ERID-204541

LA-UR-11-3673
July 2011
EP2011-0209

Completion Report for Regional Well R-63

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by the Environmental Programs Directorate

EP2011-0209

Completion Report for Regional Aquifer Well R-63

July 2011

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EXECUTIVE SUMMARY

This well completion report describes the drilling, installation, well development, aquifer testing, and sampling system installation for regional well R-63, located in Technical Area 16 (TA-16) of Los Alamos National Laboratory. This report was written in accordance with the requirements in Section IV.A.3.e.iv of the March 1, 2005 (revised 2008) Compliance Order on Consent.

R-63 was installed at the direction of the New Mexico Environment Department (NMED) to monitor groundwater quality in the regional aquifer downgradient of potential releases of high explosives from Consolidated Unit 16-021(c)-99 (also known as the 260 Outfall) at TA-16 and to provide information supporting the regional groundwater monitoring network for the 260 Outfall corrective measures evaluation.

The R-63 borehole was drilled using fluid-assisted dual-rotary and standard air-rotary drilling methods. Drilling fluid additives included potable water and a foaming agent. Injection of foam was discontinued at 1212 ft below ground surface (bgs), roughly 100 ft above the anticipated top of the regional aquifer. The R-63 borehole was advanced to a total depth of 1423.8 ft bgs using a combination of dual-rotary casing advance and open-hole drilling methods.

Geologic formations encountered during drilling included the Tshirege Member of the Bandelier Tuff, the Cerro Toledo interval, the Otowi Member of the Bandelier Tuff, the Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff, and the Puye Formation.

Several zones of perched intermediate groundwater were encountered in the Puye Formation between approximately 800 and 1200 ft bgs. Regional groundwater was also encountered in the Puye Formation, and the depth to water was measured at 1260.4 ft bgs in the completed well.

R-63 was completed per the NMED-approved well design with one screened interval from 1325 to 1345.3 ft bgs.

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Acronyms and Abbreviations

AI	array induction
amsl	above mean sea level
APS	accelerator porosity sonde
ASTM	American Society for Testing and Materials
bgs	below ground surface
CMR	combinable magnetic resonance
Consent Order	Compliance Order on Consent
DO	dissolved oxygen
DTW	depth to water
EES-14	Earth and Environmental Sciences Group 14
Eh	oxidation-reduction potential
EP	Environmental Programs
EPA	Environmental Protection Agency (U.S.)
FMI	formation micro-imager
gpd	gallons per day
gpm	gallons per minute
GR	spectral gamma ray
HE	high explosives
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
hp	horsepower
I.D.	inside diameter
LANL	Los Alamos National Laboratory
LH3	low-level tritium
NAD	North American Datum
NMED	New Mexico Environment Department
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
PETN	pentaerythritol tetranitrate
PVC	polyvinyl chloride
Qal	alluvium
Qbo	Otowi Member of the Bandelier Tuff
Qbog	Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff

Qbt	Tshirege Member of the Bandelier Tuff
Qct	Cerro Toledo interval
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
RPF	Records Processing Facility
TA	technical area
TATB	triaminotrinitrobenzene
TD	total depth
TDS	total dissolved solids
TOC	total organic carbon
Tpf	Puye Formation
TU	tritium unit
VOC	volatile organic compound
WCSF	waste characterization strategy form
wt%	weight percent
WES-EDA	Waste and Environmental Services Division–Environmental Data and Analysis

1.0 INTRODUCTION

This completion report summarizes the drilling, well construction, well development, aquifer testing, and sampling system installation for regional well R-63. The report is written in accordance with the requirements in Section IV.A.3.e.iv of the March 1, 2005 (revised 2008) Compliance Order on Consent (Consent Order). Well R-63 was drilled, installed, and developed from December 21, 2010, to February 12, 2011, at Los Alamos National Laboratory (LANL or the Laboratory) for the Environmental Programs (EP) Directorate.

Well R-63 is located within Technical Area 16 (TA-16) in the southwest corner of the Laboratory (Figure 1.0-1). R-63 was installed at the direction of the New Mexico Environment Department (NMED) to monitor groundwater quality in the regional aquifer downgradient of high explosives (HE) releases from Consolidated Unit 16-021(c)-99 (also known as the 260 Outfall), and to provide information supporting the regional groundwater monitoring network for the 260 Outfall corrective measures evaluation.

The borehole was drilled to a total depth (TD) of 1423.8 ft below ground surface (bgs). A 5.6-in. outside diameter (O.D.) stainless-steel well was then installed with one screened interval from 1325 to 1345.3 ft bgs in the regional aquifer. The composite depth to water (DTW) was measured at 1255.3 ft bgs before well installation on January 28, 2011, and at 1260.4 ft bgs after well development and aquifer testing on February 25, 2011. During drilling, cuttings samples were collected for lithologic evaluation at 5-ft intervals from ground surface to TD.

Postinstallation activities included well development, aquifer testing, pump installation, surface completion, and geodetic surveying. Future activities will include site restoration and waste management.

The information presented in this report was compiled from field reports and daily activity summaries. Records, including field reports, field logs, and survey information, are on file at the Laboratory's Records Processing Facility (RPF). This report contains brief descriptions of activities and supporting figures, tables, and appendixes associated with the R-63 well drilling and installation project.

2.0 ADMINISTRATIVE PREPARATION

The following Laboratory documents were prepared to guide activities associated with the drilling, installation, and sampling of regional aquifer well R-63:

- "Drilling Work Plan for Regional Aquifer Well R-25r" (LANL 2010, 109770) (Note: the name was subsequently changed to R-63.)
- "Well R-63 Drilling Plan, Installation of Well R-63, TA-16, Los Alamos National Laboratory" (North Wind Inc. 2010, 111693)
- "Hydrologic Testing Work Plan for Consolidated Unit 16-021(c)-99" (LANL 2010, 108534)
- "Integrated Work Document for Regional and Intermediate Aquifer Well Drilling (Mobilization, Site Preparation, and Setup Stages)" (LANL 2007, 100972)
- "Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan" (LANL 2006, 092600)
- "Waste Characterization Strategy Form for R-63 (also called R-25r), Installation of Regional Aquifer Well" (LANL 2010, 111428)

3.0 DRILLING ACTIVITIES

This section describes the drilling strategy and approach and provides a chronological summary of field activities conducted during the drilling of R-63.

3.1 Drilling Approach

The R-63 borehole was drilled using a Schramm, Inc. T130XD Rotadrill dual-rotary drilling rig with casing rotator. The dual-rotary system allows for advancement of casing with the casing rotator while drilling with conventional air/mist/foam methods with the drill string. The Schramm T130XD drill rig was equipped with conventional 5.5-in.-O.D. dual-wall drill pipe, tricone bits, downhole hammer bits, and general drilling equipment. Casing sizes used in drilling activities included 24, 18, and 12 in. Casing sizes were selected to ensure the required 2-in. minimum annular thickness of the filter pack would be achieved around a 5.6-in.-O.D. well screen, as required by the Consent Order (Section X.C.3). The dual-rotary and standard rotary (open hole) techniques used filtered, compressed air and fluid-assisted air to evacuate cuttings from the borehole.

Potable water and Baroid brand Quik-Foam foaming agent were used, as needed, between ground surface and 1212 ft bgs (approximately 100 ft above the anticipated top of the regional aquifer). The fluids were used to cool the bit and help lift cuttings from the borehole. Total amounts of drilling fluids introduced into the borehole are presented in Table 3.1-1.

3.2 Chronology of Drilling Activities

Drilling equipment was decontaminated before being moved to the site. Mobilization activities took place between December 18 and 21, 2010, and included moving the dual-rotary drill rig, air compressors, trailers, and support vehicles to the drill site. Alternative drilling tools and construction materials were staged at the Pajarito Road lay-down yard and at the well CdV-16-4ip lay-down yard in TA-16. Following inspections, drilling began on December 21 at 1550 h after notice to proceed was received from the Laboratory.

Between December 21 and 22, 24-in. casing was advanced to 57.7 ft bgs and set into competent rock. After the Laboratory’s holiday break, 18-in. casing was set on January 8, 2011, to 59.4 ft bgs. The annulus between the two casings was sealed with hydrated bentonite chips.

From January 9 to 11, a 17-in. open borehole was drilled to 867.5 ft bgs; borehole instability issues were encountered from 855 to 860 ft bgs. The instability issues resulted in slough in the borehole every time the drill bit was lifted off the bottom of the hole. On January 12, during redrilling of the slough, perched intermediate groundwater was first noted at a redrilled depth of 852 ft bgs. Laboratory personnel ran video, natural gamma, and induction logs in the open borehole. The video log showed that water was entering the borehole at approximately 807 ft bgs and the DTW was 809 ft bgs.

From January 12 to 14, 12-in. casing was set to 864.1 ft bgs. After the casing was installed and the drill string was run back into the borehole, an unsuccessful attempt was made to air-lift a groundwater sample. The decision was made to attempt to air-lift a sample every 20 ft or at any depth at which groundwater was being produced. Using this approach, three samples were collected from the perched intermediate zone(s).

On January 15, dual-rotary casing advance was used to drill a 14.3-in. borehole from 867.5 to 874.4 ft bgs. A sample was collected from perched groundwater in the open borehole between 869.8 and 874.7 ft bgs. On January 17, the borehole was advanced to 994.7 ft bgs, and a second sample was collected between 990 and 994.7 ft bgs. Beginning at 1015 ft bgs, the borehole was monitored for water every 100 ft. The borehole was advanced to 1074.7 ft bgs where a third groundwater sample was collected between 1071.7 and 1074.7 ft bgs. The three perched samples were collected by air-lifting after the borehole had been cleaned with potable water (to flush out the drilling foam) and blown out with air.

On January 18, 12-in. casing was set to 1145 ft bgs. Drilling proceeded with an 11.6-in. drill bit. The use of foam as a drilling additive was discontinued at 1212 ft bgs. The first significant water production in the borehole was observed on January 19 after drilling to a depth of 1322 ft bgs; this zone produced approximately 10 gallons per minute (gpm). Drilling continued to the TD of 1423.8 ft bgs on January 20 at 0230 h. Drilling tools were removed from the borehole and DTW was tagged on four occasions on January 20 and 21 at 1262.7 ft bgs.

Schlumberger ran a full suite of geophysical logs on January 23. Groundwater was tagged at 1255.3 ft bgs on January 28 after drilling and before well installation.

During drilling, 24-h operations were conducted in two 12-h shifts, 7 d/wk.

4.0 SAMPLING ACTIVITIES

The following sections describe the cuttings and groundwater sampling activities for regional aquifer well R-63. All sampling activities were conducted in accordance with applicable Laboratory quality procedures.

4.1 Cuttings Sampling

Cuttings samples were collected at 5-ft intervals from the borehole from ground surface to the TD of 1423.8 ft bgs. At each interval, approximately 500 mL of bulk cuttings was collected by the site geologist from the discharge cyclone, placed in resealable plastic bags, labeled, and archived in core boxes. Smaller size fractions (>#10 and >#35 mesh) were sieved from the bulk cuttings and placed in chip trays along with unsieved (whole rock) cuttings. Samples were recovered from more than 94% of the borehole; samples were not recovered from 450 to 460 ft bgs, 490 to 505 ft bgs, 555 to 565 ft bgs, 570 to 580 ft bgs, 585 to 605 ft bgs, 625 to 635 ft bgs, 795 to 805 ft bgs, and 1015 to 1020 ft bgs. Radiation control technicians screened cuttings after removal from the site. All screening measurements were within the range of background values. The core boxes and chip trays were delivered to the Laboratory's archive at the conclusion of drilling activities.

The stratigraphy encountered at R-63 is summarized in section 5.1 and detailed lithology is provided in Appendix A.

4.2 Water Sampling

Three perched intermediate groundwater samples were collected during borehole drilling. The perched zone samples were analyzed for anions, metals, volatile organic compounds (VOCs), HE, and low-level tritium (LH3), and the regional aquifer sample was analyzed for HE.

- The first perched groundwater sample was collected on January 15 in the open interval between the casing shoe at 869.8 ft bgs and bottom of the borehole at 874.7 ft bgs. Water was circulated and the borehole was blown with air for 45 min.
- A second perched groundwater sample was collected on January 17 in the open interval between the casing shoe at 990 ft bgs and the bottom of the borehole at 994.7 ft bgs. Water production

was estimated at 2–3 gpm. The borehole was first cleaned and flushed of foam for approximately 45 min.

- The third perched groundwater sample was also collected on January 17 in the open interval between the casing shoe at 1071.7 ft bgs and the bottom of the borehole at 1074.7 ft bgs. Maximum water production was estimated at 1 gpm after cleaning the hole with water and blowing it with air for approximately 1 h, 43 min.

A regional aquifer sample was collected from the open borehole on January 27, after geophysical logging and before well construction, at a depth of 1260 ft bgs and submitted for HE analysis.

Four regional aquifer samples were collected during well development and analyzed for total organic carbon (TOC). The final sample collected on February 12 was also analyzed for metals and anions.

Two samples were collected at the end of aquifer testing. The first sample was analyzed for metals and anions as well as TOC, while the second was analyzed for RDX (cyclotrimethylenetrinitramine).

Table 4.2-1 summarizes screening samples collected at R-63. Screening, groundwater chemistry, and field water-quality parameters are discussed in Appendix B.

5.0 GEOLOGY AND HYDROGEOLOGY

A brief description of the geologic and hydrogeologic features encountered at R-63 is presented below. The Laboratory's geology task leader and site geologists examined cuttings to determine geologic contacts and hydrogeologic conditions. Drilling observations, video logging, and water level measurements were used to characterize groundwater occurrences.

5.1 Stratigraphy

The stratigraphy and contacts presented below are based on lithologic descriptions of cuttings samples collected from the discharge cyclone, borehole geophysical logs, and video logs. Geologic units are described below in order of youngest to oldest geologic units. Figure 5.1-1 illustrates the stratigraphy at R-63, and Appendix A is a detailed lithologic log based on binocular microscope examination and analysis of drill cuttings.

Unit 4, Tshirege Member of the Bandelier Tuff, Qbt 4 (0 to 55 ft bgs)

Unit 4 of the Tshirege Member of the Bandelier Tuff consists of white/pinkish-white to very pale brown and brown, partly to nonwelded, crystal- and lithic-rich tuff.

Unit 3t, Tshirege Member of the Bandelier Tuff, Qbt 3t (55 to 77 ft bgs)

Unit 3t of the Tshirege Member of the Bandelier Tuff consists of light gray to very pale brown, partly to nonwelded, crystal- and lithic-rich tuff.

Unit 3, Tshirege Member of the Bandelier Tuff, Qbt 3 (77 to 205 ft bgs)

Unit 3 of the Tshirege Member of the Bandelier Tuff consists of light gray, partly to moderately welded, crystal- and lithic-rich, devitrified tuff.

Unit 2, Tshirege Member of the Bandelier Tuff, Qbt 2 (205 to 310 ft bgs)

Unit 2 of the Tshirege Member of the Bandelier Tuff consists of light gray to reddish-gray and gray, moderately to densely welded, crystal-rich, devitrified and vapor-phase-altered tuff.

Unit 1v, Tshirege Member of the Bandelier Tuff, Qbt 1v (310 to 340 ft bgs)

Unit 1v of the Tshirege Member of the Bandelier Tuff consists of light and reddish/pinkish gray to very pale brown, sparse, partly to nonwelded, crystal-rich, devitrified tuff.

Unit 1g, Tshirege Member of the Bandelier Tuff, Qbt 1g (340 to 370 ft bgs)

Unit 1g of the Tshirege Member of the Bandelier Tuff consists of pinkish-gray/gray and light gray to very pale brown, partly to nonwelded, vitric tuff.

Cerro Toledo Interval, Qct (370 to 700 ft bgs)

The Cerro Toledo interval consists of gray and reddish-gray to very pale brown, poorly to well-sorted tuffaceous sedimentary deposits separating the Tshirege and Otowi Members of the Bandelier Tuff. The deposits are predominantly reworked tuff with minor silt, sands, granules, and gravels derived from Cerro Toledo rhyolites, Tschicoma dacites, and Otowi tuffs eroded from the Sierra de los Valles highlands west of the Pajarito Plateau. The formation commonly exhibits pervasive light orange-brown oxidation. The contact between the Cerro Toledo interval and the underlying Otowi Member was difficult to determine based on drill cuttings alone; the contact was placed at 700 ft bgs, where the borehole gamma-ray response increases abruptly below that depth. A similar borehole gamma signature has been used to identify the Cerro Toledo/Otowi contact in other TA-16 wells.

Otowi Member of the Bandelier Tuff, Qbo (700 to 787 ft bgs)

The Otowi Member of the Bandelier Tuff consists of white to gray pumiceous, non- to partly welded ash-flow tuff with vitric, fibrous pumices, phenocrysts, and lithic clasts that include a variety of brown and gray intermediate-composition volcanic rocks.

Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff, Qbog (787 to 796 ft bgs)

The Guaje Pumice Bed is white to gray and reddish-gray and contains pumice fragments with subordinate amounts of volcanic lithics and quartz and sanidine phenocrysts.

Puye Formation, Tpf (796 to 1423.8 ft bgs)

The Puye Formation consists of white to very pale brown and gray/reddish-gray, poorly to moderately sorted volcaniclastic sediments with subangular to subrounded boulders, cobbles, gravels, sands, and silts. Clasts in these sedimentary deposits consist of dacitic detritus shed from the Tschicoma Formation exposed in the Sierra de los Valles highlands west of the Pajarito Plateau.

5.2 Groundwater

During drilling activities on January 12, perched groundwater was first detected in the upper part of the Puye Formation when the drilled depth was 852 ft bgs. A Laboratory video was recorded on the same day and showed water entering the borehole at 807 ft bgs with a water level of 809 ft bgs.

On January 16, after drilling to 922 ft bgs, DTW inside the casing was measured at 914.3 ft bgs. The lower DTW suggests the confining bed for the upper perched zone (~807 ft bgs) had been penetrated. A potential zone(s) of perched groundwater was also sampled at depths of 994.7 ft (with ~3 gpm flow rate) and 1074.7 ft (~1 gpm flow rate), but little is known about the vertical extent of this zone(s).

The upper zones of perched groundwater were sealed off from the borehole by 12-in. drill casing that was set to 1145 ft bgs on January 18. The open-borehole video log obtained on January 20 after TD had been reached showed no water coming from the bottom of the casing string, indicating the upper perched zones were isolated from the borehole. The DTW shown on the video was 1262.8 ft bgs.

The final borehole video obtained on January 27, 1 wk after TD was reached, showed that perched groundwater was flowing into the borehole at about 1178 ft bgs. The confining bed for this lower perched zone is not known but may be one of the silt-rich beds encountered at 1189 to 1191 ft bgs, 1193 to 1194 ft bgs, 1212 to 1216 ft bgs, 1236 to 1238 ft bgs, and 1247 to 1248 ft bgs. The DTW shown on the video was 1258.1 ft bgs.

A sustainable productive water-bearing zone indicative of the regional aquifer was detected on January 19 when drilling was temporarily halted for approximately 1 h at 1322 ft bgs for refueling. When drilling resumed and the air compressors were turned back on, abundant water was produced from the borehole, suggesting a standing water column of at least 20 to 30 ft, based upon previous observations from other boreholes. Water production was estimated to be 10 gpm.

The DTW in the open borehole at TD before well construction was 1255.3 ft bgs. On February 25, following well installation, well development, and aquifer testing, DTW was 1260.4 ft bgs in the completed well.

Additional discussion of groundwater observations made during drilling at R-63 is presented in the Final Well Design in Appendix F.

5.2.1 Regional Aquifer Groundwater Elevations

Based upon the DTW of 1260.4 ft bgs measured at R-63 after installation, development and aquifer testing, the water level elevation is approximately 6194 ft above mean sea level (amsl). This elevation is approximately 50 ft higher than the surrounding regional aquifer water level elevations (Figure 5.2-1) (e.g., the predicted elevation for R-63 would be approximately 6144 ft amsl based on the current regional aquifer water level map). The water level for R-63 measured after well installation and hydraulic testing is a preliminary value, and the water level may fluctuate as pressures in the newly installed well equilibrate.

Water levels at R-63 will continue to be monitored and data will be incorporated in periodic updates of the water-table elevation map. If future monitoring reveals the water levels remain higher than the surrounding regional aquifer elevations, an increase in the southeastern component of the water level gradient would be required to accommodate the water level at R-63. A possible explanation for the relatively high water level elevation at R-63 is infiltration via Cañon de Valle to the north of R-63.

6.0 BOREHOLE LOGGING

The following sections describe the borehole logging conducted at R-63. Table 6.0-1 presents a summary of all logging.

6.1 Video Logging

Laboratory personnel ran video logs of the R-63 borehole on four separate occasions. The first video log of the R-63 borehole was recorded on January 12, 2011, from ground surface to 852.5 ft bgs to observe the open borehole below the 24- and 18-in. casings. A second video log of the R-63 borehole was run on January 20 from ground surface to 1423.8 ft (TD) to observe the open borehole below the 12-in. casing (set at 1145 ft bgs). The third video log of the R-63 borehole was run on January 27 to determine if the 12-in. casing had been successfully cut. The final video log of the R-63 borehole was run inside the well casing following aquifer testing on February 24. The video was run through the screen and into the sump to check for screen damage and debris after successfully retrieving the well development pump that had been dropped downhole. Table 6.0-1 provides details of these logs. The video logs are provided on a DVD as Appendix D of this report.

6.2 Geophysical Logging

Laboratory personnel ran natural gamma and induction logs in the R-63 borehole on January 12, from 2 to 852 ft bgs and 90 to 852 ft bgs, respectively (Table 6.0-1).

On January 23, Schlumberger ran a full suite of geophysical logs in the R-63 borehole. These geophysical logs included array induction (AI), accelerator porosity sonde (APS), spectral gamma ray (GR), combinable magnetic resonance (CMR), and formation micro-imager (FMI). The logs were run across varying depths through a cased borehole from ground surface to 1145 ft bgs and open borehole from 1145 to 1423.8 ft bgs. The AI, APS, and GR logs were run through cased and open borehole, while the CMR and FMI logs were run through the open borehole. Table 6.0-1 shows the depths of coverage for each type of log. The Schlumberger geophysical logging report is included as Appendix E of this report (on CD).

7.0 WELL INSTALLATION

The R-63 well was installed between January 28 and February 9, 2011. The following sections summarize the well design and well construction activities.

7.1 Well Design

The R-63 well was designed in accordance with the drilling work plan (LANL 2010, 109770) and a final NMED-approved well design developed after TD was reached (Appendix F). The well was designed with one screened interval to monitor regional groundwater quality and water levels in the Puye Formation.

7.2 Well Construction

The R-63 well was constructed of 5.0-in. inside diameter (I.D.)/5.6-in.-O.D. passivated type 304 stainless-steel threaded casing fabricated to American Society for Testing and Materials (ASTM) standard A312. The screened interval consists of a 20.3-ft length of 5.0-in.-I.D. rod-based, 0.020-in. slot, wire-wrapped well screen. Compatible external stainless-steel couplings (also passivated type 304 stainless steel fabricated to ASTM A312 standards) were used to join all individual casing and screen sections. Casing and screen were provided by the Laboratory and were steam-pressure washed before installation. A 2.5-in.-O.D. steel, flush-threaded tremie pipe string, also decontaminated before use, was used to deliver annular fill materials and potable water downhole during well construction.

Decontamination of the stainless-steel well casing, screens, and tremie pipe, along with mobilization of initial well construction materials to the site, took place from January 20 to 28, while the borehole water level was being monitored and preparation for geophysical logging was underway. The NMED-approved final well design was received on January 26, 2011.

On January 28 at 1645 h, the drilling crew began installing 5.0-in.-I.D. stainless-steel well casing and screen into the borehole. Each casing section was threaded to the string using stainless-steel couplings. The well casing was set on January 29, with the bottom of the well at 1367 ft bgs. The bottom of the borehole was measured at 1423.8 ft bgs, indicating no measurable formational slough was present in the bottom of the borehole.

The well was constructed with one screened interval as specified in the well design. The top of the 20.3-ft-long screen was set at 1325 ft bgs. A 21.7-ft stainless-steel sump was placed below the bottom of the screen. Stainless-steel centralizers (two sets of four) were welded to the well casing at 1323.7 and 1346.6 ft bgs, above and below the screen. Figure 7.2-1 presents an as-built schematic showing construction details for the completed well.

A water line and materials pump were hooked up to the tremie pipe to deliver the annular fill materials that are summarized in Table 7.2-1. Bentonite backfill was placed below and around the well sump from 1423.8 to 1352.5 ft bgs. This bottom seal consisted of 0.375-in. bentonite chips with a volume of 60 ft^3. The primary filter pack for the lower screen consisted of 29.5 ft^3 of 10/20 clean silica sand from 1352.5 to 1318.5 ft bgs. Backfilling of this zone required 50% more material than the calculated volume (19.7 ft^3). Following emplacement of the filter pack, the screened interval was swabbed and surged to promote proper settling and compaction. The fine sand transition collar (2.5 ft^3 of 20/40 clean silica sand) was placed from 1318.5 to 1316.3 ft bgs and required 92% more material than the calculated volume (1.3 ft^3). The excess primary filter pack and fine sand required were because of borehole washouts in the poorly consolidated volcaniclastic sediments of the Puye Formation. The Schlumberger caliper log shows borehole washouts were present across the screened interval.

An upper bentonite seal was placed above the transition sand from 1316.3 to 69.6 ft bgs. The seal consisted of 0.375-in. bentonite chips. The quantity of materials used in this zone was 1529.6 ft^3.

On February 8, the 24-in. surface casing was washed over with 33-in.-O.D. casing from 0 to 21 ft bgs. The 33-in. casing was removed and the void was filled with 75.6 ft^3 of Portland cement. The final cement surface seal for the well was placed in the annulus from 69.6 to 2 ft bgs on February 8 and 9 using a 100 weight percent (wt%) Type I Portland cement. The volume of cement seal used in the annulus was 152.4 ft^3. The well was completed per NMED criteria on February 9 at 1400 h.

8.0 POSTINSTALLATION ACTIVITIES

Following well installation at R-63, the well was developed and tested, the sampling system was installed, the wellhead and surface pad were constructed, and a geodetic survey was performed. Site restoration activities will be completed following the final disposition of contained drill cuttings and groundwater, per the NMED-approved waste-disposal decision trees.

8.1 Well Development

Well development was conducted from February 10 to 12, 2011. Well development began with swabbing and bailing to remove formation fines in the filter pack and sump. Bailing continued until water clarity visibly improved. Final development was accomplished using a submersible pump.

The swabbing tool used was a 4-in.-diameter, 1-in.-thick rubber disc attached to a weighted-steel rod. The swabbing tool was lowered by wireline using a Semco S15000 work-over rig to 1315 ft bgs and drawn repeatedly across the screened interval. The bailing tool was a 4-in.-O.D. by 11.7-ft-long stainless-steel bailer with a total capacity of approximately 8 gal. The tool was lowered by wireline and used to remove water from the well that was then discharged into the cuttings pit. A total of 94 gal. was bailed on February 10.

While tripping out the well development pump string on February 12, the pump, shroud, and several feet of cable of were dropped down the well while attempting to unsnarl a twisted pump cable. The pump dropped from approximately 1410 ft bgs to the bottom of the well. After several unsuccessful fishing attempts, the pump and cable were retrieved from the well on February 18. Several bailing trips cleared small particles of debris from the sump, and a Laboratory video log run on February 24, after aquifer testing, showed no damage to the well-screen components.

After bailing, a 10-horsepower (hp), 4-in.-Grundfos submersible pump was installed in the well and set at multiple depths through the course of well development. The average pump rate was 6.7 gpm during the 40 h of development. Approximately 15,739 gal. of water was removed during development.

8.1.1 Well Development Field Parameters

The field parameters of turbidity, temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductance were monitored via a flow-through cell at R-63 during the pumping stage of well development. In addition, four water samples were collected for TOC analysis, and one sample was collected at the end of development for anions and metals analyses. TOC values less than 2 ppm and turbidity less than 5 nephelometric turbidity units (NTU) indicate the well has been developed adequately. A discussion of field parameters measured during development at each screen is presented in Appendix B.

Final field parameter measurements at the end of development were as follows: pH was 7.3, temperature was 14.0°C, specific conductance was 110 μS/cm, and turbidity was 3.5 NTU. TOC was not detected in the final sample (<0.2 mg/L).

Table B-1.2-1 presents all field parameters and discharge volumes recorded during development.

8.2 Aquifer Testing

Aquifer pumping tests, including preliminary step tests and a 22-h test, were conducted at R-63 between February 20 and 22, by David Schafer and Associates. Two short-duration pumping intervals with short-duration recovery intervals (step tests) were conducted on February 20. The objective of the step tests was to assess the behavior of the system and properly determine the optimal pumping rate for the 22-h test. A 22-h aquifer test was completed on February 22. A 10-hp, 4-in.-diameter Grundfos submersible pump was used to perform the aquifer tests. Approximately 17,900 gal. of groundwater was purged during aquifer testing activities. A short period of additional pumping was conducted on February 23 in an effort to clear the sump of any debris from the pump that was dropped downhole at the end of development. Results and analysis of the R-63 aquifer tests are presented in Appendix C.

Water Volumes Introduced versus Volumes Removed

Water introduced below 1260 ft bgs (the approximate static water level of the regional aquifer in R-63) included 7500 gal. used during drilling and 18,400 gal. used during well construction for a total of approximately 25,900 gal. Approximately 33,639 gal. was removed from the screened interval during well development and aquifer testing.

8.3 Dedicated Sampling System Installation

A dedicated sampling system for R-63 was installed on April 2 and 3, 2011. The system uses a single 5.0-hp Franklin Electric motor and 4-in.-O.D. environmentally retrofitted Grundfos submersible pump. The pump riser pipe consists of threaded and coupled nonannealed 1-in.-I.D. passivated stainless steel. Two 1-in.-I.D. schedule 80 polyvinyl chloride (PVC) tubes are installed along with, and banded to, the pump riser. A dedicated In-Situ Level Troll 700 transducer was installed in one of the tubes, and the second will be used for manual water level measurements. Both PVC tubes are equipped with a 1.7-ft section of 0.010-in. slotted screen and a closed bottom. Details of the dedicated sampling system are shown in Figure 8.3-1a. Figure 8.3-1b presents technical notes describing the sampling system components.

8.4 Wellhead Completion

A reinforced concrete surface pad, 10 ft ×10 ft × 6 in. thick, was installed at the R-63 wellhead. The concrete pad was slightly elevated above ground surface and crowned to promote runoff. The pad will provide long-term structural integrity for the well. A brass monument marker was embedded in the northwest corner of the pad. A 16-in.-O.D. steel protective casing with a locking lid was installed around the stainless-steel well riser. A 0.5-in. weep hole was drilled near the base of the protective casing to prevent water accumulation inside the protective casing, Pea gravel was placed between the protective casing and well casing to a height of 1 ft above the weep hole. Four steel bollards, covered by high-visibility plastic sleeves, were set at the outside edges of the pad to protect the well from accidental vehicle damage. They are designed for easy removal to allow access to the well. Details of the wellhead completion are shown in Figure 8.3-1a.

8.5 Geodetic Survey

A licensed professional land surveyor conducted a geodetic survey on April 13, 2011 (Table 8.5-1). The survey data conform to Laboratory Information Architecture project standards IA-CB02, “GIS Horizontal Spatial Reference System,” and IA-D802, “Geospatial Positioning Accuracy Standard for A/E/C and Facility Management.” All coordinates are expressed relative to New Mexico State Plane Coordinate System Central Zone 83 (North American Datum [NAD] 83); elevation is expressed in feet amsl using the National Geodetic Vertical Datum of 1929. Survey points included ground-surface elevation near the concrete pad, the top of the monument marker in the concrete pad, the top of the well casing, and the top of the protective casing. The survey data are provided in Table 8.5-1, and the survey location report is provided as Appendix G.

8.6 Waste Management and Site Restoration

Waste generated from the R-63 project includes drilling fluids, purged groundwater, drill cuttings, decontamination water, and contact waste. A summary of the waste characterization samples collected during drilling, construction, and development of the R-63 well is presented in Table 8.6-1. All waste streams produced during drilling and development activities were sampled in accordance with “Waste Characterization Strategy Form for R-63 (also called R-25r), Installation of Regional Aquifer Well” (LANL 2010, 111428).

Fluids produced during drilling and well development are expected to be land-applied after a review of associated analytical results per the waste characterization strategy form (WCSF) and

ENV-RCRA-QP-010.2, Land Application of Groundwater. If it is determined that drilling fluids are nonhazardous but cannot meet the criteria for land application, the drilling fluids will be evaluated for treatment and disposal at one of the Laboratory's wastewater treatment facilities or other authorized disposal facility. If analytical data indicate that the drilling fluids are hazardous/nonradioactive or mixed low-level waste, the drilling fluids will be either treated on-site or disposed of at an authorized facility.

Cuttings produced during drilling are anticipated to be land-applied after a review of associated analytical results per the WCSF and ENV-RCRA-QP-011.2, Land Application of Drill Cuttings. If the drill cuttings do not meet the criteria for land application, they will be disposed of at an authorized facility.

Decontamination fluid used for cleaning the drill rig and equipment is currently containerized. The fluid waste was sampled and will be disposed of at an authorized facility. Characterization of contact waste will be based upon acceptable knowledge, pending analyses of the waste samples collected from the drill fluids, drill cuttings, purge water, and decontamination fluid.

Site restoration activities will include removing drilling fluids and cuttings from the pit and managing the fluids and cuttings in accordance with applicable procedures, removing the polyethylene liner, removing the containment area berms, and backfilling and regrading the containment area, as appropriate.

9.0 DEVIATIONS FROM PLANNED ACTIVITIES

Drilling and sampling at R-63 were performed as specified in "Well R-63 Drilling Plan, Installation of Well R-63, TA-16, Los Alamos National Laboratory" (North Wind, Inc., 2010, 111693).

A deviation occurred at the end of well development. While attempting to pull the well development pump string from the borehole, the pump was dropped from approximately 1410 ft downhole on February 12. The pump was successfully retrieved on February 18 and aquifer testing activities ensued. After aquifer testing was complete, Laboratory personnel ran a video log to check the well-screen components for any damage that may have occurred from the dropping of the pump and subsequent fishing operations. The video log showed that the screen had not been damaged and no debris was observed.

10.0 ACKNOWLEDGMENTS

Layne Christensen drilled the R-63 borehole, installed the well, and helped to conduct well development and aquifer testing.

Laboratory personnel ran downhole video, natural gamma, and induction logging equipment.

David Schafer and Associates performed the aquifer testing and analyzed the data for the Aquifer Testing Report (Appendix C).

Schlumberger Water Services performed geophysical logging of the borehole and provided the Schlumberger Geophysical Logging Report (included in Appendix E).

11.0 REFERENCES AND MAP DATA SOURCES

11.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. The information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's RPF and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

LANL (Los Alamos National Laboratory), March 2006. "Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan," Los Alamos National Laboratory document LA-UR-06-1840, Los Alamos, New Mexico. (LANL 2006, 092600)

LANL (Los Alamos National Laboratory), October 4, 2007. "Integrated Work Document for Regional and Intermediate Aquifer Well Drilling (Mobilization, Site Preparation and Setup Stages)," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2007, 100972)

LANL (Los Alamos National Laboratory), February 2010. "Hydrologic Testing Work Plan for Consolidated Unit 16-021(c)-99," Los Alamos National Laboratory document LA-UR-10-0404, Los Alamos, New Mexico. (LANL 2010, 108534)

LANL (Los Alamos National Laboratory), June 2010. "Drilling Work Plan for Regional Aquifer Well R-25r," Los Alamos National Laboratory document LA-UR-10-3958, Los Alamos, New Mexico. (LANL 2010, 109770)

LANL (Los Alamos National Laboratory), December 15, 2010. "Waste Characterization Strategy Form for R-63 (also called R-25r), Installation of Regional Aquifer Well," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2010, 111428)

North Wind Inc., December 21, 2010. "Well R-63 Drilling Plan, Installation of Well R-63, TA-16, Los Alamos National Laboratory," plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (North Wind, Inc., 2010, 111693)

11.2 Map Data Sources

Coarse Scale Drainage Arcs; Los Alamos National Laboratory, Water Quality and Hydrology Group of the Risk Reduction and Environmental Stewardship Program; as published 03 June 2003.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 19 March 2008; as published 04 January 2008.

Hypsography, 100 ft Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

Inactive Outfalls; Los Alamos National Laboratory, Water Quality and Hydrology Group of the Environmental Stewardship Division at Los Alamos National Laboratory Los Alamos New Mexico; 01 September 2003.

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 19 March 2008; as published 04 January 2008.

Penetrations; Los Alamos National Laboratory, Environment and Remediation Support Services, ER2006-0664; 1:2,500 Scale Data, 01 July 2006.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 19 March 2008; as published 04 January 2008

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning and Project Initiation Group, Infrastructure Planning Division; 19 September 2007.

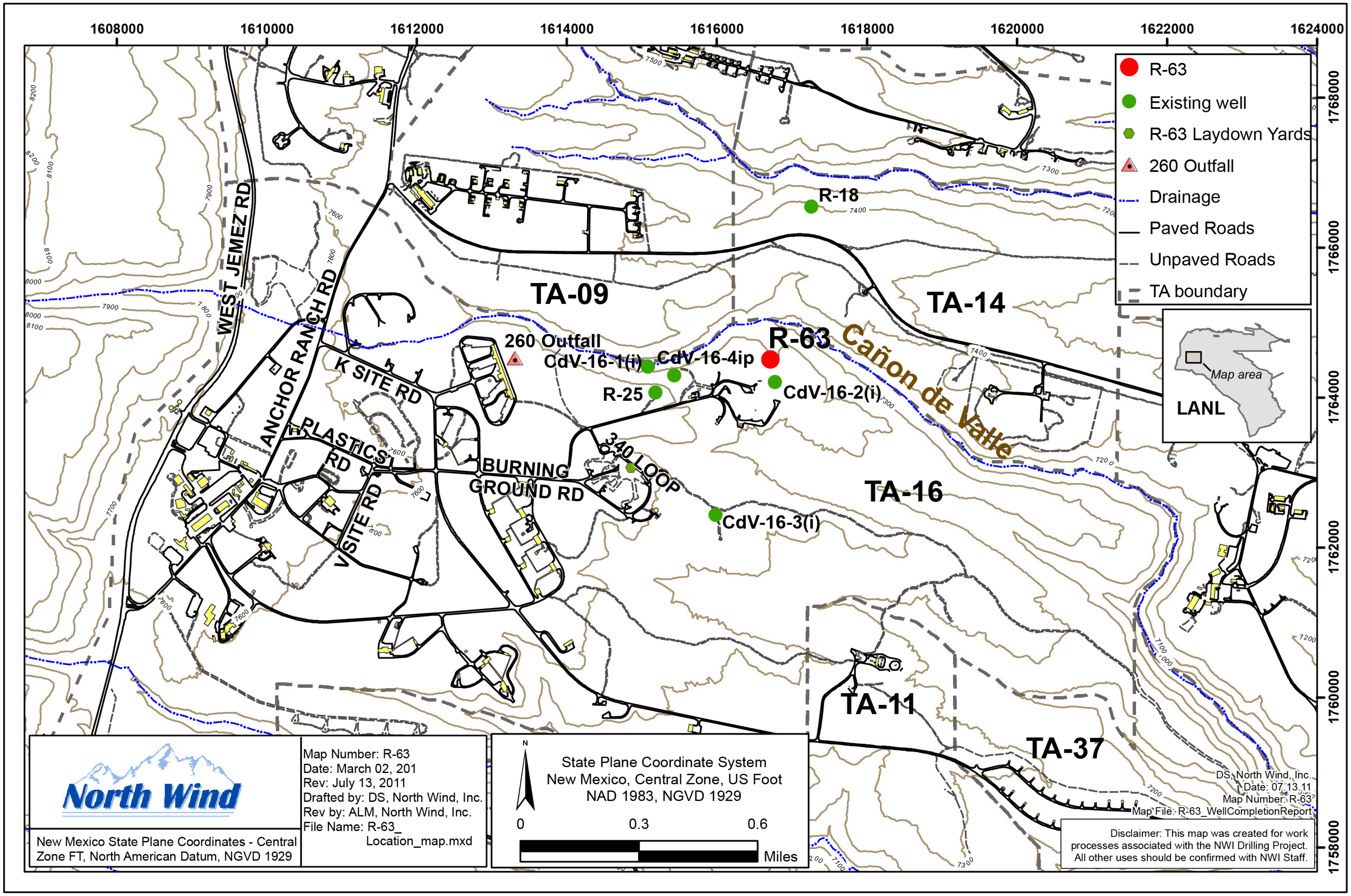

Figure 1.0-1 Well-R-63 location

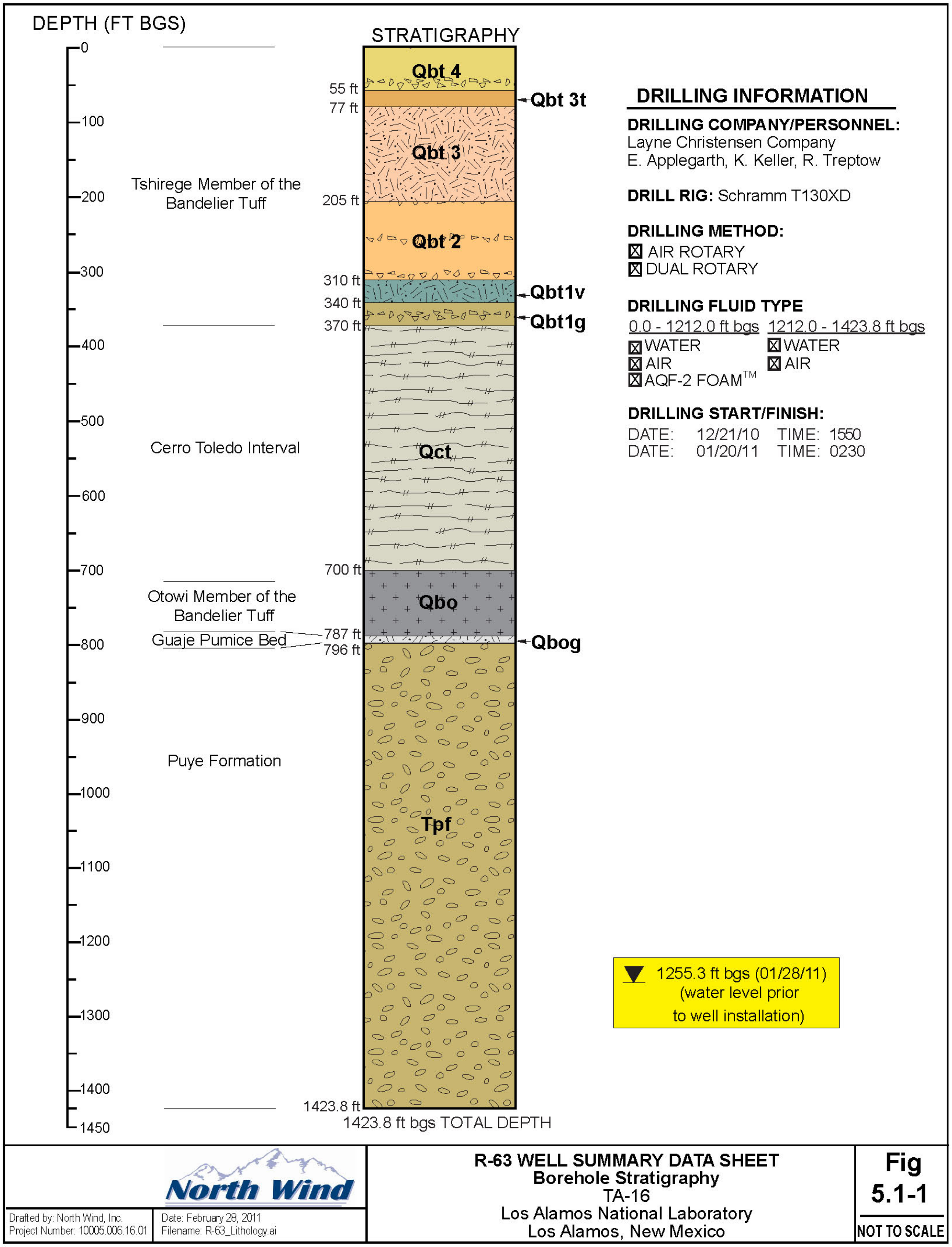

Figure 5.1-1 R-63 borehole stratigraphy

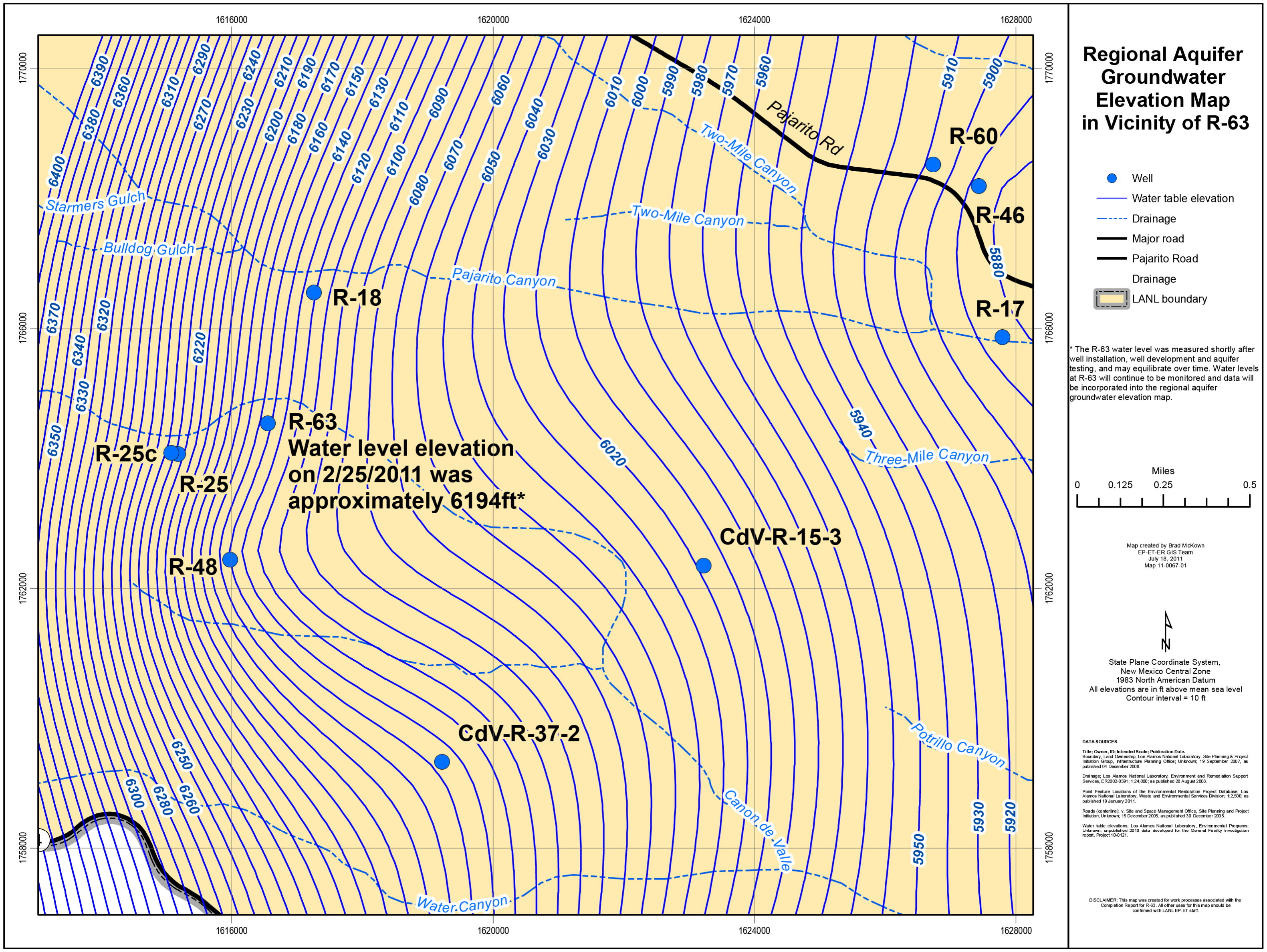

Figure 5.2-1 Regional aquifer groundwater elevations

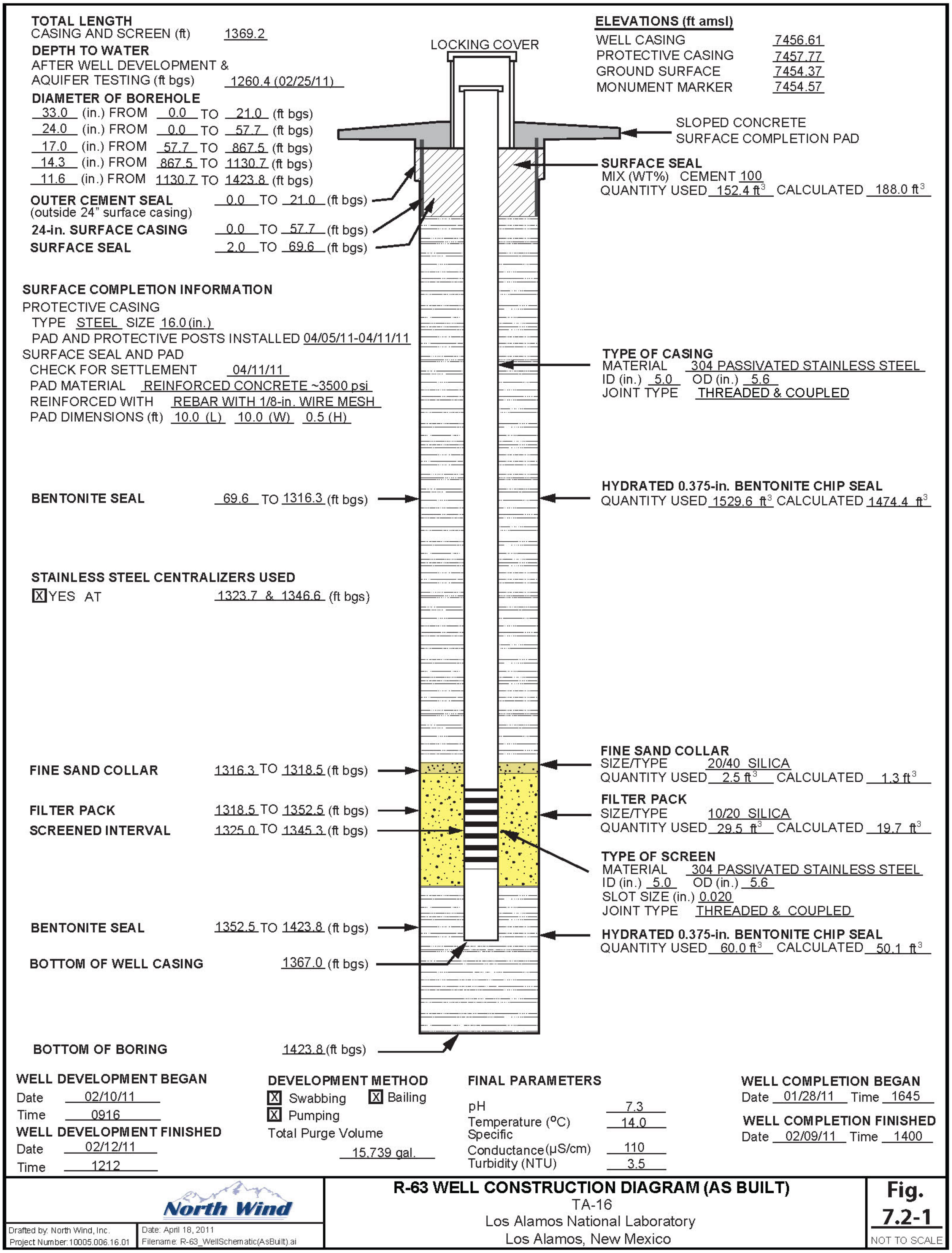

Figure 7.2-1 As-built construction diagram for well R-63

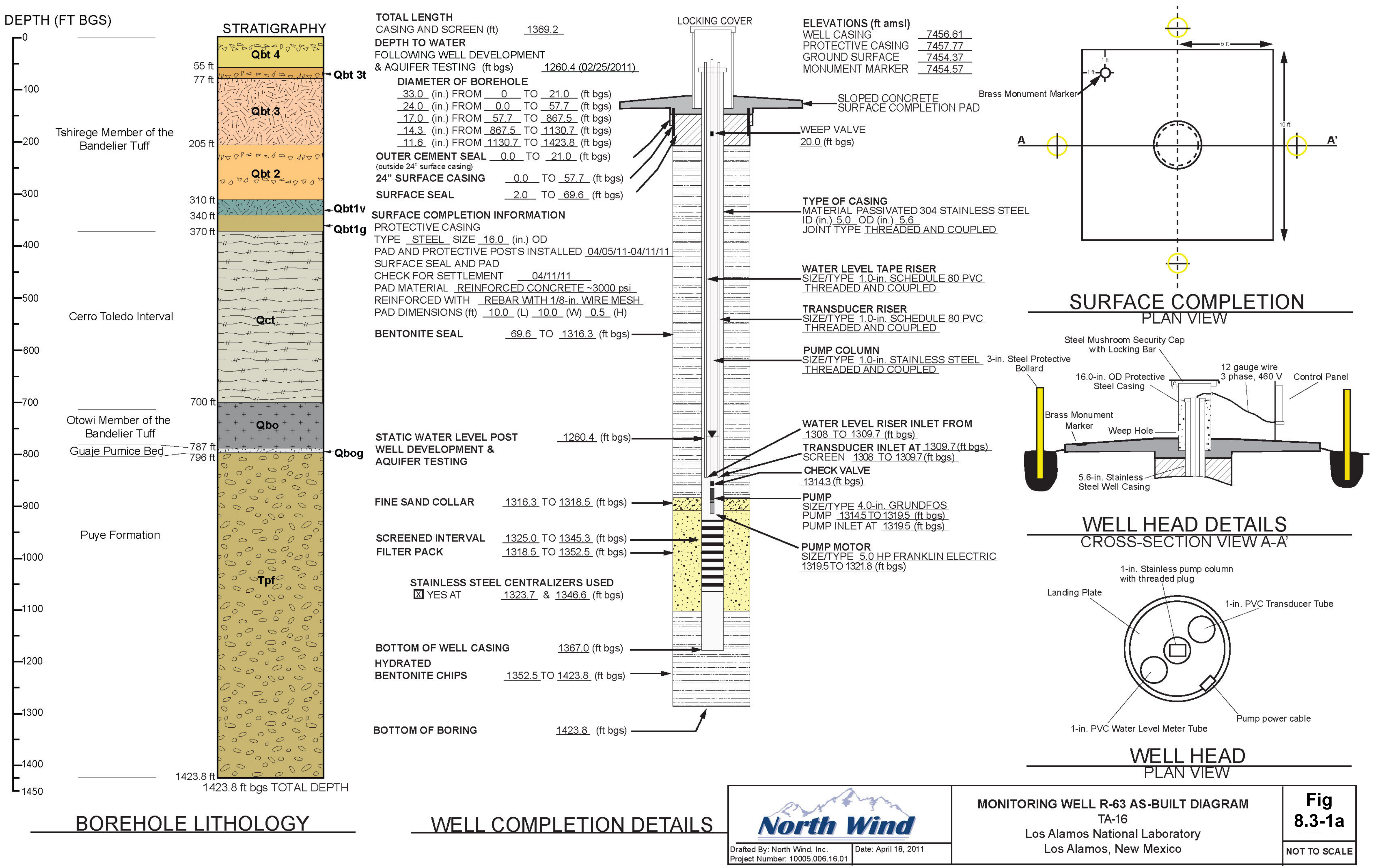

Figure 8.3-1a As-built schematic for well R-63

R-63 TECHNICAL NOTES

SURVEY INFORMATION[1]

Brass Marker

Northing:	1764532.51 ft
Easting	1616550.69 ft
Elevation	7454.57 ft amsl

Well Casing

Northing:	1764526.98 ft
Easting:	1616553.10 ft
Elevation:	7456.61 ft amsl

BOREHOLE GEOPHYSICAL LOGS

LANL Natural Gamma and Array Induction Logs
Schlumberger: formation micro-imager, array induction, accelerator porosity sonde, combinable magnetic resonance, spectral gamma ray

DRILLING INFORMATION

Drilling Company

Layne Christensen Company

Drill Rig

Schramm T130XD

Drilling Methods

Fluid-assisted air rotary
Fluid-assisted dual rotary

Drilling Fluids

Air; Quik-Foam (discontinued at 1212 ft bgs); potable water

MILESTONE DATES

Drilling

Start:	12/21/2010
Finish:	01/20/2011

Well Completion

Start:	01/28/2011
Finish:	02/09/2011

Well Development

Start:	02/10/2011
Finish:	02/12/2011

WELL DEVELOPMENT

Development Methods

Performed swabbing, bailing, and pumping
Volume Purged: 15,739 gal.

Parameter Measurements

pH:	7.3
Temperature:	14.0ºC
Specific Conductance:	110 µS/cm
Turbidity	3.5 NTU

AQUIFER TESTING

Constant Rate Pumping Test

Water Produced:	17,900 gal.
Average Flow Rate:	12.0 gpm
Performed on:	02/20/2011 - 02/22/2011

DEDICATED SAMPLING SYSTEM

Pump Type
Make: Grundfos
Model: 10S50-1125CBM
SN#: P11103478
10 U.S. gpm, intake at 1319.5 ft bgs
Environmental Retrofit

Motor
Make: 5 HP Franklin Electric
Model: 2343278602
SN#: 10M14-17-00785C

Pump Column
1-in. ID Threaded/Coupled
Schedule 80 passivated Stainless Steel

Transducer Tube
1-in. ID Flush Threaded Schedule 80 PVC with 1.7-ft long 0.010-in. Screen between 1308 and 1309.7 ft bgs

Water Level Tube
1-in. ID Flush Threaded Schedule 80 PVC
Screen between 1308 and 1309.7 ft bgs

Transducer
Installed 04/05/11
Make: In-Situ
Model: Level Troll 700
SN#: 179967

NOTES:
1) Coordinates based on New Mexico State Plane Grid Coordinates, Central Zone (NAD 83);
Elevation expressed in feet above mean sea level using the National Geodetic Vertical Datum of 1929.

North Wind

Drafted by: North Wind, Inc. | Date: April 18, 2011
Project Number:10005.006.16.01 | Filename: R-63_Tech_Specs.ai

R-63 TECHNICAL NOTES
TA-16
Los Alamos National Laboratory
Los Alamos, New Mexico

Fig. 8.3-1b
NOT TO SCALE

Figure 8.3-1b Technical notes for well R-63

Table 3.1-1
Fluid Quantities Used during R-63 Drilling and Well Construction

Date	Depth Drilled (ft)	Water (gal.)	Cumulative Water (gal.)	AQF-2 Foam (gal.)	Cumulative AQF-2 Foam (gal.)
Drilling					
01/08/11	0.0	40	40	n/a*	n/a
01/09/11	210	2000	2040	n/a	n/a
01/10/11	378.11	2500	4540	15	15
01/11/11 am	180	3000	7540	16	31
01/11/11 pm	40	1200	8740	12	43
01/12/11	0.0	100	8840	2	45
01/15/11	54.48	2000	10,840	5	50
01/16/11 am	32.4	1500	12,340	3.5	53.5
01/16/11 pm	80.3	2800	15,140	6	59.5
01/17/11 am	59.57	1500	16,640	2.5	62
01/17/11 pm	36.38	2000	18,640	3	65
01/18/11	18.34	1500	20,140	2.5	67.5
01/19/11 am	203.17	4000	24,140	5.5	73
01/19/11 pm	71.58	3500	27,640	n/a	73
Well Construction					
01/26/11	0.0	2900	2900	n/a	n/a
01/27/11	0.0	2500	5400	n/a	n/a
01/28/11	0.0	1000	6400	n/a	n/a
01/29/11 am	0.0	8100	14,500	n/a	n/a
01/29/11 pm	0.0	2000	16,500	n/a	n/a
01/30/11 am	0.0	11,200	27,700	n/a	n/a
01/30/11 pm	0.0	1400	29,100	n/a	n/a
01/31/11 am	0.0	7500	36,600	n/a	n/a
01/31/11 pm	0.0	8000	44,600	n/a	n/a
02/01/11 am	0.0	5300	49,900	n/a	n/a
02/01/11 pm	0.0	2000	51,900	n/a	n/a
02/02/11 am	0.0	14,000	65,900	n/a	n/a
02/02/11 pm	0.0	200	66,100	n/a	n/a
02/03/11	0.0	4000	70,100	n/a	n/a
02/07/11 am	0.0	3000	73,100	n/a	n/a
02/07/11 pm	0.0	1790	74,890	n/a	n/a
02/08/11	0.0	130	75,020	n/a	n/a
02/09/11	0.0	375	75,395	n/a	n/a
Total Water Volume					
R-63	103,035 gal.				

*n/a = Not applicable.

Table 4.2-1
Summary of Groundwater Screening Samples Collected at Well R-63

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Anions + Metals	VOCs	HE	LH3	TOC	RDX
Drilling										
R-63	GW63-11-3490	01/15/11	869.8–874.7	Perched zone; air-lifted (from cyclone)	X[a]	X	X	X	—[b]	—
R-63	GW63-11-3492	01/15/11	869.8–874.7	Trip blank	—	X	—	—	—	—
R-63	GW63-11-3491	01/17/11	990–994.7	Perched zone; air-lifted (from cyclone)	X	X	X	X	—	—
R-63	GW63-11-3493	01/17/11	990–994.7	Trip blank	—	X	—	—	—	—
R-63	GW63-11-4134	01/17/11	1071.7–1074.7	Perched zone; air-lifted (from cyclone)	X	X	X	X	—	—
R-63	GW63-11-4136	01/17/11	1071.7–1074.7	Trip blank	—	X	—	—	—	—
R-63	GW63-11-4717	01/27/11	1260	Regional aquifer; bailer	—	—	X	—	—	—
Well Development										
R-63	GW63-11-3494	02/10/11	1320	Regional groundwater (pump lift)	—	—	—	—	X	—
R-63	GW63-11-3495	02/11/11	1325	Regional groundwater (pump lift)	—	—	—	—	X	—
R-63	GW63-11-3496	02/11/11	1343	Regional groundwater (pump lift)	—	—	—	—	X	—
R-63	GW63-11-3497	02/12/11	1337	Regional groundwater (pump lift)	X	—	—	—	X	—
Aquifer Testing										
R-63	GW63-11-3498	02/22/11	1320	Regional groundwater (pump lift)	X	—	—	—	X	—
R-63	GW63-11-4910	02/22/11	1316.6–1423.8	Regional groundwater (pump lift)	—	—	—	—	—	X

[a] X = Collected.

[b] — = Not collected.

Table 6.0-1
R-63 Logging Runs

Date	Type of Log	Depth (ft bgs)	Description
01/12/11	Video	0–852.5	LANL video from surface to 852.5 ft bgs; borehole depth was 852.5 ft bgs. Verified bottom of 18-in. casing at 59.4 ft bgs. Confirmed contact between Qbog and Tpf at approximately 796 ft bgs. Observed water seeping in to borehole at 807 ft bgs. Observed standing water at 809.1 ft bgs.
01/12/11	Natural gamma	2–852	LANL natural gamma log run from 2 to 852 ft bgs.
01/12/11	Induction	90–852	LANL array induction tool run from 90 to 852 ft bgs.
01/20/11	Video	0–1423.8	LANL video. Video run to observe open borehole from 1145 (bottom of 12-in. casing) to 1423.8 ft bgs. Observed standing water in borehole at 1262.8 ft bgs.
01/23/11	Schlumberger geophysical logs	Varying depths	Schlumberger ran a full suite of geophysical logs in the R-63 borehole. The logs were run across varying depths through a cased borehole from ground surface to 1145 ft bgs and open borehole from 1145 to 1423.8 ft bgs. Logged depths were as follows: FMI: 1210 to 1423.8 ft bgs AI: 650 to 1423.8 ft bgs APS: 0 to 1423.8 ft bgs CMR:1200 to 1423.8 ft bgs GR: 0 to 1423.8 ft bgs
01/27/11	Video log	0–1258	LANL video was run from ground surface to 1258 ft bgs to evaluate casing cut. Video confirmed there was penetration, but the cut was not successful at approximately 1130 ft bgs. Observed abundant water seeping into borehole at approximately 1178 ft bgs. Observed standing water at 1258.1 ft bgs.
01/27/11	Temperature log	0–1424	LANL personnel attempted to run a temperature log in the open borehole in an attempt to identify the precise top of the regional aquifer. However, the tool malfunctioned and a temperature log was not obtained.
02/24/11	Video	0– ~1367	After the pump was dropped downhole at the end of well development, LANL personnel ran a video inside the well casing to the bottom of the sump to check for any damage and determine if any pump debris was present in the sump. No damage or debris was observed. (No North Wind, Inc., personnel were on-site,)

Table 7.2-1
R-63 Annular Fill Materials

Material	Volume (ft^3)
Surface seal: 100 wt% Portland cement	152.4
Upper seal: 0.375-in. bentonite chips	1529.6
Transition sand collar: 20/40 silica sand	2.5
Primary filter pack: 10/20 silica sand	29.5
Lower seal: 0.375-in. bentonite chips	60.0

Table 8.5-1
R-63 Survey Coordinates

Identification	Northing	Easting	Elevation
R-63 brass monument marker	1764532.51	1616550.69	7454.57
R-63 top of 16-in. protective casing	1764526.98	1616552.88	7457.77
R-63 top of well casing	1764526.98	1616553.10	7456.61
R-63 ground surface	1764522.49	1616539.45	7454.37

Note: All coordinates are expressed as New Mexico State Plane Coordinate System Central Zone Feet (NAD 83); elevation is expressed in feet amsl using the National Geodetic Vertical Datum of 1929.

Table 8.6-1
Summary of Waste Samples Collected at R-63

Sample ID/Event ID	Date, Time Collected (h)	Description	Sample Matrix
WST63-11-2730, 3289	12/21/10, 1755	Drill cuttings (VOCs only)	Solid
WST63-11-2733, 3289	12/21/10, 1755	Trip blank	Solid
WST63-11-2731, 3289	01/11/11, 1640	Drill cuttings (VOCs only)	Solid
WST63-11-2734, 3289	01/11/11, 1640	Trip blank	Solid
WST63-11-2732, 3289	01/20/11, 0240	Drill cuttings (VOCs only)	Solid
WST63-11-2735, 3289	01/20/11, 0240	Trip blank	Solid
WST63-11-4148, 3339	01/27/11, 1535	Drill cuttings	Solid
WST63-11-4149, 3339	01/27/11, 1535	Trip blank	Solid
WST63-11-4150, 3340	01/27/11, 1435	Decontamination water set #1	Liquid
WST63-11-4151, 3340	01/27/11, 1435	Trip blank	Liquid
WST63-11-4203, 3342	02/14/11, 1225	Development water, frac tank 1 (unfiltered sample)	Liquid
WST63-11-4204, 3342	02/14/11, 1225	Development water, frac tank 1 (filtered sample)	Liquid
WST63-11-4205, 3342	02/14/11, 1225	Field duplicate	Liquid
WST63-11-4206, 3342	02/14/11, 1225	Trip blank	Liquid
WST63-11-4485, 3354	02/14/11, 1420	Decon water set #2	Liquid
WST63-11-4486, 3354	02/14/11, 1420	Trip blank	Liquid
WST63-11-5123, 3389	02/24/11, 1210	Development water, frac tank 2 (unfiltered sample)	Liquid
WST63-11-5124, 3389	02/24/11, 1210	Development water, frac tank 2 (filtered sample)	Liquid
WST63-11-5125, 3389	02/24/11, 1210	Field duplicate	Liquid
WST63-11-5126, 3389	02/24/11, 1210	Trip blank	Liquid
WST63-11-4199, 3341	03/03/11, 1350	Drilling fluids (unfiltered sample)	Liquid
WST63-11-4200, 3341	03/03/11, 1350	Drilling fluids (filtered sample)	Liquid
WST63-11-4201, 3341	03/03/11, 1350	Field duplicate	Liquid
WST63-11-4202, 3341	03/03/11, 1350	Trip blank	Liquid

Appendix A

Well R-63 Borehole Lithologic Log

Borehole Identification (ID): R-63	**Technical Area (TA):** 16	**Page:** 1 of 21
Drilling Company: Layne Christensen Co.	**Start Date/Time:** 12/21/10 1550	**End Date/Time:** 01/20/11 0230
Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
0–10	**UNIT 4 OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** WR: Tuff, very pale brown (10YR7/3) to brown (10YR5/3), partly welded, crystal- and lithic-rich tuff (ash, sparse pumices, phenocrysts, and lithics), volcanic lithics, and quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. Pumices show “sugary” texture, and relict tube structures appear altered by devitrification and/or vapor-phase alteration. +10F: 67–72% lithic fragments, 25–30% tuff and pumice fragments, 2–3% quartz and sanidine crystals. +35F: 40–50% tuff and pumice fragments, 40–45% lithic fragments, 10–15% quartz and sanidine crystals (inclusions in quartz noted). Minor orange-brown oxidation on some lithics.	**Qbt 4**	
10–15	WR: Tuff, white (2.5YR8/1), partly welded, crystal- and lithic-rich tuff (ash, sparse pumices, phenocrysts, and lithics), volcanic lithics, and quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. Pumices show “sugary” texture, and relict tube structures appear altered by devitrification and/or vapor-phase alteration. +10F: 70% lithic fragments, 27% tuff and pumice fragments, 3% quartz and sanidine crystals. +35F: 55% lithic fragments, 30% tuff and pumice fragments, 15% quartz and sanidine crystals (inclusions in quartz and bipyramidal quartz noted). Minor oxidation on lithics.	**Qbt 4**	
15–20	WR: Tuff, pinkish white (5YR8/2), partly to nonwelded, crystal- and lithic-rich tuff (ash, sparse pumices, phenocrysts, and lithics), volcanic lithics, and quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 97% lithic fragments, 3% tuff and pumice fragments. +35F: 55% quartz and sanidine crystals, 30% tuff and pumice fragments, 15% lithic fragments.	**Qbt 4**	

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Drilling Company: Layne Christensen Co.	**Start Date/Time:** 12/21/10 1550	**End Date/Time:** 01/20/11 0230
Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
20–55	WR: Tuff, very pale brown (10YR8/2), nonwelded, crystal- and lithic-rich tuff (ash, sparse pumices, phenocrysts and lithics), volcanic lithics, and quartz and sanidine phenocrysts in an ashy/sandy and silty matrix. +10F: 90–95% lithic fragments, 2-5% tuff and pumice fragments, 0–2% quartz and sanidine crystals. +35F: 55–60% quartz and sanidine crystals, 35–40% lithic fragments, 5–15% tuff and pumice fragments. Minor orange-brown oxidation on fragments.	**Qbt 4**	
55–60	**UNIT 3t OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** WR: Tuff, very pale brown (10YR8/2), partly to nonwelded, crystal- and lithic-rich tuff (ash and sparse pumice, phenocrysts, and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy matrix. +10F: 45% lithic fragments, 35% quartz and sanidine crystals (bipyramidal quartz and inclusions in quartz noted), 20% tuff and pumice fragments. +35F: 55% quartz and sanidine crystals, 35% lithic fragments, 10% tuff and pumice fragments.	**Qbt 3t**	Note: Contact between Qbt 4 and Qbt 3t is at 55 ft bgs. This contact is based on cuttings and correlation to core taken at nearby well CdV-16-2i.
60–70	WR: Tuff, light gray (7.5YR7/1) to very pale brown (10YR7/3), partly to nonwelded, crystal- and lithic-rich tuff (ash and sparse pumice, phenocrysts, and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 40–50% lithic fragments, 30–35% quartz and sanidine crystals (bipyramidal quartz and inclusions in quartz noted), 15–30% tuff and pumice fragments. +35F: 50–60% quartz and sanidine crystals, 30–35% lithic fragments, 5–15% tuff and pumice fragments.	**Qbt 3t**	Note: Noticeable change in color in WR at 60 ft bgs.
70–77	WR: Tuff, light gray (7.5YR7/1), partly to nonwelded, crystal- and lithic-rich tuff (ash and sparse pumice, phenocrysts, and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 45% lithic fragments, 30% quartz and sanidine crystals (bipyramidal quartz and inclusions in quartz noted), 25% tuff and pumice fragments. +35F: 55% quartz and sanidine crystals, 35% lithic fragments, 10% tuff and pumice fragments.	**Qbt 3t**	

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Drilling Company: Layne Christensen Co.	**Start Date/Time:** 12/21/10 1550	**End Date/Time:** 01/20/11 0230
Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
77–80	**UNIT 3 OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** WR: Tuff, light gray (7.5YR7/1), partly to nonwelded, crystal- and lithic-rich tuff (ash and sparse pumice, phenocrysts, and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 40% lithic fragments, 35% quartz and sanidine crystals (bipyramidal quartz and inclusions in quartz noted), 25% tuff and pumice fragments. +35F: 63% quartz and sanidine crystals, 25% volcanic lithics, 12% tuff and pumice fragments.	**Qbt 3**	Note: Contact between Qbt 3t and Qbt 3 is at 77 ft bgs. Contact is primarily based on core from nearby well CdV-16-2i.
80–110	WR: Tuff, light gray (7.5YR7/1), partly to moderately welded, crystal- and lithic-rich tuff (ash and sparse pumice, phenocrysts, and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 40–50% lithic fragments, 35–40% quartz and sanidine crystals (bipyramidal quartz and inclusions in quartz noted), 5–10% tuff and pumice fragments. +35F: 60–65% quartz and sanidine crystals, 20–30% volcanic lithics, 5–20% tuff and pumice fragments.	**Qbt 3**	
110–125	WR: Tuff, light gray (7.5YR7/1), partly to moderately welded, crystal- and lithic-rich tuff (ash and sparse pumice, phenocrysts, and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 30–40% lithic fragments, 35–40% quartz and sanidine crystals (bipyramidal quartz and inclusions in quartz noted), 20–35% tuff and pumice fragments. +35F: 60–65% quartz and sanidine crystals, 20–30% volcanic lithics, 5–20% tuff and pumice fragments.	**Qbt 3**	
125–135	WR: Tuff, light gray (7.5YR7/1), moderately to partly-to moderately welded, crystal- and lithic-rich devitrified tuff (ash and sparse pumice, phenocrysts, and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 70–77% tuff fragments, 20–25% volcanic lithics, 3–7% quartz and sanidine crystals (bipyramidal quartz and inclusions in quartz noted). +35F: 55–60% quartz and sanidine crystals, 25–30% tuff fragments, 10–20% volcanic lithics.	**Qbt 3**	

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Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 7454.37		Total Depth: 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	Site Geologists: R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
135–170	WR: Tuff, light gray (2.5Y7/1) to light gray (2.5Y7/2), moderately welded, crystal- and lithic-rich devitrified tuff (ash and sparse to no pumice, phenocrysts and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy matrix. +10F: 45–50% volcanic lithics, 40–45% tuff fragments, 5–15% quartz and sanidine crystals (bipyramidal quartz and quartz with inclusions noted). +35F: 70–80% quartz and sanidine crystals, 10–15% volcanic lithics, 5–20% tuff fragments.	**Qbt 3**	
170–205	WR: Tuff, light gray (2.5Y7/1) to light gray (2.5Y7/2), nonwelded, crystal- and lithic-rich devitrified tuff (ash and sparse to no pumice, phenocrysts and lithics), volcanic lithics, and abundant quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 85–90% quartz and sanidine crystals (abundant bipyramidal quartz and quartz with inclusions noted), 5–8% volcanic lithics, 2–10% tuff fragments. +35F: 85–90% quartz and sanidine crystals, 5–7% volcanic lithics, 3–10% tuff fragments.	**Qbt 3**	Noticeable decline in intact tuff fragments as welding decreases with depth; cuttings characterized by an increase in quartz and sanidine crystals.
205–215	**UNIT 2 OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** WR: Tuff, light gray (2.5Y7/1) to gray (7.5YR5/1), moderately to partly welded, crystal- and lithic-rich devitrified and vapor-phase-altered tuff fragments (ash and sparse to no pumice, phenocrysts, and lithics), volcanic lithics, and quartz and sanidine phenocrysts in an ashy/sandy-silty matrix. +10F: 50–60% volcanic lithics, 25–35% tuff fragments, 5–25% quartz and sanidine crystals (bipyramidal quartz and quartz with inclusions noted). +35F: 30–35% tuff fragments, 45–50% quartz and sanidine crystals, 15–25% lithic fragments.	**Qbt 2**	Note: Contact between Qbt 3 and Qbt 2 is at 205 ft bgs based on minor increase on natural gamma log and appearance of moderately to strongly welded tuff fragments indicative of Qbt 2. Increase in intact welded tuff fragments and decrease in quartz and sanidine crystals.

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Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 7454.37		Total Depth: 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	Site Geologists: R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
215–310	WR: Tuff, reddish gray (2.5YR5/1) to gray (7.5YR5/1), moderately to densely welded/indurated, devitrified and vapor-phase-altered, crystal-rich tuff fragments (ash and sparse to no pumice, phenocrysts, and trace to minor lithics), volcanic lithics, and quartz and sanidine phenocrysts in an ashy/sandy matrix. Evidence of flattened pumices in tuff fragments, show "sugary" texture. +10F: 82–90% tuff fragments, 5–8% lithic fragments, 2–13% quartz and sanidine crystals (bipyramidal quartz and quartz with inclusions noted). +35F: 75–85% tuff fragments, 15–25% quartz and sanidine crystals, trace–3% lithic fragments.	**Qbt 2**	Note: WR appears to have characteristic purple hue indicative of Qbt 2.
310–315	**UNIT 1v OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** WR: Tuff, reddish gray (2.5YR5/1) to gray (7.5YR6/1), partly welded/indurated, devitrified, and vapor-phase-altered, crystal-rich tuff fragments (ash and sparse to no pumice, phenocrysts, and trace to minor lithics), volcanic lithics, and quartz and sanidine phenocrysts in an ashy/sandy matrix. +35F: 40% quartz and sanidine crystals, 35% lithic fragments, 25% tuff fragments.	**Qbt 1v**	Note: Contact between Qbt 2 and Qbt 1v is at 310 ft bgs based on cuttings and geophysical logs. Minor increase shown on the natural gamma and induction logs.
315–325	WR: Tuff, gray (7.5YR6/1) to reddish gray (2.5YR6/1), sparse partly to nonwelded devitrified crystal-rich tuff fragments (ash and pumice, phenocrysts, and lithics), quartz and sanidine crystals, and volcanic lithics in an ashy/sandy matrix. +10F: 60–65% volcanic lithics, 25–30% tuff fragments, 5–15% quartz and sanidine crystals. +35F: 65–70% quartz and sanidine crystals, 20–25% volcanic lithic fragments, 5–15% tuff fragments. Bipyramidal quartz and inclusions in quartz noted.	**Qbt 1v**	Noticeable decline in percentage of intact tuff fragments in +10F and increase in lithic fragments.
325–330	WR: Tuff, very pale brown (10YR8/2) to light gray (10YR7/1), sparse partly to nonwelded, devitrified crystal-rich light orange-brown to light gray tuff fragments (ash and pumice, phenocrysts, and lithics), abundant quartz and sanidine phenocrysts, and volcanic lithics in an ashy/sandy matrix. +10F: 98% volcanic lithic fragments, trace–1% tuff fragments, trace–1% quartz and sanidine crystals. +35F: 98% quartz and sanidine crystals, 1% tuff fragments, 1% volcanic lithic fragments. Bipyramidal quartz and inclusions in quartz noted.	**Qbt 1v**	

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
330–340	WR: Tuff, pinkish gray (7.5YR7/2) to reddish gray (2.5YR6/1), sparse partly to nonwelded, devitrified crystal-rich light orange-brown to light gray tuff fragments (ash and pumice, phenocrysts, and lithics), abundant quartz and sanidine phenocrysts, and volcanic lithics in an ashy/sandy-silty matrix. +10F: 90–95% volcanic lithic fragments, 2–5% tuff and pumice fragments, trace–8% quartz and sanidine crystals. +35F: 80–85% quartz and sanidine crystals, 10–15% volcanic lithic fragments, trace–10% tuff and pumice fragments.	**Qbt 1v**	
340–345	**UNIT 1g OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** WR: Tuff, pinkish gray (7.5YR7/2) to reddish gray (2.5YR6/1), sparse light orange-brown to light gray tuff and pumice fragments (ash and pumice, phenocrysts, and lithics), abundant quartz and sanidine phenocrysts, and volcanic lithics in an ashy/sandy matrix. +10F: 90–95% volcanic lithic fragments, 2–5% tuff and pumice fragments, trace–8% quartz and sanidine crystals. +35F: 80–85% quartz and sanidine crystals, 10–15% volcanic lithic fragments, trace–10% tuff and pumice fragments.	**Qbt 1g**	Note: Contact between Qbt 1v and Qbt 1g is at 340 ft bgs based on the first appearance of volcanic glass and light gray to white vitreous pumice lapilli in cuttings (at 340 ft bgs). Decrease shown on natural gamma log and increase on array induction log. Observance of glassy pumices.
345–350	WR: Tuff, very pale brown (10YR8/2) to light gray (7.5YR7/1), partly to nonwelded, light orange-brown to light gray tuff fragments (ash and pumice, phenocrysts, and lithics), light gray to white porous/fibrous, vitric pumice lapilli fragments, quartz and sanidine phenocrysts, and abundant volcanic lithics in light gray to pinkish white ashy/sandy matrix. +10F: 85% volcanic lithics, 10% pumice and tuff fragments, 5% quartz and sanidine crystals. +35F: 80–85% quartz and sanidine crystals, 10–15% volcanic lithic fragments, trace–10% tuff and pumice fragments.	**Qbt 1g**	

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
350–360	WR: Tuff, very pale brown (10YR8/2) to gray (10YR6/1), partly to nonwelded, light orange-brown to light gray tuff fragments (ash and pumice, phenocrysts, and lithics), light gray to white porous/fibrous, vitric pumice lapilli fragments, quartz and sanidine phenocrysts, and abundant volcanic lithics in a light gray to pinkish white ashy/sandy-silty matrix. Abundant black mineral phase, possibly amphibole, noted in some pumice fragments. Obsidian fragments noted. +10F: 65–75% volcanic lithic fragments (up to 1.5 cm), 15–25% tuff and pumice fragments, 3–10% quartz and sanidine crystals. +35F: 70–75% quartz and sanidine crystals, 15–20% tuff and pumice fragments, 5–15% volcanic lithic fragments.	**Qbt 1g**	
360–370	WR: Tuff, light gray (10YR7/2) to gray (10YR6/1), partly to nonwelded, light orange-brown to light gray tuff fragments (ash and pumice, phenocrysts, and lithics), light gray to white porous/fibrous, vitric pumice lapilli fragments, quartz and sanidine phenocrysts, and abundant volcanic lithics in light gray to pinkish white ashy/sandy matrix. +10F: 85–90% volcanic lithic fragments, 5–10% tuff and pumice fragments, 2–5% quartz and sanidine crystals. +35F: 50–60% quartz and sanidine crystals, 20–30% tuff and pumice fragments 10–20% volcanic lithic fragments. Minor to moderate orange/orange-brown oxidation.	**Qbt 1g**	Note: From 360–365 ft bgs, “woody” pumice was observed in +35F.
370–390	**CERRO TOLEDO INTERVAL:** WR: Volcaniclastic sediments, gray (10YR6/1) to very pale brown (10YR7/4), moderately to well-sorted, poorly graded silt, very fine to coarse sand, very fine to medium gravels, grains subangular to subrounded (GP-SP). +10F: detrital constituents (up to 1 cm) composed of 40–45% reworked, fibrous pumice fragments, 45–55% volcanic lithic fragments, 2–5% quartz crystals (smoky quartz noted). +35F: 30–40% pumice fragments, 30–40% quartz and sanidine crystals, 15–20% lithic fragments. Abundant light orange-brown oxidation. Note: smoky quartz and minor obsidian fragments.	**Qct**	Note: Contact between Qbt 1g and Qct is at 370 ft bgs based on cuttings, appearance of volcaniclastic sediments, and shifts on natural gamma and array induction logs. From 370–375 ft bgs, observed flow-banded rhyolite, indicative of Cerro Toledo interval.

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
390–395	WR: Volcaniclastic sediments, gray (10YR6/1) to very pale brown (10YR7/4), well-sorted, poorly graded silt, very fine to coarse sand, very fine to fine gravels, grains subangular to subrounded (GP-SP). +10F: 85% reworked, fibrous pumice fragments, 10% lithic fragments, 5% quartz and sanidine crystals, obsidian. +35F: 70% pumice fragments, 25% quartz and sanidine crystals, obsidian, 5% lithics. Light orange-brown oxidation.	**Qct**	
395–420	WR: Volcaniclastic sediments, gray (10YR6/1) to very pale brown (10YR7/4), moderately to well-sorted, poorly graded silt, very fine to coarse sand, very fine to fine gravels, grains subangular to subrounded (GP-SP). +10F: detrital constituents (up to 1 cm) composed of 35–45% reworked, fibrous pumice fragments, 40–60% volcanic lithic fragments, 5–10% quartz and sanidine crystals, obsidian. +35F: 30–45% pumice fragments, 30–40% quartz and sanidine crystals, 15–25% lithic fragments. Light orange-brown oxidation.	**Qct**	
420–425	WR: Volcaniclastic sediments, gray (10YR6/1) to very pale brown (10YR8/3), well-sorted, poorly graded silt, very fine to coarse sand, very fine to medium gravels, grains subangular to subrounded (GP-SP). +10F: 85% reworked, fibrous pumice fragments, 10% lithic fragments, 5% quartz and sanidine crystals, obsidian. +35F: 70% pumice fragments, 25% quartz and sanidine crystals, obsidian, 5% lithics. Light orange-brown oxidation.	**Qct**	
425–450	WR: Volcaniclastic sediments, gray (10YR6/1) to very pale brown (10YR7/4), moderately to well-sorted silt, very fine to coarse sand, very fine to medium gravels, grains subangular to subrounded (GP-SP). +10F: detrital constituents (up to 1 cm) composed of 45–65% lithic fragments, 20–35% reworked, fibrous pumice fragments, 5–7% quartz and sanidine crystals, obsidian. +35F: 40–55% quartz and sanidine crystals, obsidian, 15–25% pumice fragments, 15–25% lithic fragments. Light orange-brown oxidation.	**Qct**	
450–460	No returns in this interval.	**Qct**	

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab	
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs	
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson		

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
460–490	WR: Volcaniclastic sediments, gray (10YR6/1) to very pale brown (10YR7/4), moderately to poorly sorted, poorly graded with silt, very fine to very coarse sand, very fine to coarse gravels, grains subangular to subrounded (GP-SP). +10F: detrital constituents (up to 2 cm) composed of 50–65% felsic-intermediate composition volcanic lithics, 35–40% white to light orange-brown reworked fibrous pumice fragments, trace–2% quartz crystals and obsidian (smoky quartz noted). +35F: 40–55% volcanic lithics, 30–40% vitric pumice fragments, 15–25% quartz and sanidine crystals. Abundant light orange-brown oxidation.	**Qct**	
490–505	No returns in this interval.	**Qct**	No returns
505–555	WR: Volcaniclastic sediments, very pale brown (10YR8/2) to reddish gray (2.5YR6/1), moderately to poorly sorted, well graded with silt, very fine to very coarse sand, very fine to very coarse gravels, grains subangular to subrounded (SW-GW). +10F: detrital constituents (up to 3.5 cm) composed of 65–75% felsic-intermediate composition volcanic lithics, 25–35% reworked, white to light orange-brown fibrous pumice fragments, trace smoky quartz. +35F: 40–45% volcanic lithics, 30–40% vitric pumice fragments, 10–20% quartz and sanidine crystals. Abundant light orange-brown oxidation.	**Qct**	
555–565	No returns in this interval	**Qct**	
565–570	WR: Volcaniclastic sediments, gray (7.5YR6/1) to reddish gray (2.5YR5/1), moderately to poorly sorted very fine to very coarse gravels with minor silt and sand, grains subangular to subrounded (GM-GW). +10F: detrital constituents (up to 3.0 cm) composed of 95% felsic to intermediate volcanic lithics, 5% white to light orange-brown tuff and reworked, fibrous, porous pumice fragments, trace crystals, obsidian. +35F: 40% volcanic lithics, 50% quartz and sanidine crystals, obsidian, 10% tuff and pumice fragments.	**Qct**	
570–580	No returns in this interval.	**Qct**	

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
580–585	WR: Volcaniclastic sediments, white (10YR8/1) to gray (10YR6/1), moderately to poorly sorted very fine to coarse gravels with sand and silt, grains subangular to subrounded (SW/SM-GW). +10F: detrital constituents (up to 2.0 cm) composed of 75% white to light gray tuff and reworked, fibrous pumice fragments, 25% felsic to intermediate volcanic lithics, trace crystals. +35F: 40% volcanic lithics, 50% tuff and pumice fragments, obsidian, 10% crystals.	**Qct**	
585–605	No returns in this interval.	**Qct**	
605–625	WR: Volcaniclastic sediments, white (10YR8/1) to gray (10YR6/1), moderately to poorly sorted silt, sand, and very fine to very coarse gravels, grains subangular to subrounded (SW/SM-GW). +10F: detrital constituents (up to 3.0 cm) composed of 45–65% white to light gray tuff and reworked, fibrous pumice fragments, 35–55% felsic to intermediate volcanic lithics, trace crystals. +35F: 60–75% tuff and pumice fragments, 10–20% lithic fragments, 5–15% crystals, obsidian.	**Qct**	
625–635	No returns in this interval.	**Qct**	
635–660	WR: Volcaniclastic sediments, very pale brown (10YR8/2) to gray (10YR6/1), moderately to poorly sorted silt, sand, and very fine to very coarse gravels, grains subangular to subrounded (SW/SM-GW). +10F: detrital constituents (up to 3.0 cm) composed of 45–65% white to light gray tuff and reworked, fibrous pumice fragments, 35–55% felsic to intermediate volcanic lithics, trace crystals. +35F: 60–75% tuff and pumice fragments, 10–20% lithic fragments, 5–15% crystals, obsidian. Light orange-brown oxidation.	**Qct**	

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Drilling Company: Layne Christensen Co.	Start Date/Time: 12/21/10 1550	End Date/Time: 01/20/11 0230
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 7454.37		Total Depth: 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	Site Geologists: R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
660–665	WR: Volcaniclastic sediments, very pale brown (10YR8/2) to gray (10YR6/1), moderately to poorly sorted silt, sand, and very fine to coarse gravels, grains subangular to subrounded (SW/SM-GW). +10F: detrital constituents (up to 1.5 cm) composed of 75% felsic to intermediate volcanic lithics, 25% white to light gray tuff and reworked, fibrous pumice fragments, trace crystals. +35F: 40% tuff and pumice fragments, 35% lithic fragments, 25% crystals, obsidian. Light orange-brown oxidation.	**Qct**	
665–690	WR: Volcaniclastic sediments, very pale brown (10YR8/2) to gray (10YR5/1), moderately to poorly sorted with silt, sand, very fine to coarse gravels, grains subangular to subrounded (SW/SM-GW). +10F: detrital constituents (up to 2.0 cm) composed of 55–75% felsic to intermediate volcanic lithics, 15–40% reworked tuff and white to light gray and orange-brown fibrous, porous pumice fragments, trace–5% crystals, obsidian. +35F: 45–60% tuff and pumice fragments, 25–30% crystals, obsidian, 10–30% lithic fragments. Light orange-brown oxidation.	**Qct**	
690–700	WR: Volcaniclastic sediments, white (10YR8/1) to gray (10YR 5/1), moderately to well sorted with minor silt, sand, very fine to medium gravels, grains subangular-subrounded (SM-GM). +10F: detrital constituents (up to 1.0 cm) composed of 60% lithic fragments, 40% white to light gray and light orange-brown reworked tuff and fibrous, pumice fragments, trace crystals, obsidian. +35F: 65% white to light gray and light orange-brown reworked tuff and fibrous, pumice fragments, 20% crystals, obsidian, 15% lithic fragments.	**Qct**	.

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Drilling Company: Layne Christensen Co.	**Start Date/Time:** 12/21/10 1550	**End Date/Time:** 01/20/11 0230
Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
700–705	**OTOWI MEMBER OF THE BANDELIER TUFF:** Tuff, white (5Y8/1) to gray (10YR 6/1), nonwelded, white to light gray and minor light orange-brown, fibrous, vitric pumice fragments with well-preserved tubular structure, varieties of aphanitic to porphyritic volcanic lithic fragments and phenocrysts in a white/light gray ashy/sandy matrix. +10F: 70% white to light gray and light orange-brown fibrous, vitric pumice and tuff fragments (with notable hornblende phenocrysts in pumices), 30% lithic fragments. +35F: 80% white to light gray and light orange-brown fibrous, pumice and tuff fragments,15% lithic fragments, 5% crystals, obsidian.	**Qbo**	Note: Contact between Qct and Qbo is at 700 ft bgs determined from cuttings and abrupt increase on natural gamma log.
705–710	WR: Tuff, white (10YR8/1) to gray (10YR 5/1), nonwelded, white to light gray and minor light orange-brown, fibrous, vitric pumice fragments with well-preserved tubular structure, varieties of aphanitic to porphyritic volcanic lithic fragments and phenocrysts in a white/light gray ashy/sandy matrix. +10F: 90% white to light gray and light orange-brown fibrous, pumice and tuff fragments (with notable hornblende phenocrysts in pumices), 10% lithic fragments, trace crystals, obsidian. +35F: 80% white to light gray and light orange-brown fibrous, pumice and tuff fragments,10% lithic fragments, 10% crystals, obsidian.	**Qbo**	Note: Increase in pumice.
710–730	WR: Tuff, white (2.5Y8/1) to gray (2.5Y5/1), partly to nonwelded, white to light gray and minor light orange-brown, fibrous, vitric pumice fragments with well-preserved tubular structure, varieties of aphanitic to porphyritic volcanic lithic fragments and phenocrysts in a white/light gray ashy/sandy-silty matrix. +10F: 45–60% volcanic lithic fragments, 40–55% light gray to light orange-brown fibrous, vitric pumice fragments and tuff, trace crystals. +35F: 25–35% quartz and sanidine crystals, 30–40% pumice and tuff fragments, 25–35% volcanic lithic fragments.	**Qbo**	

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
730–787	WR: Tuff, white (2.5Y8/1) to gray (2.5Y5/1), partly to nonwelded, white to light gray tuff and fibrous, vitric pumice fragments with well-preserved tubular structure, varieties of aphanitic to porphyritic volcanic lithic fragments and phenocrysts in a white/light gray ashy/sandy matrix. +10F: 45–60% light gray to light orange-brown fibrous pumice fragments and tuff, 40–55% volcanic lithic fragments, trace crystals. +35F: 30–40% pumice and tuff fragments, 25–35% quartz and sanidine crystals, 25–35% volcanic lithic fragments.	**Qbo**	Abundant white to light gray and light orange-brown fibrous, vitric pumice fragments with well-preserved tubular structures, indicative of Qbo.
787–790	**GUAJE PUMICE BED OF THE OTOWI MEMBER OF THE BANDELIER TUFF:** WR: Tuff, white (2.5Y8/1) to gray (2.5Y5/1), partly to nonwelded, white to light gray tuff and fibrous, vitric pumice fragments with well-preserved tubular structure, varieties of aphanitic to porphyritic volcanic lithic fragments and phenocrysts in a white/light gray ashy/sandy matrix. +10F: 45–60% light gray to light orange-brown fibrous pumice fragments and tuff, 40–55% volcanic lithic fragments, trace crystals. +35F: 60–70% pumice and tuff fragments, 15–25% volcanic lithic fragments, 5–10% quartz and sanidine crystals.	**Qbo–Qbog**	Note: Contact between Qbo and Qbog is at 787 ft bgs, and corresponds with minor decrease on the natural gamma log and increase on array induction log.
790–796	WR: Tuff, white (5Y8/1) to reddish gray (2.5YR6/1), white fibrous, vitric pumice fragments, varieties of aphanitic to porphyritic intermediate volcanic lithics, including dacite, and phenocrysts. +10F: 55% pumice fragments, 45% lithic fragments, trace crystals. +35F: 65% pumice fragments, 20% volcanic lithics, 15% quartz and sanidine crystals.	**Qbog**	

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
796–805	**PUYE FORMATION:** No returns in this interval.	**Tpf**	Note: Contact between Qbog and Tpf is at 796 ft bgs, and corresponds with a significant decrease on the natural gamma log. Borehole video and elevated borehole conductivity suggest a 1-ft-thick silty soil horizon at top of Puye Formation.
805–810	WR: Volcaniclastic sediments, white (5Y8/1) to very pale brown (10YR7/3) to gray (10YR6/1), moderately to poorly sorted with very fine to very coarse sand and fine to medium/coarse gravels (GW-SW), grains subangular (up to ≥1.5 cm), abundant fibrous, vitric, white pumice. +10F: 55% tuff and pumice fragments, 45% aphanitic to porphyritic felsic-intermediate composition volcanic lithics, trace crystals. +35F: 65% pumice fragments, 25% quartz and sanidine crystals, 10% volcanic lithics	**Tpf**	Note: Abundant pumice—possibly slough from overlying tuffs.
810–820	WR: Volcaniclastic sediments, white (10YR8/1) to gray (10YR6/1), poorly sorted with minor sand and very fine to coarse gravels (GW), grains subangular (up to 2.0 cm). +10F: 99–100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics, 1% pumice fragments. +35F: 90–95% volcanic lithics, 3–5% pumice fragments, 2–3% quartz and sanidine crystals.	**Tpf**	Note: Significant decline in pumice content and increase in coarse dacitic clasts.

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
820–825	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR6/1), moderately to poorly sorted trace silt, sand, and very fine to fine gravels (SW-GW), sparse medium to coarse gravels, grains subangular (up to 2.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics. +35F: 99% volcanic lithics, 1% quartz and sanidine crystals, trace pumice.	**Tpf**	Note: The cuttings descriptions reflect clast sizes that are circulated to the surface during drilling. Borehole video and FMI logs indicate the Puye Formation is largely made up of stacked beds of boulders and cobbles in a sandy to silty matrix. The drilling process reduces the boulders and cobbles to gravel- and sand-size clasts.
825–830	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR6/1), poorly sorted sand and very fine to coarse gravels (GW), grains subangular (up to 2.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics. +35F: 99% volcanic lithics, 1% quartz and sanidine crystals, trace pumice.	**Tpf**	
830–835	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR6/1), moderately to poorly sorted trace silt, sand, and very fine to medium gravels (SW-GW), sparse coarse gravels, grains subangular (up to 1.5 cm). +10F: 97% aphanitic to porphyritic felsic-intermediate composition volcanic lithics, 3% tuff and pumice. +35F: 98% volcanic lithics, 1% quartz and sanidine crystals, 1% tuff and pumice.	**Tpf**	
835–850	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), poorly sorted sand and very fine to coarse gravels (GW), grains subangular (up to 2.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics. +35F: 99% volcanic lithics, 1% quartz and sanidine crystals, trace pumice.	**Tpf**	

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Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 7454.37		Total Depth: 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	Site Geologists: R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
850–860	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR6/1), moderately to poorly sorted sand and very fine to medium gravels (SW-GW), sparse coarse gravels, grains subangular (up to 1.5 cm). +10F: 99% aphanitic to porphyritic felsic-intermediate composition volcanic lithics, 1% tuff and pumice. +35F: 99% volcanic lithics, 1% quartz and sanidine crystals, trace tuff and pumice.	**Tpf**	
860–905	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), poorly sorted sand and very fine to coarse gravels (GW), some very coarse gravels, grains subangular (on average 2.5 cm, up to 4.0 cm). +10F: 99–100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic), none to 1% tuff and pumice. +35F: 95–99% volcanic lithics, trace to 5% tuff and pumice, trace to 1% quartz and sanidine crystals.	**Tpf**	
905–915	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to medium gravels (SW-GW), sparse coarse gravels, grains subangular (up to 2.0 cm). +10F: 99–100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics, trace to 1% tuff and pumice. +35F: 99% volcanic lithics, 1% quartz and sanidine crystals.	**Tpf**	
915–1015	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), poorly sorted minor sand and very fine to medium gravels, predominantly coarse gravels, some very coarse gravels to small cobbles (GW), grains subangular to subrounded (on average 1.5-2.5 cm, up to 4.5 cm). +10F: 99–100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic), none to 1% tuff and pumice. +35F: 97–99% volcanic lithics, trace to 3% tuff and pumice, trace to 1% quartz and sanidine crystals. Note some gravels coated in silty layer.	**Tpf**	
1015–1020	No cuttings returned in this interval	**Tpf**	

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Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 7454.37		Total Depth: 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	Site Geologists: R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
1020–1090	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), poorly sorted minor sand and very fine to medium gravels, predominantly coarse gravels, some very coarse gravels to small cobbles (GW), grains subangular to subrounded (on average 1.5-2.5 cm, up to 4.0 cm). +10F: 99–100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic), none to 1% tuff and pumice. +35F: 97–99% volcanic lithics, trace to 3% tuff and pumice, trace to 1% quartz and sanidine crystals. Note some gravels coated in silty layer	**Tpf**	
1090–1095	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to medium gravels (SW-GW), sparse coarse gravels, grains subangular (up to 1.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics. +35F: 99% volcanic lithics, 1% tuff and pumice.	**Tpf**	
1095–1120	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), poorly sorted minor sand and predominantly very fine to coarse gravels, some very coarse gravels (GW), grains subangular to subrounded (on average 1.5–2.5 cm, up to 4.0 cm). +10F: 99–100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic), none to 1% tuff and pumice. +35F: 98–99% volcanic lithics, trace to 2% tuff and pumice, none to trace quartz and sanidine crystals.	**Tpf**	
1120–1125	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW-GW), sparse medium gravels, grains subangular to subrounded (up to 1.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics. +35F: 99% volcanic lithics, 1% quartz and sanidine crystals.	**Tpf**	

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
1125–1135	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), poorly sorted sand and very fine to coarse gravels (GW), some very coarse gravels, grains subangular (on average 0.5–1.5 cm, up to 2.0 cm). +10F: 99–100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic), none to 1% tuff and pumice. +35F: 99–100% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	
1135–1140	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW-GW), sparse medium gravels, grains subangular to subrounded (up to 1.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics. +35F: 99% volcanic lithics, 1% quartz and sanidine crystals.	**Tpf**	
1140–1155	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to medium gravels (GW), sparse very coarse gravels, grains subangular (on average 0.4 to 1.0 cm, up to 3.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	
1155–1165	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW-GW), grains subangular to subrounded (up to 0.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	Video shows a silt bed from 1160–1161 ft bgs.
1165–1185	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to medium gravels (GW), sparse very coarse gravels, grains subangular (on average 0.5 to 1.0 cm, up to 3.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	Video shows a silt bed from 1181–1182 ft bgs.

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Ground Elevation: 7454.37		Total Depth: 1423.8 ft bgs	
Driller: E. Applegarth, K. Keller, R. Treptow	Site Geologists: R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson		

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
1185–1195	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW-GW), sparse medium-coarse gravels, grains subangular to subrounded (on average 0.2–0.5 cm, up to 1.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 100% volcanic lithics, trace quartz and sanidine crystals.	**Tpf**	Video shows silt beds from 1189–191 ft bgs and 1193–1194 ft bgs.
1195–1205	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), poorly sorted sand and very fine to medium gravels (GW), sparse very coarse gravels, grains subangular (on average 0.5 to 1.0 cm, up to 2.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	
1205–1275	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW-GW/GP), sparse medium gravels, grains subangular to subrounded (on average 0.2–0.4 cm, up to ~1.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99–100% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	Video shows interbedded silt and conglomerate from 1212–1216 ft bgs and silt beds from 1236–1238 ft bgs and 1247–1248 ft bgs. FMI log shows relatively more conductive layers (fines) from 1268.5–1269.5 ft bgs.
1275–1290	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to coarse gravels (GW), grains subangular to subrounded (on average 0.5–1.0 cm, up to 1.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99–100% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	FMI log shows relatively more conductive layers (fines) from 1287.8–1288.5 ft bgs.

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Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 7454.37		**Total Depth:** 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	**Site Geologists:** R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
1290–1325	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW/SP-GW/GP), sparse medium to coarse gravels, grains subangular to subrounded (on average 0.2–0.4 cm, up to ~2.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99–100% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	FMI log shows relatively more conductive layers (fines) from 1293–1294 ft bgs and 1309–1310 ft bgs.
1325–1330	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to coarse gravels (GW), grains subangular to subrounded (on average 0.5–1.0 cm, up to 1.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 100% volcanic lithics, trace quartz and sanidine crystals.	**Tpf**	
1330–1355	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW-GW), sparse medium to coarse gravels, grains subangular to subrounded (on average 0.2–0.4 cm, up to ~2.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99–100% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	FMI log shows relatively more conductive layers (fines) from 1331.5–1332.5 ft bgs, 1342–1343 ft bgs, 1347–1348 ft bgs, and 1349–1352 ft bgs.
1355–1360	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to coarse gravels (GW), grains subangular to subrounded (on average 0.5–1.5 cm, up to 2.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 100% volcanic lithics, trace quartz and sanidine crystals.	**Tpf**	

Borehole Identification (ID): R-63	Technical Area (TA): 16	Page: 21 of 21
Drilling Company: Layne Christensen Co.	Start Date/Time: 12/21/10 1550	End Date/Time: 01/20/11 0230
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 7454.37		Total Depth: 1423.8 ft bgs
Driller: E. Applegarth, K. Keller, R. Treptow	Site Geologists: R. Boyle, A. Feltman, D. Staires, S. Thomas, M. Whitson	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
1360–1390	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW/SP-GW/GP), sparse medium gravels, grains subangular to subrounded (on average 0.2–0.4 cm, up to 1.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99–100% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	FMI log shows relatively more conductive layers (fines) from 1362–1363.5 ft bgs, 1383–1384 ft bgs, and 1388–1389 ft bgs.
1390–1400	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to medium gravels (GW), sparse coarse gravels, grains subangular to subrounded (on average 0.5–1.0 cm, up to 2.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 100% volcanic lithics, trace quartz and sanidine crystals.	**Tpf**	
1400–1410	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately sorted sand and very fine to fine gravels (SW-GW/GP), sparse medium gravels, grains subangular to subrounded (on average 0.2–0.4 cm, up to 1.0 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 99–100% volcanic lithics, trace to 1% quartz and sanidine crystals.	**Tpf**	
1410–1423.8	WR: Volcaniclastic sediments, light gray (10YR7/1) to reddish gray (2.5YR5/1), moderately to poorly sorted sand and very fine to medium gravels (GW), sparse coarse gravels, grains subangular to subrounded (on average 0.5–1.0 cm, up to 1.5 cm). +10F: 100% aphanitic to porphyritic felsic-intermediate composition volcanic lithics (mostly dacitic). +35F: 100% volcanic lithics, trace quartz and sanidine crystals.	**Tpf**	TD = 1423.8 ft bgs

Notations and Abbreviations

7.5YR8/1 = Munsell soil color notation where hue (e.g., 7.5YR), value (e.g., 8), and chroma (e.g., 4) are expressed. Hue indicates soil color's relation to red, yellow, green, blue, and purple. Value indicates soil color's lightness. Chroma indicates soil color's strength.

% material, = percentage of material in sieved sample fraction (e.g., 35% crystals, 99% volcanic lithics, etc.)

+10F = plus No. 10 sieve sample fraction

+35F = plus No. 35 sieve sample fraction

bgs = below ground surface

FMI = formation micro-imager (Schlumberger borehole logging tool)

GM = silty gravels, poorly graded gravel-sand-silt mixtures.

GP = poorly graded gravels, gravel-sand mixtures, little or no fines

GW = well-graded gravels, gravel-sand mixtures, little or no fines

Qbt = Tshirege Member of the Bandelier Tuff

Qct = Cerro Toledo interval

Qbo = Otowi Member of the Bandelier Tuff

Qbog = Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff

SM = silt sands, sand-silt mixtures

SP = poorly graded sands, gravelly sands, little or no fines

SW = well-graded sands, gravelly sands, little or no fines

Tpf = Puye Formation

WR = whole rock

Appendix B

Screening Groundwater Analytical Results

B-1.0 SCREENING GROUNDWATER ANALYSES AT R-63

R-63 is a regional groundwater monitoring well with one screen set from 1325 to 1345.3 ft below ground surface (bgs) within the Puye Formation. This appendix presents screening laboratory analytical results for samples collected during drilling, well development and aquifer testing at R-63 as well as field parameters measured during well development and aquifer testing.

B-1.1 Laboratory Analyses

During drilling, three samples were collected from perched zones in the Puye Formation and one sample was obtained from the regional aquifer. The perched zone borehole samples were analyzed for anions, metals, volatile organic compounds (VOCs), high explosives (HE) and low-level tritium (LH3). The regional water sample collected from the borehole was analyzed for HE only.

Four samples were collected during well development and one during aquifer testing; these samples were analyzed for total organic carbon (TOC). Additionally, the final well development and aquifer testing samples were also analyzed for anions and metals.

Los Alamos National Laboratory's (LANL's or the Laboratory's) Earth and Environmental Sciences Group 14 (EES-14) conducted the anions, metals and TOC analyses. GEL, Inc., conducted the remaining analyses.

Table B-1.0-1 lists the samples submitted for analyses from R-63.

B-1.3 Field Analyses

Groundwater samples were collected from a flow-through cell at regular intervals during well development and aquifer testing and measured for pH, conductivity, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP) and turbidity.

B-2.0 SCREENING ANALYTICAL RESULTS

This section presents the analytical results for samples collected during drilling, at the end of drilling, well development, and aquifer testing.

B-2.1 Laboratory Results

Anions and Metals

EES-14 laboratory analytical results for anions and metals measured in the perched zone borehole samples collected during drilling are presented in Table B-2.1-1.

Anions and metals measured in two regional aquifer samples collected from the completed well during well development and aquifer testing are shown in Table B-2.1-2. The analytical results for the regional aquifer samples are compared to maximum background concentrations from completed regional wells (LANL 2007, 095817). It should be noted that these values were obtained for the Laboratory as a whole and background concentrations for the area upgradient of well R-63 may vary due to local variations in geochemistry.

Dissolved concentrations of the following metals exceeded Laboratory background concentrations:

- Boron was measured at 69.35 and 67.88 µg/L, slightly above the regional aquifer maximum background concentration of 51.60 µg/L.
- Barium was measured at 403.51 and 315.63 µg/L, in comparison to the regional aquifer maximum background concentration of 115.00 µg/L.
- Zinc was detected at 79.05 and 73.51 µg/L, slightly above the maximum background concentration of 32.00 µg/L.

Volatile Organic Compounds

Three perched zone samples were collected from the open borehole during drilling operations and analyzed for VOCs: GW63-11-3490 (869.8–874.7 ft bgs), GW63-11-6491 (990.0–994.7 ft bgs) and GW63-11-4134 (1071.7–1074.7 ft bgs) (Table B-1.0-1). Additionally, three trip blanks were collected to accompany each perched zone sample and submitted for VOC analyses. The data are presented in Table B-2.1-3.

Nineteen VOCs were reported in sample GW63-11-3490 collected from 869.8–874.7 ft bgs. All of the VOC concentrations are estimated and may be biased low because extraction and/or holding times were exceeded (>1 times but <2 times the extraction/holding time). Acetone was reported at the highest level with an estimated concentration of 13,700 µg/L. Methyl-2-pentanone[4-] was reported at the next highest concentration at 75.8 µg/L. Five VOCs were reported at concentrations between 10.1 and 1.1 µg/L, and the remaining 12 compounds were less than 1 µg/L (Table B-2.1-3). VOCs were not reported in the trip blank that accompanied the sample.

Acetone was the only VOC reported in sample GW63-11-3491 (990.0–994.7 ft bgs) at an estimated concentration of 57.5 µg/L. Acetone was also reported in the third perched zone borehole sample, GW63-11-4134 (1071.7–1074.7 ft bgs) at an estimated concentration of 823 µg/L. Methyl-2-pentanone[4-] was the only other VOC reported from this sample with an estimated concentration of 1.92 µg/L. VOCs were not reported in the two trip blanks that accompanied these samples.

High Explosives

RDX (cyclotrimethylenetrinitramine) was the only HE compound detected in samples GW63-11-3490 and GW63-11-3491; it was reported at the following estimated concentrations: 15, 15.9 and 0.134 µg/L. No HE compounds were detected in sample GW63-11-4134. RDX was reported at 2.24 µg/L in the regional aquifer sample GW63-11-4717, collected from the open borehole at 1260.0 ft bgs after total depth was reached. However, RDX was not detected in the regional aquifer in the completed well (1316.6–1423.8 ft bgs) at the end of aquifer testing (detection limit of 0.005 µg/L). Refer to Table B-2.1-3 for the HE analytical results.

Low-Level Tritium

LH3 was not detected in the two uppermost perched zone borehole samples, but it was reported at 1.67 tritium units (5.38 pCi/L) in the third perched zone borehole sample, GW63-11-4134 collected from 1071.7–1074.7 ft bgs. Table B-2.1-3 presents the LH3 analytical results.

B-2.2 Total Organic Carbon

TOC concentrations varied from 3.96 mgC/L near the beginning of well development to undetected in the final three samples collected at the end of development and aquifer testing in R-63 (Table B-2.2-1). These ending concentrations are below the target concentration for TOC of <2.0 mgC/L.

B-2.3 Field Parameters

Field parameters measured during well development and aquifer testing are summarized in Tables B-2.3-1 and B-2.3-2, respectively. During well development, pH varied from 7.2 to 8.2 and temperature ranged from 8.0°C to 14.5°C. (Note that these temperature readings are lower than expected in comparison with other wells in the area and could represent a calibration or instrument problem. Temperature measurements collected during routine sampling will provide additional information regarding temperature readings.) DO concentrations varied from 6.1 to 8.2 mg/L. Specific conductance ranged from 234 to 110 μS/cm, and turbidity values varied from >1000 nephelometric turbidity units (NTU) at the start of development to 3.5 NTU at the end. Corrected oxidation-reduction potential (Eh) values, determined from field ORP measurements, varied from 301.8 to 382.9 mV. Two temperature-dependent correction factors were used to calculate Eh values from field ORP measurements: 213.9 and 208.9 mV at 10°C and 15°C, respectively.

The final parameters measured at the end of well development were pH of 7.3, temperature of 14.00°C, DO of 6.1 mg/L, specific conductance of 110 μS/cm and turbidity of 3.5 NTU.

B-3.0 SUMMARY

Acetone was reported at an elevated concentration (13,700 μg/L) in the uppermost perched zone borehole sample and at 57.5 and 823 μg/L in the two lower perched zone borehole samples. Additionally, a number of other VOCs were reported in the uppermost perched zone sample. It should be noted that VOCs have not been detected in the perched zones of surrounding wells. It is possible these VOC compounds are associated with drilling or sampling equipment, and the Laboratory is presently conducting a study using equipment rinsate samples and potable water samples collected at R-63 and other wells to evaluate the potential source(s).

RDX was reported in the two uppermost perched zone borehole samples and in the borehole sample from the regional aquifer at concentrations of 15, 15.9, 0.134, and 2.24 μg/L, respectively; however, it was not detected in a sample from the regional aquifer in the completed well.

LH3 was reported only in the lowermost perched zone sample at a concentration of 5.38 pCi/L; it was not detected in the two upper perched zone samples.

For the two regional aquifer samples collected from the completed well at the end of well development and at the end of aquifer testing, boron, barium and zinc concentrations slightly exceeded Laboratory maximum background concentrations. TOC concentrations were below the target level of 2.0 mgC/L, and turbidity was below 5 NTU at the end of development. R-63 will be sampled quarterly for 1 yr, after which the data will be assessed and incorporated into the Interim Facility-Wide Groundwater Monitoring Plan. Data from ongoing sampling at R-63 will be analyzed and presented in the appropriate Laboratory periodic monitoring report.

Table B-1.0-1
Summary of Groundwater Screening Samples Collected at Well R-63

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Anions + Metals	VOCs	HE	LH3	TOC	RDX
Drilling										
R-63	GW63-11-3490	01/15/11	869.8–874.7	Perched zone; air-lifted (from cyclone)	X[a]	X	X	X	—[b]	—
R-63	GW63-11-3492	01/15/11	869.8–874.7	Trip blank	—	X	—	—	—	—
R-63	GW63-11-3491	01/17/11	990–994.7	Perched zone; air-lifted (from cyclone)	X	X	X	X	—	—
R-63	GW63-11-3493	01/17/11	990–994.7	Trip blank	—	X	—	—	—	—
R-63	GW63-11-4134	01/17/11	1071.7–1074.7	Perched zone; air-lifted (from cyclone)	X	X	X	X	—	—
R-63	GW63-11-4136	01/17/11	1071.7–1074.7	Trip blank	—	X	—	—	—	—
R-63	GW63-11-4717	01/27/11	1260	Regional aquifer; bailer	—	—	X	—	—	—
Well Development										
R-63	GW63-11-3494	02/10/11	1320	Regional groundwater (pumped)	—	—	—	—	X	—
R-63	GW63-11-3495	02/11/11	1325	Regional groundwater (pumped)	—	—	—	—	X	—
R-63	GW63-11-3496	02/11/11	1343	Regional groundwater (pumped)	—	—	—	—	X	—
R-63	GW63-11-3497	02/12/11	1337	Regional groundwater (pumped)	X	—	—	—	X	—
Aquifer Testing										
R-63	GW63-11-3498	02/22/11	1320	Regional groundwater (pumped)	X	—	—	—	X	—
R-63	GW63-11-4910	02/22/11	1316.6–1423.8	Regional groundwater (pumped)	—	—	—	—	—	X

[a] X = Collected.
[b] — = Not collected.

Table B-2.1-1
EES-14 Results for Perched Zone Samples Collected from the Borehole during Drilling

Analyte		U.S. Environmental Protection Agency Method	ID No. GW63-11-3490	ID No. GW63-11-3491	ID No. GW63-11-4134	Units
General	TDS[a]	n/a[b]	285.61	176.76	179.93	mg/L
	SiO2	360.2	90.25	8.62	22.17	mg/L
	Cations	n/a	3.55	1.59	1.70	n/a
	Anions	n/a	2.62	1.66	1.87	n/a
	Balance	n/a	0.15	-0.02	-0.05	n/a
	Lab pH	n/a	7.15	6.84	7.1	n/a
Anions	$Alk-CO3^{(-2)}$	300, rev. 2.1	0.8 U[c]	0.8 U	0.8 U	mg/L
	Alk-CO3+HCO3	310.1	98.02	71.88	81.76	mg/L
	$Br^{(-)}$	300, rev. 2.1	1.89	0.13	0.21	mg/L
	$C2O4^{(-2)}$	300, rev. 2.1	42.17	4.03	10.36	mg/L
	$Cl^{(-)}$	300, rev. 2.1	12.71	5.00	7.59	mg/L
	$ClO4^{(-)}$	314, rev. 1	0.005 U	0.005 U	0.005 U	mg/L
	$F^{(-)}$	300, rev. 2.1	0.92 U	0.21 U	0.34 U	mg/L
	$NO2^{(-)}$	300, rev. 2.1	1.56	0.01	0.05	mg/L
	NO2-N	300, rev. 2.1	0.48	0.00	0.02	mg/L
	$NO3^{(-)}$	300, rev. 2.1	1.43	4.34	3.97	mg/L
	NO3-N	300, rev. 2.1	0.32	0.98	0.90	mg/L
	$PO4^{(-3)}$	300, rev. 2.1	0.11	0.01 U	0.01 U	mg/L
	$SO4^{(-2)}$	300, rev. 2.1	21.69	7.20	7.31	mg/L
Metals	Ag	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	µg/L
	Al	200.8, rev. 5.4	455.00	113.00	73.00	µg/L
	As	200.8, rev. 5.4	0.39	0.35	0.21	µg/L
	B	200.7, rev. 4.4	307.88	263.18	152.96	µg/L
	Ba	200.7, rev. 4.4	853.48	1677.71	969.77	µg/L
	Be	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	µg/L
	Ca	200.7, rev. 4.4	25.67	9.56	11.12	µg/L
	Cd	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	mg/L
	Co	200.8, rev. 5.4	6.04	1.00 U	1.18	µg/L
	Cr	200.8, rev. 5.4	3.82	1.90	1.38	µg/L
	Cs	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	µg/L
	Cu	200.8, rev. 5.4	7.36	1.85	1.00 U	µg/L
	Fe	200.7, rev. 4.4	183.48	325.74	224.58	µg/L
	Hg	200.8, rev. 5.4	0.05 U	0.05 U	0.05 U	µg/L
	K	200.7, rev. 4.4	6.26	1.06	1.64	µg/L
	Li	200.8, rev. 5.4	69.58	17.91	20.77	mg/L
	Mg	200.7, rev. 4.4	6.65	3.52	3.90	µg/L
	Mn	200.8, rev. 5.4	1441.69	195.67	241.51	mg/L
	Mo	200.8, rev. 5.4	56.09	9.96	20.41	µg/L

Table B-2.1-1 (continued)

Analyte		U.S. Environmental Protection Agency Method	ID No. GW63-11-3490	ID No. GW63-11-3491	ID No. GW63-11-4134	Units
Metals (continued)	Na	200.7, rev. 4.4	34.03	17.37	17.32	µg/L
	Ni	200.8, rev. 5.4	14.78	3.05	4.35	mg/L
	Pb	200.8, rev. 5.4	0.43	0.30	0.2 U	µg/L
	Rb	200.8, rev. 5.4	20.19	1.00 U	1.27	µg/L
	Sb	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	µg/L
	Se	200.8, rev. 5.4	2.00	1.00 U	1.00 U	µg/L
	Si	200.7, rev. 4.4	32.76	24.67	19.63	µg/L
	Sn	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	mg/L
	Sr	200.7, rev. 4.4	188.11	55.17	58.68	µg/L
	Th	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	µg/L
	Ti	200.7, rev. 4.4	23.55	11.02	6.08	µg/L
	Tl	200.8, rev. 5.4	1.00 U	1.00 U	1.00 U	µg/L
	U	200.8, rev. 5.4	1.75	0.35	0.37	µg/L
	V	200.8, rev. 5.4	4.02	1.13	1.00 U	µg/L
	Zn	200.8, rev. 5.4	234.55	83.70	124.17	µg/L

[a] TDS = Total dissolved solids.

[b] n/a = Not applicable.

[c] U = Analyte was not detected.

Table B-2.1-2
EES-14 Results for Regional Aquifer
Samples Collected at the End of Well Development and Aquifer Testing

	Analyte	EPA Method	ID No. GW63-11-3497	ID No. GW63-11-3498	Maximum Background Value Regional Aquifer	Unit
General	TDS[a]	n/a[b]	173.69	167.16	225.0	mg/L
	SiO2	360.2	64.00	65.00	87.2	mg/L
	Cations	n/a	1.28	1.22	n/a	n/a
	Anions	n/a	1.45	1.35	n/a	n/a
	Balance	n/a	-0.06	-0.05	n/a	n/a
	Lab pH	n/a	7.45	7.30	8.96	n/a
Anions	Alk-CO3$^{(-2)}$	300, rev. 2.1	NA[c]	NA	none	mg/L
	Alk-CO3+HCO3	310.1	72.19	68.32	152	mg/L
	Br$^{(-)}$	300, rev. 2.1	0.02 U[d]	0.02 U	0.098	mg/L
	C2O4$^{(-2)}$	300, rev. 2.1	0.01 U	0.01 U	none	mg/L
	Cl$^{(-)}$	300, rev. 2.1	3.02	2.67	5.95	mg/L
	ClO4$^{(-)}$	314, rev. 1	NA	NA	0.41	mg/L
	F$^{(-)}$	300, rev. 2.1	0.15 U	0.15 U	0.57	mg/L
	NO2$^{(-)}$	300, rev. 2.1	0.01 U	0.01 U	none	mg/L
	NO2-N	300, rev. 2.1	0.003 U	0.003 U	0.0	mg/L
	NO3$^{(-)}$	300, rev. 2.1	2.06	2.10	none	mg/L
	NO3-N	300, rev. 2.1	0.47	0.47	0.53	mg/L
	PO4$^{(-3)}$	300, rev. 2.1	0.01 U	0.01 U	none	mg/L
	SO4$^{(-2)}$	300, rev. 2.1	5.86	4.58	8.63	mg/L
Metals	Ag	200.8, rev. 5.4	1.00 U	1.00 U	2.5	µg/L
	Al	200.8, rev. 5.4	7.00	4.00	73.50	µg/L
	As	200.8, rev. 5.4	0.32	0.43	12.00	µg/L
	B	200.7, rev. 4.4	69.35	67.88	51.60	µg/L
	Ba	200.7, rev. 4.4	403.51	315.63	115.00	µg/L
	Be	200.8, rev. 5.4	1.00 U	1.00 U	0.50	µg/L
	Ca	200.7, rev. 4.4	9.29	8.97	41.70	µg/L
	Cd	200.8, rev. 5.4	1.00 U	1.00 U	0.50	mg/L
	Co	200.8, rev. 5.4	1.00 U	1.00 U	7.00	µg/L
	Cr	200.8, rev. 5.4	2.94	2.47	7.20	µg/L
	Cs	200.8, rev. 5.4	1.00 U	1.00 U	none	µg/L
	Cu	200.8, rev. 5.4	1.62	1.00 U	5.00	µg/L
	Fe	200.7, rev. 4.4	18.34	51.35	147.00	µg/L
	Hg	200.8, rev. 5.4	0.05 U	0.05 U	0.26	µg/L
	K	200.7, rev. 4.4	0.81	0.79	3.11	µg/L
	Li	200.8, rev. 5.4	12.70	13.61	25.00	mg/L
	Mg	200.7, rev. 4.4	3.18	3.08	4.40	µg/L
	Mn	200.8, rev. 5.4	23.92	18.34	124.00	mg/L

Table B-2.1-2 (continued)

	Analyte	EPA Method	ID No. GW63-11-3497	ID No. GW63-11-3498	Maximum Background Value Regional Aquifer	Unit
Metals (continued)	Mo	200.8, rev. 5.4	1.00 U	1.00 U	4.40	µg/L
	Na	200.7, rev. 4.4	12.04	11.29	32.90	µg/L
	Ni	200.8, rev. 5.4	1.69	1.62	50.00	mg/L
	Pb	200.8, rev. 5.4	0.2 U	0.2 U	2.90	µg/L
	Rb	200.8, rev. 5.4	1.00 U	1.00 U	none	µg/L
	Sb	200.8, rev. 5.4	1.00 U	1.00 U	1.00	µg/L
	Se	200.8, rev. 5.4	1.00 U	1.00 U	3.93	µg/L
	Si	200.7, rev. 4.4	30.08	30.17	none	µg/L
	Sn	200.8, rev. 5.4	1.00 U	1.00 U	3.60	mg/L
	Sr	200.7, rev. 4.4	54.90	51.66	477.00	µg/L
	Th	200.8, rev. 5.4	1.00 U	1.00 U	none	µg/L
	Ti	200.7, rev. 4.4	2.00 U	2.00 U	1.00	µg/L
	Tl	200.8, rev. 5.4	1.00 U	1.00 U	0.83	µg/L
	U	200.8, rev. 5.4	0.64	0.56	2.50	µg/L
	V	200.8, rev. 5.4	2.19	2.08	29.70	µg/L
	Zn	200.8, rev. 5.4	79.05	73.51	32.00	µg/L

[a] TDS = Total dissolved solids.

[b] n/a = Not applicable.

[c] NA =Not analyzed.

[d] U = Analyte was not detected.

Table B-2.1-3
Off-Site Laboratory Analytical Results

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3490	LH3	Generic:Low_Level_Tritium	Tritium	3.13	TU[b]	U
GW63-11-3490	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	HMX[c]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	HMX	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrobenzene	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrobenzene	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	6.49	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	6.49	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	PETN[d]	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	PETN	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	RDX	15	µg/L	J-
GW63-11-3490	HE	SW-846:8321A_MOD	RDX	15.9	µg/L	J
GW63-11-3490	HE	SW-846:8321A_MOD	TATB[e]	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	TATB	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Tetryl	6.49	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Tetryl	6.49	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	3.25	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3490	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	3.25	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	13	µg/L	UJ
GW63-11-3490	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	13	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Acetone	3440	µg/L	R
GW63-11-3490	VOC	SW-846:8260B	Acetone	13700	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Acetonitrile	25	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Acetonitrile	1250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Acrolein	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Acrolein	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Acrylonitrile	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Benzene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Benzene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromobenzene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromobenzene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromochloromethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromodichloromethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromoform	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromoform	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromomethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Bromomethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Butanol[1-]	2500	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Butanone[2-]	10.1	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Butanone[2-]	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Butylbenzene[n-]	1.1	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Butylbenzene[n-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Butylbenzene[sec-]	0.66	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Butylbenzene[sec-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Butylbenzene[tert-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Carbon Disulfide	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Carbon Disulfide	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Carbon Tetrachloride	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Carbon Tetrachloride	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	50	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3490	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloro-1-propene[3-]	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chlorobenzene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chlorodibromomethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloroethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloroethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloroform	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloroform	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloromethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chloromethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chlorotoluene[2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Chlorotoluene[4-]	0.3	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Chlorotoluene[4-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dibromoethane[1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dibromomethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dibromomethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	0.26	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	0.26	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichlorodifluoromethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethane[1,1-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethane[1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethene[1,1-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	50	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3490	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropane[1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropane[1,3-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropane[2,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropene[1,1-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Diethyl Ether	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Diethyl Ether	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Ethyl Methacrylate	3.28	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Ethyl Methacrylate	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Ethylbenzene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Hexachlorobutadiene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Hexanone[2-]	4.63	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Hexanone[2-]	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Iodomethane	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Iodomethane	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Isobutyl alcohol	2500	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Isopropylbenzene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Isopropyltoluene[4-]	0.83	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Isopropyltoluene[4-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methacrylonitrile	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methyl Methacrylate	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methyl Methacrylate	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methyl tert-Butyl Ether	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methyl tert-Butyl Ether	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	75.8	µg/L	J-

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3490	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	105	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methylene Chloride	10	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Methylene Chloride	500	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Naphthalene	1.9	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Naphthalene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Propionitrile	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Propionitrile	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Propylbenzene[1-]	0.37	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Propylbenzene[1-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Styrene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Styrene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Tetrachloroethene	0.43	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Tetrachloroethene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Toluene	0.31	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Toluene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	0.46	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	0.48	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloroethene	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloroethene	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichlorofluoromethane	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	0.6	µg/L	J-
GW63-11-3490	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	0.4	µg/L	J-

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3490	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Vinyl acetate	250	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Vinyl Chloride	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Vinyl Chloride	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Xylene[1,2-]	50	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	2	µg/L	UJ
GW63-11-3490	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	100	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Acetonitrile	25	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Acrolein	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Benzene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Bromoform	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Carbon Disulfide	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Carbon Tetrachloride	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chloroform	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chloromethane	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3492	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Diethyl Ether	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Ethyl Methacrylate	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Methyl Methacrylate	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Methyl tert-Butyl Ether	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Methylene Chloride	10	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Propionitrile	5	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Styrene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Toluene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3492	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	UJ
GW63-11-3492	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Vinyl Chloride	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
GW63-11-3492	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	2	µg/L	U
GW63-11-3491	LH3	Generic:Low_Level_Tritium	Tritium	2.99	TU	U
GW63-11-3491	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	1.3	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	1.3	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	1.3	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	HMX	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Nitrobenzene	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	0.649	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	PETN	1.3	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	RDX	0.134	µg/L	J-
GW63-11-3491	HE	SW-846:8321A_MOD	TATB	1.3	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Tetryl	0.649	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	0.325	µg/L	UJ
GW63-11-3491	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	1.3	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Acetone	57.5	µg/L	J
GW63-11-3491	VOC	SW-846:8260B	Acetonitrile	25	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Acrolein	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Benzene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3491	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Bromoform	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Carbon Disulfide	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Carbon Tetrachloride	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chloroform	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chloromethane	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Diethyl Ether	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Ethyl Methacrylate	5	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3491	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Methyl Methacrylate	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Methyl tert-Butyl Ether	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Methylene Chloride	10	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Propionitrile	5	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Styrene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Toluene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	UJ
GW63-11-3491	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Vinyl Chloride	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
GW63-11-3491	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	2	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Acetonitrile	25	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Acrolein	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Benzene	1	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3493	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Bromoform	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Carbon Disulfide	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Carbon Tetrachloride	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chloroform	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chloromethane	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-3493	VOC	SW-846:8260B	Diethyl Ether	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Ethyl Methacrylate	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Methyl Methacrylate	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Methyl tert-Butyl Ether	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Methylene Chloride	10	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Propionitrile	5	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Styrene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Toluene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	UJ
GW63-11-3493	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Vinyl Chloride	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
GW63-11-3493	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	2	µg/L	U
GW63-11-4134	LH3	Generic:Low_Level_Tritium	Tritium	1.67	TU	NQ
GW63-11-4134	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	1.3	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	1.3	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4134	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	1.3	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	HMX	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Nitrobenzene	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	0.649	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	PETN	1.3	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	RDX	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	TATB	1.3	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Tetryl	0.649	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	0.325	µg/L	UJ
GW63-11-4134	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	1.3	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Acetone	1330	µg/L	R
GW63-11-4134	VOC	SW-846:8260B	Acetone	823	µg/L	J-
GW63-11-4134	VOC	SW-846:8260B	Acetonitrile	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Acetonitrile	125	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Acrolein	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Acrolein	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Acrylonitrile	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Benzene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Benzene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromobenzene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromobenzene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromochloromethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromodichloromethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromoform	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromoform	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromomethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Bromomethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4134	VOC	SW-846:8260B	Butanol[1-]	250	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butanone[2-]	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butylbenzene[n-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butylbenzene[sec-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Butylbenzene[tert-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Carbon Disulfide	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Carbon Disulfide	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Carbon Tetrachloride	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Carbon Tetrachloride	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloro-1-propene[3-]	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorobenzene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorodibromomethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloroethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloroethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloroform	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloroform	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloromethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chloromethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorotoluene[2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Chlorotoluene[4-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dibromoethane[1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dibromomethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dibromomethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4134	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichlorodifluoromethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethane[1,1-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethane[1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethene[1,1-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropane[1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropane[1,3-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropane[2,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropene[1,1-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Diethyl Ether	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Diethyl Ether	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Ethyl Methacrylate	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Ethyl Methacrylate	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Ethylbenzene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Hexachlorobutadiene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Hexanone[2-]	25	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4134	VOC	SW-846:8260B	Iodomethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Iodomethane	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Isobutyl alcohol	250	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Isopropylbenzene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Isopropyltoluene[4-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methacrylonitrile	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methyl Methacrylate	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methyl Methacrylate	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methyl tert-Butyl Ether	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methyl tert-Butyl Ether	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	1.82	µg/L	J-
GW63-11-4134	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methylene Chloride	10	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Methylene Chloride	50	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Naphthalene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Naphthalene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Propionitrile	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Propionitrile	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Propylbenzene[1-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Styrene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Styrene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Tetrachloroethene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Toluene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Toluene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	5	µg/L	UJ

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4134	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloroethene	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloroethene	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichlorofluoromethane	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Vinyl acetate	25	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Vinyl Chloride	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Vinyl Chloride	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Xylene[1,2-]	5	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	2	µg/L	UJ
GW63-11-4134	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	10	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Acetonitrile	25	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Acrolein	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Benzene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Bromoform	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4136	VOC	SW-846:8260B	Carbon Disulfide	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Carbon Tetrachloride	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chloroform	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chloromethane	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dibromo-3-Chloropropane[1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Diethyl Ether	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Ethyl Methacrylate	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4136	VOC	SW-846:8260B	Methyl Methacrylate	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Methyl tert-Butyl Ether	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Methylene Chloride	10	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Propionitrile	5	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Styrene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Toluene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	UJ
GW63-11-4136	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Vinyl Chloride	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
GW63-11-4136	VOC	SW-846:8260B	Xylene[1,3-]+Xylene[1,4-]	2	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	RDX	2.24	µg/L	NQ
GW63-11-4717	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	HMX	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	TATB	1.3	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Tetryl	0.649	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	1.3	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	1.3	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	1.3	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	PETN	1.3	µg/L	U

Table B-2.1-3 (continued)

Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Units	Qualifier Code[a]
GW63-11-4717	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	1.3	µg/L	UJ
GW63-11-4717	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Nitrobenzene	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	0.325	µg/L	UJ
GW63-11-4717	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	0.325	µg/L	U
GW63-11-4717	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	0.649	µg/L	UJ

[a] U = Undetected; UJ = undetected, estimated value; J- = Estimated value, may be biased low; J = estimated value; R = data are rejected as a result of major problems with quality assurance/quality control parameters; NQ = not qualified, result is valid.

[b] TU = Tritium unit.

[c] HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

[d] PETN = Pentaerythritol tetranitrate.

[e] TATB = Triaminotrinitrobenzene.

Table B-2.2-1
TOC Results

Sample ID	U.S. Environmental Protection Agency Method	TOC Concentration (mgC/L)
GW63-11-3494	415.1	3.96
GW63-11-3495	415.1	0.22
GW63-11-3496	415.1	0.2 U*
GW63-11-3497	415.1	0.2 U
GW63-11-3498	415.1	0.2 U

*U = The analyte was analyzed for but not detected.

Table B-2.3-1
Purge Volumes and Water-Quality Parameters during Well Development at R-63

Date	Time	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
02/10/11	1039	Surging/bailing; no parameters measured.							n/a[a]	n/a
	1200	Surging/bailing; no parameters measured.							94.0	94.0
02/11/11	0230	Pumping; no parameters measured.							n/a	94.0
	0300	8.2	8.0	8.6	169.0	382.9	234	1422.0	44.7	138.7
	0315	8.2	11.3	7.8	163.5	377.4	209	1893.0	67.5	206.2
	0330	8.1	9.6	7.4	156.2	370.1	230	1234.0	52.0	258.2
	0345	7.8	12.6	8.7	171.5	380.4	219	234.0	52.5	310.7
	0400	7.8	12.8	8.0	167.5	376.4	211	144.0	55.5	366.2
	0430	7.7	13.1	8.2	155.8	364.7	201	79.2	112.5	478.7
	0500	7.6	13.0	8.6	130.3	339.2	188	58.6	114.0	592.7
	0600	7.4	13.1	7.9	139.3	348.2	172	39.3	238.0	830.7
	0640	No parameters collected. Pump moved down 5 ft.							116.0	946.7
	0740	Totalizer stopped working.								
	0800	7.6	13.3	7.2	133.9	342.8	154	17.5	n/r[b]	n/r
	0900	7.5	13.8	6.9	140.9	349.8	149	13.8	n/r	n/r
	1000	7.4	14.2	6.9	143.4	352.3	149	11.8	n/r	n/r
	1100	7.4	14.5	7.2	140.4	349.3	147	11.0	n/r	n/r
	1200	YSI and turbidity meter being calibrated							n/a	n/a
	1208	7.3	14.4	6.2	92.9	301.8	137	9.3	n/r	n/r
	1300	7.5	14.3	6.2	109.5	318.4	134	8.1	n/r	n/r
	1400	7.6	14.4	6.4	108.2	312.1	133	11.1	n/r	n/r
	1500	7.4	14.3	6.2	123.6	332.5	132	10.0	n/r	n/r
	1537	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r
	1545	7.5	13.7	6.4	112.6	321.5	130	12.1	n/r	n/r
	1600	7.5	14.0	6.6	121.4	330.3	133	17.5	n/r	n/r
	1615	7.5	14.1	6.4	139.7	348.6	130	12.6	n/r	n/r
	1635	7.5	13.8	6.6	132.3	341.2	131	19.7	n/r	n/r
	1700	7.7	13.2	6.7	166.4	375.3	130	22.5	n/r	n/r
	1730	7.4	13.6	6.9	138.6	347.5	129	12.2	n/r	n/r
	1750	7.4	13.6	6.4	131.1	334.0	128	9.8	n/r	n/r
	1830	7.5	12.7	6.7	118.6	327.5	127	10.5	n/r	n/r
	1900	7.5	13.2	6.8	142.7	351.6	126	13.2	n/r	n/r
	2000	7.4	13.0	6.6	138.3	347.2	124	9.3	n/r	n/r
	2005	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r
	New totalizer installed.									
	2045	7.4	13.4	6.6	139.7	348.6	122	11.4	204.0	4439.1[c]
	2115	7.3	13.2	6.6	152.0	360.9	122	12.8	252.5	4691.6

Table B-2.3-1 (continued)

Date	Time	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
02/11/11	2215	7.4	13.2	6.6	159.5	368.4	121	10.8	513.5	5205.1
	2315	7.3	13.4	6.5	156.4	365.3	120	12.3	528.0	5733.1
02/12/11	0015	7.3	13.4	6.9	158.5	367.4	120	11.3	580.5	6313.6
	0115	7.3	13.2	6.9	157.4	366.3	118	8.2	575.0	6888.6
	0215	7.3	13.2	7.4	160.8	369.7	117	8.5	622.0	7510.6
	0315	7.3	13.3	7.2	158.6	367.5	117	7.7	600.5	8111.1
	0415	7.3	13.3	7.7	162.2	371.1	116	5.8	648.0	8759.1
	0515	7.3	13.3	7.3	162.6	371.5	115	5.3	565.0	9324.1
	0615	7.3	13.5	7.3	161.9	370.8	114	4.6	624.0	9948.1
02/12/11	0715	7.3	13.3	7.0	161.9	370.8	113	4.4	623.2	10,571.3
	0815	7.2	13.6	7.1	169.1	378.0	112	5.3	614.4	11,185.7
	0915	7.3	13.9	7.5	168.2	377.1	112	4.2	632.0	11,817.7
	1015	7.3	13.9	6.3	165.0	368.9	111	4.6	632.5	12,450.2
	1115	7.2	14.0	6.4	165.2	374.1	111	3.9	632.6	13,082.8
	1200	7.3	14.0	6.1	166.7	375.6	110	3.5	474.6	13,557.4
	1212	n/r	n/r	n/r	n/r	n/r	n/r	n/r	131.6	13,689.0[d]

[a] n/a = Not applicable.

[b] n/r = Not recorded.

[c] Starting volume after totalizer was replaced is based on previous bucket measurements.

[d] This purge volume is based on early volume estimates that were based upon bucket measurements made when the totalizer was not working. Due to the uncertainties associated with the bucket measurements, the frac tank volume calculation of 15,739 gal. is believed to be a more accurate indicator of the actual volume and is used as the total well development purge volume.

Table 2.3-2
Purge Volumes and Water-Quality Parameters during Aquifer Testing at R-63

Date	Time	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
Pre–Aquifer Test Bailing to Remove Potential Debris from Retrieved Pump and Shroud										
02/08/11	1450	n/a[a]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15,739.0[b]
	1746	n/a	n/a	n/a	n/a	n/a	n/a	n/a	35	15,774.0
Aquifer Testing										
02/20/11	1000	n/r[c]	n/r	n/r	n/r	n/r	n/r	n/r	n/a	15,774.0
	1030	n/r	n/r	n/r	n/r	n/r	n/r	n/r	351.5	16,125.5
	1100	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/a	16,125.5
	1200	n/r	n/r	n/r	n/r	n/r	n/r	n/r	687.5	16,813.0
02/21/11	0800	No parameters collected.							n/a	16,813.0
	0815	7.5	11.9	3.6	90.1	304.0	107	24.8	179.6	16,992.6
	0830	7.5	13.3	5.3	181.3	390.2	108	15.8	182.0	17,174.6
	0845	7.4	13.5	5.6	178.8	387.7	108	11.2	181.5	17,356.1
	0900	7.3	13.5	5.7	177.1	386.0	108	9.2	181.8	17,537.9
	0930	7.3	13.6	5.7	181.0	389.9	109	7.9	363.5	17,901.4
	1000	7.3	13.7	5.8	174.3	383.2	109	6.8	362.7	18,264.1
02/21/11	1030	7.2	13.7	5.9	177.2	386.1	109	5.7	360.5	18,624.6
	1100	7.3	13.8	5.7	172.7	381.6	109	5.3	360.5	18,985.1
	1200	7.3	13.6	5.8	170.7	379.6	110	3.9	720.0	19,705.1
	1300	7.2	13.7	5.8	166.5	375.4	110	3.2	720.3	20,425.4
	1400	7.2	13.6	5.8	167.1	376.0	110	3.2	722.1	21,147.5
	1500	7.2	13.6	5.8	166.1	375.0	110	3.0	721.1	21,868.6
	1600	7.2	13.4	5.8	166.4	375.3	110	3.1	720.0	22,588.6
	1700	7.2	13.4	6.0	168.3	377.2	110	2.1	720.0	23,308.6
	1800	7.2	13.4	5.9	165.2	374.1	110	2.4	720.0	24,028.6
	1900	7.2	13.3	5.8	167.8	376.7	110	2.3	721.0	24,749.6
	2000	7.2	13.2	6.2	167.3	376.2	109	2.2	719.5	25,469.1
	2100	7.2	13.2	6.2	167.4	376.3	109	1.9	719.1	26,188.2
	2200	7.2	13.3	5.8	166.8	375.7	109	1.9	720.9	26,909.1
	2300	7.2	13.2	5.8	172.0	380.9	109	1.8	721.3	27,630.4
02/22/11	0000	7.2	13.3	5.9	168.5	377.4	109	1.0	721.5	28,351.9
	0100	7.2	13.2	5.8	172.5	381.4	109	1.7	721.6	29,073.5
	0200	7.2	13.3	5.9	176.2	385.1	109	1.6	721.6	29,795.1
	0300	7.2	13.3	5.8	176.5	385.4	108	1.6	721.2	30,516.3
	0400	7.2	13.3	6.1	174.8	383.7	108	1.5	721.3	31,237.6
	0500	7.2	13.2	5.9	174.4	383.3	108	1.4	722.0	31,959.6
	0600	7.2	13.3	5.9	171.9	380.8	108	1.5	716.5	32,676.1

Table 2.3-2 (continued)

Date	Time	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
Additional Pumping from 1350 ft bgs to Remove any Remaining Debris from Sump										
02/23/11	0733	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/a	32,676.1
	0847	n/r	n/r	n/r	n/r	n/r	n/r	n/r	962.6	33,638.7

[a] n/a = Not applicable.

[b] Purge volume at the end of well development was calculated from frac tank volume calculations.

[c] n/r = Not recorded.

Appendix C

Aquifer Testing Report

C-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of pumping tests conducted during February 2011 at R-63, a regional aquifer well located near Cañon de Valle at Technical Area 16 (TA-16) at Los Alamos National Laboratory (LANL or the Laboratory). The tests on R-63 were conducted to characterize the saturated materials, quantify the hydraulic properties of the screened interval and assess any detectable interference effects in nearby vadose-zone and regional-aquifer wells. Testing consisted of brief trial pumping, background water level data collection, and a 22-h constant-rate pumping test. A 24-h test was planned originally for R-63. However, the work schedule at TA-16 forced an early shutdown of the test.

As in most of the R-well pumping tests conducted on the Pajarito Plateau, an inflatable packer system was used in R-63 to try to eliminate casing storage effects on the test data. It was not clear whether or not this approach was completely successful. The early pumping and recovery data showed a pattern that was consistent with a small storage effect, possibly caused by residual trapped air in the formation associated with the drilling process.

Conceptual Hydrogeology

R-63 lies within unconsolidated sands and gravels of the Puye Formation. The well screen is 20.3 ft long, extending from 1325 to 1345.3 ft below ground surface (bgs). The static water level measured on February 19, 2011, before testing was 1257.75 ft bgs. The ground surface elevation at the well was estimated at 7455 ft above mean sea level (amsl), making the estimated water level elevation 6197.25 ft amsl. The high static water level combined with a steeply sloping water table and stratification of the saturated sediments in this portion of the laboratory suggested the possibility of confined conditions at R-63

R-63 Testing

R-63 was tested from February 19 to 23, 2011. On February 19, the pump was installed and operated long enough to fill the drop pipe and set the discharge rate. Testing began with brief trial pumping on February 20, followed by recovery/background data collection overnight. The usual extended background data collection was not performed because, following the testing effort, R-63 was monitored continuously for several weeks during the subsequent testing of nearby monitoring well CdV-16-4ip. This follow-up monitoring was expected to provide adequate background water level information. On February 21, the constant-rate pumping test began and continued for 22 h until a forced shutdown on February 22. Following constant-rate testing, recovery data were recorded for 25 h, until February 23.

Trial testing of R-63 began at 10:00 a.m. on February 20 at a discharge rate of 12.1 gallons per minute (gpm) and continued for 30 min. Following shut down, recovery data were recorded for 30 min until 11:00 a.m. when trial 2 pumping began at a discharge rate of 12.1 gpm. Following 60 min of pumping, the pump was shut down and recovery/background data were collected for 1200 min until 8:00 a.m. on February 21.

At 8:00 a.m. on February 21, the 22-h pumping test was begun, with an average discharge rate during the test of 12.0 gpm. Pumping continued for 1320 min until 6:00 a.m. on February 22. Following shutdown, recovery data were recorded for 1500 min until 7:00 a.m. on February 23 when the packer was deflated in preparation for final purging of the well sump and removal of the pump.

Data Anomalies

Several water level anomalies were observed in the data set collected during the testing of R-63. Most of the anomalies are described below, but a brief summary of them is presented here.

Unusual data observations included the following:

1. When the pump was installed, the transducer was set at a depth of 1322.53 ft bgs. The static water level of 1257.75 ft bgs would be expected to exert a pressure of 64.78 ft of water over the transducer (1322.53 minus 1257.75). Because a nonvented transducer was used, the total pressure registered on the transducer would be greater than this amount by the magnitude of the atmospheric pressure, about 26.85 ft of water at the depth of the water table in R-63. Thus, the total recorded pressure should have been 64.78 + 26.85 = 91.63 ft. The actual pressure reported at the time was 86.49 ft, 5.14 ft less than the known pressure. (Note: the physical measurement of the length of the pipe string suspending the transducer could have included a small error but not nearly this large.)
2. After brief pumping to fill the drop pipe on February 19, the recovered water level overnight inexplicably remained 1.4 ft below the starting level. Then, after brief trial testing on February 20, again the recovered water level remained an additional 0.6 ft lower. Finally, following the 22-h pumping test, the water level rebounded 1 ft higher than the level at the start of the test. None of these changes were explainable or consistent with barometric pressure changes observed during those periods.
3. There was an apparent unexplained and momentary drop in discharge rate during the first minute of pumping in both trial 1 and the 22-h test.
4. Several minutes after shutdown of the 22-h test, there was a sudden and momentary rise in measured water level to a position above the static level. Though the water level quickly declined, it remained 1 to 2 ft above expected recovery levels for the duration of the observed 25-h recovery period.

There is no obvious explanation for the unusual responses cited. Possible hypotheses include (1) a malfunctioning transducer and (2) effects of air in the pumped water. In previous R-well pumping tests, somewhat similar and unexplained water level observations may have been related to high gas content in the pumped water. However, the water pumped from R-63 did not show evidence of significant gas content.

C-2.0 BACKGROUND DATA

The background water level data collected in conjunction with running the pumping tests allow the analyst to see what water-level fluctuations occur naturally in the aquifer and help distinguish between water-level changes caused by conducting the pumping test and changes associated with other causes.

Background water-level fluctuations have several causes, among them barometric pressure changes, operation of other wells in the aquifer, Earth tides, and long-term trends related to weather patterns. The background data hydrographs from the monitored wells were compared with barometric pressure data from the area to determine if a correlation existed.

Previous pumping tests on the Pajarito Plateau have demonstrated a barometric efficiency for most wells of between 90% and 100%. Barometric efficiency is defined as the ratio of water level change divided by barometric pressure change, expressed as a percentage. In the initial pumping tests conducted on the early R-wells, downhole pressure was monitored using a vented pressure transducer. This equipment measures the difference between the total pressure applied to the transducer and the barometric pressure, this difference being the true height of water above the transducer.

Subsequent pumping tests, including R-63, have utilized nonvented transducers. These devices simply record the total pressure on the transducer, that is, the sum of the water height plus the barometric pressure. This results in an attenuated "apparent" hydrograph in a barometrically efficient well. Take as an example a 90% barometrically efficient well. When monitored using a vented transducer, an increase in barometric pressure of 1 unit causes a decrease in recorded downhole pressure of 0.9 unit because the water level is forced downward 0.9 unit by the barometric pressure change. However, using a nonvented transducer, the total measured pressure increases by 0.1 unit (the combination of the barometric pressure increase and the water level decrease). Thus, the resulting apparent hydrograph changes by a factor of 100 minus the barometric efficiency, and in the same direction as the barometric pressure change, rather than in the opposite direction.

Barometric pressure data were obtained from TA-54 tower site from the Waste and Environmental Services Division–Environmental Data and Analysis (WES-EDA). The TA-54 measurement location is at an elevation of 6548 ft amsl, whereas the wellhead elevation is at roughly 7455 ft amsl. The static water level in R-63 was 1257.75 ft below land surface, making the water-table elevation approximately 6197.25 ft amsl. Therefore, the measured barometric pressure data from TA-54 had to be adjusted to reflect the pressure at the elevation of the water table within R-63.

The following formula was used to adjust the measured barometric pressure data:

$$P_{WT} = P_{TA54} \exp\left[-\frac{g}{3.281R}\left(\frac{E_{R-63} - E_{TA54}}{T_{TA54}} + \frac{E_{WT} - E_{R-63}}{T_{WELL}} \right)\right] \qquad \textbf{Equation C-1}$$

where, P_{WT} = barometric pressure at the water table inside R-63

P_{TA54} = barometric pressure measured at TA-54

g = acceleration of gravity, in m/sec^2 (9.80665 m/s^2)

R = gas constant, in J/Kg/degrees kelvin (287.04 J/Kg/degrees kelvin)

$E_{R\text{-}63}$ = land surface elevation at R-63 site, in feet (approximately 7455 ft)

E_{TA54} = elevation of barometric pressure measuring point at TA-54, in feet (6548 ft)

E_{WT} = elevation of the water level in R-63, in feet (approximately 6197.25 ft)

T_{TA54} = air temperature near TA-54, in degrees kelvin (assigned a value of 37.9 degrees Fahrenheit, or 276.4 degrees Kelvin)

T_{WELL} = air temperature inside R-63, in degrees kelvin (assigned a value of 53.1 degrees Fahrenheit, or 284.9 degrees kelvin)

This formula is an adaptation of an equation WES-EDA provided. It can be derived from the ideal gas law and standard physics principles. An inherent assumption in the derivation of the equation is that the air temperature between TA-54 and the well is temporally and spatially constant and that the temperature of the air column in the well is similarly constant.

The corrected barometric pressure data reflecting pressure conditions at the water table were compared with the water level hydrograph to discern the correlation between the two and determine whether water-level corrections would be needed before data analysis.

C-3.0 IMPORTANCE OF EARLY DATA

When pumping or recovery first begins, the vertical extent of the cone of depression is limited to approximately the well screen length, the filter pack length, or the aquifer thickness in relatively thin permeable strata. For many pumping tests on the Plateau, the early pumping period is the only time that the effective height of the cone of depression is known with certainty because soon after startup the cone of depression expands vertically through permeable materials above and/or below the screened interval. Thus, the early data often offer the best opportunity to obtain hydraulic conductivity information because conductivity would equal the earliest-time transmissivity divided by the well screen length.

Unfortunately, in many pumping tests, casing-storage effects dominate the early-time data, potentially hindering the effort to determine the transmissivity of the screened interval. The duration of casing-storage effects can be estimated using the following equation (Schafer 1978, 098240).

$$t_c = \frac{0.6\left(D^2 - d^2\right)}{\frac{Q}{s}}$$

Equation C-2

where t_c = duration of casing storage effect, in minutes

D = inside diameter of well casing, in inches

d = outside diameter of column pipe, in inches

Q = discharge rate, in gallons per minute

s = drawdown observed in pumped well at time t_c, in feet

The calculated casing storage time is quite conservative. Often, the data show that significant effects of casing storage have dissipated after about half the computed time.

For wells screened across the water table or wells in which the filter pack can drain during pumping, there can be an additional storage contribution from the filter pack. The following equation provides an estimate of the storage duration accounting for both casing and filter pack storage.

$$t_c = \frac{0.6\left[\left(D^2 - d^2\right) + S_y\left(D_B^2 - D_C^2\right)\right]}{\frac{Q}{s}}$$

Equation C-3

where S_y = short term specific yield of filter media (typically 0.2)

D_B = diameter of borehole, in inches

D_C = outside diameter of well casing, in inches

This equation was derived from Equation C-2 on a proportional basis by increasing the computed time in direct proportion to the additional volume of water expected to drain from the filter pack. (To prove this, note that the left-hand term within the brackets is directly proportional to the annular area [and volume] between the casing and drop pipe while the right-hand term is proportional to the area [and volume] between the borehole and the casing, corrected for the drainable porosity of the filter pack. Thus, the summed term within the brackets accounts for all of the volume [casing water and drained filter pack water] appropriately.)

In some instances, it is possible to eliminate casing storage effects by setting an inflatable packer above the tested screen interval before conducting the test. This approach may not have been successful in the testing performed on R-63 because the data may have included minor storage effects perhaps associated with trapped air in the formation left over from the drilling process.

C-4.0 TIME-DRAWDOWN METHODS

Time-drawdown data can be analyzed using a variety of methods. Among them is the Theis method (1934-1935, 098241). The Theis equation describes drawdown around a well as follows:

$$s = \frac{114.6Q}{T} W(u)$$ **Equation C-4**

where

$$W(u) = \int_u^\infty \frac{e^{-x}}{x} dx$$ **Equation C-5**

and

$$u = \frac{1.87r^2 S}{Tt}$$ **Equation C-6**

and where s = drawdown, in feet

Q = discharge rate, in gallons per minute

T = transmissivity, in gallons per day per foot

S = storage coefficient (dimensionless)

t = pumping time, in days

r = distance from center of pumpage, in feet

To use the Theis method of analysis, the time-drawdown data are plotted on log-log graph paper. Then, Theis curve matching is performed using the Theis type curve—a plot of the Theis well function $W(u)$ versus $1/u$. Curve matching is accomplished by overlaying the type curve on the data plot and, while keeping the coordinate axes of the two plots parallel, shifting the data plot to align with the type curve, effecting a match position. An arbitrary point, referred to as the match point, is selected from the overlapping parts of the plots. Match-point coordinates are recorded from the two graphs, yielding four values: $W(u)$, $1/u$, s, and t. Using these match-point values, transmissivity and storage coefficient are computed as follows:

$$T = \frac{114.6Q}{s} W(u)$$ **Equation C-7**

$$S = \frac{Tut}{2693r^2}$$ **Equation C-8**

where T = transmissivity, in gallons per day per foot

S = storage coefficient

Q = discharge rate, in gallons per minute

$W(u)$ = match-point value

s = match-point value, in feet

u = match-point value

t = match-point value, in minutes

An alternative solution method applicable to time-drawdown data is the Cooper-Jacob method (1946, 098236), a simplification of the Theis equation that is mathematically equivalent to the Theis equation for most pumped well data. The Cooper-Jacob equation describes drawdown around a pumping well as follows:

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2 S}$$

Equation C-9

The Cooper-Jacob equation is a simplified approximation of the Theis equation and is valid whenever the u value is less than about 0.05. For small radius values (e.g., corresponding to borehole radii), u is less than 0.05 at very early pumping times and therefore is less than 0.05 for most or all measured drawdown values. Thus, for the pumped well, the Cooper-Jacob equation usually can be considered a valid approximation of the Theis equation. An exception occurs when the transmissivity of the aquifer is very low. In that case, some of the early pumped well drawdown data may not be well approximated by the Cooper-Jacob equation.

According to the Cooper-Jacob method, the time-drawdown data are plotted on a semilog graph, with time plotted on the logarithmic scale. Then a straight line of best fit is constructed through the data points and transmissivity is calculated using:

$$T = \frac{264Q}{\Delta s}$$

Equation C-10

where T = transmissivity, in gallons per day per foot

Q = discharge rate, in gallons per minute

Δs = change in head over one log cycle of the graph, in feet

Because many of the test wells completed on the Plateau are severely partially penetrating, an alternate solution considered for assessing aquifer conditions is the Hantush equation for partially penetrating wells (Hantush 1961, 098237; Hantush 1961, 106003). The Hantush equation is as follows:

Equation C-11

$$s = \frac{Q}{4\pi T}\left[W(u) + \frac{2b^2}{\pi^2 (l-d)(l'-d')} \sum_{n=1}^{\infty} \frac{1}{n^2}\left(\sin\frac{n\pi l}{b} - \sin\frac{n\pi d}{b}\right)\left(\sin\frac{n\pi l'}{b} - \sin\frac{n\pi d'}{b}\right) W\left(u, \sqrt{\frac{K_z}{K_r}}\frac{n\pi r}{b}\right)\right]$$

where, in consistent units, s, Q, T, t, r, S, and u are as previously defined and

b = aquifer thickness

d = distance from top of aquifer to top of well screen in pumped well

l = distance from top of aquifer to bottom of well screen in pumped well

d' = distance from top of aquifer to top of well screen in observation well

l' = distance from top of aquifer to bottom of well screen in observation well

K_z = vertical hydraulic conductivity

K_r = horizontal hydraulic conductivity

In this equation, $W(u)$ is the Theis well function and $W(u,\beta)$ is the Hantush well function for leaky aquifers where:

$$\beta = \sqrt{\frac{K_z}{K_r}}\frac{n\pi r}{b}$$ **Equation C-12**

Note that for single-well tests, $d = d'$ and $l = l'$.

C-5.0 RECOVERY METHODS

Recovery data were analyzed using the Theis recovery method. This is a semilog analysis method similar to the Cooper-Jacob procedure.

In this method, residual drawdown is plotted on a semilog graph versus the ratio t/t', where t is the time since pumping began and t' is the time since pumping stopped. A straight line of best fit is constructed through the data points and T is calculated from the slope of the line as follows:

$$T = \frac{264Q}{\Delta s}$$ **Equation C-13**

The recovery data are particularly useful compared to time-drawdown data. Because the pump is not running, spurious data responses associated with dynamic discharge rate fluctuations are eliminated. The result is that the data set is generally “smoother” and easier to analyze.

Recovery data also can be analyzed using the Hantush equation for partial penetration. This approach is generally applied to the early data in a plot of recovery versus recovery time.

C-6.0 SPECIFIC CAPACITY METHOD

The specific capacity of the pumped well can be used to obtain a lower-bound value of hydraulic conductivity. The hydraulic conductivity is computed using formulas that are based on the assumption that the pumped well is 100% efficient. The resulting hydraulic conductivity is the value required to sustain the observed specific capacity. If the actual well is less than 100% efficient, it follows that the actual hydraulic conductivity would have to be greater than calculated to compensate for well inefficiency. Thus, because the efficiency is unknown, the computed hydraulic conductivity value represents a lower bound. The actual conductivity is known to be greater than or equal to the computed value.

For fully penetrating wells, the Cooper-Jacob equation can be iterated to solve for the lower-bound hydraulic conductivity. However, the Cooper-Jacob equation (assuming full penetration) ignores the contribution to well yield from permeable sediments above and below the screened interval. To account for this contribution, it is necessary to use a computation algorithm that includes the effects of partial penetration. One such approach was introduced by Brons and Marting (1961, 098235) and augmented by Bradbury and Rothschild (1985, 098234).

Brons and Marting introduced a dimensionless drawdown correction factor, s_P, approximated by Bradbury and Rothschild as follows:

$$s_P = \frac{1-\frac{L}{b}}{\frac{L}{b}}\left[\ln\frac{b}{r_w} - 2.948 + 7.363\frac{L}{b} - 11.447\left(\frac{L}{b}\right)^2 + 4.675\left(\frac{L}{b}\right)^3\right]$$ **Equation C-14**

In this equation, L is the well screen length, in feet. Incorporating the dimensionless drawdown parameter, the conductivity is obtained by iterating the following formula:

$$K = \frac{264Q}{sb}\left(\log\frac{0.3Tt}{r_w^2 S} + \frac{2s_P}{\ln 10}\right)$$ **Equation C-15**

The Brons and Marting procedure can be applied to both partially penetrating and fully penetrating wells.

To apply this procedure, a storage coefficient value must be assigned. Storage coefficient values generally range from 10^{-5} to 10^{-3} for confined aquifers and 0.01 to 0.25 for unconfined aquifers (Driscoll 1986, 104226). Confined conditions were assumed for R-63 and a storage coefficient of 5×10^{-4} was arbitrarily assigned. The calculation result is not particularly sensitive to the choice of storage coefficient value, so a rough estimate is generally adequate to support the calculations.

The analysis also requires assigning a value for the saturated aquifer thickness, b. For R-63, an arbitrary thickness of double the well screen length was assigned in the calculations. The assigned thickness does not have a great effect on the calculations, because sediments far above or below the well screen contribute little flow to the well.

C-7.0 BACKGROUND DATA ANALYSIS

Background aquifer pressure data collected during the R-63 tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure C-7.0-1 shows aquifer pressure data from R-63 during the test period along with barometric pressure data from TA-54 that have been corrected to equivalent barometric pressure in feet of water at the water table. The R-63 data are referred to in the figure as the “apparent hydrograph” because the measurements reflect the sum of water pressure and barometric pressure, having been recorded using a nonvented pressure transducer. The times of the pumping periods for the R-63 pumping tests are included on the figure for reference.

The data shown in Figure C-7.0-1 are not sufficient to estimate the barometric efficiency of the well. However, as discussed below, subsequent background data collected as part of the CdV-16-4(i)p testing effort supported this. The data do show, though, the unusual offsets in equilibrated water levels described above.

The early apparent hydrograph data showed the total head over the transducer to be about 86.5 ft. Following brief filling of the drop pipe, the level rebounded to just 85.1 ft of head—inexplicably 1.4 ft below the starting level. Following brief trial testing, the new equilibrated water level declined 0.6 ft further to a total head pressure of 84.5 ft. Finally, after substantial pumping (the 22-h test) the subsequent equilibrated total head rose about 1 ft to 85.5 ft. It is evident from the barometric pressure curve on the figure that the observed swings in head could not have been caused by atmospheric pressure changes. There was no obvious explanation for the unusual water-level responses illustrated in Figure C-7.0-1.

Figure C-7.0-2 shows subsequent water level and barometric pressure data collected after the R-63 pumping test effort. These data were collected using the permanent R-63 dedicated transducer that was vented. Note that the scale for the water level data was reversed to emphasize the similarity between the curves. The figure shows a clear correlation between water level and barometric pressure, suggesting a high barometric efficiency. There appeared to be a gradual separation of the curves over time, suggesting a slow water level decline in R-63.

These data were replotted on Figure C-7.0-3 with slight adjustments. The barometric pressure curve was adjusted for an assumed barometric efficiency while the hydrograph was modified for an assumed linear decline in water level over time. The curves illustrated in the figure are based on a barometric efficiency of 95% and a regional water level decline of 0.014 ft/d. The resulting correlation, while not perfect, supports a reasonable correspondence between the curves, confirming a high barometric efficiency for R-63.

The hydrograph shows diurnal fluctuations of several hundredths of a foot not fully represented in the barometric pressure curve. It is likely that these were Earth-tide responses.

During the R-63 tests, water levels were monitored in R-25, R-25b, CdV-16-1(i), and CdV-16-2(i)r to check for a possible response to pumping. Because these wells (except for R-25) were monitored using vented pressure transducers and the barometric-pressure-induced fluctuations in some of the hydrographs were large, it was necessary to correct some of the data by removing the barometric effect. This was done using BETCO (barometric and Earth tide correction) software—a mathematically complex correction algorithm that uses regression deconvolution (Toll, et al., 2007) to modify the data. The BETCO correction not only removes barometric pressure effects, but can remove Earth-tide effects as well.

The only screened intervals that showed a response to pumping at R-63 were R-25 screens 5, 6, 7, and 8. Figures C-7.0-4 through C-7.0-7, respectively, show the observed data. It turned out that only data from R-25 screens 7 and 8 required mathematical correction. The graphs for screens 5 and 6 show the measured water level data without correction for barometric or Earth-tide influences. The fact that the data from screens 5 and 6 needed no correction implies that there are different aquifer responses at screens 7 and 8 than at screens 5 and 6, although the cause is not fully understood.

Note that the drawdown responses in R-25 are jagged with many linear segments. This lack of smooth, flowing data traces was likely from a combination of transducer accuracy limits, superimposed background trends, barometric effects, and, in the case of screens 7 and 8, an artifact of the barometric pressure correction algorithm.

Screen 6, which is positioned at an elevation similar to the screen in R-63 showed the greatest—about 0.44 ft. The R-63 screen is set at approximate elevation 6110 to 6130 ft amsl, while R-25 screen 6 runs from 6101.4 to 6111.4 ft amsl, thus overlapping the R-63 screen slightly.

Screen 5, set between 6211.4 and 6221.4 ft amsl (81.4 ft above the R-63 screen), showed a drawdown of about 0.25 ft.

Screen 7, set between 5901.4 and 5911.4 ft amsl (198.6 ft below the R-63 screen), showed a drawdown of about 0.12 ft.

Screen 8, set between 5711.4 and 5721.4 ft amsl (388.6 ft below the R-63 screen), showed a drawdown of about 0.06 ft.

C-8.0 WELL R-63 DATA ANALYSIS

This section presents the data obtained from the R-63 pumping tests and the results of the analytical interpretations. Data are presented for drawdown and recovery from trial 1, trial 2 and the 22-h constant-rate test.

C-8.1 Well R-63 Trial 1 Test

Figure C-8.1-1 shows a semilog plot of the drawdown data collected from the trial 1 test on R-63 at a discharge rate of 12.1 gpm. As shown on the figure, there was exaggerated drawdown for the first 50 s of pumping as previously drained drop pipe refilled. Before pumping, the water level inside the drop pipe was measured and found to be 109 ft bgs, meaning a substantial volume of water had drained out overnight. The packer used for the R-63 tests had failed during previous tests where it was determined that o-ring seals had leaked where the submersible pump wires pass into the discharge pipe. Clearly, the leak was still there. The earliest drawdown data would have been corrupted anyway because of mandatory drainage of the upper portion of the drop pipe to prevent freezing overnight. Thus, there was no loss of utility of the data set. Curiously, subsequent idle periods between tests were not accompanied by significant drainage of the drop pipe.

Shortly after water was produced at the surface, the discharge rate declined substantially for a period of around 15 sec. This response corresponded to the rise in water level shown on Figure C-8.1-1 just before and after a pumping time of 1 min. There was no explanation for this unusual occurrence, although it was possible that air/gas passing through the pump could have degraded its performance briefly.

The transmissivity obtained from the Figure C-8.1-1 was 790 gallons per day (gpd)/ft. It was assumed this value reflected sediments along the full screen length of 20.3 ft. This made the computed average hydraulic conductivity 38.9 gpd/ft^2, or 5.2 ft/d. It was also possible the cone of depression had expanded vertically through a somewhat greater thickness than this, making the average hydraulic conductivity a little smaller than these values.

Figure C-8.1-2 shows the recovery data collected following shutdown of the trial 1 pumping test. The late data suggested a transmissivity of 940 gpd/ft with a corresponding hydraulic conductivity of 46.3 gpd/ft^2, or 6.2 ft/d, or perhaps somewhat less depending on the vertical extent of the cone of impression. The very early data suggested the possibility of a lesser transmissivity of 530 gpd/ft. However, the earliest data (lasting about 0.25 min) did not fall on the line of fit, casting doubt on that interpretation. Very early data may fall off the line of fit if the u value is greater than 0.05, but in this case, the u value condition would have been satisfied at a time about an order of magnitude lower than 0.25 min. Therefore, the curved portion of the initial data trace required a different interpretation.

It was possible that a storage phenomenon was responsible for the early curvature and initial straight line shown on the graph. The overall pattern had the general appearance of classical storage effects. When plotted on a log-log scale (not included here), however, the early data lacked the typical unit slope associated with storage effects, although if the source of the storage effect were trapped air in the formation, contraction and expansion of the air in response to pressure changes would produce a different effect than typical casing storage.

In summary, there were two possible interpretations of the data. In one interpretation, the early data were deemed to be storage affected, making the transmissivity of the screened interval 940 gpd/ft. In the alternate interpretation, the screened interval would be represented by the transmissivity value of 530 gpd/ft, making the average hydraulic conductivity 26.1 gpd/ft^2, or 3.5 ft/d. In the latter scenario, the greater transmissivity of 940 gpd/ft would represent the hydraulically contiguous zone penetrated by the well screen, somewhat thicker than the screen length.

C-8.2 Well R-63 Trial 2 Test

Figure C-8.2-1 shows a semilog plot of the drawdown data collected from the trial 2 test on R-63 at a discharge rate of 12.1 gpm. The first several seconds of data showed exaggerated drawdown temporarily because of intentional drainage of water from the drop pipe to prevent freezing overnight. Once the void had refilled and the water reached the discharge hose, the pumping pressure increased, reducing the discharge rate.

The initial line of fit on the drawdown graph was consistent with that seen on the trial 1 recovery graph, producing a transmissivity value of 590 gpd/ft and a hydraulic conductivity of 29.1 gpd/ft^2, or 3.9 ft/day. It was possible, though not certain, this reflected a storage phenomenon rather than true aquifer properties. The subsequent slope suggested a transmissivity of 910 gpd/ft, making the average hydraulic conductivity 44.8 gpd/ft^2, or 6.0 ft/day, or perhaps somewhat less depending on the height of the cone of depression.

Figure C-8.2-2 shows the recovery data collected following shutdown of the trial 2 pumping test. The early data showed the curved portion and an initial straight line which combined to mimic exactly typical storage response. This result was similar to that obtained from the trial 1 recovery data. As before, it could have reflected the true characteristics of the screened interval or, because of the extended duration of the curved portion, could have been a manifestation of a minor storage effect. The transmissivity obtained from the early line of fit was 550 gpd/ft, possibly making the hydraulic conductivity 27.1 gpd/ft^2, or 3.6 ft/day.

The late recovery data suggested a transmissivity of 890 gpd/ft and average hydraulic conductivity of 43.8 gpd/ft^2, or 5.9 ft/d, in good agreement with previous results. The actual hydraulic conductivity could be less, depending on the height of the cone of depression corresponding to the collected data (i.e., depending on the thickness of the hydraulically contiguous unit penetrated by the well screen).

C-8.3 Well R-63 22-Hour Constant-Rate Test

Figure C-8.3-1 shows a semilog plot of the drawdown data collected from the 22-h constant-rate pumping test conducted at an average discharge rate of 12.0 gpm. The earliest data points showed sluggish drawdown response, suggestive of storage or gas/air effects. These results contradicted earlier data. For example, in the trial 2 recovery data set (Figure C-8.2-2), the first two data points (corresponding to an elapsed time of 0.5 sec) showed a recovery magnitude of more than 5 ft, yet the first two data points from the drawdown data set on Figure C-8.3-1 showed only 1 ft of drawdown. Further, note that the first two data points from the trial 2 drawdown graph on Figure C-8.2-1 also showed about 5 ft of drawdown compared to only 1 ft at the outset of the 22-h test. These inconsistencies from one test to another implied that something changed between the tests—perhaps accumulation of a greater amount of air or possibly air in the pump interfering with its initial operation on startup.

As shown on Figure C-8.3-1, a little more than 20 s into the test, an inexplicable water level rise occurred, signaling a brief reduction in discharge rate. Such an effect is highly unusual but could be an indication of a burst of air passing through the pump and interfering with its operation.

The transmissivity determined from the line of fit was 840 gpd/ft. Assuming the cone of depression penetrated a thickness of sediment equal to the well screen length, the computed hydraulic conductivity was 41.4 gpd/ft^2, or 5.5 ft/d. As before, a greater cone of depression height would imply a somewhat lower hydraulic conductivity. The consistent time-drawdown slope over 22 h of pumping speaks to the limited vertical permeability characteristics of sediments in this portion of the laboratory. The data showed no evidence of leakage from overlying or underlying strata, implying the presence of tight aquitards above and below the screen zone.

Figure C-8.3-2 shows the recovery data collected following shutdown of the 22-h constant-rate pumping test. After a few minutes of recovery, the water level rose suddenly to a level above the original static level, then declined and slowly resumed recovery, again to a level above the original static water level. In fact, the entire recovery trace was 1 to 2 ft above the theoretically expected position for the duration of recovery.

There was no explanation for the bizarre response observed during recovery. One could hypothesize that perhaps the inflatable packer leaked, allowing water that had accumulated above the packer to flow into the screen zone. However, there are several things wrong with this theory. First, full pressure was maintained on the packer at all times. Second, a rising recovery level would tend to reduce the differential head across the packer making it less likely, rather than more likely, to leak. Third, the excess head buildup of about 2 ft above theoretical expectations for a period of 25 h would have required a greater continuous input volume of water than could have been stored above the packer. Finally, as described below, a significant volume of water remained above the packer at the conclusion of the pumping test effort, suggesting little water could have leaked out during the recovery event.

Another possible hypothesis is that water above the packer leaked past the faulty o-ring seals above the packer and also past the o-ring seals beneath the packer where the pump wires pass from inside the drop pipe back to the annulus outside the drop pipe. However, the observed jump in water level on Figure C-8.3-2 would imply a transfer of about 7 gal. of water between consecutive water level measurements that were 1 min apart (i.e., in a time period strictly less than 1 min). This implied leakage rate is greater than could reasonably be expected to occur past a snug fitting o-ring. Further, the leak would have had to stop suddenly (or diminish greatly), as evidenced by the immediate reversal in water level trend. As stated above, such leakage from the annulus above the packer is inconsistent with the leakage volume that would have been required to maintain the observed elevated heads for the full 25 h of recovery and the large water volume that remained above the packer at the conclusion of recovery.

Figure C-8.3-3 shows the data plots from all three recovery events. Theoretically, once the u-value criterion is satisfied (after just a few feet of recovery), the three curves should coincide exactly. In fact, the two trial test plots were nearly identical. The recovery trace following the 22-h pumping test, however, deviated significantly from the other curves, even at early time prior to the sudden jump in level. The departure of the curves at early time was another indicator of possible storage effects impacting the test data. There was still no explanation, however, for the subsequent jump in level and follow-up “super recovery.”

R-25 Response

The 22-h pumping test response observed in R-25 screens 5, 6, 7 and 8 (Figures C-8.3-4 through C-8.3-76 showed drawdown values of 0.25, 0.44, 0.12 and 0.06 ft, respectively. A detailed partial penetration analysis of the time-drawdown and recovery data from these screen zones was beyond the scope of the R-63 pumping test analysis. However, such an analysis should be performed to quantify the transmissivity, storage coefficient and vertical anisotropy ratio of the sediments between R-63 and R-25.

Although a detailed analysis of the R-25 data was not performed, preliminary calculations suggested a contradiction in the measured drawdown values if flat-lying sediments were assumed between the two wells. This was because of the similarity in the drawdown values measured in screens 5 and 6 (0.25 and 0.44 ft). Under the assumption of horizontal bedding planes, the elevations of screen 6 and the R-63 screen showed that they overlap slightly (i.e., lie in the same strata). Calculations using the Hantush equation showed that the screen 6 drawdown should have been substantially greater than that in screen 5 if screen 6 were located in the R-63 pumped horizon. A better match to the observed drawdown data was achieved if screen 6 was assumed to lie outside the zone screened by R-63. This implied the sediments likely dip at some angle from horizontal in this area. Thus, any solution using the R-25 drawdown and recovery data will need to include not only T, S and A as unknowns but dip angle as well.

Packer Deflation

Following 25 h of recovery, the packer was deflated to prepare for pulling the pump. Figure C-8.3-7 shows water level changes observed in R-63 when the packer was deflated. The enormous spike in water level was caused by trapped water above the packer that had flowed into the annulus through the leaky o-ring seals in the crossover assembly on top of the packer. Once the packer deflated, this trapped water moved downward into the well screen causing the observed head buildup seen on the graph. The remaining presence of this large quantity of water above the packer at the conclusion of the test seemed to preclude the possibility that annular leakage had caused the anomalous “super recovery” observed following the 22-h test.

C-8.4 Well R-63 Specific Capacity Data

Specific capacity data were used along with well geometry to estimate a lower-bound hydraulic conductivity value for the permeable zone penetrated by R-63. This was done to provide a frame of reference for evaluating the foregoing analyses.

At the end of the 22-h pumping test, the discharge rate was 12.0 gpm with a resulting drawdown of 26.8 ft for a specific capacity of 0.45 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included a storage coefficient value of 5×10^{-4}, a borehole radius of 0.57 ft (inferred from the volume of filter pack required to backfill the screen zone), a screen length of 20.3 ft, and an assigned saturated thickness of 40.6 ft (arbitrarily double the screen length).

Applying the Brons and Marting method to these inputs yielded a lower-bound hydraulic conductivity value of 25 gpd/ft^2, or 3.3 ft/d. The average hydraulic conductivity value from the foregoing pumping test analyses was 27.4 gpd/ft^2 (3.7 ft/d) for the early data and, for the late data, 43.1 gpd/ft^2 (5.8 ft/d) or possibly less, depending on the height of the cone of depression at that time The lower-bound value was consistent with either of these interpretations.

C-9.0 SUMMARY

Constant-rate pumping tests were conducted on R-63 to gain an understanding of the hydraulic characteristics of the screened zone and check for interference effects among the nearby vadose zone and saturated zone wells.

A comparison of barometric pressure and R-63 water level data shows a highly barometrically efficient screened zone and a slight downward water level trend over time.

Incorporating an inflatable packer in the pumping string was questionable in its effectiveness in eliminating storage effects. The data suggest the possibility of a minor storage-like effect, perhaps related to air left over from the drilling process that may have been trapped in the formation.

Several water level anomalies were observed during the tests at R-63 suggesting the possibility of a malfunctioning transducer and/or interference associated with trapped air in the formation. Among the oddities observed during the tests were (1) the transducer appeared to provide a head measurement error of more than 5 ft when first installed; (2) after each of several pumping events (filling the drop pipe, trial testing and the 22-h test), the post-pumping equilibrated water level measurement (head over the transducer) was substantially different with no explanation for the changes; (3) unusual, unexplained transient declines in pumping rate that occurred shortly after trial 1 and the 22-h test started; and (4) the recovery data following the 22-h test showed a bizarre response to levels substantially above predicted/theoretical levels.

There are two possible interpretations of aquifer properties from the R-63 tests. Early data from the tests suggest a possible average hydraulic conductivity of the screened interval of 27.4 gpd/ft^2, or 3.7 ft/d. It is not clear whether this result is valid or perhaps storage-affected. Slightly later data support a hydraulic conductivity estimate of 43.1 gpd/ft^2, or 5.8 ft/d for the screened interval. It was possible the cone of depression expanded sufficiently to a height in excess of the screen length, making the actual average hydraulic conductivity somewhat lower than these values. It appears the hydraulic conductivity is likely bracketed in the range of 3.7 to 5.8 ft/d.

R-63 produced 12.0 gpm for 1320 min with 26.8 ft of drawdown for a specific capacity of 0.45 gpm/ft. The lower-bound hydraulic conductivity computed from this information is 25 gpd/ft^2 or 3.3 ft/d, consistent with the pumping tests values. The result suggests a moderately efficient to efficient screen zone.

The data from the 22-h test show no changes in the slope of the time-drawdown graph over time. This suggests tight aquitards are located above and below the screened zone, consistent with the overall severe vertical anisotropy observed in the subsurface sediments in this part of the laboratory.

Intermediate zone and regional screened zones in the vicinity of R-63 were monitored during the pumping tests. The only zones that showed a response to pumping were the four regional aquifer screens in R-25: screen 5 (−0.25 ft), screen 6 (−0.44 ft), screen 7 (−0.12 ft) and screen 8 (−0.06 ft). Hantush analysis of the these data should be performed and would be useful for determining the transmissivity, storage coefficient and vertical anisotropy ratio of the saturated zone sediments between R-63 and R-25..

C-10.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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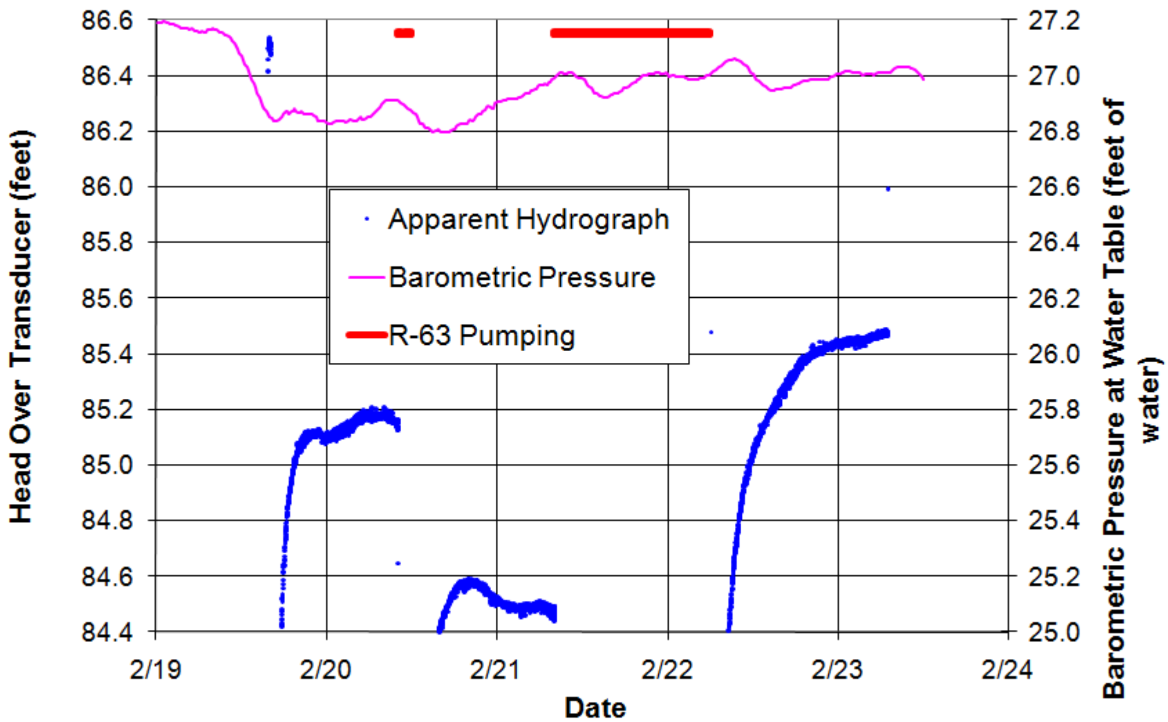


Figure C-7.0-1 Well R-63 apparent hydrograph

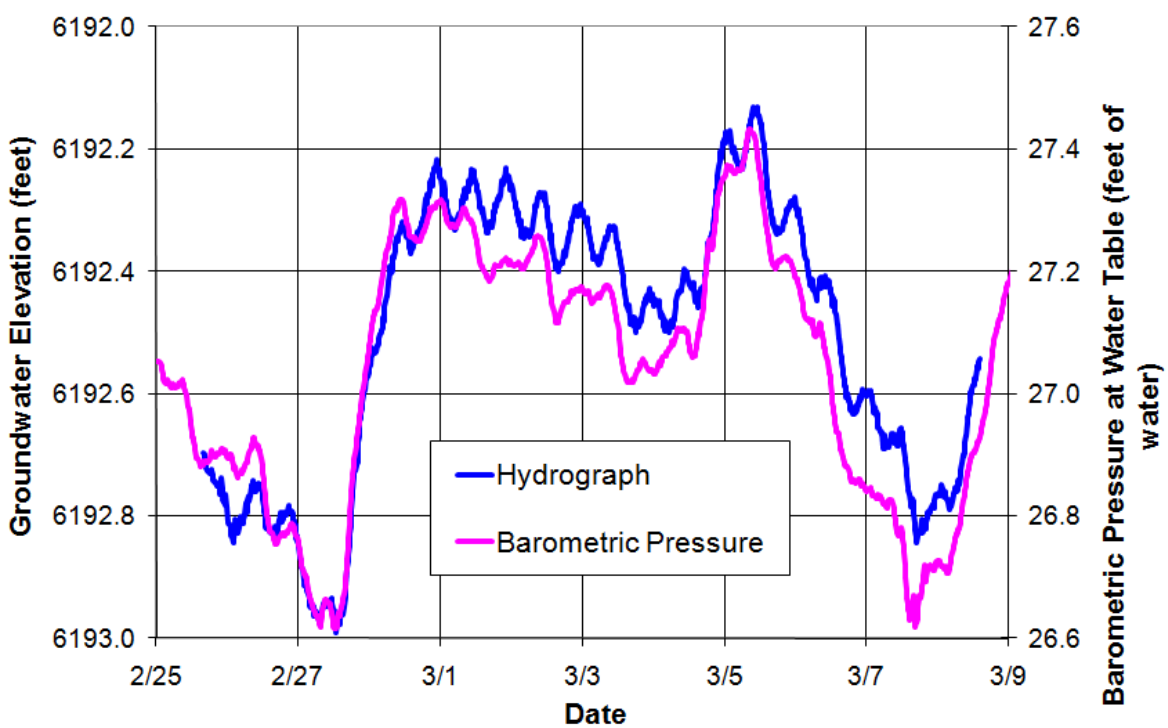


Figure C-7.0-2 Well R-63 supplementary hydrograph

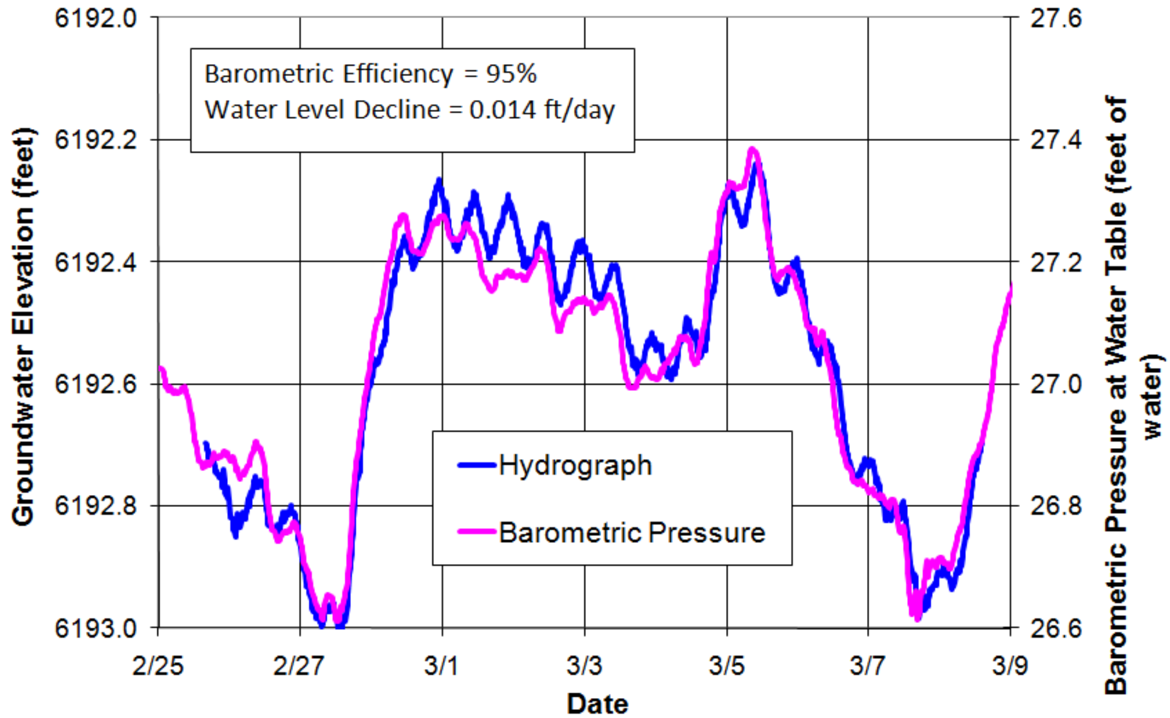


Figure C-7.0-3 Well R-63 modified supplementary hydrograph

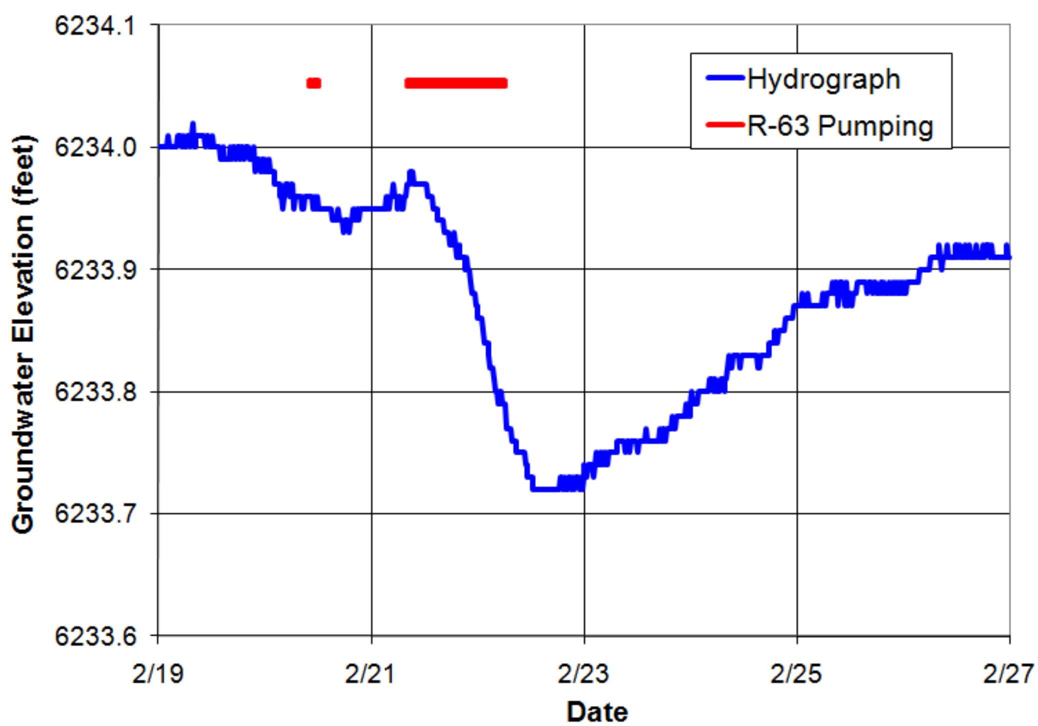


Figure C-7.0-4 Well R-25 screen 5 hydrograph

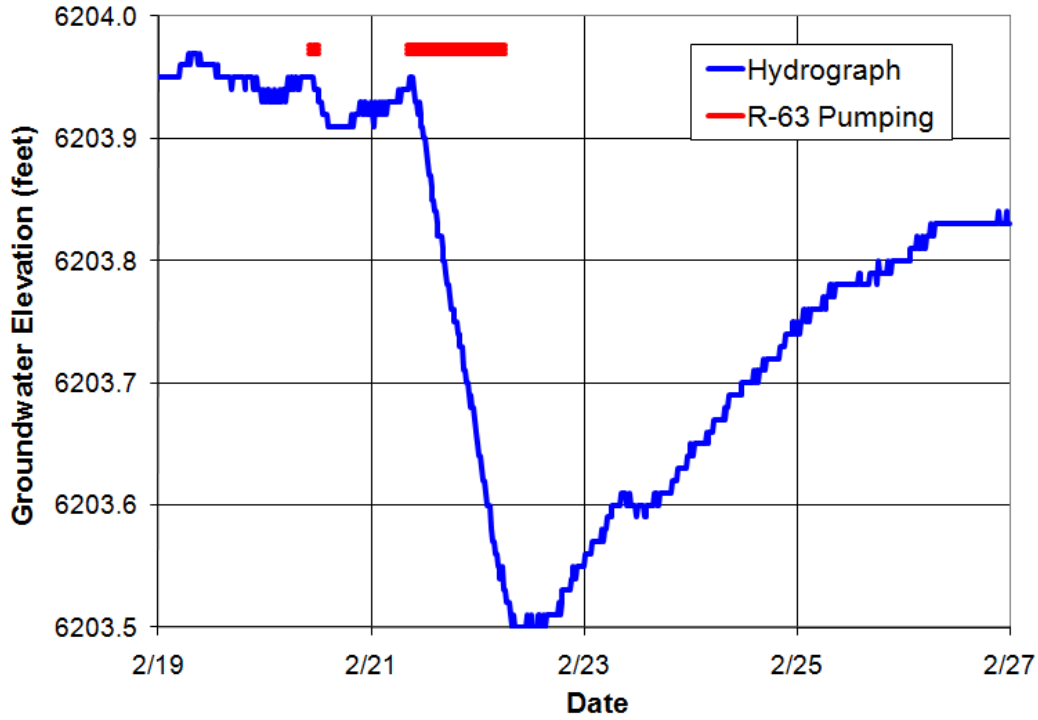


Figure C-7.0-5 Well R-25 screen 6 hydrograph

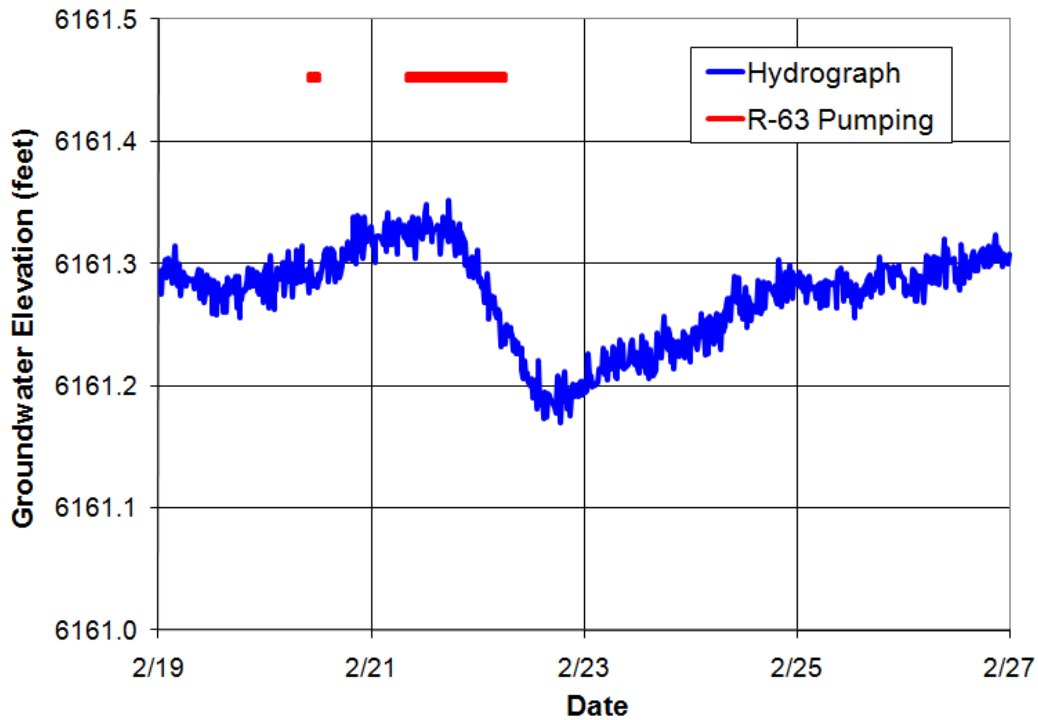


Figure C-7.0-6 Well R-25 screen 7 hydrograph

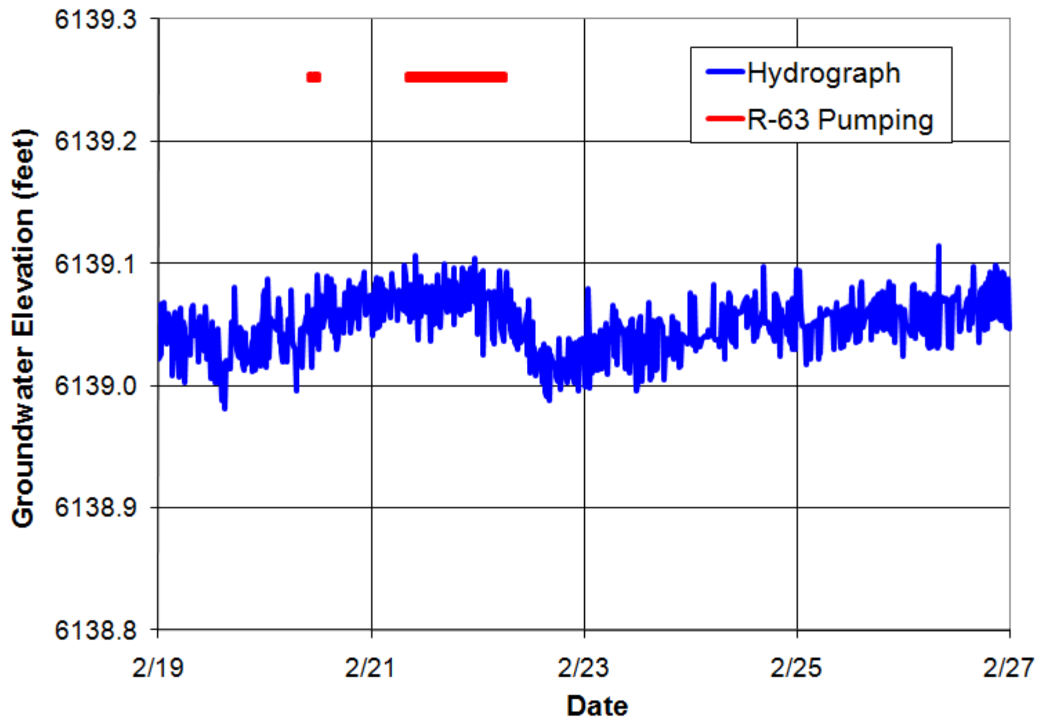


Figure C-7.0-7 Well R-25 screen 8 hydrograph

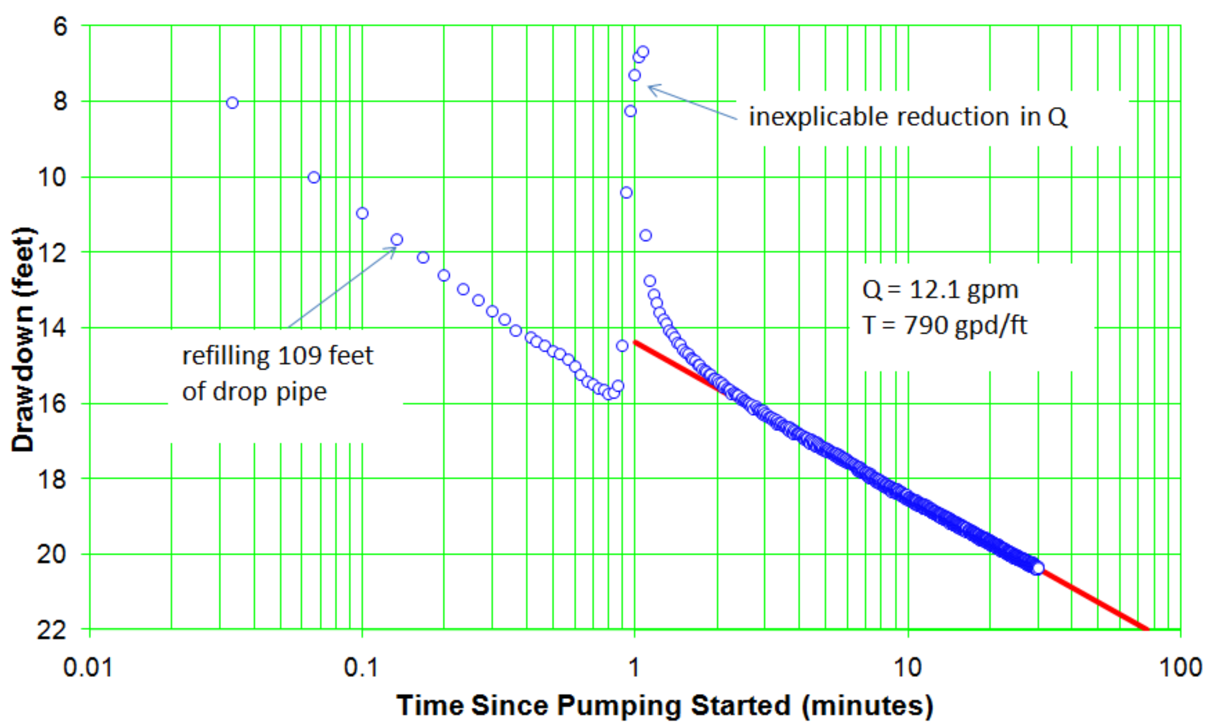


Figure C-8.1-1 Well R-63 trial 1 drawdown

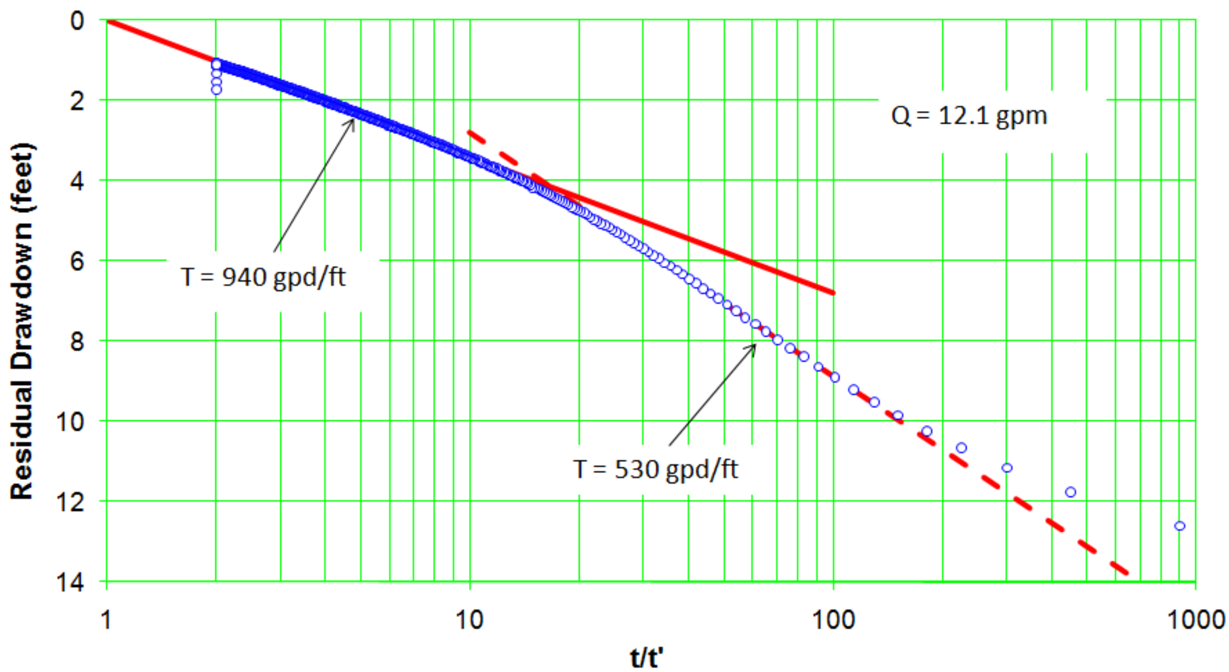


Figure C-8.1-2 Well R-63 trial 1 recovery

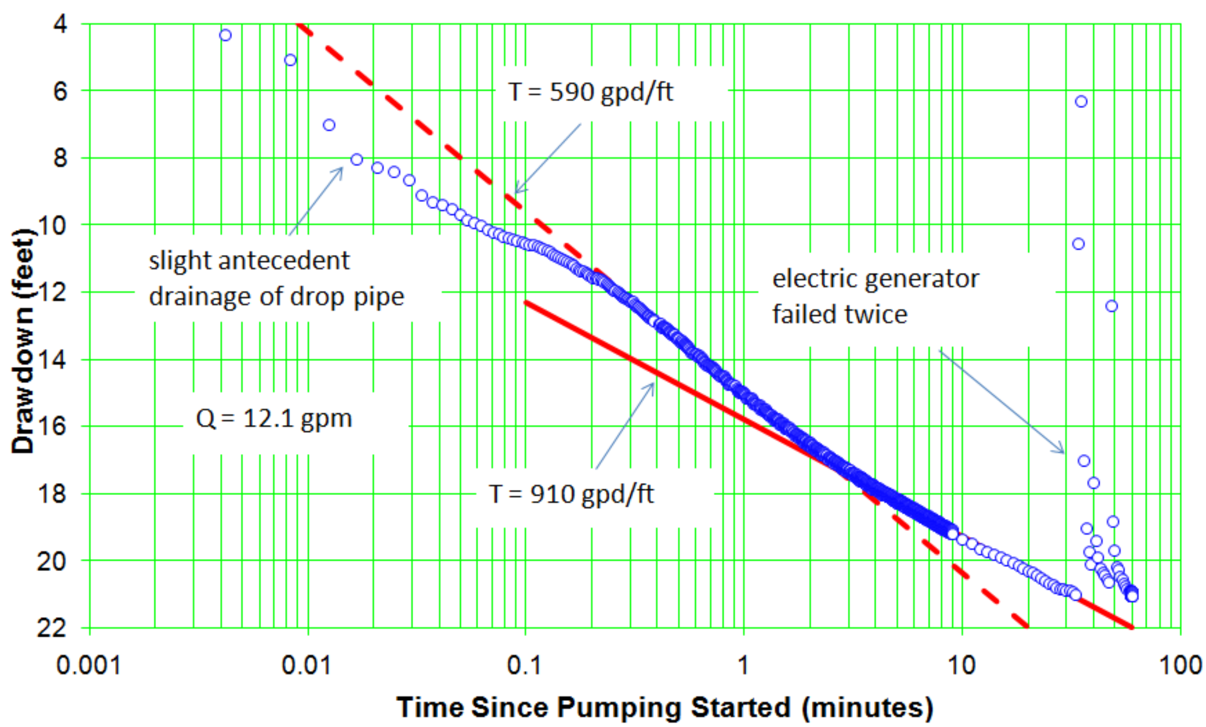


Figure C-8.2-1 Well R-63 trial 2 drawdown

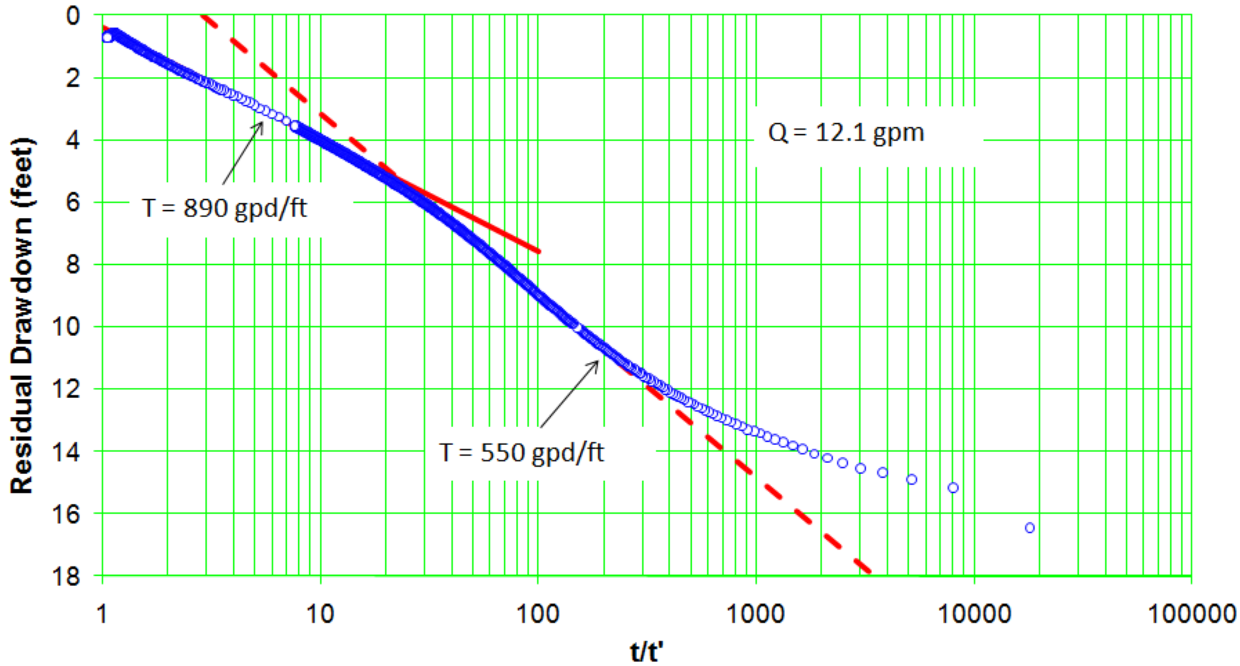


Figure C-8.2-2 Well R-63 trial 2 recovery

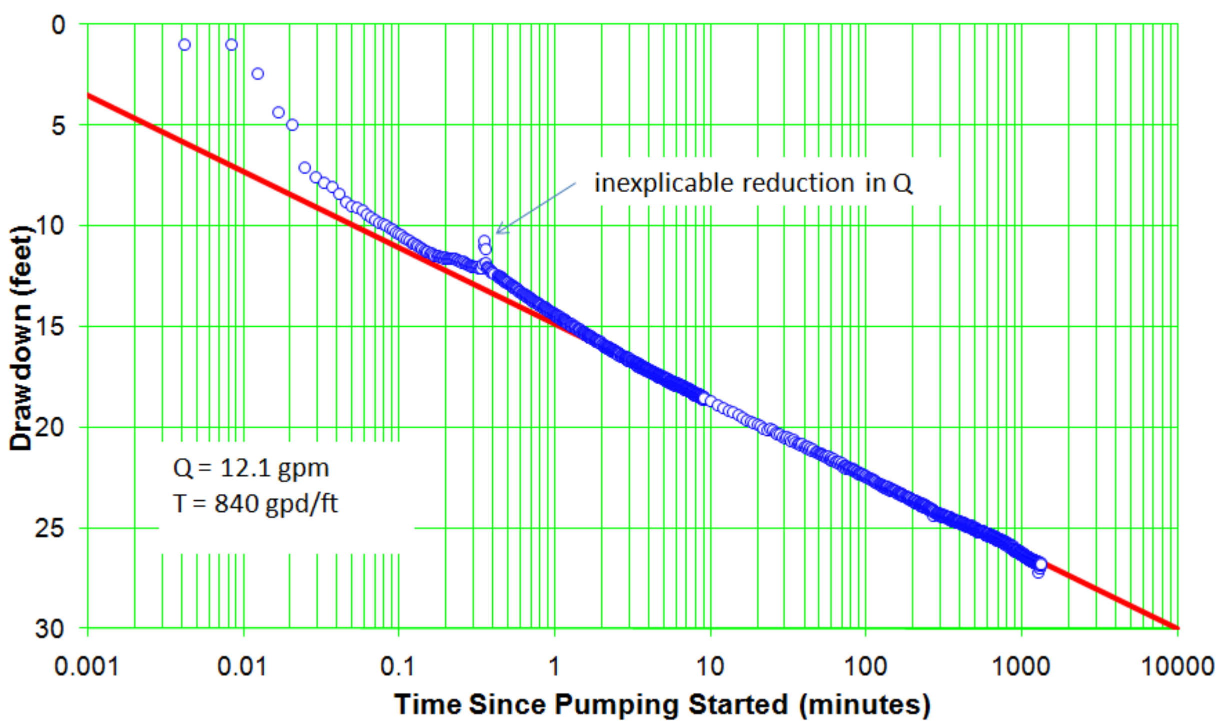


Figure C-8.3-1 Well R-63 drawdown

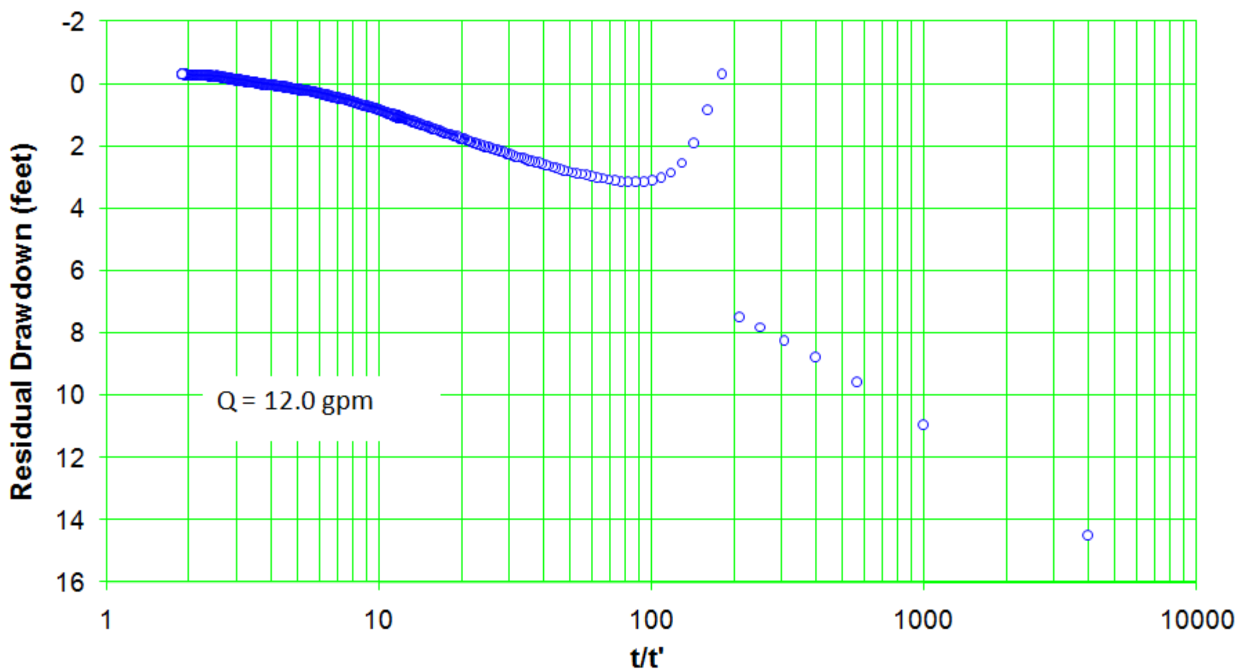


Figure C-8.3-2 Well R-63 recovery

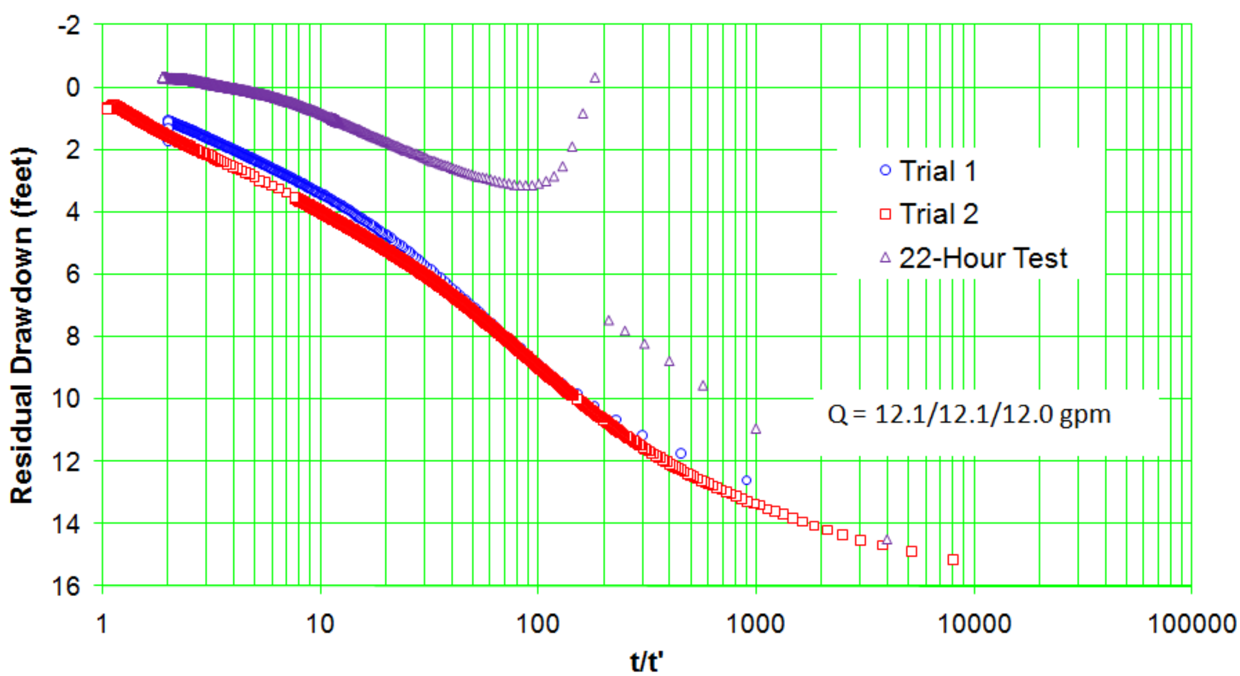


Figure C-8.3-3 Well R-63 multiple recovery plots

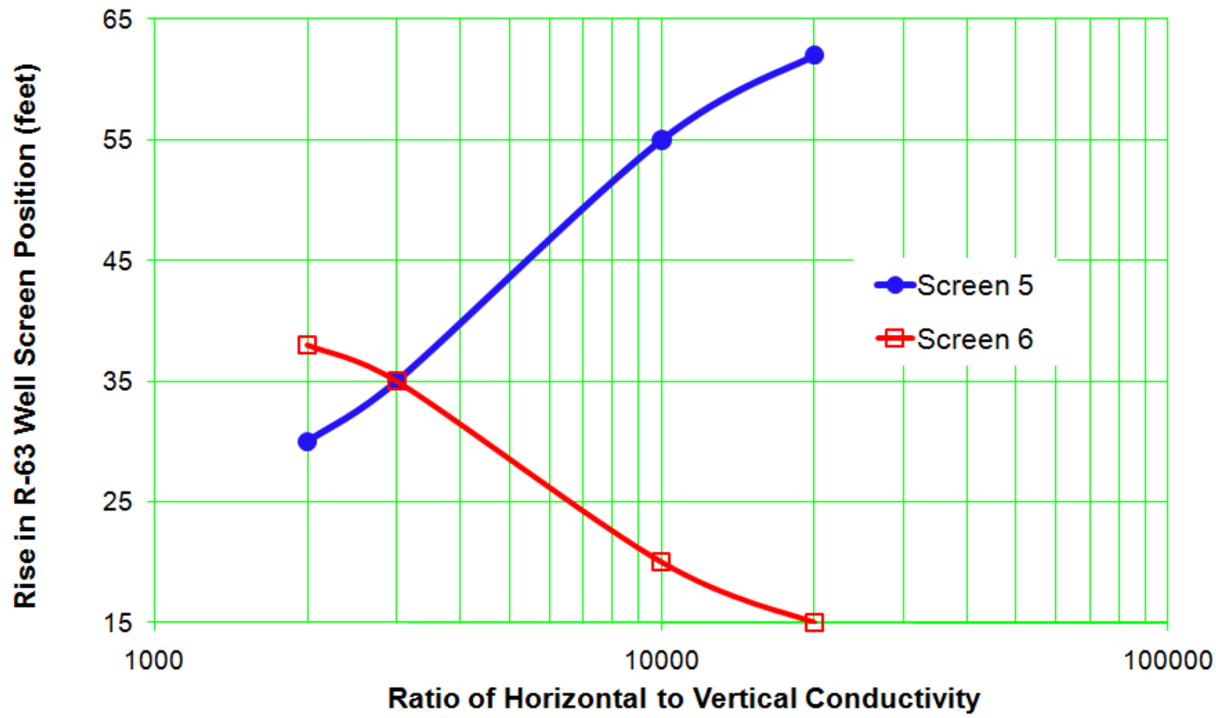


Figure C-8.3-4 Well R-63 screen movement required to reproduce R-25 screens 5 and 6 drawdown

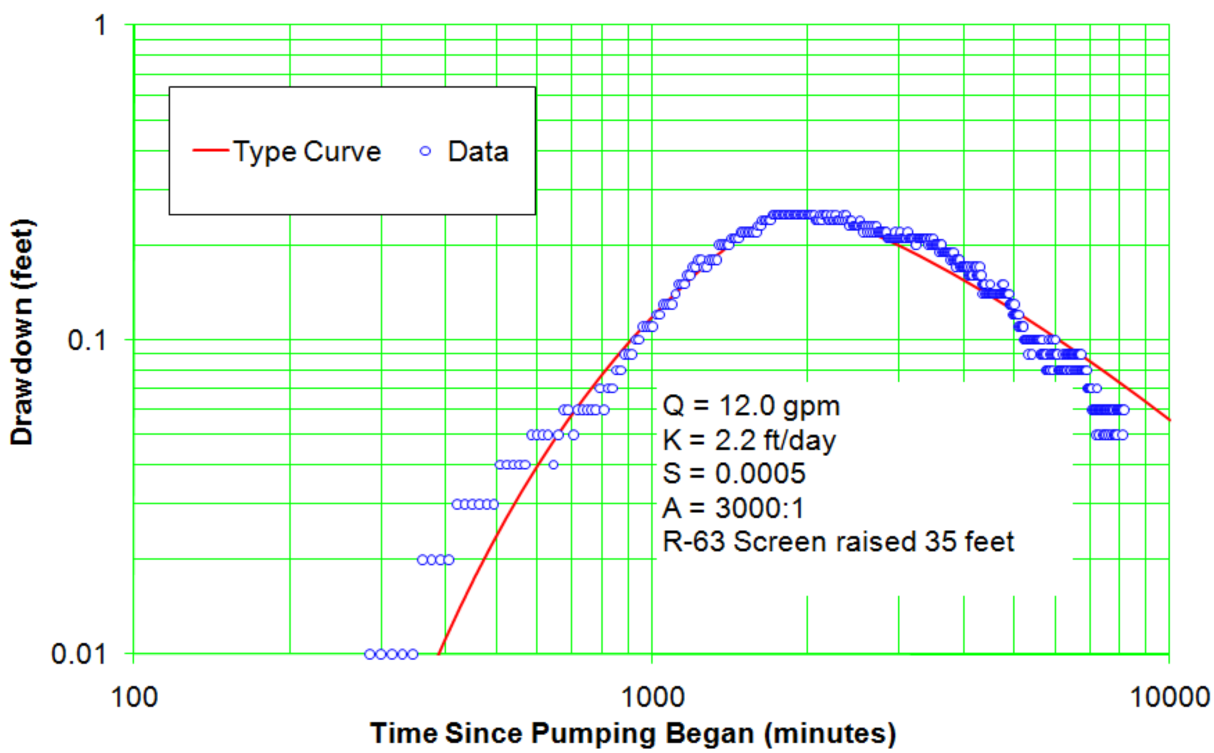


Figure C-8.3-5 Drawdown and recovery analysis of well R-25 screen 5

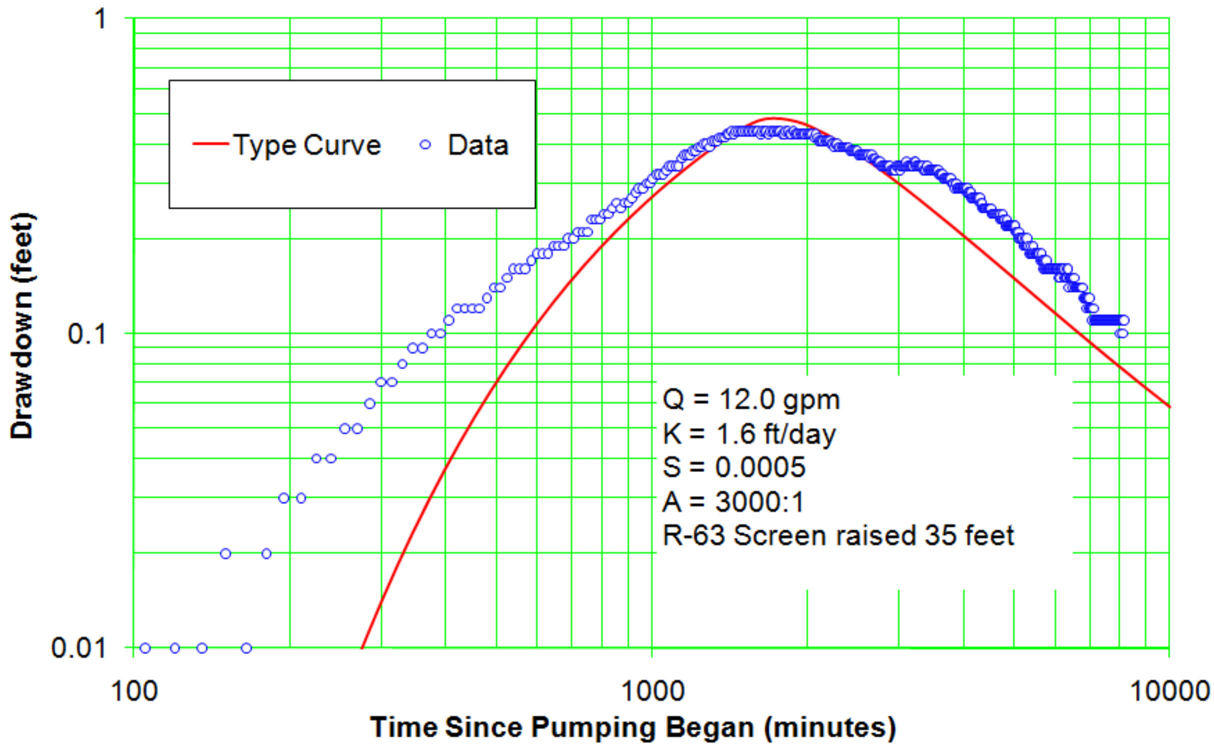


Figure C-8.3-6 Drawdown and recovery analysis of well R-25 screen 6

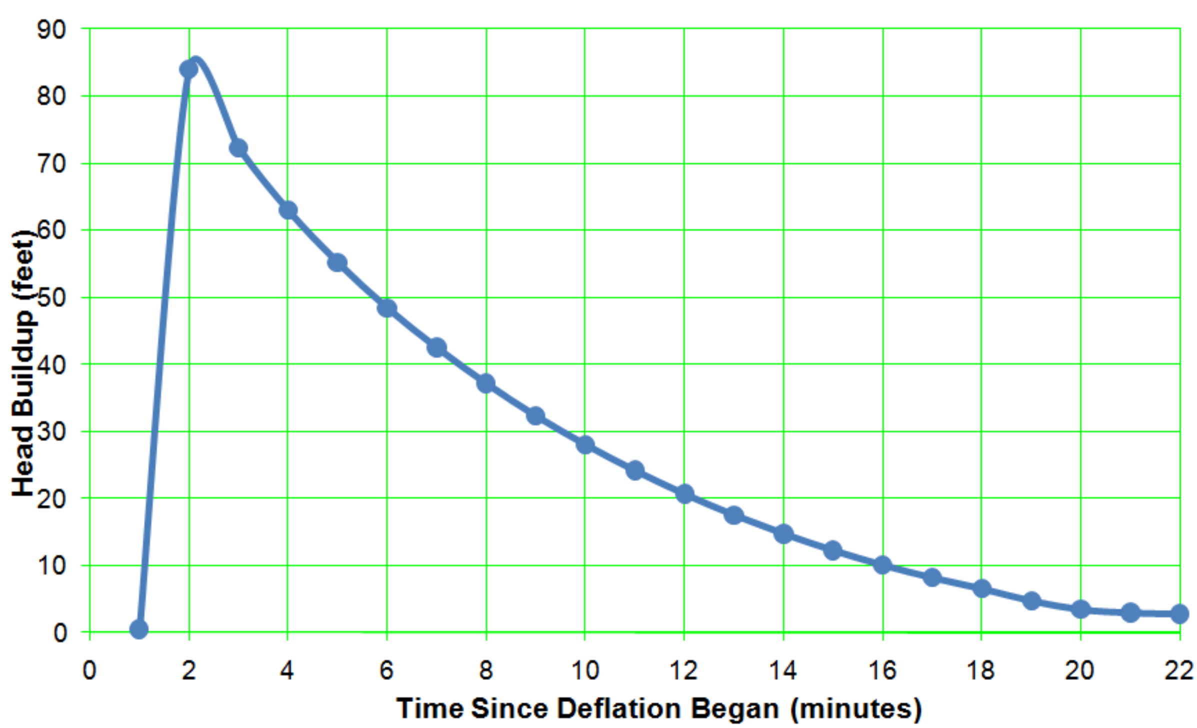


Figure C-8.3-7 Well R-63 packer deflation response

Appendix D

Borehole Video Logging
(on DVD included with this document)

Appendix E

Geophysical Logs and Schlumberger
Geophysical Logging Report
(on CD included with this document)

Appendix F

R-63 Final Well Design and
New Mexico Environment Department Approval

Note: The information in the final well design package was developed at the completion of borehole drilling and before development of the final lithologic log. The preliminary information in the well design summary may differ slightly from the final lithologic interpretations or data presented in the well completion report.

R-63 Well Objectives

Regional aquifer well R-63 is being installed to satisfy a requirement by the New Mexico Environment Department (NMED) to replace well screen 5 (in the regional aquifer) for well R-25. The primary purpose of R-63 is to provide groundwater monitoring near the top of the regional aquifer down gradient of Consolidated Unit 16-021(c)-99 (the TA-16-260 outfall) and beneath infiltration pathways associated with Cañon de Valle and perched groundwater systems in the area. The R-63 site is about 380 ft northwest of well CdV-16-2ir and about 1430 ft east-northeast of R-25 (Figure 1). Well R-63 is located near Cañon de Valle and water levels in the regional aquifer may be affected by the aquifer recharge occurring (1) along the eastern flanks of the Jemez Mountains and (2) along Cañon de Valle which is a relatively wet canyon. Because the regional aquifer is made up of well-stratified sediments, hydraulic properties are expected to be highly anisotropic, favoring lateral flow within strata, but with a substantial vertical component of hydraulic gradient (on the order of 0.3 ft/ft in this area). Water table maps indicate that groundwater flow is generally towards the east-southeast. The R-63 well objectives are best met by installing a single-screen well in the uppermost part of the regional aquifer.

R-63 Recommended Well Design

It is recommended that R-63 be installed as a single-screen well with a 20-ft stainless-steel, 20 slot, wire-wrapped well screen extending from 1325 ft to 1345 ft bgs. The primary filter pack will consist of 10/20 sand extending 5 ft above and 5 ft below the screen openings. A 2-ft secondary filter pack will be placed above the primary filter pack. The proposed well design is shown in Figure 2.

This well design is based on the objectives stated above and on the information summarized below.

R-63 Well Design Considerations

At total depth (TD), the R-63 borehole was cased from 0–1145 ft with open hole from 1145–1423 ft. Preliminary lithological logs indicate that the geologic contacts are, in descending stratigraphic order: ash-flow tuffs of the Tshirege and Otowi Members of the Bandelier Tuff with intercalated sedimentary deposits of the Cerro Toledo interval (0–796 ft) and boulders, cobbles, gravels, sands, and silts of the Puye Formation (796–1423 ft TD). The Puye Formation is the primary target for the well screen. Formation microimager and borehole video logs indicate that the Puye Formation is a coarse fanglomerate made up of boulder and cobble deposits that are stacked in beds 1 to 5 ft thick. Boulders and cobbles occur in clast-supported beds separated by sandy gravels and relatively rare thin silt beds.

Characterization activities included the collection of cuttings at 5 ft intervals, LANL gamma and induction logs from 0 to 850 ft, an open borehole video log from 58 ft to 804 ft, an open borehole video log from 1145 ft (bottom of casing) to 1423 ft, Schlumberger cased borehole (0 to 1145 ft) and open borehole (1145 to 1423 ft) logs, and water-level measurements. The Schlumberger logs are being submitted separately as electronic files.

An upper-perched groundwater zone was encountered near the top of the Puye Formation with a depth-to-water of about 804 ft bgs corresponding approximately to the zone in screen 2 in R-25 and screen 1 in CdV-16-4ip (based on stratigraphic position). This upper-perched groundwater was sealed out of the borehole by landing 12.75-in drill casing at 1145 ft bgs. The open-borehole video log from 1145 to 1423 ft TD showed water was not draining from the bottom of the casing string, indicating the upper-perched zone was isolated from the borehole. Additionally, the borehole video showed that a probable lower zone of perched groundwater (as opposed to introduced drilling water) was flowing into the borehole below about 1200 ft, with lesser amounts of flowing water occurring as high as 1170 ft (possibly corresponding to the zone in screen 4 in R-25 based on screen elevations). Water levels in the borehole were consistently measured at 1263 ft bgs over a period several days; these measurements were taken while water cascaded into the borehole from above and likely represent a composite water level representative of averaged hydraulic pressures within the water-filled section of the well (1263-1423 ft bgs). The top of the regional zone of saturation was predicted to occur between depths of about 1305 to 1322 ft based on water table maps of the area that included information from R-25, screen 5. Thus, the measured water level of 1263 ft is about 42 to 59 ft higher than predicted.

Schlumberger Water Services acquired geophysical logs both for the cased borehole (0 to 1145 ft) and the open borehole intervals (1145 to 1423 ft). Because of the proximity of R-63 to Canon de Valle, there is uncertainty about the nature of the groundwater encountered below a depth of 1200 ft and whether it is contiguous with or isolated from the regional flow system. Preliminary interpretations of the geophysical logs by Schlumberger indicate high pore water content (25 to 40%) below the borehole standing water level (1263 ft bgs), with the highest moveable water content below 1305 ft bgs. Water content measured from the porosity logs drops to less than 15% of total volume at 1270 to 1275 ft (the formation microimager shows boulders here), as well as in the section above the standing water level (it should be noted that the porosity logs only measure about 7 in. beyond the borehole wall and the lower water content above standing water may reflect drainage near the borehole wall). There is also very little moveable water measured by the magnetic resonance log above the standing water level. The induction resistivity log does not show a distinct increase in bulk resistivity that is commonly associated with the top of the water table, although the 90 in. depth of investigation resistivity does show an increase at 1305 ft and more evident high resistivity values, indicative of low pore water content, at the top of the log (1175-1190 ft and 1195-1202 ft). The spontaneous potential (SP) log also shows a systematic increase below 1305 ft that is possibly indicative of a change in pore water saturation.

Driller's observations of water production during drilling suggest that regional saturation may not be contiguous with the lower perched system. Drilling was halted briefly at 100 ft intervals (depths of 1072, 1172, and 1272 ft) as attempts were made to air-lift groundwater to determine if significant water was present in the lower vadose zone. Groundwater could not be air-lifted from the borehole at these depth intervals indicating that groundwater yield was absent or minimal. When drilling was halted at 1322 ft bgs for an hour, abundant water was produced when the air compressors were turned back on, suggesting the borehole had penetrated at least 20 to 30 ft into saturation. The borehole produced abundant groundwater from 1322 to 1423 ft TD.

Based on geophysical logs and drillers' observations of water production, the top of continuous and extensive saturation is believed to occur at a depth of approximately 1305 ft. The well screen targets the 1325–1345 ft interval because the Puye Formation in this interval appears to have good characteristics for water production. The proposed well design incorporates a 20-ft well screen. A 10-ft well screen was evaluated as a means to monitor a more discrete zone of groundwater near the top of saturation. However, the longer 20-ft screen was chosen because there are substantial uncertainties about the depth of regional saturation, the formation contains large boulders that may decrease the effective porosity of the screen interval, and the longer screen provides greater assurance that the well screen will be adequately submerged for development and periodic sampling.

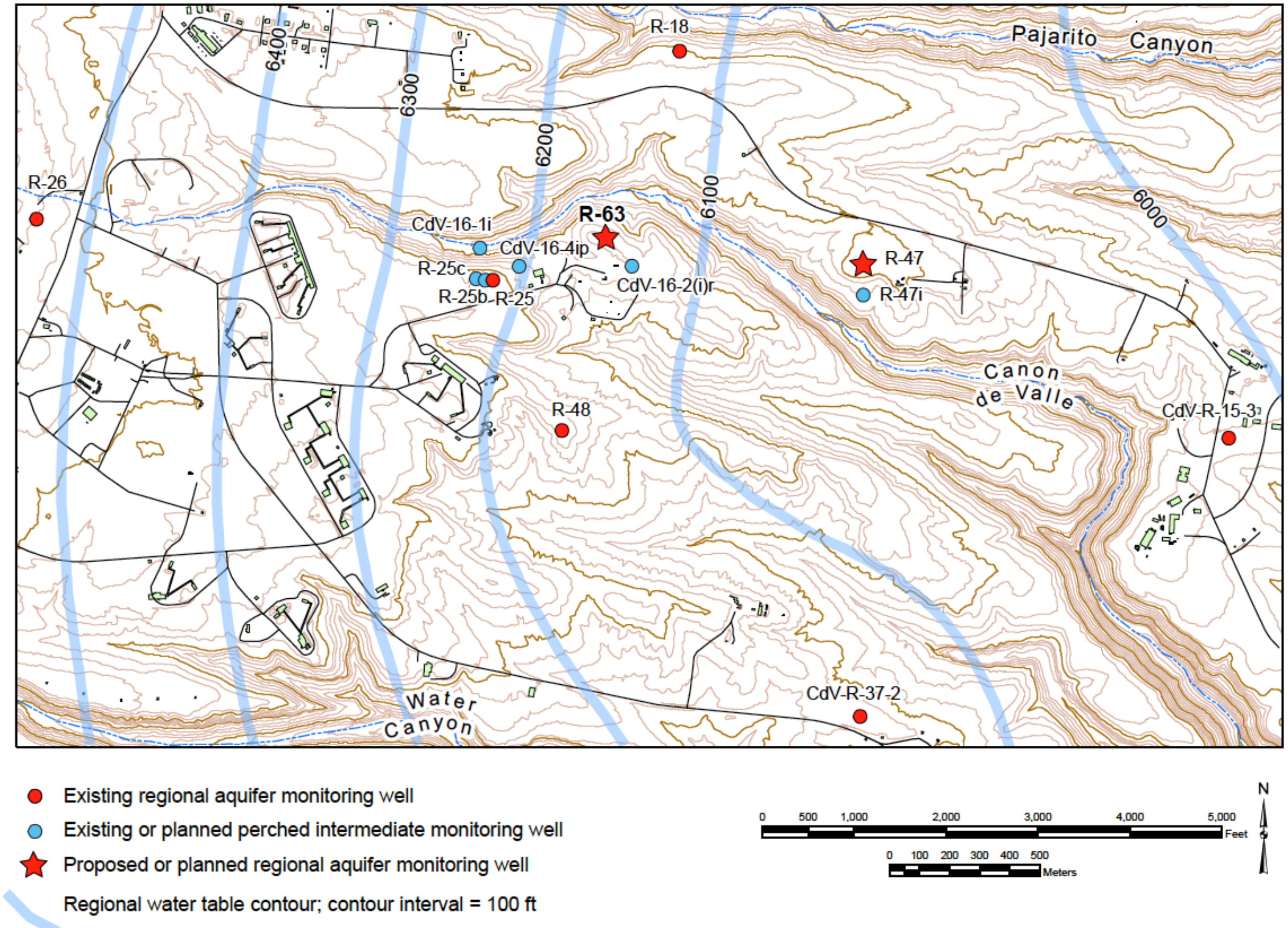


Figure 1 Map of well R-63 location

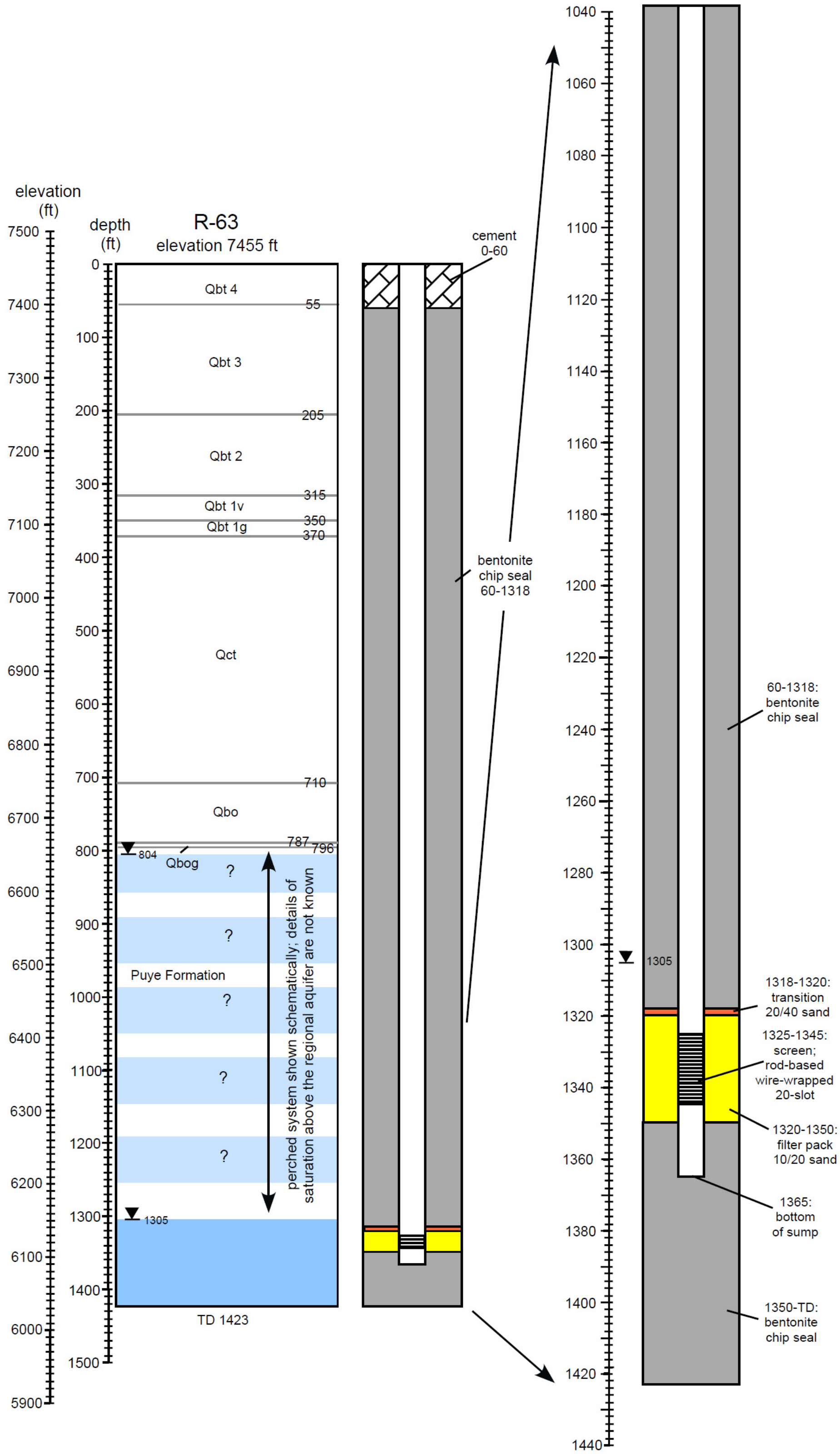


Figure 2 Proposed well design for R-63

From: "Dale, Michael, NMENV" <Michael.Dale@state.nm.us>
To: "Everett, Mark C" <meverett@lanl.gov>
Date: Wed, 26 Jan 2011 13:21:06 -0700
Subject: RE: R-63 OFFICIAL well design submittal
Mark,

This e-mail serves as NMED approval for the installation of regional aquifer well R-63 as proposed in the document attached to the original e-mail received by NMED today (January 26, 2011 at10:44 PM). This approval is based on the information available to NMED at the time of the approval. Due to the uncertainty in determining the top of saturation for the regional aquifer, LANL shall make a valid attempt at collecting a water sample at the water table and perform an in-situ temperature log from the top of water or water table to total depth. Once the temperature log is completed, LANL shall provide results to NMED. LANL shall analyze the temperature-log data with the intent on delineating the top of saturation for the regional aquifer and provide findings to NMED as soon as possible.

NMED understands that LANL will provide the results of preliminary sampling, any modifications to the well design proposed in the above-mentioned e-mail, and any additional information related to the installation of well R-63 as soon as such information becomes available. In addition, LANL shall notify NMED within three days of water-quality sampling at the conclusion of the aquifer-testing period at R-63. During the aquifer-testing period, LANL shall monitor water levels at all nearby intermediate and regional aquifer wells with the objective of collecting hydraulic properties data. LANL shall give notice of this installation to the New Mexico Office of the State Engineer as soon as possible. Thank you.

Michael Dale, NMED HWB

Hazardous Waste Bureau
New Mexico Environment Department
2905, Rodeo Park Drive East, Building 1
Santa Fe, NM 87505
Phone (505) 476-6052 / Fax (505) 476-6030
Main HWB Phone (505) 476-6000
Los Alamos Phone (505) 661-2673 / Cell 660-1679

From: "Everett, Mark C" <meverett@lanl.gov>
To: "Dale, Michael, NMENV" <Michael.Dale@state.nm.us>, "Jerzy Kulis (jerzy.kulis@state.nm.us)" <jerzy.kulis@state.nm.us>, "Dave Cobrain (dave.cobrain@state.nm.us)" <dave.cobrain@state.nm.us>
Date: Wed, 26 Jan 2011 10:44:43 -0700
Subject: R-63 OFFICIAL well design submittal

Michael,

As discussed at our meeting this morning, here is LANL's proposed well design for R-63. Please respond with your concurrence or give me a call so that we can discuss it further.

Thanks,

Mark Everett

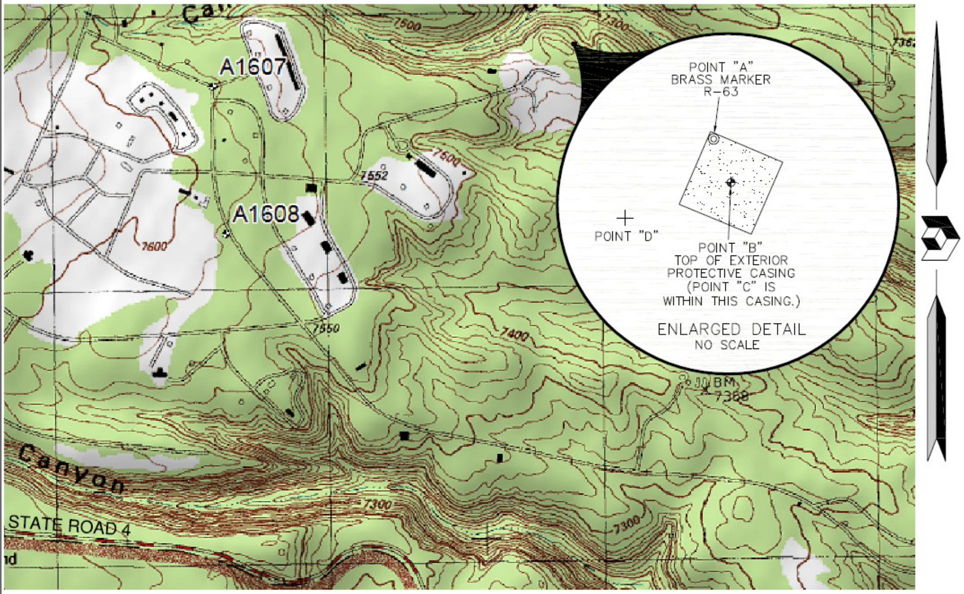
ADEP ET-EI

(505) 667-5931

Appendix G

Geodetic Survey

LANL MONITORING WELL LOCATION REPORT
DESIGNATED R-63
WITHIN TECHNICAL AREA 16
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS COUNTY, NEW MEXICO
APRIL, 2011



POINT	DESCRIPTION	EASTING (X)	NORTHING (Y)	ELEVATION
A	BRASS MARKER R-63	1616550.69	1764532.51	7454.57
B	TOP OF 16" PROTECTIVE CASING	1616552.88	1764526.98	7457.77
C	TOP OF 6" WELL	1616553.10	1764526.98	7456.61
D	GROUND	1616539.45	1764522.49	7454.37

Notes

1.) FIELD SURVEY COMPLETED ON APRIL 13, 2011.

2.) THIS AREA LIES WITHIN LOS ALAMOS NATIONAL LABORATORY PROPERTY IN TECHNICAL AREA 16, LOS ALAMOS COUNTY, NEW MEXICO.

3.) HORIZONTAL COORDINATES CALCULATED USING TOPCON HIPER+ RECEIVER AND ARE BASED UPON GPS LOCALIZATION DERIVED FROM LANL LAB WIDE CONTROL NETWORK MONUMENTS A0001, A0002, A0003, A0006, A0009, A0306, A1607, A1608, B0001, B0002, B0004, B3303, PAJ10, PAJ16, NMSR4 15 AND NMSR4 25. LANL LAB WIDE CONTROL NETWORK HORIZONTAL DATUM: NAD 1983.

4.) VERTICAL COORDINATES ARE BASED UPON GPS LOCALIZATION DERIVED FROM LANL LAB WIDE CONTROL NETWORK MONUMENTS A0003, A0006, A0306, A0602, A1607, A1608, B0001, B0004, B3303, BC1709, NMSR4-2, PAJ10, AND PAJ16. VERTICAL DATUM: NGVD 1929.

5.) HORIZONTAL COORDINATES ARE STATE PLANE GRID COORDINATES, NEW MEXICO CENTRAL ZONE, NAD 83.

AUTHORITY:
THIS MONITORING WELL LOCATION REPORT WAS PREPARED FROM A SURVEY DONE UNDER MY SUPERVISION ON THE 13TH DAY OF APRIL, 2011 AND FROM INSTRUCTION PROVIDED TO US BY NORTH WIND, INC.

LW Medrano

LARRY W. MEDRANO, N.M.P.L.S. NO. 11993   *DATE* 04/25/2011

LARRY W. MEDRANO
NEW MEXICO
11993
REGISTERED PROFESSIONAL SURVEYOR

PRECISION SURVEYS, INC. 1460 TRINITY DRIVE, SUITE 3 LOS ALAMOS, N.M. 87544 **PHONE** (505) 661-4262 **FAX** (505) 661-4263