600	0/1
Iron	1	1018.6	05/22/01	F	1	0	—	[46]	300	0/1	1000	0/1
Iron	1	1018.6	05/22/01	NF	1	0	—	[60]	—	—	—	—
Lead	1	1018.6	05/22/01	F	1	0	—	[0.37]	15	0/2	50	0/2
Lead	1	1018.6	05/22/01	NF	1	1	—	[0.178]	—	—	—	—
Magnesium	1	1018.6	05/22/01	F	1	1	3500	—	—	—	—	—
Magnesium	1	1018.6	05/22/01	NF	1	1	3500	—	—	—	—	—
Manganese	1	1018.6	05/22/01	F	1	1	0.24	—	50	0/1	200	0/1
Manganese	1	1018.6	05/22/01	NF	1	1	0.86	—	—	—	—	—
Mercury	1	1018.6	05/22/01	F	1	0	—	[0.033]	2	0/1	—	—

Table A-10 (continued)

Parameters and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Dates	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Mercury	1	1018.6	05/22/01	NF	1	0	—	[0.033]	—	—	2	0/1
Molybdenum	1	1018.6	05/22/01	F	1	0	—	[3.8]	—	—	—	—
Molybdenum	1	1018.6	05/22/01	NF	1	0	—	[3.8]	—	—	—	—
Nickel	1	1018.6	05/22/01	F	1	0	—	[0.3]	100	0/1	200	0/1
Nickel	1	1018.6	05/22/01	NF	1	0	—	[0.3]	—	—	—	—
Nitrate + Nitrite (as N)	1	1018.6	05/22/01	F	1	1	2400	—	10000	0/1	—	—
Perchlorate	1	1018.6	05/22/01	F	1	1	4.19	—	—	—	—	—
Phosphorus (as P)	1	1018.6	05/22/01	F	1	0	—	[50]	—	—	—	—
Potassium	1	1018.6	05/22/01	F	1	1	1800	—	—	—	—	—
Potassium	1	1018.6	05/22/01	NF	1	1	1800	—	—	—	—	—
Selenium	1	1018.6	05/22/01	F	1	0	—	[1.9]	50	0/1	50	0/1
Selenium	1	1018.6	05/22/01	NF	1	0	—	[1.9]	—	—	—	—
SiO <sub>2</sub>	1	1018.6	05/22/01	F	1	1	72760	—	—	—	—	—
SiO <sub>2</sub>	1	1018.6	05/22/01	NF	1	1	72760	—	—	—	—	—
Silver	1	1018.6	05/22/01	F	1	0	—	[0.57]	100	0/1	50	0/1
Silver	1	1018.6	05/22/01	NF	1	0	—	[0.57]	—	—	—	—
Sodium	1	1018.6	05/22/01	F	1	1	8500	—	—	—	—	—
Sodium	1	1018.6	05/22/01	NF	1	1	8400	—	—	—	—	—
Strontium	1	1018.6	05/22/01	F	1	1	56	—	—	—	—	—
Strontium	1	1018.6	05/22/01	NF	1	1	56	—	—	—	—	—
Sulfate	1	1018.6	05/22/01	F	1	1	6100	—	250000	0/1	600000	0/1
Thallium	1	1018.6	05/22/01	F	1	1	—	[0.189]	2	0/2	—	—
Thallium	1	1018.6	05/22/01	NF	1	1	—	[0.133]	—	—	—	—

Table A-10 (continued)

Parameters and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Dates	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Total Kjeldahl Nitrogen	1	1018.6	05/22/01	F	1	0	—	[0.1]	—	—	—	—
Uranium	1	1018.6	05/22/01	F	1	1	0.375	—	20	0/1	5000	0/1
Uranium	1	1018.6	05/22/01	NF	1	1	0.379	—	—	—	—	—
Vanadium	1	1018.6	05/22/01	F	1	1	6	—	—	—	—	—
Vanadium	1	1018.6	05/22/01	NF	1	1	6.1	—	—	—	—	—
Zinc	1	1018.6	05/22/01	F	1	0	—	[0.31]	5000	0/1	10000	0/1
Zinc	1	1018.6	05/22/01	NF	1	0	—	[0.31]	—	—	—	—
<b>Stable Isotopes (‰)</b>												
δ <sup>18</sup> O/ <sup>16</sup> O	1	1018.6	05/22/01	NF	1	1	-11.2	—	—	—	—	—
δD/H	1	1018.6	05/22/01	NF	1	1	-79	—	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from New Mexico Quality Control Commission Regulations, Ground and Surface Water Protection, 20 NMAC 6.2.

<sup>e</sup> NF = Nonfiltered.

<sup>f</sup> — = Not applicable or not available.

<sup>g</sup> NTU = Nephelometric turbidity unit.

<sup>h</sup> F = Filtered.

**Table A-11**  
**Regional Well R-15 Screen 1 Fourth Round Sample Results: Data Summary for Radionuclides**

Parameters and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Dates	Field Preparation	Number of Analyses	Number of Detects	Detected Value (pCi/L)	Nondetected Value (pCi/L)	Drinking Water MCL <sup>b</sup> (pCi/L)	Frequency of Detects > Drinking Water MCL
Actinium-228	1	1018.6	05/22/01	F <sup>c</sup>	1	0	— <sup>d</sup>	[5]	—	—
Americium-241	1	1018.6	05/22/01	F	1	0	—	[0.7]	15	0/2
Annihilation Radiation	1	1018.6	05/22/01	F	1	0	—	[-0.4]	—	—
Barium-140	1	1018.6	05/22/01	F	1	0	—	[2 to 2]	—	—
Bismuth-212	1	1018.6	05/22/01	F	1	0	—	[22]	—	—
Bismuth-214	1	1018.6	05/22/01	F	1	1	20	—	—	—
Cadmium-109	1	1018.6	05/22/01	F	1	0	—	[15]	—	—
Cerium-139	1	1018.6	05/22/01	F	1	0	—	[0.1]	—	—
Cerium-144	1	1018.6	05/22/01	F	1	0	—	[-2]	—	—
Cesium-134	1	1018.6	05/22/01	F	1	0	—	[-0.6]	—	—
Cesium-137	1	1018.6	05/22/01	F	1	0	—	[-1.3]	—	—
Cobalt-57	1	1018.6	05/22/01	F	1	0	—	[-0.3]	—	—
Cobalt-60	1	1018.6	05/22/01	F	1	0	—	[0.5]	—	—
Europium-152	1	1018.6	05/22/01	F	1	0	—	[-24]	—	—
Gross Alpha Radiation	1	1018.6	05/22/01	NF <sup>e</sup>	1	0	—	[-0.19]	—	—
Gross Beta Radiation	1	1018.6	05/22/01	NF	1	0	—	[0.8]	—	—
Gross Gamma Radiation	1	1018.6	05/22/01	NF	1	1	240	—	—	—
Lanthanum-140	1	1018.6	05/22/01	F	1	0	—	[2.8]	—	—
Lead-211	1	1018.6	05/22/01	F	1	0	—	[15]	—	—
Lead-212	1	1018.6	05/22/01	F	1	0	—	[1.9]	—	—
Lead-214	1	1018.6	05/22/01	F	1	0	—	[13.9]	—	—
Manganese-54	1	1018.6	05/22/01	F	1	0	—	[-1.8]	—	—
Mercury-203	1	1018.6	05/22/01	F	1	0	—	[-0.8]	—	—
Neptunium-237	1	1018.6	05/22/01	F	1	0	—	[8.4]	—	—
Plutonium-238	1	1018.6	05/22/01	F	1	0	—	[-0.002]	15	0/1
Plutonium-239	1	1018.6	05/22/01	F	1	0	—	[0.003]	15	0/1
Potassium-40	1	1018.6	05/22/01	F	1	0	—	[-24]	—	—

Table A-11 (continued)

Parameters and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Dates	Field Preparation	Number of Analyses	Number of Detects	Detected Value (pCi/L)	Nondetected Value (pCi/L)	Drinking Water MCL <sup>b</sup> (pCi/L)	Frequency of Detects > Drinking Water MCL
Protactinium-231	1	1018.6	05/22/01	F	1	0	—	[13]	—	—
Protactinium-233	1	1018.6	05/22/01	F	1	0	—	[-5]	—	—
Protactinium-234M	1	1018.6	05/22/01	F	1	0	—	[60]	—	—
Radium-223	1	1018.6	05/22/01	F	1	0	—	[16]	—	—
Radium-226	1	1018.6	05/22/01	F	1	0	—	[25]	5	0/1
Radon-219	1	1018.6	05/22/01	F	1	0	—	[0]	—	—
Ruthenium-106	1	1018.6	05/22/01	F	1	0	—	[19]	—	—
Selenium-75	1	1018.6	05/22/01	F	1	0	—	[-0.2]	—	—
Sodium-22	1	1018.6	05/22/01	F	1	0	—	[0.5]	—	—
Strontium-85	1	1018.6	05/22/01	F	1	0	—	[0.4]	—	—
Strontium-90	1	1018.6	05/22/01	F	1	0	—	[-0.1]	8	0/1
Thallium-208	1	1018.6	05/22/01	F	1	0	—	[3.1]	—	—
Thorium-227	1	1018.6	05/22/01	F	1	0	—	[0]	—	—
Thorium-234	1	1018.6	05/22/01	F	1	0	—	[-22]	—	—
Tin-113	1	1018.6	05/22/01	F	1	0	—	[0.1]	—	—
Tritium	1	1018.6	05/22/01	NF	1	1	3.29	—	20000	0/1
Uranium-234	1	1018.6	05/22/01	F	1	1	0.257	—	—	—
Uranium-235	1	1018.6	05/22/01	F	1	0	—	[0.007]	—	—
Uranium-238	1	1018.6	05/22/01	F	1	1	0.099	—	—	—
Yttrium-88	1	1018.6	05/22/01	F	1	0	—	[3.1]	—	—
Zinc-65	1	1018.6	05/22/01	F	1	0	—	[3.3]	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15, when the well was sampled, was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> F = Filtered.

<sup>d</sup> — = Not applicable or not available.

<sup>e</sup> NF = Nonfiltered.

**Table A-12**  
**Regional Well R-15 Screen 1 Fourth Round Sample Results: Data Summary for Detected Organic Chemicals**

Parameters and Analyte	Screen	Depth (ft) <sup>a</sup>	Collection Dates	Field Preparation	Number of Analyses	Number of Detects	Detected Value (µg/L)	Non-detected Value (µg/L)	Drinking Water MCL <sup>b</sup> (µg/L)	Frequency of Detects > Drinking Water MCL	NMED <sup>c</sup> Groundwater Standard <sup>d</sup> (µg/L)	Frequency of Detects > NMED Groundwater Standard
Dissolved Organic Carbon	1	1018.6	05/22/01	F <sup>e</sup>	1	0	— <sup>f</sup>	—	—	—	—	—
Total Organic Carbon	1	1018.6	05/22/01	NF <sup>g</sup>	1	0	—	—	—	—	—	—

<sup>a</sup> The static water level for the regional aquifer at R-15 when the well was sampled was 986 ft.

<sup>b</sup> MCL = Maximum contaminant level. US Environmental Protection Agency (EPA) MCLs are from the National Primary Water Regulations, 40 CFR Part 141. US EPA secondary MCLs are from National Secondary Drinking Water Regulations, 40 CFR Part 143. State of New Mexico MCLs are from Drinking Water Regulations, 20 NMAC 7.1.

<sup>c</sup> NMED = New Mexico Environment Department.

<sup>d</sup> State of New Mexico groundwater standards are from New Mexico Water Quality Control Commission Regulations, Ground and Surface Water Protection, 20 NMAC 6.2.

<sup>e</sup> F = Filtered.

<sup>f</sup> — = Not applicable or not available.

<sup>g</sup> NF = Nonfiltered.

<sup>h</sup> High explosive compounds and associated degradation products were less than instrument detection limits, and, therefore, are not reported in this table.

# **Appendix B**

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## *Geochemical Calculations*



Geochemical Calculations for R-15 (10/11/00).

16.90 mg/L	0.000	0.00000E+00		
1 1 1 0	1 0 0 0	1 1 0 0	0	
1.20	0.0	0.00	0.000	0.00
0	0	0		
330	0.000E+00	-7.90 y		/H+1
140	3.292E+01	-19.94 y		/Total CO3-2 alkali
150	1.200E+01	-3.52 y		/Ca+2
460	3.200E+00	-3.88 y		/Mg+2
500	6.800E+00	-3.53 y		/Na+1
410	1.600E+00	-4.39 y		/K+1
732	4.800E+00	-4.30 y		/SO4-2
180	4.000E+00	-3.95 y		/Cl-1
270	2.200E-01	-4.94 y		/F-1
280	2.000E-02	-6.45 y		/Fe+2
470	1.200E-03	-7.66 y		/Mn+2
492	1.010E+01	-3.79 y		/NO3-1
770	1.022E+02	-2.97 y		/H4SiO4
800	5.100E-02	-6.24 y		/Sr+2
871	4.100E-04	-8.79 y		/Ti(OH)3
893	3.700E-04	-8.86 y		/UO2+2
144	1.200E+00	-6.22		/DOM1
3	1			
330	7.9000	0.0000		/H+1

Geochemical Calculations for R-15 (02/24/00).

20.60 mg/L	0.000	0.00000E+00	
1 0 1 0	1 0 0 0	1 1 0 0	0 0
0 0 0			
330	0.000E+00	-8.06 y	/H+1
140	3.058E+01	-19.97 y	/Total CO3-2 alkali
150	1.200E+01	-3.52 y	/Ca+2
460	3.400E+00	-3.85 y	/Mg+2
500	9.100E+00	-3.40 y	/Na+1
732	5.200E+00	-4.27 y	/SO4-2
180	3.700E+00	-3.98 y	/Cl-1
270	2.090E-01	-4.96 y	/F-1
280	2.100E-01	-5.42 y	/Fe+2
470	1.800E-02	-6.48 y	/Mn+2
492	9.680E+00	-3.81 y	/NO3-1
770	1.130E+02	-2.93 y	/H4SiO4
800	5.500E-02	-6.20 y	/Sr+2
871	1.200E-03	-8.33 y	/Ti(OH)3
893	3.900E-04	-8.84 y	/UO2+2
3 1			
330	7.9000	0.0000	/H+1

Geochemical Calculations for R-15 (02/15/01).

19.00 mg/L	0.000	0.00000E+00		
1 0 1 0	1 0 0 0	1 1 0 0	0 0	
0	0	0		
330	0.000E+00	-8.15 y		/H+1
140	3.357E+01	-19.93 y		/Total CO3-2 alkali
150	1.200E+01	-3.52 y		/Ca+2
460	3.400E+00	-3.85 y		/Mg+2
500	8.700E+00	-3.42 y		/Na+1
410	1.700E+00	-4.36 y		/K+1
732	6.400E+00	-4.18 y		/SO4-2
180	4.900E+00	-3.86 y		/Cl-1
270	1.700E-01	-5.05 y		/F-1
280	4.800E-02	-6.07 y		/Fe+2
470	4.000E-04	-8.14 y		/Mn+2
492	1.056E+01	-3.77 y		/NO3-1
770	1.164E+02	-2.92 y		/H4SiO4
800	5.500E-02	-6.20 y		/Sr+2
871	6.900E-04	-8.57 y		/Ti(OH)3
893	4.000E-04	-8.83 y		/UO2+2
3	1			
330	8.1500	0.0000		/H+1

Geochemical Calculations for R-15 (05/22/01).

21.50 mg/L	0.000	0.00000E+00	
1 0 1 0	1 0 0 0	1 1 0 0	0 0
0 0	0		
330	0.000E+00	-7.87 y	/H+1
140	3.477E+01	-19.92 y	/Total CO3-2 alkali
150	1.300E+01	-3.49 y	/Ca+2
460	3.500E+00	-3.84 y	/Mg+2
500	8.500E+00	-3.43 y	/Na+1
410	1.800E+00	-4.34 y	/K+1
732	6.100E+00	-4.20 y	/SO4-2
180	4.700E+00	-3.88 y	/Cl-1
270	1.400E-01	-5.13 y	/F-1
280	6.000E-02	-5.97 y	/Fe+2
470	8.600E-04	-7.81 y	/Mn+2
492	1.060E+01	-3.77 y	/NO3-1
770	1.164E+02	-2.92 y	/H4SiO4
800	5.600E-02	-6.19 y	/Sr+2
893	4.200E-04	-8.81 y	/UO2+2
3 1			
330	7.8700	0.0000	/H+1