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Completion Report for Regional Aquifer Well R-3

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EXECUTIVE SUMMARY

This well completion report describes the drilling, installation, development, aquifer testing, and dedicated sampling system installation of regional groundwater-monitoring well R-3. R-3 is located in Pueblo Canyon, within Los Alamos National Laboratory Technical Area 74 (TA-74). This report was written in accordance with the requirements in section IV.A.3.e.iv of the Compliance Order on Consent.

Well R-3 was installed at the direction of the New Mexico Environment Department (NMED) to provide a monitoring well in the regional aquifer near municipal production well Otowi 1, determine water levels in the regional aquifer in this area, and characterize potential contaminant flow paths.

The R-3 borehole was successfully completed to a total depth of 1077.7 ft below ground surface (bgs) using standard air-rotary, fluid-assisted rotary, and dual-rotary methods. Fluids used during drilling included potable water, foam, and approved drilling mud additives.

Geologic formations encountered during drilling were alluvium, an upper section of the Puye Formation, Cerros del Rio volcanic rocks, a lower section of the Puye Formation, an upper section of the Santa Fe Group, Miocene volcanic rocks, and a lower section of the Santa Fe Group. Regional groundwater was encountered in the lower section of the Santa Fe Group and measured at 643.6 ft bgs before well construction.

The R-3 monitoring well was completed with a 20.5-ft-long single screen from 974.5 to 995.0 ft bgs, designed to evaluate water quality and measure water levels in the regional aquifer within the Santa Fe Group. The water level after well completion was measured at 652.9 ft bgs. The well was completed in accordance with the NMED-approved well design. Well development and aquifer testing indicate that the well will perform effectively to meet the planned objectives. A dedicated sampling system and water-level transducer were installed and groundwater sampling will be performed as part of the facility-wide groundwater-monitoring program.

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Acronyms and Abbreviations

amsl	above mean sea level
APS	accelerator porosity sonde
ASTM	American Society for Testing and Materials
bgs	below ground surface
Consent Order	Compliance Order on Consent
DTW	depth to water
DO	dissolved oxygen
ECS	elemental capture spectroscopy
EES-14	Earth and Environmental Sciences Group 14
Eh	oxidation-reduction potential
EP	Environmental Programs
EPA	Environmental Protection Agency (U.S.)
gpm	gallons per minute

HE	high explosives
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HNGS	hostile natural gamma spectroscopy
I.D.	inside diameter
LANL	Los Alamos National Laboratory
LH3	low-level tritium
µS/cm	microsiemens per centimeter
mV	millivolt
NAD	North American Datum
NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
NTU	nephelometric turbidity unit
O-1	Otowi 1
O.D.	outside diameter
ORP	oxidation-reduction potential
PETN	pentaerythritol tetranitrate
PFD	phosphate-free dispersant
pH	potential of hydrogen
PVC	polyvinyl chloride
Qal	alluvium
QP	quality procedure
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RPF	Records Processing Facility
SOP	standard operating procedure
TA	technical area
TATB	triaminotrinitrobenzene
Tb 4	Cerros del Rio volcanic rocks
TD	total depth
TL	triple lithodensity
TOC	total organic carbon
Tpf	Puye Formation
Tsf	Santa Fe Group
VOC	volatile organic compound
WCSF	waste characterization strategy form

1.0 INTRODUCTION

This completion report summarizes site preparation, borehole drilling, well construction, well development, aquifer testing, and dedicated sampling system installation for regional groundwater-monitoring well R-3. The report is written in accordance with the requirements in section IV.A.3.e.iv of the Compliance Order on Consent (Consent Order). The R-3 monitoring well was drilled and installed between April 30 and June 21, 2010, at Los Alamos National Laboratory (LANL or the Laboratory) for the Environmental Programs (EP) Directorate.

The R-3 project site is located in Pueblo Canyon, near the eastern boundary of the Laboratory's Technical Area 74 (TA-74) (Figure 1.0-1). Well R-3 was drilled at the direction of the New Mexico Environment Department (NMED) to provide a regional aquifer monitoring well within potential contamination flow paths in the regional aquifer near municipal production well Otowi 1 (O-1). Other hydrogeologic and geochemical objectives were to clarify the depth to the regional aquifer in the vicinity of O-1 and TW-1 as well as to characterize potential contaminant flow paths and concentrations.

The R-3 borehole was drilled to a total depth (TD) of 1077.7 ft below ground surface (bgs). A monitoring well was then installed with one 20.5-ft screen between 974.5 and 995.0 ft bgs. The depth to water (DTW) before well installation was measured at 643.6 ft bgs on May 29, 2010, and 652.9 ft bgs after well installation on June 3, 2010. During drilling, cuttings samples were collected at 5-ft intervals in the borehole from ground surface to TD.

Postinstallation activities included well development, aquifer testing, surface completion, geodetic surveying, and dedicated sampling system installation. 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 completed to date that are associated with the R-3 well drilling and installation.

2.0 PRELIMINARY ACTIVITIES

Preliminary activities included preparing administrative planning documents and preparing the drill site and drill pad. All preparatory activities were completed in accordance with Laboratory policies and procedures and regulatory requirements.

2.1 Administrative Preparation

The following documents helped guide the implementation of the scope of work for well R-3:

- "Drilling Work Plan for Los Alamos and Pueblo Canyons Groundwater Monitoring Wells," (LANL 2008, 103015),
- "Well R-3 Drilling Plan, Installation of Well R-3, TA-74, Los Alamos National Laboratory," (North Wind Inc. 2010, 109457),
- "Waste Characterization Strategy Form, Regional Well R-3 in Pueblo Canyon," (LANL 2010, 108851),
- "Integrated Work Document for Regional and Intermediate Aquifer Well Drilling"(LANL 2007, 100972), and

- "Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan" (LANL 2007, 096981).

2.2 Site Preparation

Drill pad construction was performed by Laboratory personnel between April 19 and 21, 2010, before the rig was mobilized. Mobilization activities included moving the dual-rotary drill rig, air compressors, trailers, and support vehicles to the drill site, and staging alternative drilling tools and construction materials at the Pajarito Road laydown yard.

3.0 DRILLING ACTIVITIES

This section describes the drilling strategy and approach and provides a chronological summary of field activities conducted at well R-3.

3.1 Drilling Approach

The R-3 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. Other drilling equipment included tricone bits, downhole hammer bits, and 5.5-in. dual-wall drill pipe. Auxiliary equipment included three Ingersoll Rand 1070 ft^3/min trailer-mounted air compressors and two Sullair 1150 ft^3/min trailer-mounted air compressors. Temporary protective casing sizes used in drilling activities included 24-in., 18-in., 16-in., and 12-in. The dual-rotary technique used filtered compressed air and fluid-assisted air to evacuate cuttings from the borehole. In addition, the casing sizes selected ensured that the required 2-in. minimum annular thickness of the filter pack around a 5.6-in. outside diameter (O.D.) well, as required by the Consent Order (section X.C.3), would be met.

Drilling additives were used, as needed, between ground surface and 769.3 ft bgs. These fluids were used to cool the bit, lift cuttings from the borehole, and stabilize the borehole. Potable water, approved Baroid AQF-2 foaming agent, and mud additives were used with NMED approval. Potable water was also used during borehole cleaning and during well construction. Total amounts and types of drilling fluids and additives introduced into the borehole are presented in Table 3.1-1.

3.2 Chronological Drilling Activities

Equipment was decontaminated before mobilization to the site. Following inspections on April 21, notice to proceed was received from LANL. Drilling began on April 22 at 0345 h.

During the initial drilling attempt at R-3, a pilot hole was drilled to a depth of 600 ft bgs between April 22 and 28, 2010. On April 28, while over-reaming the pilot hole, the 22-in. hammer bit, collars, and barrel stabilizer became stuck at 114 ft bgs. From April 28 to 30, several unsuccessful attempts were made to free the tool string and it was decided to drill another borehole for R-3. On April 30, the drill crew secured the initial R-3 borehole and moved the drill rig off the location; the hammer bit, collars, and barrel stabilizer were recovered on June 23. Plugging and abandonment of the initial R-3 borehole was completed on July 16, 2010, in accordance with the Laboratory's Standard Operating Procedure (SOP) EP-ERSS-5034, New Mexico Office of the State Engineer (NMOSE) Rules and Regulations 19.27.4.31 (K), and an NMOSE-approved plugging plan (Appendix H). A concrete surface pad, 3-ft long x 3-ft wide x 0.5-ft thick, with a brass monument marker, was later installed over the abandoned hole.

The drill rig was repositioned 12 ft to the north of the initial R-3 borehole and drilling began on the final, successful R-3 borehole April 30 at 2228 h. Between April 30 and May 1, a 22-in. tricone bit and 24-in. steel casing were advanced using dual-rotary techniques to 53.3 ft bgs at the top of the Cerros del Rio volcanic rocks, a temporary 18-in. casing was landed at 50.5 ft bgs, and a 17.5-in. open borehole was advanced from 53.3 to 143.0 ft bgs. On May 2, the 18-in. casing was retracted and the borehole was over-reamed with a 22-in. tricone bit from 53.3 to 146 ft bgs.

The borehole was advanced from 146 to 155.4 ft bgs with a 17.5-in. hammer bit and stabilizer on May 4 when drilling activities were temporarily paused due to borehole instability in an interflow breccia zone within the Cerros del Rio volcanic rocks. The borehole was grouted from 155.4 to 91.4 ft bgs. The grout was drilled out with a 22-in. tricone bit on May 5. From May 6 to 7, a 22-in. borehole was advanced to 419.8 ft bgs through Cerros del Rio volcanic rocks and into the lower section of the Puye Formation. Drilling was paused at this time to clean the hole and collect groundwater samples at 300 ft bgs and 350 ft bgs.

Between May 7 and 9, the 22-in. borehole was advanced from 419.8 to 620 ft bgs. Poorly consolidated clay- and silt-rich sediments of the Santa Fe Group were encountered at approximately 530 ft bgs. Drilling was stopped to install 18-in. welded casing. Between May 9 and 11, the casing was installed to 627 ft bgs. Drilling then continued through the clay-rich strata with a 17.5-in. tricone bit to 744 ft bgs. Drilling was stopped to measure water levels and monitor recharge. The DTW was tagged on four occasions within 1 h on May 13 at 516.9 ft bgs, and later in the day at 633.1 ft bgs.

Between May 14 and 17, 12-in. inside diameter (I.D.) casing was installed to approximately 648 ft bgs, when it was immediately retracted due to borehole instability and suspected swelling clays. On May 15, while the 12-in. casing was at approximately 637 ft bgs, the DTW was tagged at 466.2 ft bgs. After seeking and obtaining NMED approval to use mud additives to stabilize the borehole, air-mud rotary drilling was used to ream the borehole only over the interval from 635 to 744 ft bgs on May 18. On May 18 and 19, 16-in. casing could not be installed past 686.3 ft bgs due to formation instability and sloughing below that depth. At this point, the dual-rotary casing advance method was used to advance the 16-in. casing into competent formation at 764.3 ft bgs, where it was landed on May 20.

On May 21, at the request of NMED, neutralizing agents were added to groundwater in the 5-ft interval of open hole between the bottom of the casing at 764.3 ft bgs and the bit at 769.3 ft bgs. The neutralizing agents were 1 gal. of AquaClear Phosphate-Free Dispersant (PFD) and 9 gal. of bleach mixed with 450 gal. of water. They were added in an attempt to neutralize any remaining mud polymer residues that had been used to a depth of 744 ft bgs. Two samples of borehole fluids were collected on May 20 and 21 from 769 ft bgs, before and after the borehole was treated, to evaluate the neutralization technique. The borehole was blown out for 4.5 h before collecting the second sample.

The use of mud additives was discontinued at 744 ft bgs, and AQF-2 drilling fluid was not used below 769.3 ft bgs. Neutralizers were only used in the interval between 764.3 and 769.3 ft bgs.

After installing 12-in. drive casing to 739 ft bgs, a regional aquifer groundwater level reading of 648.2 ft bgs was measured, with a borehole depth of 764.3 ft bgs. Between May 21 and 26, an 11.88-in. hammer bit and an 11.63-in. tricone bit were used to advance the borehole and 12-in. casing to the TD of 1077.7 ft bgs, reached on May 26 at 1945 h. Schlumberger performed cased-hole geophysical logging on May 27 and 28. On May 29, the 12-in.casing was cut at 1024 ft bgs, leaving 53.6 ft of casing in the bottom of the hole. The bottom of the borehole was then tagged at 1022.5 ft bgs, indicating 55.2 ft of slough had accumulated. The DTW was 643.6 ft bgs on May 29 before well installation.

During drilling, 24-h operations were conducted, consisting of two 12-h shifts, 7 d per wk. While drilling R-3, borehole instability was encountered in Cerros del Rio volcanic rocks at 155.4 ft bgs. Field geologists noted that sloughing and swelling of formational material during drilling occurred predominantly within the Santa Fe Group, particularly in clay-rich zones at approximately 600 ft bgs, 648 ft bgs, 686.3 ft bgs, and 848.9 ft bgs. Delays occurred while attempting to free the downhole tools that became stuck in the initial R-3 borehole and while repositioning the drill rig to the final R-3 location.

4.0 SAMPLING ACTIVITIES

This section describes the cuttings and groundwater sampling activities for monitoring well R-3. Sampling activities were conducted in accordance with applicable Laboratory quality procedures (QPs).

4.1 Cuttings Sampling

Cuttings samples were collected at 5-ft intervals from the initial R-3 borehole from ground surface to 600 ft bgs, and from the final R-3 borehole from 600 ft bgs to the TD of 1077.7 ft bgs.

At each interval, approximately 500 mL of bulk cuttings were collected by the site geologist from a discharge cyclone, placed in resealable plastic bags, labeled, and archived in core boxes. Sieved fractions (>#10 and >#35 mesh) were also collected from ground surface to TD and placed in chip trays along with unsieved (whole rock) cuttings. Samples were recovered over 87% of the borehole. No samples were recovered between 625 and 770 ft bgs. Radiation control technicians screened cuttings before 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.

R-3 stratigraphy is summarized in section 5.1 and detailed lithology is provided in Appendix A.

4.2 Water Sampling

Two intermediate perched water samples were collected during borehole drilling of the initial R-3 borehole. The first sample was collected on April 25 from perched water between 350 and 363 ft bgs. The second sample was collected on April 26 at a depth of 441 ft bgs. Two additional perched water samples were collected while drilling the final R-3 borehole on May 7 at depths of 300 and 350 ft bgs. All samples were collected by air lifting. Perched zone screening samples were analyzed for metals, cations, anions (including perchlorate), high explosives (HE), volatile organic compounds (VOCs), and low-level tritium (LH3).

A regional aquifer groundwater sample was not collected when it was first encountered at 744 ft bgs during drilling, as directed by Laboratory personnel. However, two regional aquifer samples were collected on May 20 and 21, each from a depth of 769 ft bgs. The samples were collected before and after treating regional groundwater from 764.3 to 769.3 ft bgs with drilling mud neutralizing agents. These two samples were analyzed for total organic carbon (TOC), metals, and anions, including perchlorate.

Fourteen groundwater samples were collected during well development from the development pump’s discharge line. The samples were analyzed for TOC, metals, and anions, with the exception of the first two samples that were analyzed only for TOC.

Table 4.2-1 shows a summary of screening samples collected from the initial and final boreholes at R-3. Groundwater chemistry and field water-quality parameters are discussed in Appendix B.

Further groundwater characterization sampling will be conducted from the completed well in accordance with the Consent Order. For the first year, the samples will be analyzed for the full suite of constituents to include radioactive elements, anions/cations, general inorganic chemicals, volatile and semivolatile organic compounds; and stable isotopes of hydrogen, nitrogen, and oxygen. The analytical results will be included in the appropriate periodic monitoring report issued by the Laboratory. After the first year, the analytical suite and sample frequency at R-3 will be evaluated and presented in the annual "Interim Facility-Wide Groundwater Monitoring Plan."

5.0 GEOLOGY AND HYDROGEOLOGY

A brief description of the geologic and hydrogeologic features encountered at R-3 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 observed in the R-3 borehole is based on lithologic descriptions of cuttings samples collected from the discharge cyclone and borehole geophysical logs and described below in order of youngest to oldest geologic units. Figure 5.1-1 illustrates the stratigraphy penetrated at R-3. A detailed lithologic log based on binocular microscope examination and analysis of drill cuttings is presented in Appendix A.

Alluvium, Qal (0–30 ft bgs)

Alluvial sediments occur at R-3 from ground surface to 30 ft bgs and consist of silty sand, gravel, and minor clay (including volcanic rocks, tuff, and vitric pumices) and rock fragments. The rock fragments are angular to subangular, poorly to strongly weathered, and grayish orange pink to light brown. The upper 5 ft is heavily bioturbated and some well pad construction gravels are noted in the top 5 to 10 ft of the interval.

Puye Formation, Tpf (30–53 ft bgs)

An upper section of the Puye Formation occurs from 30 to 53 ft bgs and consists of poorly to moderately sorted volcaniclastic clayey silt, silt, silty sand, and sandy gravel deposits. Gravels are angular and subangular to subrounded with some moderately rounded clasts and consist of felsic to intermediate-composition volcanic rock fragments, volcaniclastic siltstones and sandstones, minor pumice clasts, and quartz and sanidine crystals. The formation ranges from light gray to light brownish gray in color.

Cerros del Rio Volcanic Rocks, Tb 4 (53–246 ft bgs)

The Cerros del Rio volcanic rocks occur from 53 to 246 ft bgs and consist of multiple lava flows ranging from vesicular to massive basalt, scoria, and interflow breccias (basaltic gravels). Volcanic clasts consist of light to medium gray and medium to dark gray, aphanitic, fine-grained phaneritic and porphyritic phaneritic basalt, and local amygdaloidal basalt. Clasts are nonvesicular to strongly vesicular and contain coarse, anhedral phenocrysts of plagioclase and olivine. Also included are minor pumice fragments, quartz and sanidine crystals, and minor clay to silty clay.

Puye Formation, Tpf (246–440 ft bgs)

The lower section of the Puye Formation occurs from 246 to 440 ft bgs, and consists of medium gray to medium dark gray poorly to moderately sorted volcaniclastic silty clay, silt, silty sand, and sandy gravel deposits. Gravels are angular to rounded and consist of volcaniclastic siltstone and sandstone, felsic to intermediate-composition volcanic fragments, minor basalt, and quartz and sanidine crystals.

Santa Fe Group, Tsf (440–460 ft bgs)

An upper section of the Miocene Santa Fe Group occurs from 440 to 460 ft bgs and consists of poorly to moderately sorted very pale orange to medium dark gray volcaniclastic sediments including silt, sand, silty sand, and sandy gravels. Gravels and sands are subangular to subrounded and consist of felsic to intermediate volcanic clasts, minor basalts and scoria, volcanic siltstones and sandstones, and mudstones.

Miocene Volcanic Rocks (460–530 ft bgs)

Miocene volcanic rocks occur from 460 to 530 ft bgs and consist of medium dark gray, predominantly highly fractured and rubbleized basalt. The nonvesicular to weakly vesicular basalt is moderately to highly weathered and phaneritic, containing abundant plagioclase and olivine phenocrysts and pyroxene showing alteration around rims. Minor mud and claystone, siltstone, and volcanic siltstone are also present.

Santa Fe Group, Tsf (530–1077.7 ft bgs)

A lower section of the Miocene Santa Fe Group occurs from 530 to 1077.7 ft bgs, borehole TD, and consists of interlayered poorly to moderately sorted volcaniclastic sediments including clay, silt, sand, silty sand, and silty sandy gravels with interspersed clayey zones that range from grayish orange and pale brown to medium and dark gray in color. Gravels and sands are subangular to subrounded and rounded and consist of mixed igneous clasts (e.g., felsic to intermediate volcanic clasts, granitic clasts), minor basalts and scoria, chert, quartzite, volcanic siltstones and sandstones, mudstones, and quartz and sanidine crystals. Minor calcite cementation is present. The Santa Fe Group is moderately to strongly weathered.

5.2 Groundwater

Three perched intermediate groundwater zones were observed in the initial R-3 borehole and two intermediate zone were observed in the final R-3 borehole. Regional groundwater was reached only in the final R-3 borehole. This section describes the groundwater occurrences.

During drilling of the final R-3 borehole, one additional perched zone was sampled on May 7 at approximately 300 ft bgs in the lower section of the Puye Formation. A second perched water samples was collected at 350 ft bgs to compare to the groundwater chemistry of the same zone in the initial R-3 borehole.

A second perched zone was identified in the initial borehole during drilling on April 25 at approximately 363 ft bgs in the lower section of the Puye Formation. The borehole was cleaned by air lifting for 1 h and afterwards a water level of 162 ft bgs was measured. The flow rate was estimated to be less than 1 gallons per minute (gpm) and a groundwater sample was collected. The borehole was grouted from 363 to 321.8 ft bgs to seal off the zone.

A third perched zone in the initial borehole was identified on April 26 during drilling at approximately 441 ft bgs at the top of the upper section of the Santa Fe Group. The hole was cleaned by air lifting for 20 min. The zone was estimated to be making less than 0.5 gpm and a perched zone groundwater sample was collected. Drilling resumed without grouting as directed by Laboratory personnel.

During drilling of the final R-3 borehole, no attempt was made to identify or resample the shallow intermediate perched zones encountered in the initial R-3 borehole. One additional perched zone was identified and sampled on May 7 at approximately 300 ft bgs in the lower section of the Puye Formation. The hole was cleaned by air lifting for approximately 40 min and two perched water samples were collected at 300 and 350 ft bgs.

On May 13, regional groundwater was first detected at 744 ft bgs in the lower section of the Santa Fe Group. Borehole advancement was temporarily suspended, the hole was cleaned by air lifting for approximately 30 min, and the water level was monitored. Three water level measurements of approximately 633.2 ft bgs were measured on May 13. A sample was not collected per direction from Laboratory personnel.

On May 26, at the borehole TD of 1077.7 ft bgs, an accurate water-level measurement was unattainable due to sloughing and heaving of sands into the bottom of the 12-in. casing. Regional groundwater was measured at 643.6 ft bgs on May 29, 2010, after reaching TD and cutting off the casing shoe.

Groundwater screening samples collected during drilling and well development are discussed in section 4.2. Groundwater chemistry and field water-quality parameters are discussed in Appendix B. Aquifer testing data and analysis are discussed in Appendix C.

6.0 BOREHOLE LOGGING

The following sections describe the video and geophysical logging conducted at R-3. A summary of all logging is provided in Table 6.0-1.

6.1 Video Logging

LANL personnel ran a video log of the initial R-3 borehole on April 27 in the open borehole from 53.3 to 600 ft bgs. Details of this log are provided in Table 6.0-1. Video logs are provided on DVD as Appendix D with this report.

6.2 Geophysical Logging

LANL personnel ran natural gamma and array induction logs in the initial R-3 borehole on April 27 from ground surface to 600 ft bgs. Additionally, a suite of Schlumberger geophysical logs was run inside the temporary 12-in.-I.D. casing at R-3 from ground surface to 1028.0 ft bgs on May 27 and 28. These geophysical logs included accelerator porosity sonde (APS), triple lithodensity (TL), elemental capture spectroscopy (ECS), hostile natural gamma spectroscopy (HNGS), and gamma logs. Interpretation and details of the logging are presented in the Geophysical Logging Report and accompanying CD included in Appendix E.

7.0 WELL INSTALLATION

The R-3 well was installed between May 29 and June 21, 2010. The following sections provide the well design and a summary of well construction activities.

7.1 Well Design

The R-3 well was designed in general accordance with the drilling work plan (LANL 2010, 103015), a final well design developed after TD was reached, and an approved modification to the final well design. The final well design, the modified design, and NMED approval are included in Appendix F. The well was designed with a single-screened interval between 974.5 ft and 995.0 ft bgs to monitor the regional aquifer groundwater quality and water level in the Santa Fe Group.

7.2 Well Construction

The R-3 monitoring well was constructed of 5.0-in.-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 two 10-ft lengths 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 the screen were provided by the Laboratory and were steam pressure washed on-site 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 May 27 to 28 while the borehole water level was being monitored and preparation for geophysical logging was under way. The NMED-approved final well design was received on May 29, 2010.

On May 29 at 2140 h, the drilling crew began installing 5-in. 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 May 30, with the bottom of the well tagged at 1006.8 ft bgs. Slough was tagged at 1022.5 ft bgs in the bottom of the borehole. The 53.6 ft section of 12-in. casing that remained downhole after the casing shoe was cut is within the slough from 1077.6 to 1024.0 ft bgs.

The top of the 20.5-ft-long screen was set at 974.5 ft bgs. An 11.8-ft stainless-steel sump was placed below the bottom of the screen. Four stainless-steel centralizers were welded to the well casing approximately 0.5 ft above and 1.1 ft below the well 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. The borehole was backfilled with 0.375-in. bentonite chips (15.9 ft^3) from 1022.5 to 1003.6 ft bgs. A 10/20 silica sand filter pack (46.2 ft^3) was placed from 1003.6 to 967.8 ft bgs, surrounding the screened interval of the well, and exceeded the calculated amount (34.3 ft^3) by 32%. During placement of the filter pack, the screened interval was swabbed and the borehole surged to promote proper setting and compaction. A 20/40 silica sand transition collar (31.6 ft^3) was then installed on top of the filter pack from 967.8 to 961.6 ft bgs. The volume of 20/40 silica sand used exceeded the calculated amount (3.9 ft^3) by 710%. These differences are most likely due to fine silts, sands, and gravels within the lower Santa Fe Group washing out across the borehole wall.

A bentonite seal consisting of 1968.2 ft^3 of 0.375-in. bentonite chips was installed above the sand collar from 961.6 to 73.5 ft bgs. The surface seal of Type I Portland cement was installed from 73.5 to 3.0 ft bgs on June 21 with a volume of 160.7 ft^3. The well was completed per NMED criteria on June 21 at 1232 h.

On July 15, the outside of the 24-in. surface casing was over-reamed with a 34-in. wash-over from 0 to 20.4 ft bgs, and the annulus was filled from 20.4 to 3.0 ft bgs with Portland cement.

8.0 POSTINSTALLATION ACTIVITIES

Following well installation at R-3, well development and aquifer testing were performed. The wellhead and surface pad were constructed, a geodetic survey was performed, and a dedicated sampling system was installed. 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 June 26 to 28 and intermittently between July 11 and August 17, 2010. Well development began with swabbing and bailing water to remove drilling fluids and 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 was a 4.5-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 1006.8 ft bgs and drawn repeatedly across the screened interval from 995 to 974.5 ft bgs. The bailing tool was a 4-in.-O.D. by 11.0-ft-long carbon steel bailer with a total capacity of approximately 7 gal. The tool was lowered by wireline and used to remove water from the well that was then dumped into the cuttings pit. A total of 151 gal. was bailed between June 26 and 27.

After bailing, a 10-hp, 4-in.-Grundfos submersible pump was installed in the well and set at multiple depths through the course of well development including 975 ft bgs, 983 ft bgs, 1001.5 ft bgs, and 812.6 ft bgs. The screen was pumped at an average rate of 2.9 gpm during the first 40 h of development from June 27 to July 12, at 5.7 gpm during the second 40 h of development from July 19 to 22, 2010, at 6.3 gpm during the next 30 h of development from July 22 to 28, 2010, and at 10.5 gpm during the final 40 h of development from August 14 to 17, 2010.

Approximately 54,084 gal. of groundwater was removed during development. The Consent Order specifies that the volume of water removed during development should be approximately equivalent to the volume of water introduced during drilling and well construction. At R-3, approximately 138,000 gal. of potable water was introduced below the top of the regional aquifer water: 5,000 gal. while drilling, 16,000 gal. for mud additives between 635 and 744 ft bgs, and 116,926 gal. during well construction. The relatively large amount of water used during well construction was required to keep swelling clays and heaving sands from entering the screened interval or clogging the temporary drill casing.

Laboratory personnel were able to demonstrate that after 54,000 gal. of water had been removed during development, the groundwater chemistry for key constituents at R-3 was similar to the known regional aquifer chemistry at the O-1 municipal supply well. Additionally, the turbidity was 0.3 nephelometric turbidity unit (NTU), and TOC readings were less than 1 mgC/L. On this basis, a purge volume variance was requested and received from NMED, which allowed well development to cease (Appendix F).

8.1.1 Well Development Field Parameters

The field parameters of turbidity, temperature, potential of hydrogen (pH), dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductance were monitored at R-3 during the pumping stage of well development. In addition, water samples were collected for TOC analysis. TOC should be less than 2.0 ppm and turbidity should be less than 5 NTUs to indicate that the well has been developed adequately.

Field parameters were measured at well R-3 by collecting aliquots of groundwater from the discharge pipe with the use of a flow-through cell. During development, pH varied from 6.8 to 9.1. Temperature varied from 16.3°C to 28.1°C. DO generally varied from 0.2 to 8.9 mg/L, with some values exceeding 9 mg/L, indicating that the meter was likely malfunctioning during those readings. Specific conductance ranged from 167 to 266 microsiemens per centimeter (µS/cm). Corrected oxidation-reduction potential (Eh) varied from approximately 300 to 400 millivolts (mV) for most of development. However, readings between –14.9 and 287 mV were measured over one 2-d period, again indicating possible equipment malfunction. One outlier was recorded at 1465.6 mV on the next to the last day of development. Turbidity ranged from 0.1 to 125 NTUs over the entire course of well development.

The final development parameters at R-3 were: pH of 8.0, temperature of 24.8°C, specific conductance of 167 µS/cm, and turbidity of 0.3 NTU. The final TOC concentration was 0.60 mg/L. Table B-1.2-1, in Appendix B, presents field parameters and water volumes discharged during development.

8.2 Aquifer Testing

Aquifer pumping tests, including preliminary step tests and a 24-h aquifer test, were conducted at R-3 between June 29 and July 2 by David Schafer and Associates. Two short-duration pumping intervals with short-duration recovery intervals (step tests) were conducted on June 29. The objective of the step-tests was to assess the behavior of the system and properly determine the optimal pumping rate for the 24-h test. A 24-h aquifer test was completed on July 1 and 2. A 10-hp, 4-in. diameter Grundfos submersible pump was used to perform the aquifer tests. Approximately 3864 gal. of groundwater was purged during aquifer testing. Results of the R-3 aquifer tests are presented in Appendix C.

8.3 Dedicated Sampling System Installation

A dedicated sampling system for R-3 was installed between September 28 and October 7, 2010. The system uses a single 3.0-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. stainless steel. Two 1-in.-I.D. schedule 80 polyvinyl chloride (PVC) tubes are installed along with and banded to the pump riser. One is for installation of a dedicated In-Situ Level Troll 500 transducer and the second is 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 presented in Figure 8.3-1a. Figure 8.3-1b presents technical notes.

8.4 Wellhead Completion

A reinforced concrete surface pad, 10 ft long × 10 ft wide × 6 in. thick, was installed at the R-3 wellhead. The concrete pad was slightly elevated above the 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. Four steel bollards, painted yellow for visibility, were set at the outside edges of the pad to protect the well from traffic. They are designed for easy removal to allow access to the well. Details of the wellhead completion are presented in Figure 8.3-1a.

8.5 Geodetic Survey

A licensed professional land surveyor conducted a geodetic survey on September 2, 2010 (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 the New Mexico State Plane Coordinate System Central Zone (North American Datum [NAD] 83); elevation is expressed in feet (ft) above mean sea level (amsl) using the National Geodetic Vertical Datum of 1929. Survey points include ground surface elevation near the concrete pad, the brass marker in the concrete pad, the top of the well casing, and the top of the protective casing for the R-3 monitoring well (Appendix G).

8.6 Waste Management and Site Restoration

Waste generated from the R-3 project included drilling fluids, purged groundwater, drill cuttings, concrete slurry, decontamination water, and contact waste. A summary of the waste characterization samples collected during drilling, construction, and development of the R-3 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 Regional Well R-3 in Pueblo Canyon," (LANL 2010, 108851).

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 EP-Directorate's 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. If analytical data indicate that the drilling fluids are hazardous/nonradioactive or mixed low-level waste, the drilling fluids will be 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-011.1, 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 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 SOPs, removing the polyethylene liner, removing the containment-area berms, and backfilling and regrading the containment area, as appropriate.

9.0 DEVIATIONS FROM PLANNED ACTIVITIES

Work at R-3 deviated from the original drilling plan when the initial R-3 borehole, drilled to 600 ft bgs, encountered borehole stability problems and had to be abandoned after over-reaming drill tools became stuck at approximately 114 ft bgs.

Drilling, sampling, and well construction at the final R-3 borehole were performed as specified in "R-3 Drilling Plan, Installation of Well R-3, TA-74, Los Alamos National Laboratory," (North Wind, Inc., 2010, 109457).

10.0 ACKNOWLEDGMENTS

Layne Christensen drilled and installed the R-3 monitoring well.

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

David Schafer and Associates performed the aquifer testing and provided the write-up and data for the Aquifer Testing Report.

Schlumberger Water Services performed geophysical logging of the borehole and Ned Clayton provided the Schlumberger Geophysical Logging Report.

North Wind, Inc., provided oversight on all preparatory and field-related activities.

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. This information is also included in text citations. ER IDs are assigned by the EP 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 2007. "Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan, Annual Update - 2007," Los Alamos National Laboratory document LA-UR-07-1789, Los Alamos, New Mexico. (LANL 2007, 096981)

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), May 2008. "Drilling Work Plan for Los Alamos and Pueblo Canyons Groundwater Monitoring Wells," Los Alamos National Laboratory document LA-UR-08-2738, Los Alamos, New Mexico. (LANL 2008, 103015)

LANL (Los Alamos National Laboratory), March 1, 2010. "Waste Characterization Strategy Form for Regional Well R-3 in Pueblo Canyon, Regional Well Installation and Aquifer Testing," Los Alamos, New Mexico. (LANL 2010, 108851)

North Wind Inc., April 20, 2010. "Well R-3 Drilling Plan, Installation of Well R-3, TA-74, Los Alamos National Laboratory," with handwritten annotations, plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (North Wind, Inc., 2010, 109457)

11.2 Map Data Sources

Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2008-0109; 28; February 2008.

Hypsography, 100 and 20 Ft Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

Surface Drainages, 1991; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2002-0591; 1:24,000 Scale Data; unknown publication date.

Fences, Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section, 06 January 2004; as published 04 January 2008.

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 04 January 2008.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 04 January 2008.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 04 January 2008.

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

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

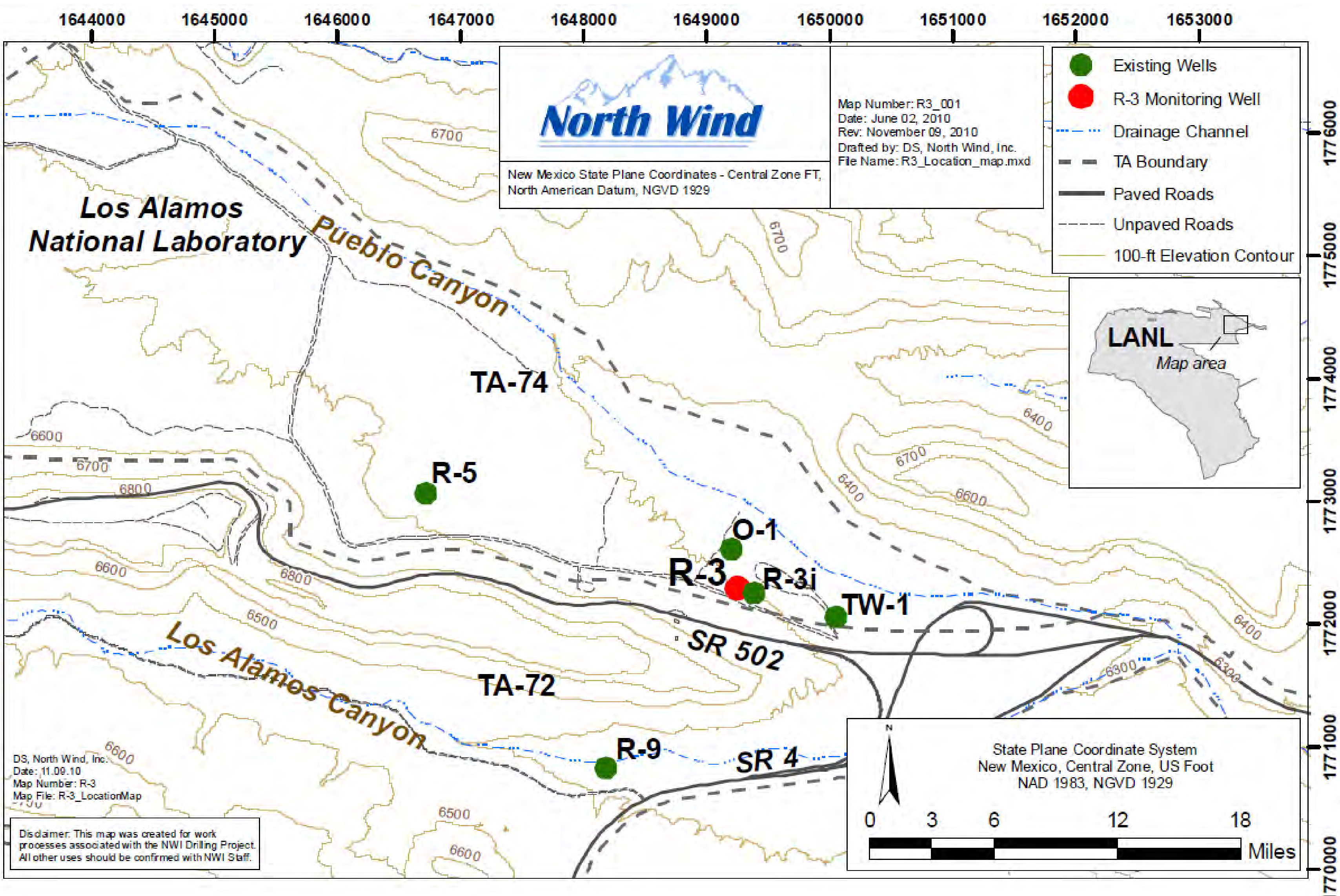


Figure 1.0-1 Location of monitoring well R-3

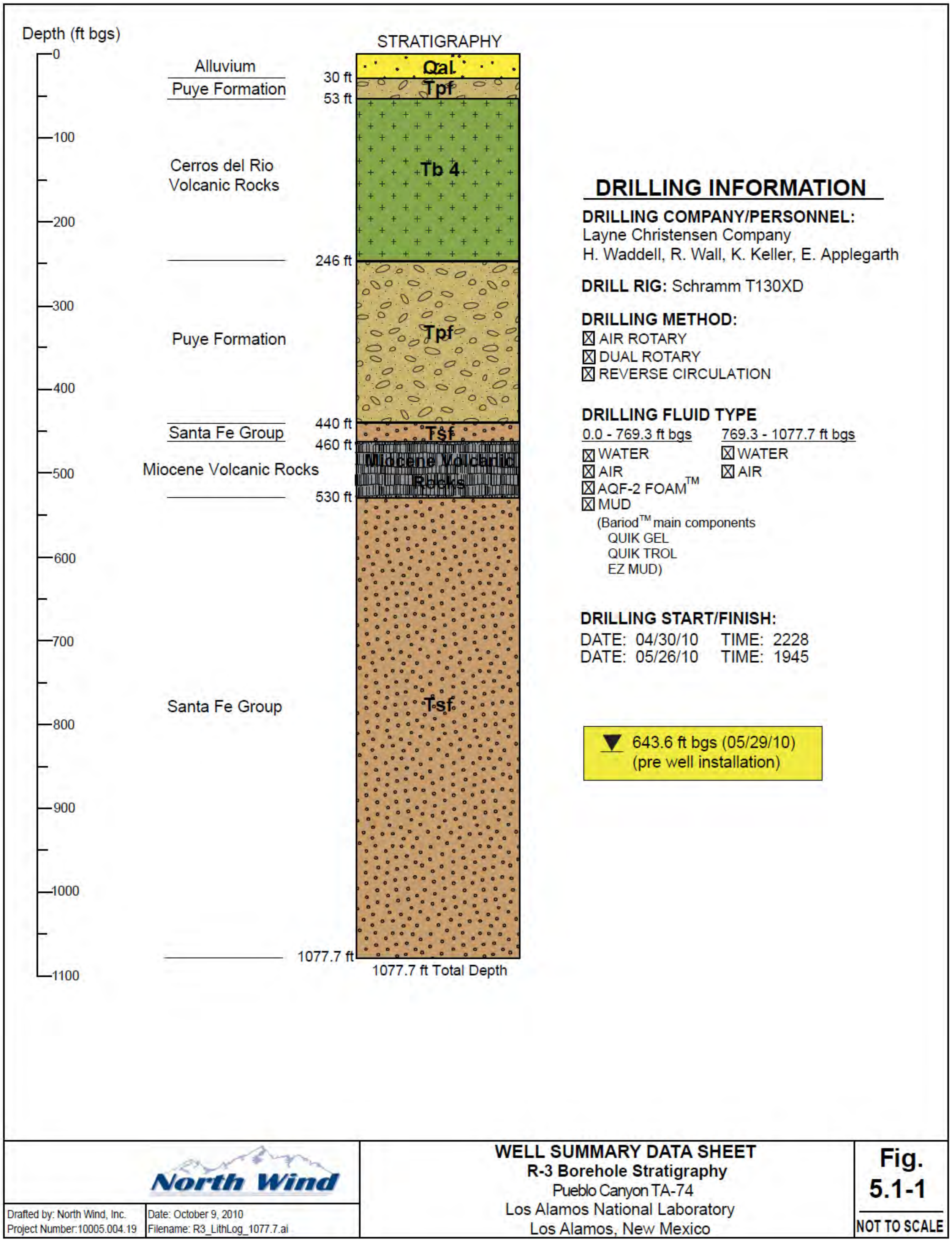


Figure 5.1-1 Monitoring well R-3 borehole stratigraphy

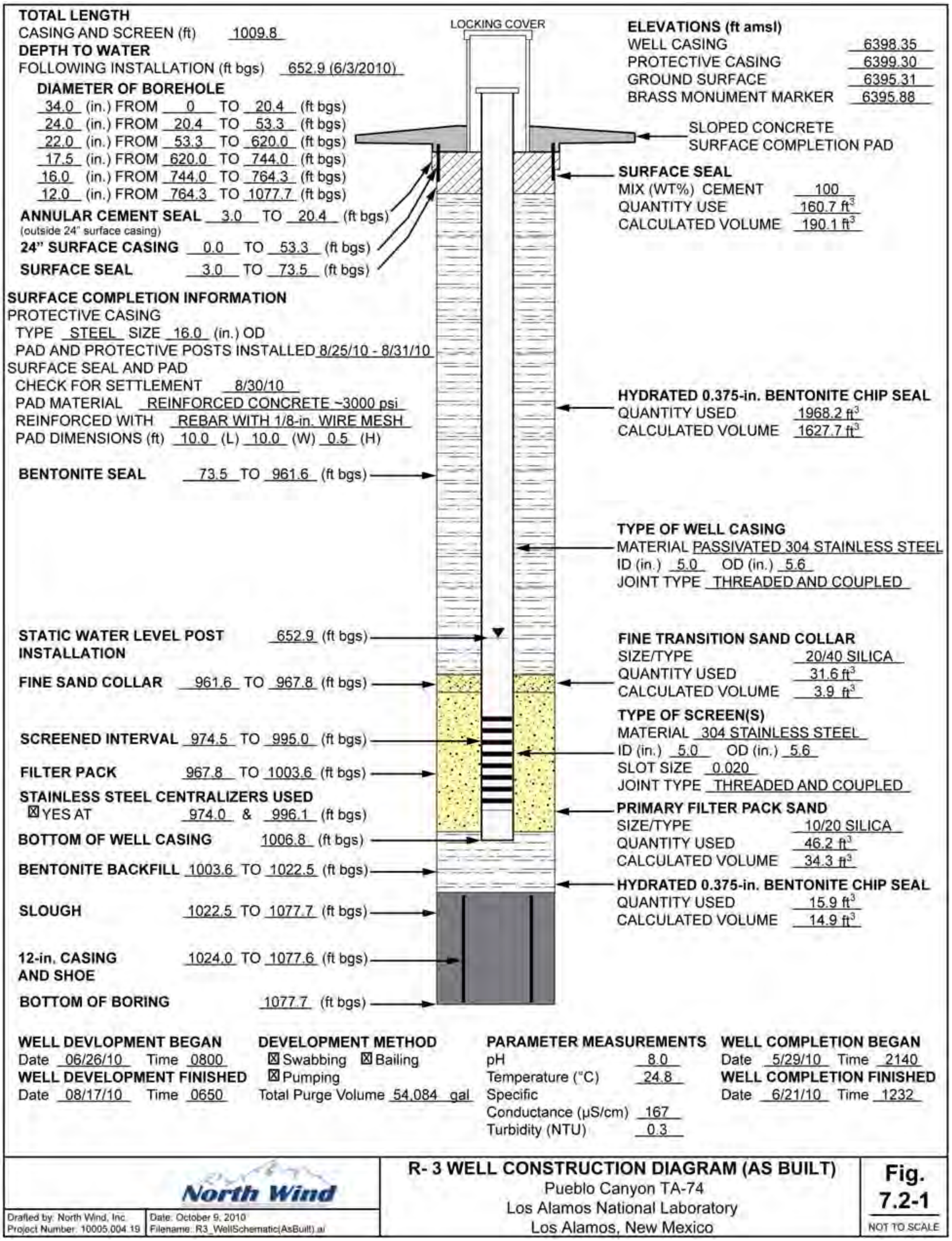


Figure 7.2-1 Monitoring well R-3 as-built well construction diagram

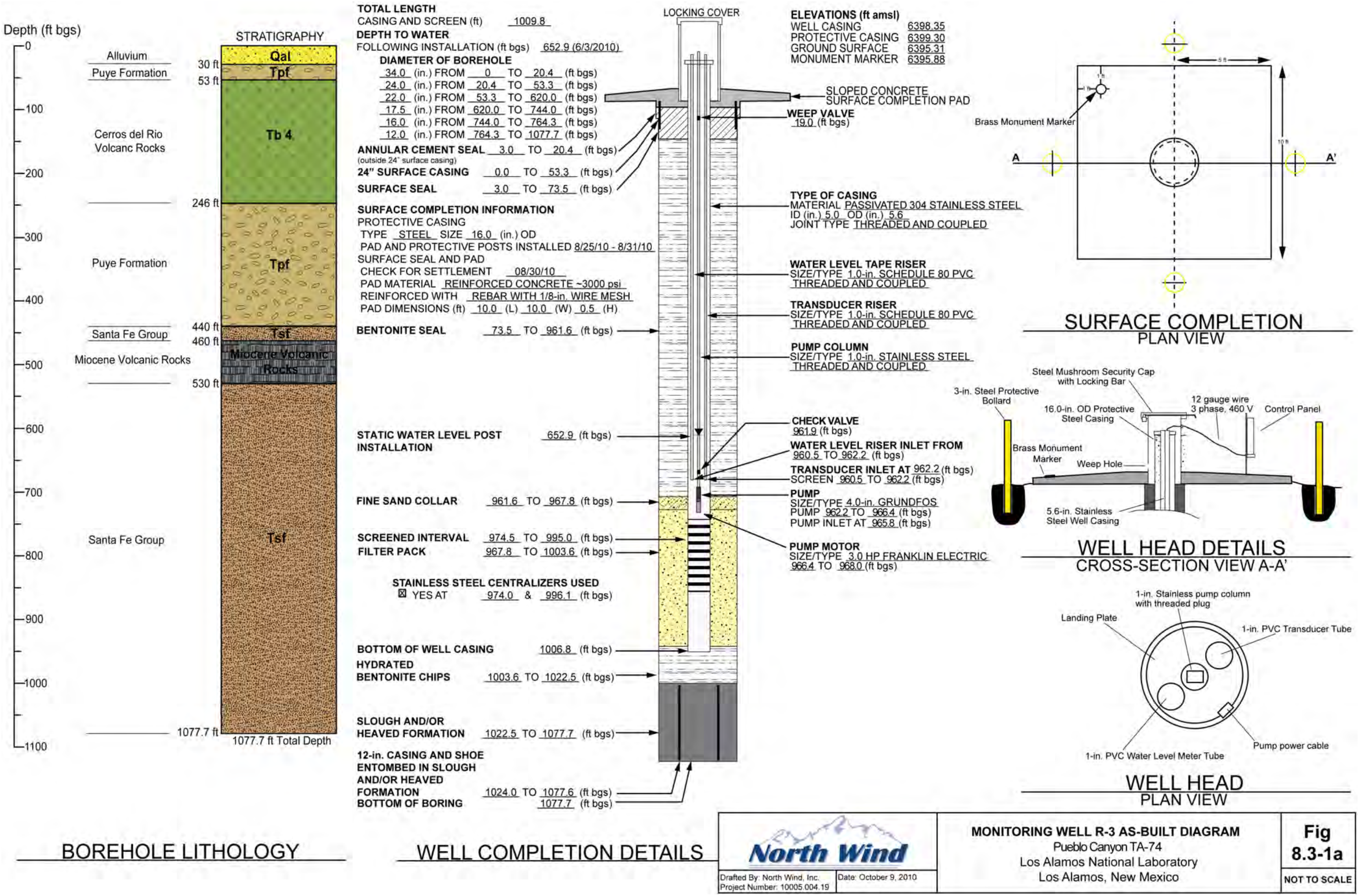


Figure 8.3-1a As-built schematic for intermediate water monitoring well R-3

R-3 TECHNICAL NOTES

SURVEY INFORMATION[1]

Brass Marker

Northing:	1772598.75 ft
Easting	1649037.61 ft
Elevation	6395.88 ft amsl

Well Casing

Northing:	1772593.10 ft
Easting:	1649038.67 ft
Elevation:	6398.35 ft amsl

BOREHOLE GEOPHYSICAL LOGS

LANL Natural Gamma and Array Induction Logs
Schlumberger: hostile natural gamma spectroscopy, elemental capture sonde, triple detector lithodensity, accelerator porosity sonde

DRILLING INFORMATION

Drilling Company

Layne Christensen Company

Drill Rig

Schramm T130XD

Drilling Methods

Fluid-assisted air rotary
Fluid-assisted dual rotary

Drilling Fluids

Air; AQF-2 Foam, Quik-Trol,
EZ-Mud Gold, Soda Ash,
Quick-Gel (discontinued at 744 ft bgs);
AquaClear, bleach (between 764.3 and 769.3 ft bgs);
potable water

MILESTONE DATES

Drilling

Start:	04/30/2010
Finish:	05/26/2010

Well Completion

Start:	05/29/2010
Finish:	06/21/2010

Well Development

Start:	06/26/2010
Finish:	08/17/2010

WELL DEVELOPMENT

Development Methods

Performed swabbing, bailing, and pumping
Volume Purged: 54,084 gal.

Parameter Measurements

pH:	8.0
Temperature:	24.8°C
Specific Conductance:	167 µS/cm
Turbidity	0.3 NTU

AQUIFER TESTING

Constant Rate Pumping Test

Water Produced:	3864 gal.
Average Flow Rate:	2.3 gpm
Performed on:	06/29/2010 - 07/02/2010

DEDICATED SAMPLING SYSTEM

Pump Type

Make: Grundfos
Model: 5S30-820CBM
SN#: B96023161-P10909086
5.0 U.S. gpm, intake at 965.8 ft bgs
Environmental Retrofit

Motor

Make: 3.0 HP Franklin Electric
Model: 2343268602
SN#: 09B18-10-0013

Pump Column

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

Transducer Tube

1-in. ID Flush Threaded Schedule 80 PVC with 1.7-ft long 0.010-in. Screen between 960.5 - 962.2 ft bgs

Water Level Tube

1-in. ID Flush Threaded Schedule 80 PVC
Screen between 960.5 - 962.2 ft bgs

Transducer

Installed 10/13/10
Make: In-Situ
Model: Level Troll 500
SN#: 171229

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.
Project Number:10005.004.19
Date: October 9, 2010
Filename: R-3_Tech_Specs.ai

R-3 TECHNICAL NOTES
Pueblo Canyon TA-74
Los Alamos National Laboratory
Los Alamos, New Mexico

Fig. 8.3-1b
NOT TO SCALE

Figure 8.3-1b As-built technical notes for monitoring well R-3

Table 3.1-1
Fluid Quantities Used During Initial R-3 Drilling and Final R-3 Drilling and Well Construction

Date	Water (gal.)	Cumulative Water (gal.)	AQF-2 Foam (gal.)	Cumulative AQF-2 Foam (gal.)	Drilling Mud Additives[a]	Water Used in Mud (gal.)	Cumulative Mud Volume (gal.)
Drilling (initial R-3 borehole)							
04/22/10	2000	2000	n/a[b]	n/a	n/a	n/a	n/a
04/23/10	6000	8000	n/a	n/a	n/a	n/a	n/a
04/24/10	300	8300	n/a	n/a	n/a	n/a	n/a
04/25/10	5200	13,500	n/a	n/a	n/a	n/a	n/a
04/26/10	10,000	23,500	n/a	n/a	n/a	n/a	n/a
04/27/10	50	23,550	n/a	n/a	n/a	n/a	n/a
04/28/10	8000	31,550	50	50	n/a	n/a	n/a
Drilling (final R-3 borehole)							
04/30/10	2500	2,500	n/a	50	n/a	n/a	n/a
05/01/10	5500	8,000	n/a	50	n/a	n/a	n/a
05/02/10	14,500	22,500	55	105	n/a	n/a	n/a
05/03/10	13,000	35,500	60	165	n/a	n/a	n/a
05/04/10	2000	37,500	n/a	165	n/a	n/a	n/a
05/05/10	5500	43,000	n/a	165	n/a	n/a	n/a
05/06/10	19,000	62,000	5	170	n/a	n/a	n/a
05/07/10	10,000	72,000	15	185	n/a	n/a	n/a
05/08/10	8000	80,000	50	235	n/a	n/a	n/a
05/11/10	3500	83,500	n/a	235	n/a	n/a	n/a
05/13/10	3000	86,500	n/a	235	n/a	n/a	n/a
05/17/10	n/a	86,500	n/a	235	80 lb Quik-Trol 80 lb EZ-Mud Gold, 75 lb Soda Ash, 600 lb Quick-Gel,	8000	8000
05/18/10	n/a	86,500	n/a	235	100 lb Quick-Gel, 15 lb Soda Ash, 80 lb Quick-Trol 120 lb EZ-Mud Gold	7500	15,500
05/20/10	5,450	92,450	n/a	235	9 gal. bleach; 1 gal. AquaClear PFD added as neutralizer[c]	500	16,000
05/22/10	500	92,950	n/a	235	n/a	n/a	16,000
05/23/10	3,700	96,650	n/a	235	n/a	n/a	16,000
05/24/10	6,800	103,450	n/a	235	n/a	n/a	16,000
05/25/10	6000	109,450	n/a	235	n/a	n/a	16,000
05/26/10	6000	115,450	n/a	235	n/a	n/a	16,000
05/28/10	2000	117,450	n/a	235	n/a	n/a	16,000

Table 3.1-1 (continued)

Date	Water (gal.)	Cumulative Water (gal.)	AQF-2 Foam (gal.)	Cumulative AQF-2 Foam (gal.)	Drilling Mud Additives[a]	Water Used in Mud (gal.)	Cumulative Mud Volume (gal.)
Well Construction							
05/31/10	3500	3500	n/a	n/a	n/a	n/a	n/a
06/03/10	27,200	30,700	n/a	n/a	n/a	n/a	n/a
06/05/10	9800	40,500	n/a	n/a	n/a	n/a	n/a
06/06/10	10,800	51,300	n/a	n/a	n/a	n/a	n/a
06/07/10	2000	53,300	n/a	n/a	n/a	n/a	n/a
06/08/10	6400	59,700	n/a	n/a	n/a	n/a	n/a
06/09/10	17,600	77,300	n/a	n/a	n/a	n/a	n/a
06/10/10	28,000	105,300	n/a	n/a	n/a	n/a	n/a
06/11/10	3000	108,300	n/a	n/a	n/a	n/a	n/a
06/14/10	3200	111,500	n/a	n/a	n/a	n/a	n/a
06/15/10	9700	121,200	n/a	n/a	n/a	n/a	n/a
06/18/10	33,300	154,500	n/a	n/a	n/a	n/a	n/a
06/19/10	30,500	185,000	n/a	n/a	n/a	n/a	n/a
06/20/10	19,600	204,600	n/a	n/a	n/a	n/a	n/a
06/21/10	780	205,380	n/a	n/a	n/a	n/a	n/a
Total Water Volume (gal.)							
R-3	354,380						

[a] Description of drilling mud additives and container sizes:

1. OCI Chemical Corp Dense Soda Ash (sodium carbonate, anhydrous, 50 lb bag).
2. Baroid QUIK-GEL (high-yield bentonite, 50 lb bag).
3. Baroid QUIK-TROL (filtration control agent, 40 lb bucket).
4. Baroid QUIK-TROL LV (modified natural cellulosic polymer, 40 lb bucket).
5. Baroid EZ-MUD GOLD (clay/shale stabilizer, 40 lb bucket).

[b] n/a = Not applicable.

[c] These constituents are neutralizing agents, not mud additives.

Table 4.2-1
Summary of Groundwater Screening Samples
Collected during Drilling and Well Development of Well R-3

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Analysis
Drilling					
Initial R-3	GW03-10-16674	04/25/10	350–363	Perched water (air lift)	Metals/anions, HE, VOCs, LH3
Initial R-3	GW03-10-16675	04/26/10	441	Perched water (air lift)	Metals/anions, HE, VOCs, LH3
Final R-3	GW03-10-16676	05/07/10	300	Perched water (air lift)	Metals/anions, HE, VOCs, LH3
Final R-3	GW03-10-16677	05/07/10	350	Perched water (air lift)	Metals/anions, HE, VOCs, LH3
Final R-3	GW03-10-17505	05/20/10	769	Regional aquifer/ borehole fluids (air lift)	TOC, metals/anions
Final R-3	GW03-10-17506	05/21/10	769	Regional aquifer (air lift)	TOC, metals/anions
Initial R-3	GW03-10-16669	04/25/10	350–363	Perched water	Trip blank/VOCs
Initial R-3	GW03-10-16671	05/07/10	300	Perched water	Trip blank/VOCs
Initial R-3	GW03-10-16672	05/07/10	350	Perched water	Trip blank/VOCs
Well Development					
R-3	GW03-10-16954	06/27/10	983	Groundwater, pumped	TOC
R-3	GW03-10-16955	06/28/10	1001.5	Groundwater, pumped	TOC
R-3	GW03-10-24323	07/19/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-24324	07/19/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-24325	07/20/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-24326	07/21/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-24327	07/22/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-24697	07/26/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-24698	07/27/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-24699	07/28/10	1001.5	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-25478	08/14/10	812.6	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-25479	08/15/10	812.6	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-25480	08/16/10	945.7	Groundwater, pumped	TOC, metals/anions
R-3	GW03-10-25481	08/17/10	945.7	Groundwater, pumped	TOC, metals/anions

Table 6.0-1
R-3 Video and Geophysical Logging Runs

Date	Depth (ft bgs)	Description
04/27/10	53.3–600	LANL borehole video log run in initial R-3 borehole from bottom of 24.0-in. casing, 53.3–600 ft bgs
04/27/10	0–600	LANL natural gamma and array induction logs run in initial R-3 borehole from ground surface to 600 ft bgs; surface casing to 53.3 ft bgs
05/27/10–05/28/10	0–1028.0	Schlumberger cased-hole geophysical logging suite in R-3: TL, ECS, APS, and HNGS

Table 7.2-1
R-3 Monitoring Well Annular Fill Materials

Material	Volume
Upper surface seal: Portland cement	160.7 ft^3
Upper bentonite seal: bentonite chips	1968.2 ft^3
Fine sand collar: 20/40 silica sand	31.6 ft^3
Filter pack: 10/20 silica sand	46.2 ft^3
Lower bentonite seal: bentonite chips	15.9 ft^3

Table 8.5-1
R-3 Survey Coordinates

Identification	Northing	Easting	Elevation
R-3 brass monument marker	1772598.75	1649037.61	6395.88
R-3 ground surface near pad	1772607.70	1649034.30	6395.31
R-3 top of protective casing	1772593.20	1649038.72	6399.30
R-3 top of stainless-steel well casing	1772593.10	1649038.67	6398.35

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

Table 8.6-1
Summary of Waste Samples Collected during Drilling and Development of R-3

Sample ID/Event ID	Date, Time Collected (h)	Description	Sample Matrix
WST03-10-17092/2822	05/07/10, 1145	Concrete/soil rolloff*	Solid
WST03-10-17093/2822	05/07/10, 1145	Trip blank	Solid
WST03-10-17507/2845	05/26/10, 1605	Grout water	Liquid
GW03-10-17247/2837	05/12/10, 1401	Perched water from lined pit (#1)	Liquid
GW03-10-17248/2837	05/12/10, 1353	Perched water from lined pit (#3)	Liquid
GW03-10-17249/2837	05/12/10, 1347	Perched water from lined pit (#2)	Liquid
WST03-10-17508/2845	05/26/10, 1605	Trip blank	Liquid
WST03-10-19127/2859	06/4/10, 1200	Decon water	Liquid
WST03-10-19128/2859	06/4/10, 1200	Trip blank	Liquid
WST03-10-19388/2868	06/11/10, 1035	Drilling mud	Liquid
WST03-10-19389/2868	06/11/10, 1035	Trip blank	Liquid
WST03-10-21763/2887	06/18/10, 1200	Trip blank	Liquid
WST03-10-21764/2887	06/18/10, 1200	Decon water	Liquid
WST03-10-23241/2948	06/29/10, 1444	Decon water	Liquid
WST03-10-23242/2948	06/29/10, 1444	Trip blank	Liquid
WST03-10-23539/2963	07/07/10, 1210	Development water	Liquid
WST03-10-23540/2963	07/07/10, 1140	Development water	Liquid
WST03-10-23541/2963	07/07/10, 1210	Trip blank	Liquid
WST03-10-23542/2963	07/07/10, 1210	Trip blank	Liquid
WST03-10-23991/2975	07/14/10, 0908	Drill cuttings	Solid
WST03-10-23992/2975	07/14/10, 0908	Trip blank	Solid
WST-03-23987/2974	07/16/10, 1045	Drilling fluids	Liquid
WST-03-23988/2974	07/16/10, 1045	Drilling fluids	Liquid
WST-03-23989/2974	07/16/10, 1045	Trip blank	Liquid
WST-03-23990/2974	07/16/10, 1045	Trip blank	Liquid
GW03-10-24668/2997	07/27/10, 1436	Development water	Liquid
GW03-10-24669/2997	07/27/10, 1436	Development water	Liquid
GW03-10-24670/2997	07/27/10, 1436	Trip blank	Liquid
GW03-10-24671/2997	07/27/10, 1436	Trip blank	Liquid
WST03-10-24579/2991	07/27/10, 1020	Decon water	Liquid
WST03-10-24580/2991	07/27/10, 1020	Trip blank	Liquid
WST03-10-25522/3041	08/19/10, 1220	Trip blank	Liquid
WST03-10-25523/3041	08/19/10, 1220	Trip blank	Liquid
WST03-10-25524/3041	08/19/10, 1220	Development water	Liquid
WST03-10-25525/3041	08/19/10, 1220	Development water	Liquid

Table 8.6-1 (continued)

Sample ID/Event ID	Date, Time Collected (h)	Description	Sample Matrix
WST03-10-25526/3042	08/19/10, 1300	Trip blank	Liquid
WST03-10-25527/3042	08/19/10, 1300	Trip blank	Liquid
WST03-10-25528/3042	08/19/10, 1300	Development water	Liquid
WST03-10-25529/3042	08/19/10, 1300	Development water	Liquid

* Concrete slurry waste generated from drilling through downhole grouted intervals.

Appendix A

Borehole R-3 Lithologic Log

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 1 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
0–30	**ALLUVIUM:** Surficial alluvial deposits: silty sand, gravel, and minor clay, unconsolidated to loosely consolidated, angular to subangular, poorly sorted, weakly to strongly weathered, upper 5' heavily bioturbated. Composed of felsic to intermediate igneous intrusive, volcanic, and volcaniclastic fragments, as well as volcanic glass, quartz grains, fine sediment, minor tuff fragments, and vitric pumices. Grayish orange pink to light brown (5YR6/3). +10F: Rock fragments (felsic to intermediate intrusives, volcanic and volcaniclastic rocks, including tuff & pumice) +35F: 85% coarse, angular quartz fragments, 15% rock fragments (as above), <1% pumice fragments.	**Qal**	Some construction gravels in top 5–10 ft.
30–55	**PUYE FORMATION:** Clast-supported, volcanic-derived, sediments. Clayey/silty sand, siltstone, and gravel, angular/subangular to subround, moderately weathered. Medium light gray to light brownish gray (5YR6/1). WR: Poorly sorted, felsic, intermediate, porphyritic to aphanitic, volcanic clasts (notable dacite) with minor pumice, quartz grains, and trace sanidine. +10F: Moderately sorted, 80% rock fragments (as above) with 10% moderately rounded tuff, 10% subrounded pumice, and <1% angular quartz. +35F: Moderately sorted, 40%−50% rock fragments (as above), 30%−40% angular quartz with minor sanidine, 10%−20% fine welded tuff fragments.	**Tpf**	Contact between Qal and Tpf at 30 ft bgs based on shift on induction log.
55–60	**CERROS DEL RIO VOLCANIC ROCKS:** Volcanic clasts and medium-dark gray, fine-grained phaneritic basalt and amygdaloidal basalt, weakly vesicular, plagioclase and olivine phenocrysts, coarse, anhedral. Medium gray (N5). WR: Basalt and 50%−55% felsic, intermediate, porphyritic, aphanitic, & volcanic clasts with minor pumice, quartz grains, and trace sanidine, clay coating some surfaces and infilling of vesicles. +10F: As above. +35F: As above.	**Tb 4**	Samples heavily mixed with cuttings from uphole.
60–65	WR: Medium-dark gray fine grained phaneritic to porphyritic phaneritic basalt and amygdaloidal basalt, weakly vesicular, plagioclase and olivine phenocrysts, coarse, anhedral. Silty clay coating most surfaces. Medium gray (N5). +10F: As above. +35F: As above, 5% clay galls.	**Tb 4**	

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 2 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
65–105	WR, +10F, & +35F: Light-medium gray fine-grained phaneritic basalt, crystalline, nonvesicular to weakly vesicular, unweathered, allotriomorphic-granular or sugary texture. 90−95 ft: <1% amorphous, coarse, milky quartz fragments. Minor clay coating concave surfaces. 5% medium-grained, anhedral olivine phenocrysts, occasional euhedral amphibole, trace sanidine. Medium gray (N5). Homogeneous throughout.	**Tb 4**	Decrease in induction from 80–100 ft bgs. Possible interflow breccias.
105–125	Rubblized basalt, aphanitic to fine phaneritic groundmass, moderately vesicular, amygdaloidal. Weathered–mottled red oxidation on 25% of cuttings. Significant clay coating clasts and filling vesicles. 5% fine to coarse, anhedral olivine phenocrysts. Medium dark gray (N4). WR: 80%–90% basalt, 10%–20% clay coating/fill. +10F: 75% basalt, 25% sandy clay clasts, minor pumice fragments/reworked tuff. Clay contains up to 50% subangular, fine to coarse, moderate sorted sand, mostly basaltic composition. +35F: 60% basalt, up to 40% sandy clay clasts (as above).	**Tb 4**	Fast drilling 105'–121'. Basaltic gravels.
125–140	Fine-grained phaneritic basalt, weakly vesicular. 5% medium-grained, anhedral olivine phenocrysts. Minor well-sorted to sandy clay clasts. Red-brown oxidation on <5% of surfaces. Medium dark gray (N4). WR: 90%–95% basalt, 5%–10% clay clasts. +10F: 95% basalt, 5% clay clasts. +35F: 95% basalt, 5% clay clasts.	**Tb 4**	Decrease in induction.
140–145	Rubblized basalt, fine-grained phaneritic groundmass, moderately vesicular. 5% medium-grained, anhedral olivine phenocrysts. Significant fine-grained matrix–silt to fine-grained sand, moderately sorted, angular to subangular. Minor well-sorted to sandy clay clasts and clay filling vesicles. Dark gray (N3). WR: 90% basalt, 10% clay coating. +10F: 90%−95% basalt, 5%−10% clay clasts. +35F: 95% basalt, 5% clay clasts.	**Tb 4**	Fast drilling 140'–145'. Basaltic gravels.
145–155	Fine-grained phaneritic basalt, weakly vesicular. 2−3% fine- to medium-grained, anhedral olivine phenocrysts. Minor well-sorted to sandy clay clasts. Red-brown oxidation on <5% of surfaces. Clay filling vesicles. Medium dark gray (N4). 150'–155' section moderately weathered to sugary texture. WR: 90–95% basalt, 5–10% clay clasts. +10F: 95% basalt, 5% clay clasts. +35F: 95% basalt, 5% clay clasts.	**Tb 4**	Decrease in induction.

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 3 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
155–160	Rubblized basalt, aphanitic to fine-grained phaneritic texture, vesicular. Locally scoriaceous. 2%–5% fine- to medium-grained anhedral olivine phenocrysts. Clay coating fragments and filling vesicles. Locally weathered (oxidized) moderate brown. Medium gray (N5). WR: coarse (gravel) fragments, clay-coated. Infrequent coarse (2 mm) euhedral olivine phenocrysts. +10F: 95% scoriaceous basalt, 5% clay clasts. +35F: 95% basalt, 5% clay fragments.	**Tb 4**	Basaltic gravels
160–165	Scoria and aphanitic scoriaceous/vesicular basalt, amygdaloidal. Weathered to subrounded gravel (up to 2 cm). <1% fine, anhedral olivine phenocrysts. Clay coating large fragments and filling vesicles. Brownish gray (5YR4/1). WR: Scoria fragments coated with significant clay. +10F: 95% scoria fragments, 5% clay clasts. +35F: 60% scoria/basalt fragments, 40% clay clasts.	**Tb 4**	Basaltic gravels
165–180	WR: Aphanitic vesicular basalt, amygdaloidal. Weathered to coarse (gravel) fragments. Clay coating fragments and filling vesicles. <1% fine, anhedral olivine phenocrysts. Medium dark gray (N4). +10F: 80% basalt, 20% clay clasts. +35F: 70% basalt, 30% clay, <1% free olivine crystals, trace angular quartz fragments.	**Tb 4**	Basaltic gravels
180–205	Fine-grained phaneritic vesicular basalt with scoria. Strongly weathered to coarse gravel fragments. Some fragments oxidized rust brown. 2% fine, anhedral olivine phenocrysts, locally altered to brown. Clay coating basalt fragments. Medium dark gray (N4). +10F: 95% basalt with clay-filled vesicles. +35F: 90% basalt, 10% clay clasts, few free olivine crystals.	**Tb 4**	Basaltic gravels
205–210	Fine-grained phaneritic basalt. Highly vesicular. Weathered along fractures to sugary texture, locally oxidized rust brown. Up to 5% anhedral olivine phenocrysts. Clay fills vesicles. Medium dark gray (N4). +10F: 95% basalt, 5% clay clasts. +35F: 95% basalt, 5% clay clasts.	**Tb 4**	Basaltic gravels

Borehole Identification (ID): R-3	**Technical Area (TA):** 74	**Page:** 4 of 14
Drilling Company: Layne Christensen Co.	**Start Date/Time:** 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	**End Date/Time:** 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	**Machine:** Schramm T130XD RIG T25	**Sampling Method:** Grab
Ground Elevation: 6395.31		**Total Depth:** 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	**Site Geologists:** A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
210–225	Aphanitic to fine- to medium-grained phaneritic scoriaceous vesicular basalt. 2% medium to coarse, anhedral olivine phenocrysts. Clay fills vesicles and fractures. Medium dark gray (N4). WR: Rounded basalt gravel, clay coated. +10F: 95% rounded basalt fragments, clay coated, 5% clay clasts. +35F: 85–95% basalt, 5–15% clay clasts.	**Tb 4**	Fast drilling 208'–220'. Basaltic gravels
225–235	Fine-grained phaneritic vesicular basalt. 5% fine- to medium-grained, anhedral olivine phenocrysts. Clay fills vesicles and fractures. 1% pyroxene. Dark gray (N3). WR: Weathered angular to subangular basalt gravel coated with clay. +10F: Basalt fragments, subround with clay filling vesicles. +35F: 85–95% basalt, 5–15% clay clasts.	**Tb 4**	Decrease in induction.
235–240	Aphanitic nonvesicular basalt. 5%–8% fine to medium, anhedral olivine phenocrysts. Medium dark gray (N4). WR: Basalt clasts, surface weathered to sugary texture, possibly silicified. 1% clay clasts. +10F: 97% basalt, 3% clay clasts. +35F: 97% basalt, 3% clay clasts.	**Tb 4**	Decrease in induction. Possible interflow breccias.
240–245	Aphanitic basalt, moderately vesicular. 2% coarse to medium-grained, anhedral olivine phenocrysts. Clay filling vesicles and fractures. Moderately weathered. Olivine weathered brown. Oxidation on some clast surfaces and fractures. Occasional drusy quartz. Some broken fragments display alteration halo. Medium dark gray (N4). WR: Subangular basalt fragments, some clay coating, 2% clay clasts. +10F: Subangular basalt fragments, some clay coating, 2% clay clasts. +35F: 90% basalt, 10% clay clasts, trace sanidine.	**Tb 4**	Basaltic gravels.
245–260	**PUYE FORMATION:** Fine phaneritic basalt fragments, medium dark gray (N4), 5% coarse anhedral olivine phenocrysts and silty/clayey sandstone, fine-grained, angular to subangular, moderately to well sorted, vuggy in places composed of quartz with olivine, biotite, coarse lithic fragments, minor dacitic clasts. Moderate brown 5YR4/4. Minor pumice fragments. WR: Clasts heavily clay coated. 60% basalt, 40% sand. +10F: 50% basalt, 50% sand. +35F: 70% sand, 30% basalt.	**Tpf**	Contact between Tb 4 and Tpf at 246 ft bgs corresponds to significant increase on gamma and induction logs. 255−260 ft: Contains intermediate-composition volcanic clasts.

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 5 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
260–305	Volcaniclastic sediments, clayey sandy/silty very coarse sand and gravel, angular to round, moderately weathered, clay in fractures. Medium to medium dark gray (N4-N5). WR: Very fine- to medium-grained, moderate to poorly sorted intermediate-composition volcanic fragments and minor basalt, aphanitic and minor fine phaneritic texture with quartz, biotite, feldspar, pyroxene/hornblende phenocrysts. Clasts are subrounded to round, clay coated. Minor reworked tuff downsection. +10F: Round to subround clasts, light clay coating. +35F: As above, includes 1% coarse angular quartz.	**Tpf**	
305–335	Volcaniclastic sediments, fine-grained to medium-grained, angular to subround, poorly sorted basalt and intermediate-mafic clasts. Moderately weathered, oxidation on 25% of surfaces. Medium light to medium dark gray (N4-N6). WR: Subangular to subround fragments, minor clay coating and clay in fractures. 60% intermediate-composition lithics, 40% basalt and scoria. Trace reworked tuff. +10F: As above. +35F: As above.	**Tpf**	
335–340	Volcaniclastic sediments, very fine-grained to fine-grained silt and sandstone, tuffaceous siltstone, and gravels. Gravels subangular to subround, poorly to moderately sorted felsic to intermediate-composition volcanic clasts with quartz and feldspar phenocrysts, tuffaceous siltstone, and minor basalt. Moderately weathered, clay coating on clasts. Light brownish gray (5YR6/1). WR: Clasts exhibit clay alteration on surfaces. 60% tuffaceous siltstone and siltstone, 40% gravels. +10F: Oxidation on 40% surfaces. 60% Intermediate-composition volcanic clasts, 40% tuffaceous siltstone and siltstone. +35F: As above. 1% coarse, angular quartz.	**Tpf**	
340–350	Volcaniclastic sediments, fine- to coarse-grained, angular to subround, moderately sorted intermediate-composition volcanic clasts and minor basalt, coarse quartz crystals. Moderately weathered, clay coating on surfaces. Medium gray (N4). WR: Subangular to subround fragments, clay coating. +10F: 95% intermediate-composition volcanic rock, 5% basalt and scoria. +35F: As above.	**Tpf**	

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 6 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
350–360	Volcaniclastic sediments, very fine-grained to fine-grained silt and sandstone, tuffaceous siltstone, and gravels. Gravels subangular to round, poorly sorted. Felsic to intermediate-composition volcanic clasts, tuffaceous siltstone, minor scoriaceous basalt, trace quartz crystals. Moderately weathered, clay coating on clasts. Medium light gray (N6). WR: 60% tuffaceous siltstone and siltstone, 40% felsic to intermediate volcanic clasts. +35F: 50% tuffaceous siltstone and siltstone, 50% felsic to intermediate volcanic clasts. +10F: As above. 1% coarse angular quartz.	**Tpf**	
360–365	Volcaniclastic sediments, sandy/silty very coarse sand and gravel, angular to subround, poorly to moderately sorted. Gravels felsic to intermediate-composition volcanic, minor basalt. Moderately weathered. Medium gray (N5). WR: Clay coating and oxidation on 10% surfaces. +10F: 70% felsic to intermediate volcanic rock, 30% basalt, scoriaceous basalt. Oxidation on 40% surfaces. +35F: As above. Trace coarse angular quartz.	**Tpf**	
365–435	Volcaniclastic sediments, fine to coarse sand and gravel, subangular to subround, poorly to moderately sorted. Moderately weathered. Gravels predominantly mafic (basalt and scoria and minor gabbro) and aphanitic to phaneritic intermediate-composition volcanics (including dacite). Also minor tuffaceous siltstone and sandstone, and phaneritic felsic volcanic rock (rhyolitic). Pale brown−pale red (5YR5/2-10R6/2) to medium dark gray (N4). WR: Gravel clasts are clay coated. Weathering to fine sand with fine sand, silty matrix binding clasts in the 400’–405‘ and 414’–420’ intervals. +10F: 55–65% felsic to intermediate volcanic rock, quartz, 35–45% basalt and scoria. +35F: As above. 1% coarse angular quartz.	**Tpf**	
435–440	Volcaniclastic sediments, fine to coarse ash, silt, and sand and gravels, poorly sorted. Gravels subangular to subround, moderately weathered, mixed volcanic lithologies. WR: Abundant ash and silt and fine to coarse sand in matrix and coating gravels. Fine sand, silt binding clasts. +10F: 92% felsic to intermediate volcanic clasts, 5% basalt and scoria, 1% tuffaceous siltstone, siltstone, 2% quartzite clasts. +35F: As above. Trace quartz crystals.	**Tpf**	Appearance of quartzite clast.

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 7 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
440–445	**SANTA FE GROUP:** Volcaniclastic sediments. Minor silt, coarse sand, and gravels, moderately sorted. Gravels subround to round, moderately weathered, mixed volcanic lithologies (notably basaltic-intermediate composition). WR: Sandy silt coating grains. +10F: 80% felsic to intermediate volcanic clasts, 15% basalt and scoria, 3% tuffaceous siltstone and siltstone, 2% quartzite. +35F: As above.	**Tsf**	Contact between Tpf and Tsf at 440 ft bgs corresponds with significant shifts on induction and gamma logs. Increase in induction, decrease in gamma.
445–450	Volcaniclastic sediments, very fine-grained to medium-grained sand and subangular to subrounded gravels of siltstone, sandy siltstone, mudstone, and silty claystone. Poorly sorted. Very pale orange (10YR8/2). WR: 95% siltstone, sandy siltstone, mudstone, and silty claystone, likely altered/reworked tuff and pumice, 5% vesicular basalt felsic volcanic rocks. Moderately weathered. +10F: 90% silt, mud, and claystone, 10% basalt and felsics. +35F: 80% silt, mud, and claystone, 20% basalt and felsics.	**Tsf**	Predominantly tuffaceous, altered pumice and tuff. High induction peak.
450–460	Volcaniclastic sediments, coarse sand and subangular to subrounded gravels including sandy siltstone, white tuffaceous siltstone and claystone, phaneritic felsic and intermediate volcanic rocks (including rhyolite and dacite). Minor calcite cementation. Light brown (5YR6/4) to medium dark gray (N4). Moderately weathered. WR: 60–70% felsic and intermediate volcanic rocks, 30–40% silt and claystone. +10F: As above. +35F: 50–60% silt and claystone, 40–50% felsic and intermediate volcanics.	**Tsf**	

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 8 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
460–500	**MIOCENE VOLCANIC ROCKS** Medium dark gray (N4) phaneritic basalt, non to weakly vesicular. Hypidiomorphic-granular texture, coarse groundmass. Abundant crystals including plagioclase, olivine, and pyroxene with much alteration around rims. Phenocrysts generally euhedral to subhedral. Minor claystone, siltstone and tuffaceous siltstone, felsic to intermediate volcanic rocks, quartz crystals, quartzite. WR: 90–95% basalt, highly fractured and rubbleized. 5–10% other. +10F: As above. +35F: As above.	**Miocene volcanic rocks**	Contact between Tsf and Miocene volcanic rocks at 460 ft bgs; corresponds with significant decrease in gamma and induction.
500–530	Medium dark gray (N4) phaneritic basalt, with abundant silt and sandy silt. Non to weakly vesicular. Moderately to highly weathered, abundant alteration of phenocrysts. Minor mud and claystone, siltstone with minor calcite cement, tuffaceous siltstone, felsic to intermediate volcanic, quartz crystals. WR: Silt and sandy silt coating clasts. +10F: 90–95% basalt, 5–10% other. +35F: As above.	**Miocene volcanic rocks**	Corresponds with shift on gamma log (500’– ~525’). Relatively higher gamma and induction.
530–595	**SANTA FE GROUP:** Volcanic sediments, poorly sorted gravels, coarse sand, and silt (GM). Gravels subangular to subrounded including quartz sandstone (fine to medium grained, subangular to subrounded, grayish orange [10YR7/4]), basalt and scoria (aphanitic, sugary texture, dark gray [N3]), quartzite (fine to coarse grained, medium gray [N5]), chert (grayish red [10YR4/2]), and felsic to intermediate volcanic lithic fragments (aphanitic to fine-grained phaneritic). Trace quartz crystals, siltstone. Moderately to locally strongly weathered, feldspars to clay. WR: subangular to round gravel with clay coating on surfaces. +10F: subround to round gravel, mixed lithology. +35: subangular to round, mixed lithology. 1% very coarse angular quartz.	**Tsf**	Contact between Miocene volcanic rocks and Tsf at 530 ft bgs

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 9 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
595–600	Poorly sorted fine-coarse sand, silt, and gravels. Light red (2.5YR6/6). Gravels subround to round, predominantly tuffaceous sandy claystone (lithic rich), and siltstone, also reworked pumice, felsic to intermediate volcanic clasts, and sandstone (medium to coarse sand), minor quartzite. Minor calcite cementation. WR: Abundant sand and silt coating and supporting clasts. +10F: 75% tuffaceous clayey sandstone and siltstone, 25% other. +35F: As above. Including rounded and angular quartz sand grains.	**Tsf**	Abundant tuffaceous sediment.
600–615	Gravels, coarse sand, and silt, poorly to moderately sorted. Gravels subangular to subround consisting predominantly of fine- to medium-grained phaneritic basalt with abundant plagioclase, pyroxene. Also siltstone, claystone, felsic to intermediate volcanic and intrusive clasts, minor quartzite, and carbonate cement. Medium dark gray (N4). Moderately to highly weathered and altered. WR: Silty sandy coating on clasts. +10F: 60–70% basalt, 30–40% other. +35F: As above.	**Tsf**	Abundant basalt.
615–620	Gravels and coarse sand, moderately sorted. Gravels subangular to subround consisting of tuffaceous sandstone, siltstone, claystone (with minor carbonate cement) and phaneritic basalt. Also quartzite, felsic to intermediate volcanic rocks. Reddish gray (2.5YR6/1) to gray (10YR5/1) WR: Minor silty coating. +10F: 60–70% tuffaceous sand, silt, and claystone, 20–30% basalt, <5% other. +35F: As above.	**Tsf**	
620–625	Gravels and minor coarse sand, moderately sorted. Gravels subround to well rounded including aphanitic and phaneritic basalt and scoria, sand, silt, and trace to no clay/claystone, quartzite, felsic to intermediate volcanic clasts. Reddish gray (2.5YR6/1) to gray (10YR5/1). WR: Trace silt. +10F: 70% basalt and scoria, 20% silt, sand, and claystone, 10% other. +35F: As above. Including 1% calcite and/or limestone.	**Tsf**	Abundant basalt.

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 10 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
625–770	No returns. Silt/clay interval.	**Tsf**	Based on neutron capture log cross section, this interval may contain some fine-grained (low-porosity) sands. 640 to 705 ft bgs increase in clays and fines on the log.
770–805	Gravels, silt, and fine to coarse sand, poorly sorted. Gravels subround to round including mixed volcanic clasts, quartz and lithic rich sandstone, siltstone, claystone, and minor quartzite. Light red (2.5YR6/6) to gray (10YR6/1) and light gray (10YR7/2). WR: Abundant silt and sand in matrix, supporting clasts. +10F: 60–70% felsic to intermediate volcanic rocks, 30–40% other. +35F: As above. 1–3% quartz crystals.	**Tsf**	
805–815	Granule-sized gravels, subangular to round, moderately to well sorted. Gravels include felsic to intermediate volcanic rocks, minor basalt, quartzite, quartz-rich sandstone, tuffaceous siltstone, silty claystone. Minor silty sand. Reddish brown (2.5YR4/3) to gray (10YR5/1). WR: clean gravels. +10F 70–75% felsic to intermediate volcanic rocks, 25–30% other. +35F: As above.	**Tsf**	
815–845	Granule-sized gravels, silt, and fine to coarse quartz and lithic sand, poorly to moderately sorted. Gravels subround to round including mixed volcanic clasts, quartz-rich sandstone, siltstone, claystone, and minor quartzite. Light red (2.5YR6/6) to very pale brown (10YR8/2). WR: Abundant silt and sand in matrix, supporting clasts. +10F: 60–70% felsic to intermediate volcanic rocks, 30–40% other. +35F: As above. 1–3% quartz crystals.	**Tsf**	

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 11 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
845–850	Granule- to pebble- sized (~4-5 mm) gravels and sand, moderately sorted. Gravels subangular to subround, include quartz-rich sandstone with minor lithics (quartz arenite); sand, round to well rounded, moderately to well sorted, with carbonate cement; also granule- to pebble-sized clasts of felsic to intermediate volcanic rock. Gray (1YR6/1) to very pale brown (8/2). WR: Clean gravels. +10F: 70% quartz arenite sandstone, 30% volcanic lithic clasts. +35F: 83% sandstone, 15% volcanic lithic clasts, 2% siltstone.	**Tsf**	Carbonate cement
850–860	Granule-sized gravels, subangular to round, medium to coarse quartz and lithic sand, and minor silt, poorly sorted. Gravels include predominantly mudstone, quartz-rich, carbonate-cemented sandstone (quartz arenite), minor volcanic lithics. Very pale brown (10YR8/2) to very pale brown (10YR7.2). WR: Abundant quartz and lithic sand and minor silt in matrix. +10F: 55–65% mudstone, 35–45% sandstone, trace volcanic lithic clasts. +35F: As above.	**Tsf**	
860–880	Granule-sized gravels, subangular to round, medium to coarse quartz and lithic sand, and minor silt, moderately sorted. Gravels include predominantly mudstone, quartz-rich, carbonate-cemented sandstone (quartz arenite), minor volcanic lithics. Very pale brown (10YR8/2) to gray (10YR6/1). WR: Abundant quartz and lithic sand and minor silt in matrix. +10F: 55% mudstone, 43% sandstone, 2% volcanic lithic clasts. +35F: 65% mudstone, 33% sandstone (quartz and lithic sand), 2% volcanic lithic clasts.	**Tsf**	
880–895	Granule-sized gravels and medium to coarse sand, minor silt, poorly sorted. Gravels subangular to subround including felsic to intermediate volcanic lithic clasts as well as siltstone, tuffaceous siltstone, quartz-rich sandstone, mudstone, quartzite. Reddish brown (2.5YR5/3) to gray (10YR6/1). WR: Clasts coated with sand. +10F: 85-90% volcanic lithic clasts, 5-10% other. +35F: As above.	**Tsf**	
895–900	Granule- to pebble-sized gravels and medium to coarse sand, silt, poorly sorted. Gravels subangular to subround including felsic to intermediate volcanic lithic clasts, siltstone, tuffaceous siltstone, quartz-rich sandstone, mudstone, quartzite. Very pale brown (10YR8/2) to pale red (2.5YR7/2). WR: Clasts coated in sand. +10F: 35% volcanic lithics, 65% mudstone, sandstone, and siltstone. +35F: As above.	**Tsf**	

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 12 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
900–910	Granule-sized (~4 mm) gravels and coarse sand, poorly sorted. Gravels subrounded to well rounded including predominantly mudstone, siltstone, felsic- to intermediate volcanic, minor sandstone. Very pale brown (10YR8/3) to gray (10YR6/1). WR: Granule- and pebble-sized gravels with minor coarse sand. +10F: 45% mudstone, 35% volcanic rocks, 20% siltstone and sandstone. +35F: As above.	**Tsf**	
910–915	Granule-sized gravels and medium to coarse silty sand, clay, poorly sorted. Gravels subangular to subround including felsic to intermediate volcanic lithic clasts as well as siltstone, tuffaceous siltstone, quartz-rich sandstone, mudstone, quartzite. Very pale brown (10YR8/3) to gray (10YR6/1). WR: Clasts coated with sand. +10F: 85−90% volcanic lithic clasts, 5–10% other. +35F: As above.	**Tsf**	
915–920	Granule-sized gravels, medium- to coarse-grained silty sand, and clay. Gravels subangular to round including mudstone, volcanic lithic clasts, and minor siltstone. Very pale brown (10YR8/3) to gray (10YR6/1). WR: Abundant clay-rich sands and gravels. +10F: 55% mudstone, 40% volcanic lithic clasts, 55% minor siltstone and quartzite. +35F: As above.	**Tsf**	
920–970	Granule- to pebble-sized gravel, local cobbles in bag sample, medium- to coarse-grained sand, and minor silt and clay, poorly sorted. Gravels subangular to round including mudstone, quartz-rich carbonate-cemented sandstone, volcanic clasts. Very pale brown (10YR8/3) to gray (10YR6/1). WR: Clasts coated with sand and clayey silt. +10F: 60–85% mudstone, 20–40% volcanic clasts, siltstone, quartzite. +35F: As above.	**Tsf**	
970–980	Granule-sized gravel and medium to coarse quartz and lithic sand, silt, trace clay, moderately sorted. Gravels subangular to subround including volcanic lithic clasts and minor siltstone, quartz crystals, quartzite, quartz-rich sandstone, and mudstone. Very pale brown (10YR8/2) to pale red (2.5YR7/2). WR: Gravels and sand. +10F: 85–90% volcanic lithic clasts, 10–15% other. +35F: As above.	**Tsf**	

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 13 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
980–1000	Granule- to pebble-sized gravels and silty clayey sand, poorly to moderately sorted. Medium- to coarse-grained quartz and lithic sand in the 995'–1000' interval. Gravels subangular to subround including felsic to intermediate volcanic and intrusive igneous lithic fragments and minor basalt and scoria (altered), quartzite, siltstone, quartz-rich sandstone, chert. Pale red (2.5YR6/2) to gray (10YR6/1). WR: Gravel. +10F: 90–95% felsic to intermediate volcanic and intrusive igneous lithic clasts, 5–10% other. +35F: As above.	**Tsf**	
1000–1020	Medium- to coarse-grained quartz and lithic sand and silt and granule-sized gravels, poorly sorted. Gravels subround to round including sandstone (quartz and lithic arenite, fine to medium, rounded sand), mudstone, mixed igneous clasts, quartz. Light gray (10YR7/2) to gray (10YR6/1). WR: Sand and gravel. +10F: 65–70% sandstone, 10–15% mixed igneous clasts, 15–25% other. +35F: As above.	**Tsf**	
1020–1030	Granule- to pebble-sized gravels and fine to coarse quartz and lithic sand, minor clayey silt, poorly sorted. Trace to no clay. Gravels subangular to subround including mixed igneous clasts, quartz and lithic sandstone, mudstone, siltstone. Pale red (2.5YR7/2) to gray (10YR6/1). WR: Gravel and sand. +10F: 85–90% mixed igneous clasts, 10–15% other. +35F: As above.	**Tsf**	
1030–1040	Fine to medium sand with silt and abundant clay and lesser granule-sized gravels, poorly sorted. Gravels subrounded to well rounded including mixed igneous clasts, silty sandstone, and quartz-rich sandstone. Light gray (10YR7/2) to gray (10YR6/1). WR: Sand and gravel. +10F: 90%–95% mixed igneous clasts, 5%–10% silty sandstone. Minor quartz. +35F: As above.	**Tsf**	
1040–1050	Granule-sized gravels and fine to coarse sand, silt, moderately sorted. Gravels subround to round including mixed igneous clasts, siltstone. Gray (10YR6/1) to grayish brown (10YR5/2). WR: Gravel and sand, minor clay. +10F: 85%–95% mixed igneous clasts, 5%–10% other. +35F: As above.	**Tsf**	

Borehole Identification (ID): R-3	Technical Area (TA): 74	Page: 14 of 14
Drilling Company: Layne Christensen Co.	Start Date/Time: 04/22/10 0345 (initial R-3 borehole; sampled 0–600 ft bgs)	End Date/Time: 05/26/10 1945 (final R-3 borehole; sampled 600–1077.7 ft bgs)
Drilling Method: Air Rotary	Machine: Schramm T130XD RIG T25	Sampling Method: Grab
Ground Elevation: 6395.31		Total Depth: 1077.7
Driller: H. Waddell, K. Keller, R. Wall, E. Applegarth	Site Geologists: A. Feltman, T. Klepfer, B. Larzelere, D. Staires , S. Thomas, M. Whitson	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
1050–1055	Silty sand and clay and granule-sized gravels, moderately sorted. Gravel subrounded to rounded including mudstone and lesser quartz-rich sandstone, siltstone, and mixed igneous clasts. Gray (10YR6/1) to grayish brown (10YR5/2). WR: Silty sand with clay and gravels. +10F: 60% mixed igneous clasts, 35% mudstone, 5% silt and sandstone. +35F: As above.	**Tsf**	
1055–1060	Fine-grained to very fine-grained sand with trace very coarse-grained sand to granule-sized gravel, well sorted. Sand is predominantly quartz with some lithic clasts, subrounded to well rounded. Very coarse sand to gravel includes sandstone and volcanic lithic clasts. Very pale brown (10YR7/3) to pale brown (10YR6/3). WR: Sand with trace gravel. +10F: 50% quartz sandstone, 50% lithic clasts. +35: Quartz and lithic sand.	**Tsf**	
1060–1065	Fine-grained to very fine-grained sand and coarse-grained sand to granule-sized gravel (50:50), moderately to well sorted. Minor clay. Sand is quartz with some lithic clasts, subrounded to well rounded. Coarser sand and gravels include mudstone, quartz sandstone. Very pale brown (10YR7/3) to pale brown (10YR6/3). WR: Sand and gravel. +10F: 30% mudstone, 40% sandstone, 30% lithic clasts. +35F: quartz and lithic sand and mudstone.	**Tsf**	
1065–1070	Fine-grained to very fine-grained sand with trace very coarse-grained sand to granule-sized gravel, well sorted. Sand is predominantly quartz with some lithic clasts, subrounded to well rounded. Very coarse sand to gravel includes sandstone and volcanic lithic clasts. Very pale brown (10YR7/3) to pale brown (10YR6/3). WR: Sand with trace gravel. +10F: 50% quartz sandstone, 50% lithic clasts. +35F: Quartz and lithic sand.	**Tsf**	
1070–1077.7	Fine-grained to very fine-grained sand and coarse-grained sand to granule-sized gravel and minor silt and clay, moderately sorted. Sand is predominantly quartz and some lithic clasts, subrounded to well rounded. Gravels include volcanic lithic clasts, sandstone, mudstone, and claystone. Very pale brown (10YR7/3) to pale brown (10YR6/3). WR: Sand, gravel, and silty clay. +10F: 70% volcaniclastics, 25% mud and claystone, 5% sandstone. +35F: Quartz and lithic clasts and clay/mud.	**Tsf**	Bottom of borehole is 1077.7 ft bgs

Abbreviations

5YR6/3 = Munsell soil color notation where hue, value, and chroma are expressed (e.g., hue=10YR, value=6, and chroma=3)

35% crystals = visually estimated percentage of material in sieve sample fraction

bgs = below ground surface

ft = foot

Qal = alluvium

Tb 4 = Cerros del Rio volcanic rocks

Tpf = Puye Formation

Tsf = Santa Fe Group

WR = whole rock

+10F = plus No. 10 sieve sample fraction

+35F = plus No. 35 sieve sample fraction

Appendix B

Groundwater Analytical Results

B-1.0 SAMPLING AND ANALYSIS OF GROUNDWATER AT R-3

Six borehole groundwater samples were collected for screening purposes at R-3 during drilling. Four were collected from perched intermediate zone groundwater and two were collected from the regional aquifer, as described below.

- Initial R-3 borehole perched zone samples:
  - GW03-10-16674 from 350–363 ft below ground surface (bgs)
  - GW03-10-16675 from 441 ft bgs
- Final R-3 borehole perched zone samples:
  - GW03-10-16676 from 300 ft bgs
  - GW03-10-16677 from 350 ft bgs
- Final R-3 borehole regional aquifer samples:
  - GW03-10-17505 and GW03-10-17506 from 769 ft bgs

The four perched zone samples were analyzed for anions (including perchlorate), metals, high explosives (HE) compounds, volatile organic compounds (VOCs), and low-level tritium (LH3). The anion and metal analyses were conducted by Los Alamos National Laboratory (LANL or the Laboratory), Earth and Environmental Services Group 14 (EES-14). The HE, VOC, and LH3 analyses were conducted by an off-site laboratory.

The two regional aquifer samples (GW03-10-17505 and GW03-10-17506) were collected at 769 ft bgs from a 5-ft-long interval of open borehole between the bit and the drill casing to assess the groundwater chemistry after mud drilling ceased. Sample GW03-10-17505 was collected after mud polymer additives had been washed from the borehole. Then the borehole water was treated with Aquaclear phosphate-free dispersant (PFD) and sodium hypochlorite (bleach) as a neutralizing technique; sample GW03-10-17506 was taken after the PFD and bleach were added, and after the borehole had been blown out for 4.5 h. These samples were analyzed for total organic carbon (TOC), metals, and anions, including perchlorate by EES-14.

Fourteen groundwater samples were collected from the completed well R-3 during development. These groundwater samples were collected from depths between 812.6 ft bgs and 1001.5 ft bgs. The first two samples collected during well development were analyzed only for TOC; EES-14 analyzed the remaining development samples for TOC as well as metals and anions.

B-1.1 EES-14 Analytical Techniques

Groundwater samples were filtered (0.45-µm membranes) before preservation and chemical analyses. Samples were acidified at the EES-14 wet chemistry laboratory with analytical-grade nitric acid to a pH of 2.0 or less for metal and major cation analyses.

Groundwater samples were analyzed using techniques specified by the U.S. Environmental Protection Agency (EPA) methods for water analyses. Ion chromatography (EPA Method 300, rev. 2.1) was the analytical method for bromide, chloride, fluoride, nitrate, nitrite, oxalate, perchlorate, phosphate, and sulfate. The instrument detection limit for perchlorate was 0.005 ppm using EPA Method 314.0, rev. 1. Total carbonate alkalinity (EPA Method 310.1) was measured using standard titration techniques. The precision limits (analytical error) for major ions and trace elements were generally less than ±7%. TOC analysis was performed per EPA Method 415.1.

Inductively coupled (argon) plasma optical emission spectroscopy (EPA Method 200.7, rev. 4.4) was used for analyses of dissolved aluminum, barium, boron, calcium, total chromium, iron, lithium, magnesium, manganese, potassium, silica, sodium, strontium, titanium, and zinc. Dissolved aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, cesium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, rubidium, selenium, silver, thallium, thorium, tin, vanadium, uranium, and zinc were analyzed by inductively coupled (argon) plasma mass spectrometry (EPA Method 200.8, rev. 5.4). For metals analyzed by both techniques, EES-14 reports the analytical result with the lower concentration.

B-1.2 Field Parameters

B-1.2.1 Well Development

Water samples were drawn from the flow-through cell and field parameters were measured using a YSI multimeter. Field parameter measurements, consisting of pH, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), corrected oxidation-reduction potential (Eh), specific conductance, and turbidity (nephelometric turbidity unit [NTU]), are provided in Table B-1.2-1.

Over the course of development, concentrations of pH and temperature varied from 6.8 to 9.1 and from 16.3°C to 28.1°C, respectively. Reliable concentrations of DO ranged from 0.2 to 8.9 mg/L with many DO values exceeding 9 mg/L, indicating that the meter was likely malfunctioning during those readings.

The bulk of the corrected Eh values, determined from field ORP measurements, varied from approximately 300 to 400 millivolts (mV). However, reading between –14.9 and 287 mV were measured over one 2-d period, again indicating possible equipment malfunction. One outlier was recorded at 1,465.6 mV on the next to the last day of development (Table B-1.2-1).

Four temperature-dependent correction factors for calculating Eh values from field ORP measurements were based on an Ag/AgCl, KCl-saturated filling solution contained in the ORP electrode. The correction factors are 208.9 mV, 203.9 mV, 198.5 mV, and 193.5 mV at 15ºC, 20ºC, 25ºC, and 30ºC, respectively, with most of the temperature measurements close to 25ºC. Most of the corrected Eh values associated with well R-3 are considered to be generally reliable and representative of the known relatively oxidizing conditions of the regional aquifer.

Specific conductance values generally decreased from 266 microsiemens per centimeter (µS/cm) near the beginning of development to 167 µS/cm near the end. Turbidity readings ranged from a high of 125 NTU at the beginning of one day's development to 0.1 to NTU near the end. Overall, turbidity readings were low during development, with approximately 80% of the turbidity measurements less than 5 NTU (Table B-1.2-1).

B-1.3 Analytical Results

Analytical results for off-site laboratory and LANL EES-14 analyses are presented below for the following samples:

- four perched water samples,
- two regional aquifer samples, and
- fourteen well development samples.

Selected analytical results for well development samples are screened against regional aquifer background concentrations developed for the Laboratory as a whole (LANL 2007, 095817). It should be noted that, due to localized variations in geochemistry, background concentrations for the area upgradient of well R-3 may vary.

B-1.3.1 Off-site Laboratory Results for VOCs, HE, and LH3

Offsite laboratory analytical results for the four borehole perched water samples are provided in Table B-1.3-1. One VOC, methyl-2-pentanone, was detected at an estimated concentration of 1.95 μg/L in sample GW03-10-16675 from 441 ft bgs in the initial R-3 borehole. No other VOCs were reported in the four perched zone samples.

HE compounds were not detected in the four perched water samples. LH3 was detected in samples GW03-10-16674 (350–363 ft bgs) and GW03-10-16675 (441 ft bgs) in the initial R-3 borehole, and in sample GW03-10-16677 (350 ft bgs) from the final R-3 borehole at concentrations of 10.05, 6.6, and 10.96 tritium units, or 32.8, 21.5, and 35.7 pCi/L, respectively. A tritium result was not reported for sample GW03-10-16676 in the off-site laboratory analytical data set.

B-1.3.2 EES-14 Results for Metals, Anions, Perchlorate, and TOC

EES-14 analytical results for the 4 borehole perched water samples, the 2 regional samples collected at well R-3 during drilling, and the 12 groundwater samples collected during drilling and well development are provided in Table B-1.3-2. The 6 filtered-borehole samples consisted of disaggregated colloidal aquifer material, drilling material, water used during drilling, and native groundwater.

Perchlorate was not detected in any of the groundwater samples analyzed from R-3.

B-1.3.2.1 Perched Zone Samples

Note that screening results were available for the uppermost perched zone sample (GW03-10-16674) from 350–363 ft bgs in the initial R-3 borehole before that same zone was reached in the final R-3 borehole. Because the concentrations of some constituents in the GW03-10-16674 sample were elevated, a second sample was collected from the same zone in the final R-3 borehole (GW03-10-16677). The results from that sample generally show lower concentrations than in the first sample, so it was concluded that there was some sort of sample interference for the initial borehole sample. The interference in the initial R-3 borehole sample from approximately 350 ft bgs led to an elevated pH reading and may have been associated with grouting uphole. Please refer to Table B-1.3-2 to more easily compare the results from both samples. For the purposes of this section, the data from sample GW03-10-16677 will be presented for the 350 ft bgs perched zone.

Sample GW03-10-16675 from 441 ft bgs, slightly deeper in the initial borehole, also shows an elevated pH, and the analytical results are indicative of interference from uphole grouting as well, although a second sample from the final R-3 borehole at the same depth was not collected.

Note that because the perched zone samples contain borehole fluids, disaggregated colloidal aquifer material, drilling material, water used during drilling, and native groundwater, they will not be screened against background data that were generated from completed, developed intermediate zone wells.

Analytical results for the perched zone samples are presented in the order of their depth, e.g., data from the two perched zone samples from 300 ft bgs and 350 ft bgs in the final R-3 borehole will be presented first, followed by the data from the 441 ft bgs sample from the initial R-3 borehole.

- Dissolved chloride concentrations were 38.54, 47.98, and 73 ppm (see previous paragraph for respective depths of perched zone samples presented in this section).

- Dissolved fluoride concentrations were 0.40, 0.30, and 1.00 ppm.
- Dissolved nitrate (N) concentrations were 1.65, 3.18, and 6.42 ppm.
- Dissolved sulfate concentrations were 27.47, 35.25, and 84.81 ppm.
- Dissolved barium concentrations were 0.187, 0.322, and 1.067 ppm.
- Dissolved total chromium concentrations were 0.006, 0.006, and 0.013 ppm.
- Dissolved molybdenum concentrations were 0.001, 0.002, and 0.027 ppm.
- Dissolved uranium concentrations were 0.0040, 0.0030, and U (<0.0002) ppm.

B-1.3.2.2 Regional aquifer samples

Borehole samples

As previously mentioned, two samples were collected from the regional aquifer from 769 ft bgs, before and after a neutralization technique was used for the open-borehole zone of 764.3 ft bgs to 769.3 ft bgs. This procedure was conducted at the request of the New Mexico Environment Department (NMED). Table B-1.3-3 summarizes the key analytical results for anions and cations from these samples; complete results are shown in Table B-1.3-2.

Well development samples

- Figure B-1.3-1 shows concentrations of dissolved chloride, nitrate(N), and sulfate measured during development at R-3 plotted against the same analytes from inactive supply well Otowi 1 (O-1). As the figure shows, concentrations of these three anions in R-3 are similar to those measured at O-1 during 2010.
- Figure B-1.3-2 shows concentrations of dissolved boron, bromide, and uranium measured during development at well R-3 plotted against concentrations of the same analytes from well O-1. Boron and uranium concentrations from R-3 are similar to those measured at inactive supply well O-1 during 2009. Bromide was not detected in O-1, with detection limits between <0.066 ppm and 0.200 ppm.
- Dissolved iron concentrations ranged from 0.010 to 0.134 ppm. Maximum background concentration for dissolved iron in the regional aquifer is 0.147 mg/L (LANL 2007, 095817).
- Dissolved manganese concentrations ranged from 0.006 to 0.040 ppm. Maximum background concentration for dissolved manganese in the regional aquifer is 0.124 ppm (LANL 2007, 095817).
- Dissolved zinc ranged from 0.007 to 0.069 ppm. Maximum background concentration for dissolved zinc in the regional aquifer is 0.032 ppm (LANL 2007, 095817).
- Concentrations of dissolved barium during development ranged from 0.234 ppm to 0.506 ppm. Maximum background concentration for dissolved barium in the regional aquifer is 0.115 ppm (LANL 2007, 095817).
- Dissolved concentrations of boron ranged from 0.056 ppm to 0.112 ppm in the borehole water samples collected during well development. Maximum background concentration for dissolved boron in the regional aquifer is 0.0516 mg/L (LANL 2007, 095817).
- Concentrations of total dissolved chromium during development ranged from U (<0.001) to 0.004 ppm. Maximum regional aquifer background concentration for total dissolved chromium is 0.0072 ppm (LANL 2007, 095817).

- Concentrations of dissolved uranium varied from 0.0003 ppm to 0.0026 ppm in groundwater samples collected during development. Maximum background concentration of dissolved uranium in the regional aquifer is 0.00250 ppm (LANL 2007, 095817).
- TOC concentrations ranged from U (<0.2) to 0.6 mgC/L), below the well development target of 2 mgC/L.

B-1.4 Summary

In summary, perchlorate and HE compounds were not detected in the perched zone or regional groundwater at R-3. With the exception of one compound, methyl-2-pentanone, with an estimated concentration of 1.95 μg/L, no other VOCs were identified. Tritium was detected at concentrations of 32.8, 21.5 and 35.7 pCi/L in three of the perched zone samples. TOC values in the well development samples were below the target of 2 mgC/L.

Groundwater at well R-3 is relatively oxidizing, based on corrected positive Eh values recorded during well development. Redox conditions are generally similar to other previously drilled wells in the Pueblo watershed.

B-2.0 REFERENCE

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.

LANL (Los Alamos National Laboratory), May 2007. "Groundwater Background Investigation Report, Revision 3," Los Alamos National Laboratory document LA-UR-07-2853, Los Alamos, New Mexico. (LANL 2007, 095817)

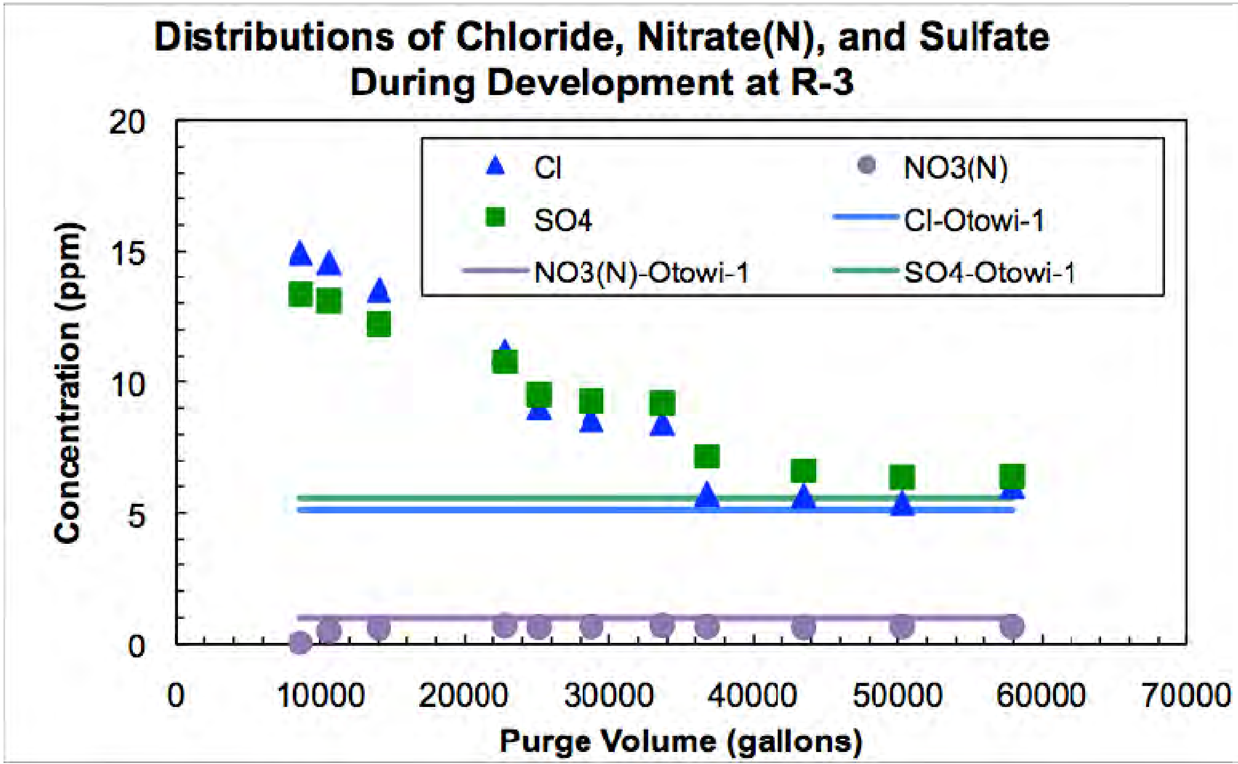


Figure B-1.3-1 **Concentrations of dissolved chloride, nitrate (N), and sulfate during development at well R-3**

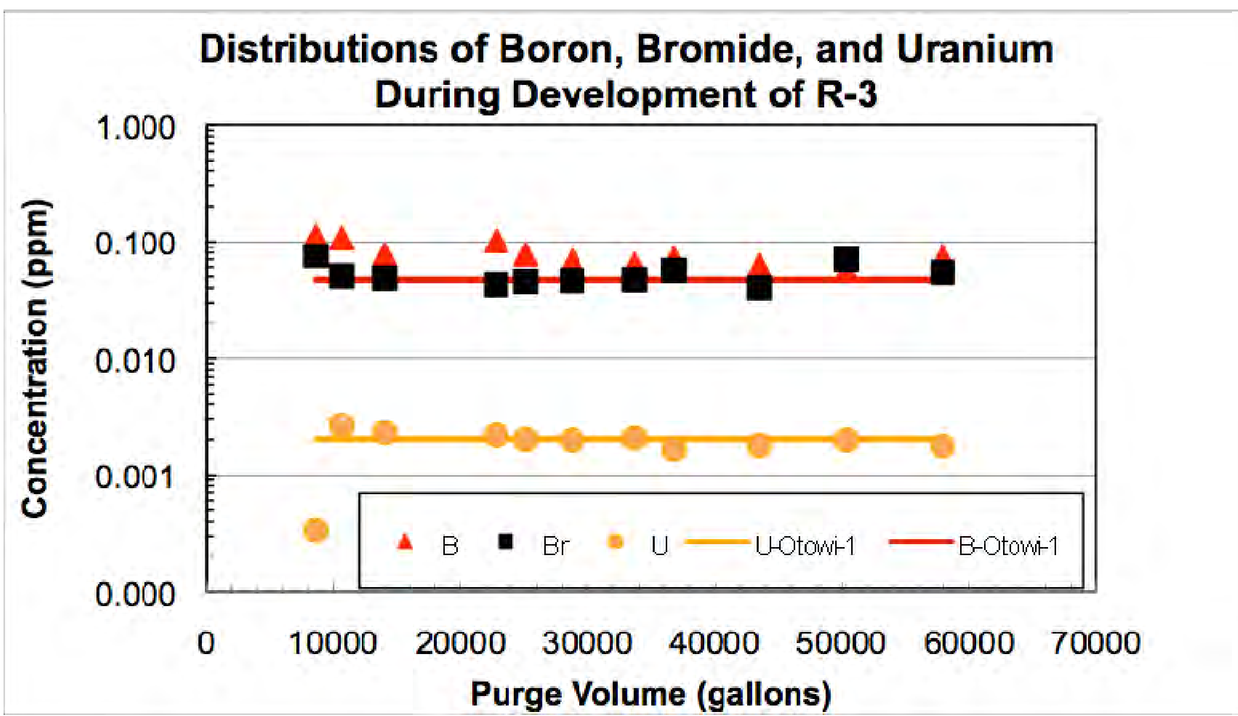


Figure B-1.3-2 **Concentrations of dissolved boron, bromide, and uranium during development at well R-3**

Table B-1.2-1
Well Development Volumes and Associated Field Water-Quality Parameters for R-3

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.)
Well Development (1st 40 hours)										
06/26/10 and 6/27/10	Swabbing and bailing (parameters not recorded)									151
06/27/10	1500	n/r[a]	n/r	n/r	n/r	n/r	n/r	n/r	0	151
	1519	n/r	n/r	n/r	n/r	n/r	n/r	n/r	320	471
	1543	n/r	n/r	n/r	n/r	n/r	n/r	n/r	218	689
	1600	n/r	n/r	n/r	n/r	n/r	n/r	n/r	114	803
	1615	7.8	25.5	161.1	162.5	366.4	265	1.1	67	870
	1645	7.8	24.6	63.0	153.4	357.3	264	2.7	141	1011
	1700	7.8	24.9	67.8	150.8	354.7	266	2.5	79	1090
	1730	7.9	24.7	69.5	154.6	358.5	265	3.3	69	1159
	1815	7.8	23.7	75.3	159.3	363.2	261	2.5	117	1276
	1845	7.8	23.6	67.0	158.3	362.2	262	3.3	44	1320
	1930	7.8	23.2	83.0	157.7	361.6	258	3.8	83	1403
	2000	7.9	22.8	84.2	157.6	361.5	259	5.1	39	1442
	2015	7.9	22.6	75.7	157.6	361.5	261	4.4	25	1467
	2030	7.9	22.6	80.5	159.3	363.2	261	5.3	25	1492
	2045	7.9	22.5	84.5	158.6	362.5	260	5.3	19	1511
	2100	7.9	22.5	83.3	157.7	361.6	260	4.6	38	1549
	2130	7.9	22.4	80.1	157.6	361.5	260	5.1	44	1593
	2200	7.9	22.3	87.3	158.2	362.1	260	3.1	46	1639
	2230	7.9	22.3	82.0	157.7	361.6	260	2.9	53	1692
	2300	7.9	22.2	86.5	157.4	361.3	260	2.7	50	1742
	2330	7.9	22.2	87.1	156.7	360.6	260	2.7	63	1805
	2400	7.9	22.2	85.8	156.0	359.9	259	1.7	60	1865
06/28/10	0745	8.2	19.3	4.6	128.6	332.5	237	56.3	24	1889
	0845	8.2	22.9	5.2	125.3	329.2	249	78.0	83	1972
	0945	8.1	24.4	6.6	129.0	332.9	258	9.6	79	2051
	1045	8.0	25.3	6.5	126.8	330.7	257	7.1	77	2128
	1145	8.0	26.5	6.5	122.2	326.1	257	4.8	78	2206
	1245	8.0	25.3	6.8	116.9	320.8	255	3.8	82	2288
	1345	7.9	24.2	6.9	119.4	323.3	253	3.3	86	2374
	1445	7.9	22.8	7.1	121.4	325.3	251	3.4	77	2451
	1545	7.9	22.5	7.3	118.2	322.1	249	3.4	89	2540

Table B-1.2-1 (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.)
Well Development (1st 40 hours) (continued)										
06/28/10 (continued)	1645	7.9	22.9	7.2	114.4	318.3	249	3.1	73	2613
	1745	7.9	23.2	7.2	113.0	316.9	247	3.2	77	2690
	1845	7.9	23.7	7.3	107.5	311.4	246	3.3	89	2779
	1900	7.9	23.7	7.1	109.9	313.8	246	3.0	19	2798
Aquifer Testing										
06/29/10[b]	1317	n/r	n/r	n/r	n/r	n/r	n/r	n/r	0	2798
	1330	7.4	23.3	1.6	-17.2	186.7	232	139	12	2810
	1430	7.4	27.9	0.7	-44.9	159	223	145	120	2930
	1506	n/r	n/r	n/r	n/r	n/r	n/r	n/r	0	2930
	1530	7.4	24.2	1.3	-38.5	165.4	222	124	50	2980
06/30/10 (step test)	1050	n/r	n/r	n/r	n/r	n/r	n/r	n/r	0	2980
	1130	7.8	23.7	3.4	41.6	245.5	222	53.7	92	3072
	1210	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	3072
	1300	n/r	n/r	n/r	n/r	n/r	n/r	n/r	0	3072
	1403	n/r	n/r	n/r	n/r	n/r	n/r	n/r	317	3389
07/01/10 (24-h test)	0900	n/r	n/r	n/r	n/r	n/r	n/r	n/r	0	3389
	0920	8.3	18.8	2.6	-56.1	147.8	207	129	35.1	3424.1
	1020	8.1	24.7	8.8	55.8	259.7	224	8.1	198.3	3622.4
	1200	8.0	25.1	8.5	76.2	280.1	230	8.2	278.9	3901.3
	1300	8.0	25.4	8.8	86.9	290.8	229	7.4	142	4043.3
	1400	8.0	25.9	8.8	90.1	294	228	6.6	134.7	4178
	1500	8.0	26.2	8.9	89.5	293.4	227	6.1	136.7	4314.7
	1600	8.0	26.1	8.8	89.5	293.4	226	6.4	133.0	4447.7
	1700	8.0	25.5	9.1	89.4	293.3	224	5.1	135.0	4582.7
	1800	8.0	25.3	9.2	87.1	291	224	5.4	133.6	4716.3
	1900	8.0	24.7	9.4	90.6	294.5	223	5.6	132.5	4848.8
	2000	7.9	24.2	9.6	99.3	303.2	222	5.1	131.6	4980.4
	2100	7.9	24.1	9.7	103.6	307.5	221	5.5	137.1	5117.5
	2200	8.0	24.1	9.7	106.7	310.6	220	5.1	135.4	5252.9
	2300	8.0	24.0	9.6	109.9	313.8	219	4.6	128.2	5381.1
	2330	8.0	24.0	9.8	112.3	316.2	220	4.2	67.1	5448.2
	2400	8.0	23.9	9.8	113.7	317.6	219	3.9	83.5	5531.7
07/02/10 (24-h test)	0100	8.0	23.9	9.9	114.0	317.9	219	2.6	108	5639.7
	0200	8.0	24.0	9.8	115.7	319.6	219	2.2	131.3	5771
	0300	8.0	23.9	10.1	116.8	320.7	219	2.0	128	5899

Table B-1.2-1 (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.)
Aquifer Testing (continued)										
07/02/10 (24-h test)	0400	8.0	23.9	10.0	118.6	322.5	219	1.9	135.3	6034.3
	0500	8.0	24.0	10.1	119.4	323.3	219	1.4	119.1	6153.4
	0600	8.0	24.0	10.1	121.7	325.6	219	1.8	126.8	6280.2
	0700	8.0	24.0	10.2	122.4	326.3	219	1.5	127.8	6408
	0800	8.0	24.3	10.1	122.3	326.2	219	1.6	125.5	6533.5
	0900	8.0	25.2	10.0	120.6	324.5	220	1.2	128.7	6662.2
Well Development										
07/11/10	1244	8.0	20.2	0.5	-74.2	129.7	158	65.4	52	6714.2
	1300	9.1	24.1	0.2	-218.8	-14.9	151	90.7	21	6735.2
	1315	7.8	22.9	1.8	-45.0	158.9	237	80.6	24	6759.2
	1330	8.0	22.4	2.9	-51.8	152.1	240	49.2	31	6790.2
	1345	8.1	22.4	2.9	-70.6	133.3	242	32.0	35	6825.2
	1400	8.2	23.5	4.5	32.0	235.9	231	11.1	65	6890.2
	1500	8.3	24.4	5.0	56.6	260.5	231	3.3	163	7053.2
	1600	8.2	25.1	5.6	65.1	269	233	2.4	190	7243.2
	1700	8.1	24.5	5.8	72.2	276.1	234	2.1	174	7417.2
	1800	8.1	24.2	6.5	83.8	287.7	234	2.2	189	7606.2
07/12/10	0949	8.1	28.1	1.4	67.9	271.8	240	27.9	n/r	7606.2
	1000	8.1	17.6	0.6	64.4	268.3	191	70.8	29.5	7635.7
	1015	8.3	21.6	1.1	48.4	252.3	194	90.4	40.3	7676
	1030	8.3	25.2	0.9	53.5	257.4	196	24.4	24.9	7700.9
	1045	8.0	22.9	4.4	69.8	273.7	222	12.9	24.0	7724.9
	1100	8.0	24.6	5.5	69.8	273.7	226	9.8	76.2	7801.1
	1200	8.0	25.0	5.2	73.0	276.9	229	2.1	297.1	8098.2
	1300	8.0	26.1	6.2	66.8	270.7	231	2.1	284.3	8382.5
	1400	8.0	26.7	6.2	72.8	276.7	231	2.7	249.5	8632
07/19/10	1222	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	8632
	1235	7.5	20.8	n/r	n/r	n/r	221	42.4	74.1	8706.1
	1335	8.1	25.1	6.8	47.2	251.1	217	2.4	321.2	9027.3
	1435	7.4	25.0	8.1	98.6	302.5	219	1.3	321.2	9348.5
	1535	7.9	25.0	9.7	84.2	288.1	223	1.7	327.5	9676
	1635	7.5	25.6	9.6	77.7	281.6	226	1.8	321.5	9997.5
	1735	7.7	25.6	10.0	72.3	276.2	227	1.7	314.0	10,311.5
	1835	6.8	25.6	8.7	96.9	300.8	226	1.5	310.5	10,622
	1900	7.7	25.4	9.2	69.4	273.3	226	1.7	128.1	10,750.1

Table B-1.2-1 (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.)
Well Development (continued)										
07/20/10	0707	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	10,750.1
	0715	6.0	15.7	5.9	262.0	465.9	202	60.9	42.9	10,793
	0815	8.0	24.3	10.9	149.1	353.0	224	3.4	319.0	11,112
	0915	7.9	25.0	9.9	149.2	353.1	224	1.7	308.2	11,420.2
	1015	7.9	25.1	10.4	144.6	348.5	224	1.5	310.7	11,730.9
	1115	7.9	25.7	9.9	142.4	346.3	224	1.2	309.1	12,040
	1215	7.9	25.9	11.1	135.5	339.4	223	1.1	303.5	12,343.5
	1315	7.8	26.2	11.2	139.3	343.2	223	1.1	303.0	12,646.5
	1415	7.9	25.3	12.1	116.0	319.9	222	1.5	300.0	12,946.5
	1515	7.9	25.1	12.6	125.5	329.4	221	1.3	301.0	13,247.5
	1615	7.9	25.1	12.7	126.2	330.1	220	1.2	305.5	13,553
	1715	7.9	25.2	13.0	127.3	331.2	219	1.1	305.5	13,858.5
	1755	7.8	25.1	10.8	128.4	332.3	219	1.1	199.8	14,058.3
07/21/10	0708	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	14,058.3
	0730	8.0	22.1	11.7	128.7	332.6	217	6.0	112.8	14,171.1
	0830	7.9	24.9	13.5	134.6	338.5	216	1.3	376.8	14,547.9
	0930	7.9	25.3	15.2	139.5	343.4	215	1.0	397.0	14,944.9
	1030	7.9	25.4	14.0	134.1	338.0	214	0.8	394.1	15,339.0
	1130	7.8	25.5	17.6	134.8	338.7	212	1.2	366.8	15,705.8
	1230	7.9	25.4	15.0	127.8	331.7	213	1.4	432.7	16,138.5
	1330	7.8	25.8	14.3	125.5	329.4	213	0.8	353.0	16,491.5
	1430	7.8	25.6	14.9	128.1	332.0	212	0.7	371.9	16,863.4
	1530	7.8	25.8	14.8	128.5	332.4	210	1.0	393.6	17,257.0
	1630	7.8	25.5	15.3	121.6	325.5	209	0.6	393.3	17,650.3
	1730	7.8	25.5	15.4	136.0	339.9	208	0.6	394.7	18,045.0
	1830	7.7	25.3	14.8	136.8	340.7	207	0.7	394.1	18,439.1
	1900	7.8	25.3	14.6	132.8	336.7	207	0.8	212.2	18,651.3
07/22/10	0715	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	18,651.3
	0725	8.0	16.3	11.5	165.5	369.4	187	20.3	60.2	18,711.5
	0825	8.0	24.7	13.5	151.4	355.3	206	1.4	375.2	19,086.7
	0925	7.9	25.0	14.6	155.6	359.5	205	0.7	372.5	19,459.2
	1025	7.9	25.2	12.9	146.9	350.8	204	0.7	372.4	19,831.6
	1125	7.9	25.5	13.9	144.5	348.4	204	0.5	373.1	20,204.7
	1225	7.9	25.8	13.7	138.6	342.5	203	0.6	372.3	20,577.0
	1325	7.9	25.4	13.0	118.9	322.8	202	0.6	370.0	20,947.0

Table B-1.2-1 (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.)
Well Development (continued)										
07/22/10 (continued)	1425	7.9	25.6	13.0	112.7	316.6	202	0.7	371.1	21,318.1
	1525	7.8	25.6	15.5	132.5	336.4	200	0.3	372.5	21,690.6
	1625	7.8	25.6	15.8	122.9	326.8	199	0.4	372.9	22,063.5
	1725	7.8	25.4	14.7	121.7	325.6	199	0.4	373.0	22,436.5
	1825	7.8	25.5	14.2	112.4	316.3	198	0.4	373.9	22,810.4
07/26/10	1150	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	22,810.4
	1200	6.8	18.1	0.2	-100.4	103.5	140	96.3	70.5	22,880.9
	1300	n/r[b]	n/r[b]	n/r[b]	n/r[b]	n/r[b]	n/r[b]	n/r	376.1	23,257.0
	1400	8.0	24.8	15.9	111.2	315.1	207	0.7	378.7	23,635.7
	1500	8.0	25.1	17.5	116.1	320.0	204	0.9	373.9	24,009.6
	1600	8.0	25.2	17.5	115.9	319.8	203	1.1	374.0	24,383.6
	1700	8.0	25.0	17.9	118.0	321.9	202	0.6	375.1	24,758.7
	1800	7.9	25.1	18.5	134.8	338.7	201	0.8	378.9	25,137.6
07/27/10	0830	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	25,137.6
	0900	8.0	23.6	18.7	94.1	298.0	202	2.3	184.9	25,322.5
	1000	8.0	24.9	18.7	98.4	302.3	202	1.2	379.8	25,702.3
	1100	8.0	25.3	18.9	103.5	307.4	201	1.0	380.4	26,082.7
	1200	7.9	25.5	18.8	110.3	314.2	200	1.5	385.3	26,468.0
	1300	7.9	25.5	19.2	114.3	318.2	200	0.8	385.5	26,853.5
	1400	7.9	25.5	19.3	103.4	307.3	199	0.7	385.2	27,238.7
	1500	7.9	25.6	19.3	103.1	307.0	199	0.7	388.3	27,627.0
	1600	7.9	25.4	19.3	108.6	312.5	198	0.7	386.5	28,013.5
	1700	7.8	25.4	19.4	105.6	309.5	197	0.6	381.6	28,395.1
	1800	7.8	25.3	18.9	108.5	312.4	197	0.5	381.1	28,776.2
07/28/10	0705	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	28,776.2
	0800	8.1	24.6	17.0	78.2	309.1	200	1.1	342.1	29,118.3
	0900	8.0	25.0	18.2	96.4	327.3	196	0.8	390.0	29,508.3
	1000	8.0	25.3	17.7	100.8	331.7	195	0.6	386.7	29,895.0
	1100	8.0	25.4	17.5	103.9	334.8	195	0.6	382.2	30,277.2
	1200	8.0	25.7	17.3	98.6	329.5	194	0.4	386.2	30,663.4
	1300	8.0	25.4	17.7	95.2	326.1	193	0.3	387.4	31,050.8
	1400	8.0	25.3	17.2	106.5	337.4	193	0.5	388.3	31,439.1
	1500	8.0	25.5	17.6	101.5	332.4	192	0.3	390.0	31,829.1
	1600	8.0	25.7	17.6	92.0	322.9	192	0.4	387.9	32,217.0
	1700	8.0	25.4	16.9	101.7	332.6	192	0.6	381.5	32,598.5

Table B-1.2-1 (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.)
Well Development (continued)										
07/28/10 (continued)	1800	7.9	25.3	17.4	112.4	343.3	191	0.6	379.2	32,977.7
	1900	7.9	25.3	17.9	119.8	350.7	191	0.5	377.1	33,354.8
	1945	7.9	25.2	18.2	120.9	351.8	191	0.5	290.6	33,645.4
08/14/10	1043	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	33,645.4
	1049	8.3	18.2	0.7	80.9	311.8	119	67.0	50.5	33,695.9
	1055	7.7	23.2	6.7	131.9	362.8	183	67.9	8.7	33,704.6
	1100	8.2	24.0	11.1	101.0	331.9	186	37.2	32.8	33,737.4
	1110	8.2	24.5	13.6	96.9	327.8	188	17.3	68.2	33,805.6
	1130	8.3	28.7	4.9	99.6	330.5	201	5.8	134.6	33,940.2
	1200	8.2	25.1	6.2	99.0	329.9	202	1.5	201.6	34,141.8
	1300	8.2	25.4	8.7	120.2	351.1	202	0.9	413.7	34,555.5
	1400	8.1	25.7	12.3	87.9	318.8	200	2.0	390.5	34,946.0
	1500	8.0	25.1	10.8	108.7	339.6	195	2.5	397.4	35,343.4
	1600	8.1	25.5	11.7	108.2	339.1	191	2.3	394.8	35,738.2
	1700	8.0	25.5	12.0	121.1	352.0	188	2.0	396.8	36,135.0
	1800	8.0	25.4	12.4	115.9	346.8	186	1.8	396.7	36,531.7
	1840	8.0	25.3	15.1	120.4	351.3	185	1.6	265.8	36,797.5
	1845	n/r	n/r	n/r	n/r	n/r	n/r	n/r	27.8	36,825.3
08/15/10	0725	6.3	16.5	17.0	252.6	483.5	165	125.0	10.0	36,835.3
	0730	8.0	20.0	14.4	146.8	377.7	174	27.2	40.1	36,875.4
	0745	8.1	23.7	13.9	120.7	351.6	179	2.5	122.0	36,997.4
	0800	8.2	24.4	12.7	117.3	348.2	187	1.7	125.1	37,122.5
	0900	8.1	25.2	12.1	112.7	343.6	180	1.2	501.5	37,624.0
	0915	8.0	25.6	14.7	114.1	345.0	180	1.2	135.2	37,759.2
	0925	8.1	26.0	10.8	107.7	338.6	180	1.2	96.8	37,856.0
	0935	8.1	25.5	13.4	108.9	339.8	178	1.3	96.3	37,952.3
	1000	8.0	28.8	12.5	107.7	338.6	174	0.8	243.0	38,195.3
	1100	8.0	26.2	14.0	106.6	337.5	179	0.2	579.1	38,774.4
	1120	8.0	25.8	13.2	92.9	323.8	178	0.6	191.8	38,966.2
	1140	8.0	25.7	12.6	102.9	333.8	180	1.5	99.8	39,066.0
	1200	8.1	26.8	11.5	100.7	331.6	180	1.5	213.1	39,279.1
	1215	8.0	26.6	11.3	99.2	330.1	179	1.0	165.9	39,445.0
	1230	8.0	26.4	12.8	101.3	332.2	180	1.3	166.5	39,611.5
	1300	8.1	27.1	12.4	96.0	326.9	180	0.9	333.9	39,945.4
	1400	8.0	27.4	11.4	87.3	318.2	179	1.0	663.7	40,609.1

Table B-1.2-1 (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.)
Well Development (continued)										
08/15/10 (continued)	1500	8.1	28.5	11.3	85.3	316.2	180	0.7	659.6	41,268.7
	1515	8.0	26.2	13.5	88.3	319.2	178	0.9	173.7	41,442.4
	1530	8.0	25.8	14.7	95.5	326.4	178	0.6	178.8	41,621.2
	1540	8.0	25.7	15.0	102.2	333.1	179	1.1	127.4	41,748.6
	1745	8.0	24.8	14.7	124.7	355.6	176	0.5	1589.9	43,338.5
	1800	8.0	24.8	15.2	124.6	355.5	177	0.6	189.2	43,527.7
08/16/10	0920	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r	43,527.7
	0930	7.8	23.2	13.8	118.4	349.3	171	11.8	113.1	43,640.8
	0940	8.1	24.5	13.7	100.8	331.7	179	2.3	114.6	43,755.4
	1001	8.1	24.9	13.7	102.6	333.5	172	1.0	240.0	43,995.4
	1015	8.1	25.2	12.4	106.1	337.0	170	1.1	161.7	44,157.1
	1030	8.0	25.3	14.5	105.3	336.2	169	0.9	174.2	44,331.3
	1036	8.0	25.4	15.0	106.9	337.8	171	0.7	70.8	44,402.1
	1040	8.0	25.4	14.4	105.4	336.3	168	1.3	49.8	44,451.9
	1130	8.0	25.7	13.2	107.2	338.1	170	0.4	619.2	45,071.1
	1140	8.0	25.7	13.6	107.5	338.4	169	1.0	135.0	45,206.1
	1200	8.0	25.8	13.1	107.7	338.6	170	0.6	273.3	45,479.4
	1300	8.0	26.0	12.9	104.5	335.4	169	0.2	838.2	46,317.6
	1400	8.0	25.4	13.3	94.1	325.0	170	0.6	844.5	47,162.1
	1415	8.0	25.2	12.9	96.3	327.2	169	0.6	218.0	47,380.1
	1700	7.9	24.3	19.5**	128.2	359.1	169	1.0	1597.5	48,977.6
	1720	8.0	24.9	12.4	125.5	356.4	169	3.1	224.0	49,201.6
	1730	8.0	25.3	13.4	125.1	356.0	169	1.5	153.1	49,354.7
	1745	8.0	25.4	11.3	126.3	357.2	169	1.7	237.0	49,591.7
	1755	8.0	25.4	11.5	122.5	353.4	169	2.5	166.1	49,757.8
	1800	8.0	25.5	10.5	120.8	351.7	169	9.8[c]	102.8	49,860.6
	1807	8.0	25.3	13.2	121.8	352.7	170	9.4[c]	147.2	50,007.8
	1815	8.0	24.9	10.6	122.4	353.3	169	4.7	148.1	50,155.9
	1825	8.0	25.5	11.1	123.5	354.4	169	2.2	182.8	50,338.7
	1925	8.0	25.1	12.7	129.0	359.9	168	0.5	648.2	50,986.9
	2025	8.0	24.9	11.2	1234.7	1465.6	168	0.1	614.0	51,600.9
	2125	7.2	24.8	12.0	176.8	407.7	167	0.3	604.6	52,205.5
	2225	8.0	24.0	11.8	137.2	368.1	166	0.1	615.1	52,820.6
	2325	8.0	25.3	12.9	147.5	378.4	167	0.2	627.2	53,447.8

Table B-1.2-1 (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.)
Well Development (continued)										
08/17/10	0024	7.7	25.2	12.6	154.3	385.2	168	0.1	609.1	54,056.9
	0125	7.4	24.9	13.0	176.0	406.9	167	0.1	586.3	54,643.2
	0225	7.3	25.2	10.8	180.6	411.5	167	0.1	621.0	55,264.2
	0325	7.3	24.9	11.9	178.1	409.0	167	0.1	612.5	55,876.7
	0425	8.0	25.0	12.3	148.7	379.6	166	0.2	603.1	56,479.8
	0525	8.0	25.0	15.8	146.8	377.7	167	0.3	602.8	57,082.6
	0625	8.0	25.0	14.3	145.2	376.1	167	0.3	608.9	57,691.5
	0650	8.0	24.8	13.4	150.1	381.0	167	0.3	257.1	57,948.6

[a] nr = Not recorded.

[b] YSI meter being calibrated.

[c] Possibly caused by very high volume of water moving through the flow cell.

Table B-1.3-1
Analytical Results By Event ID

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3037	GW03-10-16674	LH3[a]	Generic:Low_Level_Tritium	Tritium	10.05	TU[b]	NQ[c]
10-2920	GW03-10-16674	HE[d]	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	1.3	µg/L	U[e]
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	1.3	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	1.3	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	HMX[f]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Nitrobenzene	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	0.649	µg/L	UJ[g]
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	PETN[h]	1.3	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	RDX[i]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	TATB[j]	1.3	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Tetryl	0.649	µg/L	R[k]
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	0.325	µg/L	U
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	0.325	µg/L	UJ
10-2920	GW03-10-16674	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	1.3	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Aluminum	87300	µg/L	NQ[l]
10-2920	GW03-10-16674	METALS	SW-846:6020	Antimony	3	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6020	Arsenic	5	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Barium	1070	µg/L	NQ

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16674	METALS	SW-846:6010B	Beryllium	3.17	µg/L	J[m]
10-2920	GW03-10-16674	METALS	SW-846:6010B	Boron	94.2	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6020	Cadmium	1	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Calcium	254000	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6020	Chromium	10	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Cobalt	55.3	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6010B	Copper	134	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6010B	Iron	114000	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6020	Lead	2	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Magnesium	42200	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6010B	Manganese	2900	µg/L	NQ
10-2920	GW03-10-16674	METALS	EPA:245.2	Mercury	0.2	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6020	Molybdenum	0.196	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6020	Nickel	2	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Potassium	141000	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6020	Selenium	5	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6020	Silver	1	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Sodium	117000	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6010B	Strontium	1560	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6020	Thallium	1	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Tin	500	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6020	Uranium	0.2	µg/L	U
10-2920	GW03-10-16674	METALS	SW-846:6010B	Vanadium	228	µg/L	NQ
10-2920	GW03-10-16674	METALS	SW-846:6010B	Zinc	326	µg/L	J+[n]
10-2920	GW03-10-16674	VOC[o]	SW-846:8260B	Acetone	10	µg/L	UJ
10-2920	GW03-10-16674	VOC	SW-846:8260B	Acetonitrile	25	µg/L	R

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16674	VOC	SW-846:8260B	Acrolein	5	µg/L	R
10-2920	GW03-10-16674	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Benzene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Bromoform	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
10-2920	GW03-10-16674	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Carbon disulfide	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Carbon tetrachloride	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chloroform	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chloromethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dibromo-3-chloropropane[1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	UJ
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Diethyl ether	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Ethyl methacrylate	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
10-2920	GW03-10-16674	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	R
10-2920	GW03-10-16674	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16674	VOC	SW-846:8260B	Methyl methacrylate	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Methyl tert-butyl ether	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Methylene chloride	10	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Propionitrile	5	µg/L	R
10-2920	GW03-10-16674	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Styrene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Toluene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	UJ
10-2920	GW03-10-16674	VOC	SW-846:8260B	Vinyl chloride	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
10-2920	GW03-10-16674	VOC	SW-846:8260B	Xylene[1,3-]+xylene[1,4-]	2	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16674	WET_CHEM	SM:A2340B	Hardness	808	mg/L	NQ
10-2954	GW03-10-16675	LH3	Generic:Low_Level_Tritium	Tritium	6.6122	TU	J
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	13	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	13	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	13	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	HMX	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Nitrobenzene	3.25	µg/L	UJ
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	3.25	µg/L	UJ
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	3.25	µg/L	UJ
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	6.49	µg/L	UJ
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	PETN	13	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	RDX	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	TATB	13	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Tetryl	6.49	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	3.25	µg/L	U
10-2937	GW03-10-16675	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	13	µg/L	U
10-2937	GW03-10-16675	METALS	SW-846:6010B	Aluminum	12400	µg/L	J
10-2937	GW03-10-16675	METALS	SW-846:6020	Antimony	1.24	µg/L	J
10-2937	GW03-10-16675	METALS	SW-846:6020	Arsenic	5	µg/L	U
10-2937	GW03-10-16675	METALS	SW-846:6010B	Barium	385	µg/L	NQ

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2937	GW03-10-16675	METALS	SW-846:6010B	Beryllium	3	µg/L	J
10-2937	GW03-10-16675	METALS	SW-846:6010B	Boron	143	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6020	Cadmium	0.307	µg/L	J
10-2937	GW03-10-16675	METALS	SW-846:6010B	Calcium	137000	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6020	Chromium	43.9	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6010B	Cobalt	20.2	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6010B	Copper	19.1	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6010B	Iron	24500	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6020	Lead	21.5	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6010B	Magnesium	14100	µg/L	J-[p]
10-2937	GW03-10-16675	METALS	SW-846:6010B	Manganese	1340	µg/L	J-
10-2937	GW03-10-16675	METALS	EPA:245.2	Mercury	0.2	µg/L	U
10-2937	GW03-10-16675	METALS	SW-846:6020	Molybdenum	26.4	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6020	Nickel	39.1	µg/L	J-
10-2937	GW03-10-16675	METALS	SW-846:6010B	Potassium	40700	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6020	Selenium	5	µg/L	U
10-2937	GW03-10-16675	METALS	SW-846:6020	Silver	1	µg/L	U
10-2937	GW03-10-16675	METALS	SW-846:6010B	Sodium	84900	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6010B	Strontium	810	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6020	Thallium	0.556	µg/L	J
10-2937	GW03-10-16675	METALS	SW-846:6010B	Tin	10	µg/L	U
10-2937	GW03-10-16675	METALS	SW-846:6020	Uranium	3.13	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6010B	Vanadium	45.6	µg/L	NQ
10-2937	GW03-10-16675	METALS	SW-846:6010B	Zinc	363	µg/L	NQ
10-2937	GW03-10-16675	VOC	SW-846:8260B	Acetone	10	µg/L	R
10-2937	GW03-10-16675	VOC	SW-846:8260B	Acetonitrile	25	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2937	GW03-10-16675	VOC	SW-846:8260B	Acrolein	5	µg/L	R
10-2937	GW03-10-16675	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Benzene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Bromoform	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
10-2937	GW03-10-16675	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Carbon disulfide	5	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Carbon tetrachloride	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chloroform	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chloromethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dibromo-3-chloropropane[1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	UJ
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Diethyl ether	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Ethyl methacrylate	5	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
10-2937	GW03-10-16675	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	R
10-2937	GW03-10-16675	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2937	GW03-10-16675	VOC	SW-846:8260B	Methyl methacrylate	5	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Methyl tert-butyl ether	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	1.95	µg/L	J
10-2937	GW03-10-16675	VOC	SW-846:8260B	Methylene chloride	10	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Propionitrile	5	µg/L	R
10-2937	GW03-10-16675	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Styrene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Toluene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	UJ
10-2937	GW03-10-16675	VOC	SW-846:8260B	Vinyl chloride	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
10-2937	GW03-10-16675	VOC	SW-846:8260B	Xylene[1,3-]+xylene[1,4-]	2	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2937	GW03-10-16675	WET_CHEM	SM:A2340B	Hardness	401	mg/L	NQ
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	1.3	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	1.3	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	1.3	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	HMX	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Nitrobenzene	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	0.649	µg/L	UJ
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	PETN	1.3	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	RDX	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	TATB	1.3	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Tetryl	0.649	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	0.325	µg/L	U
10-3094	GW03-10-16676	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	1.3	µg/L	U
10-3094	GW03-10-16676	METALS	SW-846:6010B	Aluminum	88300	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6020	Antimony	3	µg/L	UJ
10-3094	GW03-10-16676	METALS	SW-846:6020	Arsenic	9.13	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6010B	Barium	1020	µg/L	J+
10-3094	GW03-10-16676	METALS	SW-846:6010B	Beryllium	2.21	µg/L	J

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16676	METALS	SW-846:6010B	Boron	111	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6020	Cadmium	1.41	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6010B	Calcium	134000	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6020	Chromium	67.5	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6010B	Cobalt	46.4	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6010B	Copper	87.8	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6010B	Iron	75800	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6020	Lead	23	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6010B	Magnesium	43400	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6010B	Manganese	1820	µg/L	J+
10-3094	GW03-10-16676	METALS	EPA:245.2	Mercury	2	µg/L	U
10-3094	GW03-10-16676	METALS	SW-846:6020	Molybdenum	6.56	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6020	Nickel	123	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6010B	Potassium	17800	µg/L	J+
10-3094	GW03-10-16676	METALS	SW-846:6020	Selenium	25	µg/L	UJ
10-3094	GW03-10-16676	METALS	SW-846:6020	Silver	0.741	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6010B	Sodium	63600	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6010B	Strontium	1000	µg/L	J+
10-3094	GW03-10-16676	METALS	SW-846:6020	Thallium	0.754	µg/L	U
10-3094	GW03-10-16676	METALS	SW-846:6010B	Tin	500	µg/L	UJ
10-3094	GW03-10-16676	METALS	SW-846:6020	Uranium	8.34	µg/L	NQ
10-3094	GW03-10-16676	METALS	SW-846:6010B	Vanadium	152	µg/L	J
10-3094	GW03-10-16676	METALS	SW-846:6010B	Zinc	153	µg/L	J
10-3094	GW03-10-16676	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
10-3094	GW03-10-16676	VOC	SW-846:8260B	Acetonitrile	25	µg/L	R
10-3094	GW03-10-16676	VOC	SW-846:8260B	Acrolein	5	µg/L	R

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16676	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Benzene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Bromoform	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	UJ
10-3094	GW03-10-16676	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16676	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	UJ
10-3094	GW03-10-16676	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Carbon Disulfide	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Carbon Tetrachloride	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chloroform	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chloromethane	1	µg/L	UJ
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dibromo-3-chloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Diethyl ether	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Ethyl methacrylate	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	UJ
10-3094	GW03-10-16676	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16676	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	R
10-3094	GW03-10-16676	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Methyl methacrylate	5	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16676	VOC	SW-846:8260B	Methyl tert-butyl ether	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Methylene chloride	10	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Propionitrile	5	µg/L	R
10-3094	GW03-10-16676	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Styrene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Toluene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Vinyl Chloride	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
10-3094	GW03-10-16676	VOC	SW-846:8260B	Xylene[1,3-]+xylene[1,4-]	2	µg/L	U
10-3094	GW03-10-16676	WET_CHEM	SM:A2340B	Hardness	513	mg/L	NQ

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3123	GW03-10-16677	LLH3	Generic:Low_Level_Tritium	Tritium	10.95	TU	NQ
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	2,4-Diamino-6-nitrotoluene	1.3	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	2,6-Diamino-4-nitrotoluene	1.3	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	3,5-Dinitroaniline	1.3	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Amino-2,6-dinitrotoluene[4-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Amino-4,6-dinitrotoluene[2-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Dinitrobenzene[1,3-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Dinitrotoluene[2,4-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Dinitrotoluene[2,6-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	HMX	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Nitrobenzene	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Nitrotoluene[2-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Nitrotoluene[3-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Nitrotoluene[4-]	0.649	µg/L	UJ
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	PETN	1.3	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	RDX	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	TATB	1.3	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Tetryl	0.649	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Trinitrobenzene[1,3,5-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Trinitrotoluene[2,4,6-]	0.325	µg/L	U
10-3094	GW03-10-16677	HE	SW-846:8321A_MOD	Tris (o-cresyl) phosphate	1.3	µg/L	U
10-3094	GW03-10-16677	METALS	SW-846:6010B	Aluminum	31500	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6020	Antimony	3	µg/L	UJ
10-3094	GW03-10-16677	METALS	SW-846:6020	Arsenic	6.64	µg/L	NQ
10-3094	GW03-10-16677	METALS	SW-846:6010B	Barium	455	µg/L	J+
10-3094	GW03-10-16677	METALS	SW-846:6010B	Beryllium	5	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16677	METALS	SW-846:6010B	Boron	177	µg/L	NQ
10-3094	GW03-10-16677	METALS	SW-846:6020	Cadmium	0.465	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6010B	Calcium	110000	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6020	Chromium	24.7	µg/L	NQ
10-3094	GW03-10-16677	METALS	SW-846:6010B	Cobalt	18.5	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6010B	Copper	36.8	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6010B	Iron	30500	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6020	Lead	8.21	µg/L	NQ
10-3094	GW03-10-16677	METALS	SW-846:6010B	Magnesium	27800	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6010B	Manganese	844	µg/L	J+
10-3094	GW03-10-16677	METALS	EPA:245.2	Mercury	2	µg/L	U
10-3094	GW03-10-16677	METALS	SW-846:6020	Molybdenum	2.41	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6020	Nickel	47.8	µg/L	NQ
10-3094	GW03-10-16677	METALS	SW-846:6010B	Potassium	10200	µg/L	J+
10-3094	GW03-10-16677	METALS	SW-846:6020	Selenium	5	µg/L	UJ
10-3094	GW03-10-16677	METALS	SW-846:6020	Silver	0.839	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6010B	Sodium	36200	µg/L	NQ
10-3094	GW03-10-16677	METALS	SW-846:6010B	Strontium	542	µg/L	J+
10-3094	GW03-10-16677	METALS	SW-846:6020	Thallium	1	µg/L	U
10-3094	GW03-10-16677	METALS	SW-846:6010B	Tin	500	µg/L	UJ
10-3094	GW03-10-16677	METALS	SW-846:6020	Uranium	6.73	µg/L	NQ
10-3094	GW03-10-16677	METALS	SW-846:6010B	Vanadium	61.3	µg/L	J
10-3094	GW03-10-16677	METALS	SW-846:6010B	Zinc	72.5	µg/L	J
10-3094	GW03-10-16677	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
10-3094	GW03-10-16677	VOC	SW-846:8260B	Acetonitrile	25	µg/L	R
10-3094	GW03-10-16677	VOC	SW-846:8260B	Acrolein	5	µg/L	R

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16677	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Benzene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Bromoform	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	UJ
10-3094	GW03-10-16677	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16677	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	UJ
10-3094	GW03-10-16677	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Carbon disulfide	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Carbon tetrachloride	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chloroform	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chloromethane	1	µg/L	UJ
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dibromo-3-chloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Diethyl ether	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Ethyl methacrylate	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	UJ
10-3094	GW03-10-16677	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16677	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	R
10-3094	GW03-10-16677	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Methyl methacrylate	5	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16677	VOC	SW-846:8260B	Methyl tert-butyl ether	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Methylene chloride	10	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Propionitrile	5	µg/L	R
10-3094	GW03-10-16677	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Styrene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Toluene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Vinyl chloride	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
10-3094	GW03-10-16677	VOC	SW-846:8260B	Xylene[1,3-]+xylene[1,4-]	2	µg/L	U
10-3094	GW03-10-16677	WET_CHEM	SM:A2340B	Hardness	388	mg/L	NQ

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16669	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
10-2920	GW03-10-16669	VOC	SW-846:8260B	Acetonitrile	25	µg/L	R
10-2920	GW03-10-16669	VOC	SW-846:8260B	Acrolein	5	µg/L	R
10-2920	GW03-10-16669	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Benzene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Bromoform	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
10-2920	GW03-10-16669	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Carbon disulfide	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Carbon tetrachloride	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chloroform	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chloromethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dibromo-3-chloropropane[1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	UJ
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	UJ
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Diethyl ether	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Ethyl methacrylate	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
10-2920	GW03-10-16669	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	R
10-2920	GW03-10-16669	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16669	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Methyl methacrylate	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Methyl tert-butyl ether	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Methylene chloride	10	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Propionitrile	5	µg/L	R
10-2920	GW03-10-16669	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Styrene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Toluene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	UJ
10-2920	GW03-10-16669	VOC	SW-846:8260B	Vinyl chloride	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-2920	GW03-10-16669	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
10-2920	GW03-10-16669	VOC	SW-846:8260B	Xylene[1,3-]+xylene[1,4-]	2	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
10-3094	GW03-10-16671	VOC	SW-846:8260B	Acetonitrile	25	µg/L	R
10-3094	GW03-10-16671	VOC	SW-846:8260B	Acrolein	5	µg/L	R
10-3094	GW03-10-16671	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Benzene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Bromoform	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	UJ
10-3094	GW03-10-16671	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16671	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	UJ
10-3094	GW03-10-16671	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Carbon disulfide	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Carbon tetrachloride	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chloroethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chloroform	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chloromethane	1	µg/L	UJ

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dibromo-3-chloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Diethyl ether	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Ethyl methacrylate	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	UJ
10-3094	GW03-10-16671	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16671	VOC	SW-846:8260B	Iodomethane	5	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16671	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	R
10-3094	GW03-10-16671	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Methyl methacrylate	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Methyl tert-butyl ether	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Methylene chloride	10	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Propionitrile	5	µg/L	R
10-3094	GW03-10-16671	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Styrene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Toluene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16671	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Vinyl chloride	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
10-3094	GW03-10-16671	VOC	SW-846:8260B	Xylene[1,3-]+xylene[1,4-]	2	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Acetone	10	µg/L	UJ
10-3094	GW03-10-16672	VOC	SW-846:8260B	Acetonitrile	25	µg/L	R
10-3094	GW03-10-16672	VOC	SW-846:8260B	Acrolein	5	µg/L	R
10-3094	GW03-10-16672	VOC	SW-846:8260B	Acrylonitrile	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Benzene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Bromobenzene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Bromochloromethane	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Bromodichloromethane	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Bromoform	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Bromomethane	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Butanol[1-]	50	µg/L	UJ
10-3094	GW03-10-16672	VOC	SW-846:8260B	Butanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16672	VOC	SW-846:8260B	Butylbenzene[n-]	1	µg/L	UJ
10-3094	GW03-10-16672	VOC	SW-846:8260B	Butylbenzene[sec-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Butylbenzene[tert-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Carbon disulfide	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Carbon tetrachloride	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chloro-1,3-butadiene[2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chloro-1-propene[3-]	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chlorobenzene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chlorodibromomethane	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chloroethane	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chloroform	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chloromethane	1	µg/L	UJ
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chlorotoluene[2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Chlorotoluene[4-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dibromo-3-chloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dibromoethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dibromomethane	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichlorobenzene[1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichlorobenzene[1,3-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichlorobenzene[1,4-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichlorodifluoromethane	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloroethane[1,1-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloroethane[1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloroethene[1,1-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloroethene[cis-1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloroethene[trans-1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloropropane[1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloropropane[1,3-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloropropane[2,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloropropene[1,1-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloropropene[cis-1,3-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Dichloropropene[trans-1,3-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Diethyl ether	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Ethyl methacrylate	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Ethylbenzene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Hexachlorobutadiene	1	µg/L	UJ

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16672	VOC	SW-846:8260B	Hexanone[2-]	5	µg/L	UJ
10-3094	GW03-10-16672	VOC	SW-846:8260B	Iodomethane	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Isobutyl alcohol	50	µg/L	R
10-3094	GW03-10-16672	VOC	SW-846:8260B	Isopropylbenzene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Isopropyltoluene[4-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Methacrylonitrile	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Methyl methacrylate	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Methyl tert-butyl ether	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Methyl-2-pentanone[4-]	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Methylene chloride	10	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Naphthalene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Propionitrile	5	µg/L	R
10-3094	GW03-10-16672	VOC	SW-846:8260B	Propylbenzene[1-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Styrene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Tetrachloroethane[1,1,1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Tetrachloroethane[1,1,2,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Tetrachloroethene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Toluene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichlorobenzene[1,2,3-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichlorobenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichloroethane[1,1,1-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichloroethane[1,1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichloroethene	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichlorofluoromethane	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trichloropropane[1,2,3-]	1	µg/L	U

Table B-1.3-1 (continued)

Lab Request Number	Sample Name	Analytical Suite Code	Analytical Method Code	Analyte Description	Result	Unit	Qualifier
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trimethylbenzene[1,2,4-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Trimethylbenzene[1,3,5-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Vinyl acetate	5	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Vinyl chloride	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Xylene[1,2-]	1	µg/L	U
10-3094	GW03-10-16672	VOC	SW-846:8260B	Xylene[1,3-]+xylene[1,4-]	2	µg/L	U

[a] LH3 = Low-level tritium.

[b] TU = Tritium unit.

[c] NQ = Data are valid and not qualified.

[d] HE = High explosives.

[e] U = The analyte was analyzed for but not detected.

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

[g] UJ = The analyte was not identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.

[h] PETN = Pentaerythritol tetranitrate.

[i] RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

[j] TATB = Triaminotrinitrobenzene.

[k] R = The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

[l] NQ = Data are not valid and not qualified.

[m] J = The analyte was positively identified, and the associated numerical value is estimated.

[n] J+ = The analyte was positively identified, and the result is likely to be biased high.

[o] VOC = Volatile organic compound.

[p] J- = The analyte was positively identified, and the result is likely to be biased low.

Table B-1.3-2
EES-14 Analytical Results

Sample ID	Sample Type	Depth (ft bgs)	Ag rslt (ppm)	stdev[a] (Ag)	Al rslt (ppm)	stdev (Al)	As rslt (ppm)	stdev (As)	B rslt (ppm)	stdev (B)	Ba rslt (ppm)	stdev (Ba)	Be rslt (ppm)	stdev (Be)	Br(-) ppm	TOC rslt (ppm)	Ca rslt (ppm)	stdev (Ca)	Cd rslt (ppm)	stdev (Cd)
GW03-10-16674	Initial borehole, perched water	350–363	0.001	U[b]	0.137	0.00	0.0013	0.0001	0.110	0.001	0.288	0.003	0.001	U	0.17	na[c]	102.33	1.78	0.001	U
GW03-10-16675	Initial borehole, perched water	441	0.001	U	0.037	0.01	0.0024	0.0004	0.369	0.004	1.067	0.016	0.001	U	0.16	na	11.02	0.12	0.001	U
GW03-10-16676	Final borehole, perched water	300	0.001	U	0.260	0.00	0.0020	0.0000	0.174	0.001	0.187	0.000	0.001	U	0.04	na	46.53	0.23	0.001	U
GW03-10-16677	Final borehole, perched water	350	0.001	U	0.006	0.00	0.0015	0.0000	0.190	0.000	0.322	0.001	0.001	U	0.08	na	62.29	0.27	0.001	U
GW03-10-17505	Borehole, regional	769	0.001	U	0.151	0.001	0.0012	0.0000	0.668	0.004	3.028	0.034	0.001	U	0.02	39	10.65	0.05	0.001	U
GW03-10-17506	Borehole, regional	769	0.001	U	0.043	0.001	0.0015	0.0003	0.886	0.008	5.829	0.014	0.001	U	0.01, U	183	33.12	0.17	0.001	U
GW03-10-16954	Development, regional	983	na	na	na	na	na	na	na	na	na	na	na	na	na	1.0	na	na	na	na
GW03-10-16955	Development, regional	1001.5	na	na	na	na	na	na	na	na	na	na	na	na	na	0.7	na	na	na	na
GW03-10-24323	Development, regional	1001.5	0.001	U	0.002	U	0.0002	0.0000	0.112	0.000	0.506	0.001	0.001	U	0.08	0.4	9.90	0.01	0.001	U
GW03-10-24324	Development, regional	1001.5	0.001	U	0.002	U	0.0015	0.0000	0.107	0.001	0.467	0.002	0.001	U	0.05	0.2, U	23.74	0.04	0.001	U
GW03-10-24325	Development, regional	1001.5	0.001	U	0.002	U	0.0015	0.0000	0.077	0.000	0.294	0.000	0.001	U	0.05	0.2, U	23.31	0.04	0.001	U
GW03-10-24326	Development, regional	1001.5	0.001	U	0.002	U	0.0015	0.0000	0.072	0.000	0.320	0.001	0.001	U	0.04	0.3	22.24	0.04	0.001	U
GW03-10-24327	Development, regional	1001.5	0.001	U	0.002	U	0.0015	0.0000	0.101	0.001	0.285	0.001	0.001	U	0.04	0.4	22.13	0.16	0.001	U
GW03-10-24697	Development, regional	1001.5	0.001	U	0.002	U	0.0015	0.0000	0.077	0.000	0.245	0.001	0.001	U	0.05	0.3	21.73	0.08	0.001	U
GW03-10-24698	Development, regional	1001.5	0.001	U	0.002	U	0.0016	0.0000	0.068	0.001	0.234	0.001	0.001	U	0.05	0.5	21.18	0.06	0.001	U
GW03-10-24699	Development, regional	1001.5	0.001	U	0.002	U	0.0018	0.0000	0.064	0.000	0.259	0.001	0.001	U	0.05	0.6	20.49	0.07	0.001	U
GW03-10-25478	Development, regional	812.6	0.001	U	0.002	U	0.0018	0.0002	0.072	0.000	0.245	0.001	0.001	U	0.06	0.4	19.78	0.12	0.001	U
GW03-10-25479	Development, regional	812.6	0.001	U	0.002	U	0.0020	0.0003	0.062	0.000	0.250	0.001	0.001	U	0.04	0.4	19.49	0.11	0.001	U
GW03-10-25480	Development, regional	954.7	0.001	U	0.002	U	0.0025	0.0007	0.056	0.000	0.254	0.002	0.001	U	0.07	0.3	19.57	0.09	0.001	U
GW03-10-25481	Development, regional	954.7	0.001	U	0.002	U	0.0022	0.0004	0.075	0.000	0.435	0.001	0.001	U	0.05	0.6	18.83	0.11	0.001	U

Table B-1.3-2 (continued)

Cl(-) ppm	ClO4(-) ppm	Co rslt (ppm)	stdev (Co)	Alk-CO3 rslt (ppm)	Cr rslt (ppm)	stdev (Cr)	Cs rslt (ppm)	stdev (Cs)	Cu rslt (ppm)	stdev (Cu)	F(-) ppm	Fe rslt (ppm)	stdev (Fe)	Alk-CO3+HCO3 rslt (ppm)	Hg rslt (ppm)	stdev (Hg)	K rslt (ppm)	stdev (K)	Li rslt (ppm)	stdev (Li)	Mg rslt (ppm)	stdev (Mg)	Mn rslt (ppm)
69.97	0.01, U	0.001	0.000	293	0.213	0.001	0.001	U	0.004	0.000	0.72	0.013	0.000	25.5	0.00035	0.00003	121.20	1.04	0.144	0.001	0.02	0.00	0.001
73.00	0.01, U	0.001	0.000	36	0.013	0.002	0.001	U	0.003	0.001	1.00	0.032	0.001	55.1	0.00015	0.00001	28.23	0.34	0.112	0.015	0.83	0.01	0.001
38.54	0.005, U	0.001	U	0.8, U	0.006	0.001	0.001	U	0.002	0.000	0.40	0.060	0.000	217	0.00040	0.00001	6.85	0.03	0.028	0.002	12.14	0.17	0.006
47.98	0.005, U	0.001	0.000	0.8, U	0.006	0.000	0.001	U	0.002	0.000	0.30	0.010	U	313	0.00016	0.00001	5.29	0.02	0.017	0.001	17.41	0.21	0.015
16.44	0.005, U	0.001	U	0.8, U	0.007	0.000	0.001	U	0.002	0.000	0.81	0.219	0.001	234	0.00034	0.00002	3.51	0.01	0.037	0.000	2.00	0.01	0.028
473	0.005, U	0.001	U	0.8, U	0.009	0.000	0.001	U	0.011	0.000	1.16	0.456	0.001	332	0.00032	0.00003	15.74	0.09	0.067	0.001	6.55	0.01	0.156
na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
14.95	0.005, U	0.001	U	0.8, U	0.001	U	0.001	U	0.001	U	0.39	0.010	U	87	0.00005	U	2.74	0.03	0.022	0.000	2.97	0.02	0.006
14.59	0.005, U	0.001	U	0.8, U	0.001	0.000	0.001	U	0.001	U	0.43	0.060	0.000	142	0.00005	U	2.77	0.00	0.032	0.000	5.89	0.03	0.040
13.50	0.005, U	0.001	U	0.8, U	0.001	0.000	0.001	U	0.001	U	0.41	0.134	0.000	138	0.00005	U	2.76	0.01	0.031	0.000	5.65	0.04	0.032
12.33	0.005, U	0.001	U	0.8, U	0.002	0.000	0.001	U	0.001	U	0.41	0.056	0.000	132	0.00005	U	2.60	0.01	0.028	0.000	5.35	0.03	0.023
11.18	0.005, U	0.001	U	0.8, U	0.003	0.000	0.001	U	0.001	U	0.40	0.046	0.000	126	0.00005	U	2.89	0.02	0.032	0.000	5.27	0.02	0.020
9.02	0.005, U	0.001	U	0.8, U	0.003	0.000	0.001	U	0.004	0.000	0.32	0.032	0.000	128	0.00005	U	2.60	0.00	0.027	0.000	5.15	0.02	0.028
8.57	0.005, U	0.001	U	0.8, U	0.003	0.000	0.001	U	0.001	U	0.33	0.037	0.000	122	0.00005	U	2.54	0.01	0.026	0.000	5.04	0.03	0.021
8.44	0.005, U	0.001	U	0.8, U	0.003	0.000	0.001	U	0.001	U	0.32	0.029	0.000	134	0.00005	U	2.48	0.00	0.025	0.000	4.87	0.02	0.018
5.71	0.005, U	0.001	U	0.8, U	0.003	0.000	0.001	U	0.003	0.000	0.31	0.017	0.00	117	0.00005	U	2.40	0.01	0.025	0.000	4.71	0.02	0.027
5.64	0.005, U	0.001	U	0.8, U	0.003	0.000	0.001	U	0.001	U	0.31	0.010	U	115	0.00005	U	2.33	0.01	0.024	0.000	4.60	0.02	0.014
5.36	0.005, U	0.001	U	0.8, U	0.003	0.000	0.001	U	0.001	U	0.31	0.015	0.00	113	0.00005	U	2.33	0.01	0.023	0.000	4.64	0.03	0.012
6.00	0.005, U	0.001	U	0.8, U	0.004	0.000	0.001	U	0.002	0.000	0.28	0.014	0.00	118	0.00005	U	2.10	0.00	0.022	0.000	4.46	0.01	0.010

Table B-1.3-2 (continued)

stdev (Mn)	Mo rslt (ppm)	stdev (Mo)	Na rslt (ppm)	stdev (Na)	Ni rslt (ppm)	stdev (Ni)	NO2 (ppm)	NO2-N rslt	NO2-N (U)	NO3 ppm	NO3-N rslt	C2O4 rslt (ppm)	Pb rslt (ppm)	stdev (Pb)	Lab pH	PO4(-3) rslt (ppm)	Rb rslt (ppm)	stdev (Rb)	Sb rslt (ppm)	stdev (Sb)	Se rslt (ppm)	stdev (Se)	Si rslt (ppm)
U	0.094	0.001	117	0.64	0.020	0.001	0.01	0.003	U	25.36	5.73	0.01, U	0.0002	U	11.41	0.01	0.223	0.005	0.001	U	0.011	0.001	42.4
U	0.027	0.001	86.35	0.92	0.015	0.002	0.01	0.003	U	28.41	6.42	0.01, U	0.0002	U	9.34	0.01	0.036	0.005	0.001	0.000	0.005	0.001	28.7
0.000	0.002	0.000	47.79	0.32	0.010	0.001	1.70	0.517	U	7.30	1.65	0.01, U	0.0002	U	7.96	0.01	0.008	0.000	0.001	U	0.002	0.000	31.9
0.000	0.001	0.000	32.25	0.02	0.013	0.001	0.01	0.003	U	14.08	3.18	0.01, U	0.0002	U	7.48	0.01	0.008	0.000	0.001	U	0.002	0.000	26.5
0.000	0.017	0.000	84.76	0.50	0.001	0.000	0.01	0.003	U	1.44	0.33	0.01, U	0.0004	0.0000	7.37	0.03	0.003	0.000	0.001	0.000	0.001	0.000	12.0
0.001	0.080	0.001	519	2.24	0.004	0.000	0.01	0.003	U	7.42	1.68	4.81	0.0002	U	6.13	0.92	0.014	0.000	0.001	0.000	0.032	0.002	7.3
na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
0.000	0.002	0.000	20.28	0.06	0.001	0.000	0.01	0.003	U	0.07	0.02	0.01, U	0.0002	U	8.43	0.02	0.002	0.000	0.001	U	0.001	U	5.2
0.003	0.003	0.000	19.80	0.13	0.003	0.000	0.01	0.003	U	2.22	0.50	0.01, U	0.0002	U	7.79	0.01, U	0.003	0.000	0.001	U	0.001	0.000	32.7
0.000	0.003	0.000	18.73	0.06	0.003	0.000	0.01	0.003	U	2.70	0.61	0.01, U	0.0002	U	7.83	0.01, U	0.003	0.000	0.001	U	0.001	U	32.9
0.000	0.002	0.000	17.31	0.01	0.003	0.000	0.01	0.003	U	2.98	0.67	0.01, U	0.0002	U	7.92	0.03	0.003	0.000	0.001	U	0.001	U	31.8
0.000	0.002	0.000	16.85	0.02	0.003	0.000	0.01	0.003	U	3.05	0.69	0.01, U	0.0002	U	7.90	0.01, U	0.003	0.000	0.001	U	0.001	U	31.9
0.000	0.002	0.000	16.38	0.02	0.003	0.000	0.01	0.003	U	2.83	0.64	0.01, U	0.0002	U	8.00	0.01, U	0.003	0.000	0.001	U	0.001	U	31.4
0.000	0.002	0.000	15.77	0.04	0.003	0.000	0.01	0.003	U	2.92	0.66	0.01, U	0.0002	U	7.93	0.01, U	0.003	0.000	0.001	U	0.001	U	31.2
0.000	0.002	0.000	15.41	0.05	0.003	0.000	0.01	0.003	U	3.12	0.70	0.01, U	0.0002	U	7.94	0.01	0.003	0.000	0.001	U	0.001	0.000	30.8
0.000	0.001	0.000	14.89	0.07	0.003	0.001	0.01	0.003	U	2.90	0.66	0.01, U	0.0002	0.0000	7.97	0.01, U	0.003	0.000	0.001	U	0.001	0.000	29
0.000	0.001	0.000	14.38	0.06	0.003	0.000	0.01	0.003	U	2.81	0.63	0.01, U	0.0002	U	7.83	0.01, U	0.003	0.001	0.001	U	0.001	0.000	29
0.000	0.001	0.000	14.07	0.11	0.003	0.001	0.01	0.003	U	2.92	0.66	0.01, U	0.0002	U	7.52	0.01, U	0.004	0.001	0.001	U	0.002	0.001	29
0.000	0.001	0.000	14.46	0.07	0.005	0.002	0.01	0.003	U	2.94	0.66	0.01, U	0.0002	U	7.71	0.01, U	0.003	0.001	0.001	U	0.001	0.000	29

Table B-1.3-2 (continued)

stdev (Si)	SiO2 rslt (ppm)	stdev (SiO2)	Sn rslt (ppm)	stdev (Sn)	SO4(-2) rslt (ppm)	Sr rslt (ppm)	stdev (Sr)	Th rslt (ppm)	stdev (Th)	Ti rslt (ppm)	stdev (Ti)	Tl rslt (ppm)	stdev (Tl)	U rslt (ppm)	stdev (U)	V rslt (ppm)	stdev (V)	Zn rslt (ppm)	stdev (Zn)	TDS (ppm)	Cations	Anions	Balance
0.8	90.7	1.6	0.001	U	290	0.778	0.005	0.001	U	0.002	U	0.001	U	0.0002	U	0.038	0.001	0.011	0.000	1182	13.33	20.67	-0.22
0.5	61.4	1.0	0.001	U	84.81	0.105	0.002	0.001	U	0.002	U	0.001	U	0.0002	U	0.023	0.004	0.016	0.002	468	5.13	6.45	-0.11
0.2	68.2	0.5	0.001	U	27.47	0.223	0.000	0.001	U	0.009	0.000	0.001	U	0.0030	0.0002	0.011	0.001	0.058	0.000	475	5.59	5.41	0.02
0.1	56.7	0.3	0.001	U	35.25	0.306	0.003	0.001	U	0.002	U	0.001	U	0.0040	0.0002	0.005	0.000	0.059	0.000	586	6.09	7.48	-0.10
0.0	25.8	0.1	0.001	U	14.34	0.098	0.003	0.001	U	0.013	0.000	0.001	U	0.0034	0.0000	0.003	0.000	0.022	0.001	399	4.52	4.72	-0.02
0.0	15.6	0.1	0.001	U	41.27	0.280	0.000	0.001	U	0.003	0.000	0.001	U	0.0008	0.0000	0.002	0.000	0.040	0.000	1453	25.26	19.83	0.12
na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
0.0	11.0	0.0	0.001	U	13.34	0.059	0.000	0.001	U	0.002	U	0.001	U	0.0003	0.0000	0.001	U	0.007	0.000	164	1.70	2.17	-0.12
0.1	70.1	0.2	0.001	U	13.09	0.119	0.001	0.001	U	0.002	U	0.001	U	0.0026	0.0001	0.009	0.001	0.069	0.003	296	2.62	3.08	-0.08
0.2	70.3	0.5	0.001	U	12.21	0.115	0.000	0.001	U	0.002	U	0.001	U	0.0023	0.0001	0.008	0.000	0.048	0.000	288	2.53	2.96	-0.08
0.1	68.0	0.3	0.001	U	11.45	0.108	0.002	0.001	U	0.002	U	0.001	U	0.0024	0.0001	0.009	0.000	0.043	0.000	275	2.38	2.82	-0.08
0.1	68.2	0.2	0.001	U	10.76	0.109	0.001	0.001	U	0.002	U	0.001	U	0.0022	0.0000	0.009	0.000	0.043	0.000	268	2.36	2.68	-0.06
0.1	67.2	0.2	0.001	U	9.50	0.107	0.000	0.001	U	0.002	U	0.001	U	0.0020	0.0000	0.009	0.000	0.042	0.000	263	2.30	2.62	-0.07
0.2	66.8	0.5	0.001	U	9.26	0.104	0.001	0.001	U	0.002	U	0.001	U	0.0020	0.0001	0.010	0.000	0.039	0.000	255	2.23	2.49	-0.06
0.1	65.8	0.2	0.001	U	9.19	0.100	0.001	0.001	U	0.002	U	0.001	U	0.0021	0.0001	0.011	0.000	0.045	0.001	264	2.17	2.69	-0.11
0.2	63.1	0.5	0.001	U	7.15	0.095	0.000	0.001	U	0.002	U	0.001	U	0.0017	0.0002	0.012	0.001	0.041	0.001	240	2.09	2.33	-0.05
0.2	62.2	0.3	0.001	U	6.61	0.092	0.000	0.001	U	0.002	U	0.001	U	0.0018	0.0003	0.013	0.002	0.049	0.001	234	2.05	2.27	-0.05
0.1	63.0	0.3	0.001	U	6.34	0.095	0.001	0.001	U	0.002	U	0.001	U	0.0020	0.0006	0.016	0.005	0.050	0.000	233	2.04	2.23	-0.04
0.0	61.6	0.1	0.001	U	6.37	0.090	0.001	0.001	U	0.002	U	0.001	U	0.0018	0.0004	0.014	0.003	0.053	0.000	236	2.00	2.32	-0.07

[a] stdev = Standard deviation for detected analytes; U entered if not detected.

[b] U = Constituent not detected.

[c] na = Constituent not analyzed.

Table B-1.3-3
Pre- and Post-Neutralization Analytical Results

Sample ID	Alk ($CaCO_3$) ppm	Cl ppm	K ppm	Na ppm	NO_3(N) ppm	PO_4 ppm	SO_4 ppm	TOC ppm
GW03-10-17505	0.8 (U)	16.44	3.51	84.76	0.33	0.03	14.34	39
GW03-10-17506	0.8 (U)	473	15.74	519	1.68	0.92	41.27	183

Appendix C

Aquifer Testing Report

C-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of pumping tests conducted in June and July 2010 at well R-3 located in Pueblo Canyon. The tests on R-3 were conducted to evaluate the hydraulic properties of the sediments in which the well is completed.

Testing consisted of brief trial pumping of R-3, a 24-h constant-rate pumping test, and extensive background data collection. As with most of the R-well pumping tests conducted on the plateau, implementation of an inflatable packer system was attempted in R-3 to minimize the effects of casing storage on the test data. However, exceptionally high gas content in the pumped water interfered with pump operation, especially when the packer was inflated. Therefore, much of the testing was performed without the packer inflated.

Conceptual Hydrogeology

Well R-3 is drilled into sediments of the Santa Fe Group. The well was completed with 20.5 ft of 5-in. stainless steel well screen set from 974.5 to 995.0 ft below ground surface (bgs). The static water level measured on June 29 was 659.32 ft bgs, more than 315 ft above the top of the well screen. The estimated ground surface elevation was 6397 ft above mean sea level (amsl), putting the static water level at an estimated elevation of 5737.68 ft amsl.

The saturated Santa Fe Group includes alternating layers of permeable sands and gravels with intervening clays and mudstones. The interval from 970 to 1000 ft, in which the screen was placed, was identified as a sand and gravel unit. This description implied the possibility of overlying and underlying aquitards at 970 and 1000 ft. During testing, the pump intake was placed at 849 ft bgs, well below the static water level and well above the well screen.

R-3 Testing

Well R-3 was tested from June 29 to July 12, 2010. After filling the drop pipe on June 29, testing consisted of brief trial pumping on June 30, a 24-h constant-rate pumping test that was begun on July 1 and recovery/background data collected until July 11. On July 11, while the transducer was still recording water levels, supplemental development purging was performed, providing an additional data set for analysis. All testing showed an enormous proportion of air/gas in the pumped water.

After filling the drop pipe on June 29, the packer was inflated and brief pumping was performed. The well was pumped at an average rate of 2.1 gpm for 24 min from 3:06 to 3:30 p.m. Following shutdown, recovery/background data were recorded for 1160 min until 10:50 a.m. on June 30.

Two trial tests were conducted on June 30. Trial 1, a step-drawdown test, was conducted at multiple discharge rates ranging from 2.0 to 6.0 gpm for 80 min from 10:50 to 12:10 p.m. and was followed by 50 min of recovery until 1:00 p.m. The step-drawdown test incorporated seven pumping steps, starting at 2.0 gpm, ramping up to 6.0 gpm, and then cutting back to 4.5 gpm. The large gas content in the pumped water had an effect on the pump efficiency, causing discharge rate variations during each pumping step. At 12:30 p.m., 20 min after pump shutoff, the packer was deflated for 5 min as a precaution to expel any trapped gas beneath the packer before conducting trial 2.

Trial 2 was conducted for 63 min from 1:00 to 2:03 p.m. at an initial discharge rate of 3.9 gpm. However, after less than 10 min of pumping, the discharge rate began declining, reaching zero after 16 min of pumping. The packer was deflated to release gas/air that may have been trapped, but still no water was produced, so the pump was stopped at 1:21 p.m.

The pump was restarted at 1:27 p.m., producing about 2.0 gpm. Within several minutes, the rate began declining, reaching zero after about 11 min of pumping. The pump was shut off again at 1:38 p.m.

The pump was run again from 1:45 to 1:48 p.m. and 2:00 to 2:03 p.m. Each time, the pump produced little more than 1 gpm for only 2 min before the rate dropped to zero. Shortly after shutting down the pump, the packer was deflated.

It was assumed that air buildup beneath the inflatable packer during the trial testing had forced the pumping level to the pump intake. (The packer was set less than 10 ft above the pump intake.) Further accumulation of air caused a continuing and steady reduction in effective available drawdown, which, combined with cavitation due to air entrainment in the water, reduced the discharge rate dramatically. Alternatively, it was possible that the sheer volume of air produced with the groundwater was sufficient to reduce the pump bowl efficiency to the point that the pump couldn't produce sufficient pressure to lift water to the surface.

Following shutdown of trial 2, recovery/background data were recorded for 1137 min until 9:00 a.m. on July 1.

At 9:00 a.m. on July 1, the 24-h pumping test was begun at a rate of 2.1 gpm. Pumping was begun with the packer deflated to try to minimize disruption of pumping caused by trapped gas/air. The initial discharge rate was achieved by running the pump on a variable frequency drive unit (VFD) at 59% of maximum speed. After several minutes of pumping, the discharge rate began to decline, eventually reaching zero. At 9:21 a.m. the VFD was speeded up to 60% of maximum, achieving some flow, but less than 2 gpm. At 9:25 the pump speed was adjusted again, to 62% of maximum, increasing the flow rate to over 3 gpm and then to over 4 gpm. However, further gas/air interference eventually caused the rate to decline below 2 gpm. Two additional speed increases were implemented to try to maintain a steady flow rate: to 63% at 11:16 a.m. and 64% at 11:40 a.m. Going to 64% of maximum speed was successful in maintaining the desired flow. The rate was approximately 2.5 gpm initially, eventually settling in at about 2.2 gpm (plus or minus) over the final 19 h of pumping.

At 8:54 a.m. on July 2, shortly before the planned shutdown of the 24-h pumping test, the packer was inflated in an attempt to obtain a water level recovery signal without storage effects. Remarkably, within approximately 1 min, the discharge rate began plummeting. The packer was deflated immediately in an attempt to restore the discharge rate to the antecedent level before shutting down the test. Once the rate had been restored to 2.2 gpm, the test was terminated at 9:03 a.m. Following shutdown, recovery/background measurements were recorded for an additional 9 d until 12:10 p.m. on July 11.

At 12:10 p.m. on July 11, pumping resumed to provide supplemental development purging of the well. Pumping continued for 358 min from 12:10 to 6:08 p.m. at various rates between approximately 2 and 4 gpm. An average discharge rate of approximately 3.0 gpm was maintained over the last half of the pumping period. Following shutdown, recovery data were obtained for 901 min until 9:09 a.m. on July 12 when the transducer timed out and ceased recording data.

Aerated Water

As with many of the recent R-well pumping tests, gas or air was detected in the groundwater during the R-3 pumping tests. It is possible that the observed gas is natural. On the other hand, it is possible that high-pressure compressed air used in the drilling process invaded the aquifer zones during drilling, collecting in the formation pore spaces and/or dissolving in the groundwater. When water is pumped from the aquifer, trapped gas or air in the formation pores can move with the pumped water as well as expand and contract in response to pressure changes. Also, pressure reduction associated with pumping can allow dissolved gas or air to come out of solution. The significant quantity of gas or air present in the formations in recently tested wells has had several effects, including 1) interfering with pump operating efficiency, 2) causing transient changes in aquifer permeability, 3) inducing pressure transients as the gas or air expands and contracts, and 4) causing storage-like effects associated with changes in gas or air volume in the formation voids, filter pack, and/or well casing.

As mentioned above, in R-3 air entrainment in the pumped water and buildup of trapped air beneath the inflatable packer had a profound effect on pump operation and the ability to pump water. The effects were severe enough to preclude effective use of the inflatable packer to eliminate storage effects in some of the tests. Also, maintaining a steady discharge rate proved difficult because of the variable effect on pump bowl efficiency caused by transient gas content in the pumped water.

The gas/air content in R-3 was substantially greater than that observed in any other R-well pumping tests. It was possible to approximate the gas content by diverting a portion of the discharge through a clear plastic tube and observing the relative length of the tube filled with water compared with gas bubbles at various times. Visual inspection of the discharge through the clear tube suggested a gas content equal to approximately 50% of the water volume.

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 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-3, have used 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. As an example, when a 90% barometrically efficient well is 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 the changes are in the same direction as the barometric pressure change, rather than in the opposite direction.

Barometric pressure data were obtained from Technical Area 54 (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 approximately 6397 ft amsl. The static water level in R-3 was 659.32 ft below land surface, making the calculated water-table elevation approximately 5737.68 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-3.

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

$$P_{WT} = P_{TA54} \exp\left[-\frac{g}{3.281R}\left(\frac{E_{R-3} - E_{TA54}}{T_{TA54}} + \frac{E_{WT} - E_{R-3}}{T_{WELL}}\right)\right]$$ **Equation C-1**

where, P_{WT} = barometric pressure at the water table inside R-3

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

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

R = gas constant, in J/Kg/degree Kelvin (287.04 J/Kg/degree Kelvin)

E_{R-3} = land surface elevation at R-3 site, in feet (approximately 6397 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-3, in feet (approximately 5737.68 ft)

T_{TA54} = air temperature near TA-54, in degrees Kelvin (assigned a value of 69.6 degrees Fahrenheit, or 294.0 degrees Kelvin)

T_{WELL} = air temperature inside R-3, in degrees Kelvin (assigned a value of 73.1 degrees Fahrenheit, or 296.0 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. Unfortunately, temporal and spatial gas content variations in the water column in R-3 caused large and erratic pressures changes on the transducer, making a correlation between barometric pressure and water levels difficult.

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):

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

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 approximately half the computed time.

For wells screened across the water table (not applicable here), there can be an additional storage contribution from the filter pack around the screen. The following equation provides an estimate of the storage duration accounting for both casing and filter pack storage:

$$t_c = \frac{0.6\left[\left(D^2 - d^2\right) + S_y\left(D_B^2 - D_C^2\right)\right]}{\frac{Q}{s}} \qquad \textbf{Equation C-3}$$

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 term within the brackets is directly proportional to the annular area (and volume) between the casing and drop pipe, while the right 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. Therefore, this option has been implemented for the R-well testing program, including R-3. However, as stated previously, the high gas content in the pumped water in R-3 precluded the use of the packer in some of the tests.

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

$$u = \frac{1.87 r^2 S}{Tt}$$ **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**

$$S = \frac{Tut}{2693 r^2}$$ **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:

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2 S} \quad . \qquad \textbf{Equation C-9}$$

The Cooper–Jacob equation is a simplified approximation of the Theis equation and is valid whenever the u value is less than approximately 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.

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:

$$T = \frac{264Q}{\Delta s} \qquad \textbf{Equation C-10}$$

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:

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

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:

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

The recovery data are particularly useful compared with 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.

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 Rothchild (1985, 098234).

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

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

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:

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

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. Confined conditions were assumed for R-3 because of the substantial water-level rise above the likely upper aquitard at 970 ft bgs. Storage coefficient values for confined conditions can be expected to range from approximately 10^{-5} to 10^{-3} (Driscoll 1986, 104226). A value of 5×10^{-4} was used for the R-3 calculations. The calculation result is not particularly sensitive to the choice of storage coefficient value, so a rough estimate of the storage coefficient is generally adequate to support the calculations.

The analysis also requires assigning a value for the saturated aquifer thickness, b. For the purposes of this exercise, an estimated saturated thickness of 30 ft was assigned: the thickness of the gravel interval from 970 to 1000 ft identified during drilling.

C-7.0 BACKGROUND DATA ANALYSIS

Background aquifer pressure data collected during the R-3 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-3 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-3 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 R-3 are included on the figure for reference.

The data on Figure C-7.0-1 were plotted on a vertical axis having a scale an order of magnitude greater than what is usually required for these plots. This was necessary because the substantial water-level fluctuations in R-3 encompassed a magnitude of several feet. It was determined that the large water-level fluctuations were caused by operation of Los Alamos County production well PM-1.

Based on historical water-level records, PM-1 was known to affect water levels in screen 4 within R-5 at a distance of approximately 2410 ft from R-3. R-5 is located 5060 ft NNW of PM-1, while R-3 is approximately 4625 ft NNE of PM-1. A comparison was made of water levels from R-3 and R-5 screen 4.

Figure C-7.0-2 shows the water levels for R-3 and R-5 screen 4 along with the run times for PM-1. The correlation between PM-1 operation and water-level responses in R-3 and R-5 is clear.

Despite the PM-1 interference effects in the data signal, it did not appear that the subtle barometric pressure fluctuations were superimposed on the apparent R-3 hydrograph. This suggests the possibility of a fairly high barometric efficiency at R-3.

The extensive increases and decreases in measured R-3 water levels over time imply that long-term water level trends during pumping and recovery would be of no use in determining aquifer characteristics. For example, it is clear that the steady increasing drawdown observed during the 24-h pumping period on July 1 and 2 was not a result of R-3 pumping per se, but rather a response to relatively continuous pumping at PM-1 before and after pumping R-3. Similarly, the recovery data set did not show a steady rise in water level over time, but instead showed a brief recovery followed by continued decline for more than a day. Thus, calculation of aquifer coefficients was generally restricted to the early portion of any given data set to minimize the effects of these large trends. No attempt was made to correct the R-3 water level data for the PM-1 pumping effects, as the magnitude of the correction would have substantially exceeded the subtle water-level changes caused by pumping R-3.

C-8.0 WELL R-3 DATA ANALYSIS

This section presents the data obtained from the R-3 pumping tests and the results of the analytical interpretations. Data are presented for drawdown and/or recovery for initial pumping, trials 1 and 2, the 24-h constant-rate pumping test, and subsequent purge development activities.

C-8.1 Well R-3 Initial Test

After filling the drop pipe on June 29, a brief test was conducted on R-3. Figure C-8.1-1 shows a semilog plot of the drawdown data collected during the pumping period. The transmissivity calculated from the line of fit shown on the graph was 2340 gpd/ft. Based on a permeable zone thickness of 30 ft (from 970 to 1000 ft), the computed hydraulic conductivity was 78 gpd/ft^2, or 10.4 ft/d.

Figure C-8.1-2 shows the recovery data collected following shutdown of the initial pumping test. The early slope supported a transmissivity calculation of 1790 gpd/ft, making the hydraulic conductivity 60 gpd/ft^2, or 8.0 ft/d. The subsequent data reflect the large response to PM-1 operation discussed previously.

C-8.2 Well R-3 Trial 1

Figure C-8.2-1 shows a linear plot of the drawdown data collected from trial 1, a step-drawdown test. Each pumping interval was characterized by slight changes in discharge rate, as shown on the graph. The largest discharge rate change occurred during the third step when the initial rate of 3.3 gpm declined to 1.9 gpm. The shifts in pumping rate for the other steps were smaller than this. Nevertheless, the large gas content in the pumped water made it impossible to maintain constant rates during the individual pumping steps. As a result, the form of the plot on Figure C-8.2-1 does not mimic typical step-drawdown data plots.

Figure C-8.2-2 shows the recovery data collected following shutdown of the trial 1 pumping test. The early slope supports a transmissivity calculation of 1450 gpd/ft, making the hydraulic conductivity 48 gpd/ft^2, or 6.5 ft/d.

The subsequent data show a large water-level spike reaching nearly 15 ft above the static water level when the packer was deflated temporarily to release any air that might have been trapped beneath it. This is an indication that water had leaked from the drop pipe into the casing above the packer, caused by failure of an o-ring seal where the submersible pump wires pass through the drop pipe above the packer. When the packer deflated, the water trapped above the packer raised the pressure on the transducer as it flowed slowly into the formation. This equipment defect was previously observed during the testing at R-52. Two attempts were made to repair the seal, but the R-3 trial 1 data show that the seal continued to leak.

C-8.3 Well R-3 Trial 2

Figure C-8.3-1 shows a linear plot of the drawdown data collected from trial 2. As described previously, the gas content in the water interfered with pump operation, dropping the discharge rate to zero and forcing shutdown of the pump on several occasions. Each restart of the pump produced progressively less flow and forced pump shutoff earlier. The resulting chaotic pumping and recovery data sets could not be analyzed.

C-8.4 Well R-3 24-H Constant-Rate Pumping Test

Figure C-8.4-1 shows a semilog plot of the drawdown data collected during the 24-h pumping test. As described previously, the gas content in the water interfered with pump operation, resulting in chaotic discharge rate variations and forcing periodic increases in pump speed in an effort to try to maintain a reasonable pumping rate. The data were not analyzed because of the significant fluctuations in pumping rate and the obvious fact that the transient increase in drawdown was dominated by supply well pumping, as discussed previously (Figure C-7.0-2).

Figure C-8.4-2 shows the recovery data recorded following the 24-h pumping test. The times related to casing storage effects are included on the plot for reference. The early data were storage affected, while the late data reflected the PM-1 pumping effects illustrated on Figure C-7.0-2. Thus, data analysis was limited to a narrow window of recovery response between these two effects.

Figure C-8.4-3 shows an expanded-scale plot of the recovery data. Analysis of the post-storage data yielded a transmissivity of 2160 gpd/ft, making the hydraulic conductivity of the screened interval 72 gpd/ft^2, or 9.6 ft/d.

C-8.5 Well R-3 Development

On July 11, following an extensive background data monitoring period, well development continued at R-3 while the pressure transducer was still active. This allowed obtaining an additional data set for analysis.

Figure C-8.5-1 shows the drawdown data recorded during the purge development that occurred on July 11. The discharge rate varied during the pumping event and the late data were affected significantly by operation of PM-1. Therefore, the data did not support a rigorous analysis. Analysis was restricted to the subsequent recovery data set.

Figure C-8.5-2 shows the recovery data obtained following pump shutoff. The casing storage times are included on the plot for reference. Based on an effective average discharge rate of 3.0 gpm over the last half of the purging period, the early post-storage recovery data support a transmissivity calculation of 2100 gpd/ft, making the hydraulic conductivity 70 gpd/ft^2, or 9.4 ft/d.

C-8.6 Well R-3 Specific Capacity Data

Specific capacity data were used along with well geometry to estimate a lower-bound transmissivity value for the portion of the aquifer penetrated by the R-3 well screen. This was done to provide a frame of reference for evaluating the foregoing analyses.

Data used to support the lower-bound calculation was the final step of the step-drawdown trial 1 pumping test. Data from the 24-h pumping test were not used for this purpose because of the large PM-1 pumping effects that occurred during the 24-h test.

After 80 min of pumping during trial 1, ending with a discharge rate of 4.5 gpm, the observed drawdown was 4.0 ft, making the specific capacity 1.13 gpm/ft at that time. In addition to specific capacity and pumping time, other input values used in the calculations included a storage coefficient value of 5 x 10^{-4}, an estimated aquifer thickness of 30 ft, and a borehole radius of 0.80 ft (inferred from the volume of filter pack required to backfill the screen zone).

Applying the Brons and Marting method to these inputs yielded a lower-bound transmissivity of 1690 gpd/ft, making the lower-bound hydraulic conductivity 56 gpd/ft^2, or 7.5 ft/d. The pumping test analyses, on the other hand, yielded transmissivity values averaging 1970 gpd/ft for an average hydraulic conductivity of approximately 66 gpd/ft^2, or 8.8 ft/d. Thus, the lower-bound estimate is consistent with the pumping test analyses, as it is comparable in magnitude but slightly lower.

C-9.0 SUMMARY

Constant-rate pumping tests were conducted on R-3. The tests were performed to gain an understanding of the hydraulic characteristics of the Santa Fe Group sediments in which R-3 is screened. Several observations and conclusions were drawn for the tests as summarized below.

The water produced from R-3 contained a very large air or gas component, with a gas volume roughly 50% of the water volume. The presence of gas in the water interfered with pump operation, especially when the packer was inflated. As a result, some of the pumping events were performed with the packer deflated. Also, the discharge rates varied in a chaotic way because of the variable gas content interfering with the pump bowl efficiency.

Background data recorded in R-3 show water level fluctuations of several feet in response to supply well pumping at PM-1.

A comparison of barometric pressure and R-3 water level data was impeded by the PM-1 pumping effects, but suggest a high barometric efficiency.

Transmissivity values computed from usable portions of the pumping test data averaged 1970 gpd/ft, making the average hydraulic conductivity of the 30-ft zone in which the well screen was placed 66 gpd/ft^2, or 8.8 ft/d.

R-3 produced 4.5 gpm with 4.0 ft of drawdown after 80 min of pumping, resulting in a specific capacity of 1.13 gpm/ft at that particular pumping time. The corresponding computed lower-bound transmissivity was 1690 gpd/ft, making the lower-bound hydraulic conductivity 56 gpd/ft^2, or 7.5 ft/d, consistent with the pumping test values.

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.

Bradbury, K.R., and E.R. Rothschild, March-April 1985. “A Computerized Technique for Estimating the Hydraulic Conductivity of Aquifers from Specific Capacity Data,” *Ground Water,* Vol. 23, No. 2, pp. 240-246. (Bradbury and Rothschild 1985, 098234)

Brons, F., and V.E. Marting, 1961. “The Effect of Restricted Fluid Entry on Well Productivity,” *Journal of Petroleum Technology,* Vol. 13, No. 2, pp. 172-174. (Brons and Marting 1961, 098235)

Cooper, H.H., Jr., and C.E. Jacob, August 1946. “A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-Field History,” *American Geophysical Union Transactions,* Vol. 27, No. 4, pp. 526-534. (Cooper and Jacob 1946, 098236)

Driscoll, F.G., 1986. Excerpted pages from *Groundwater and Wells*, 2nd Ed., Johnson Filtration Systems Inc., St. Paul, Minnesota. (Driscoll 1986, 104226)

Hantush, M.S., July 1961. “Drawdown around a Partially Penetrating Well,” *Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers,* Vol. 87, No. HY 4, pp. 83-98. (Hantush 1961, 098237)

Hantush, M.S., September 1961. “Aquifer Tests on Partially Penetrating Wells,” Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, pp. 171–195. (Hantush 1961, 106003)

Schafer, D.C., January-February 1978. "Casing Storage Can Affect Pumping Test Data," *The Johnson Drillers Journal,* pp. 1-6, Johnson Division, UOP, Inc., St. Paul, Minnesota. (Schafer 1978, 098240)

Theis, C.V., 1934-1935. “The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage,” *American Geophysical Union Transactions,* Vol. 15-16, pp. 519-524. (Theis 1934-1935, 098241)

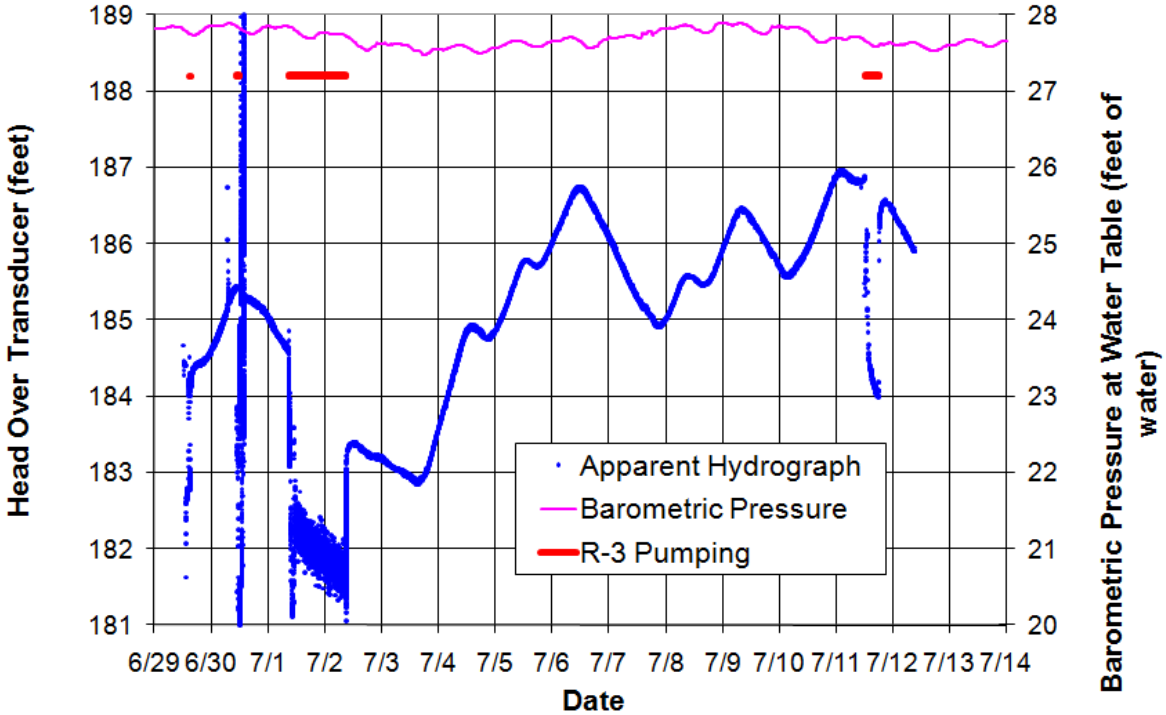


Figure C-7.0-1 Well R-3 apparent hydrograph

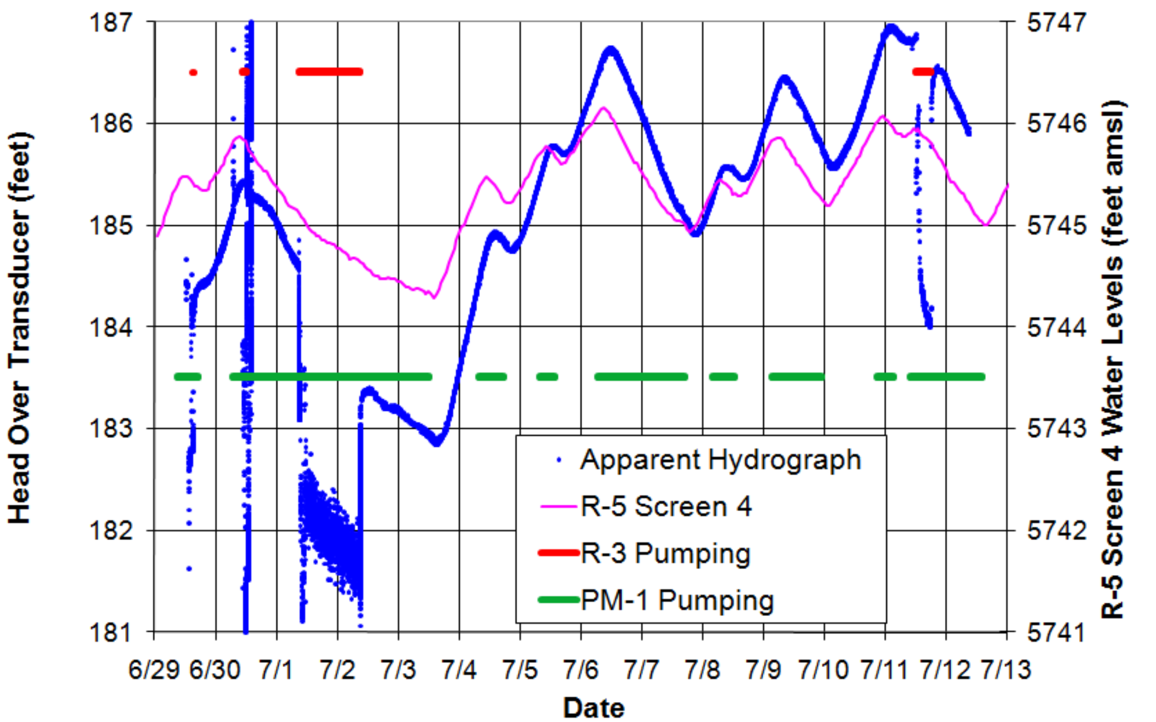


Figure C-7.0-2 Well R-3 and R-5 Screen 4 Comparison

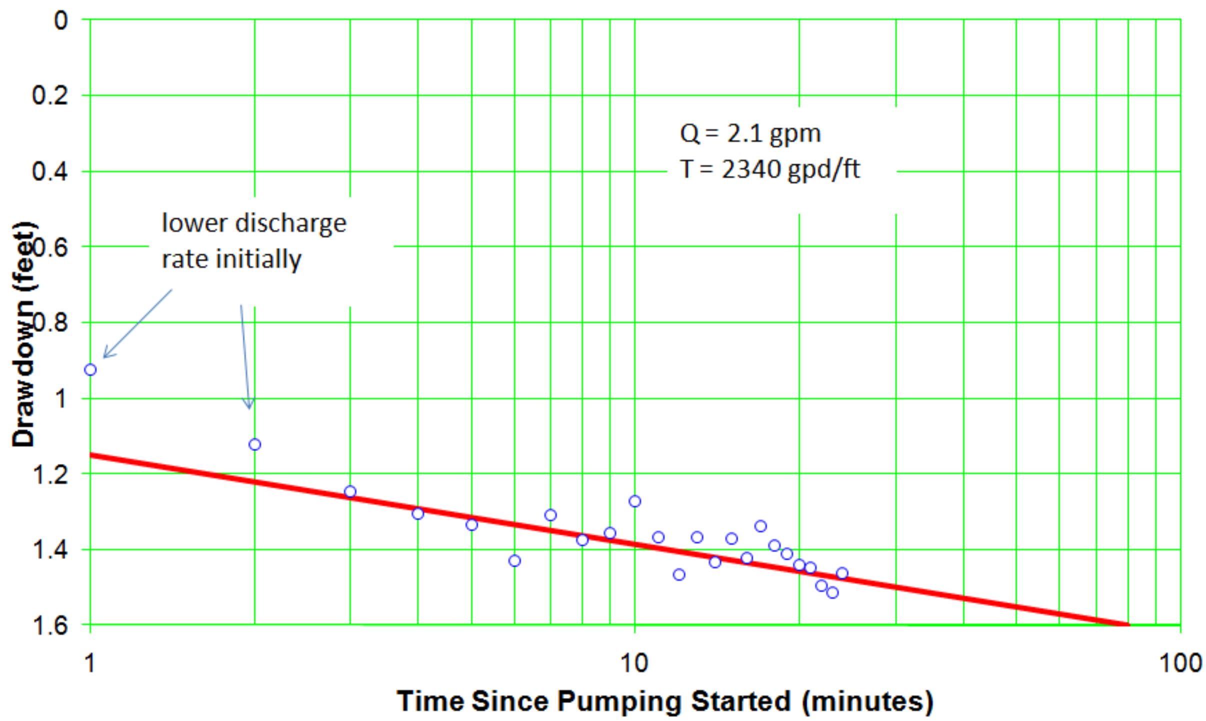


Figure C-8.1-1 Well R-3 initial drawdown

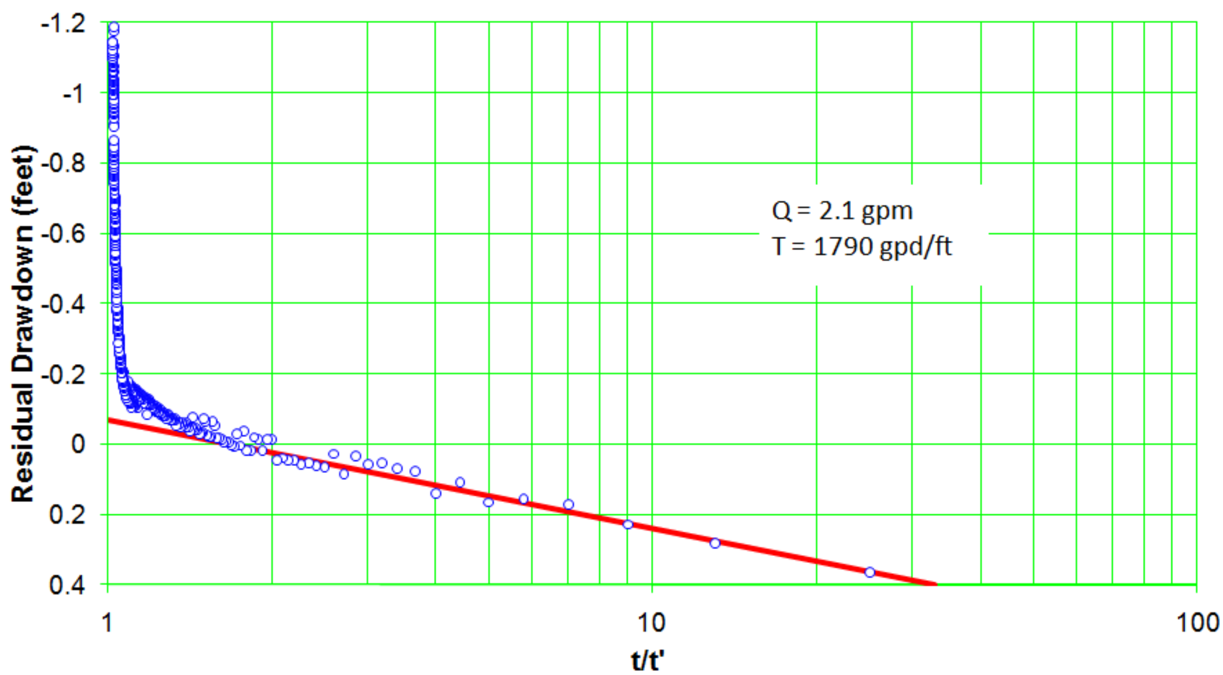


Figure C-8.1-2 Well R-3 initial recovery

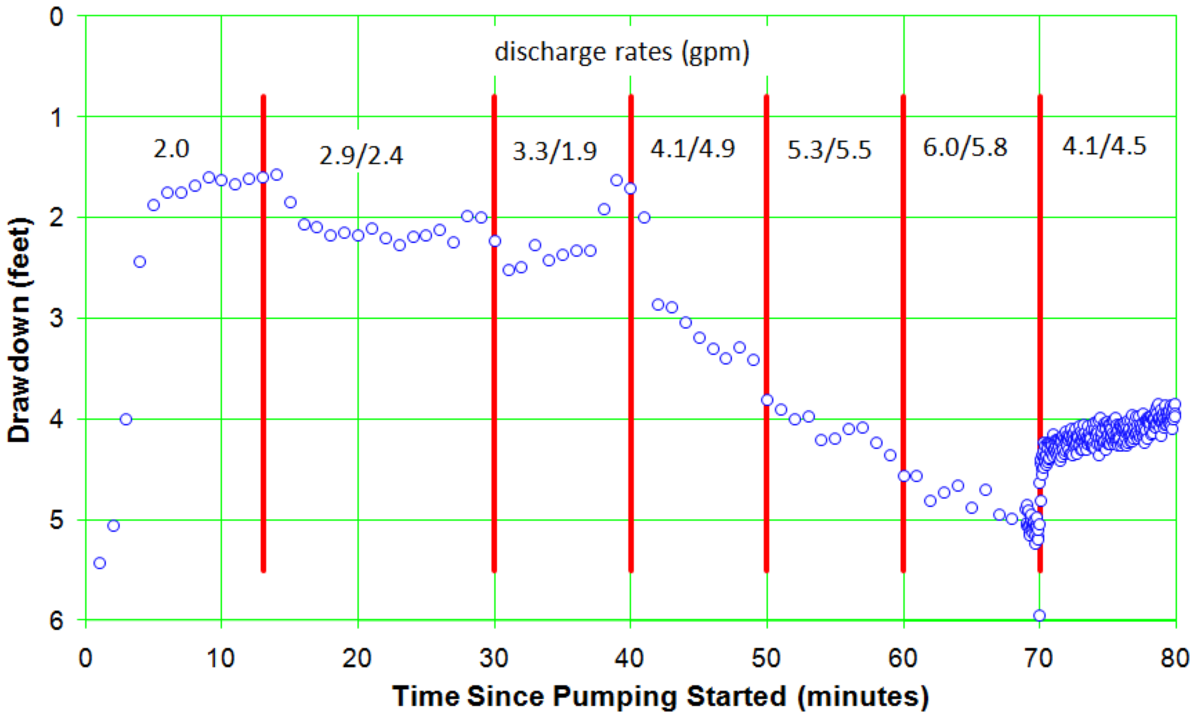


Figure C-8.2-1 Well R-3 trial 1 drawdown

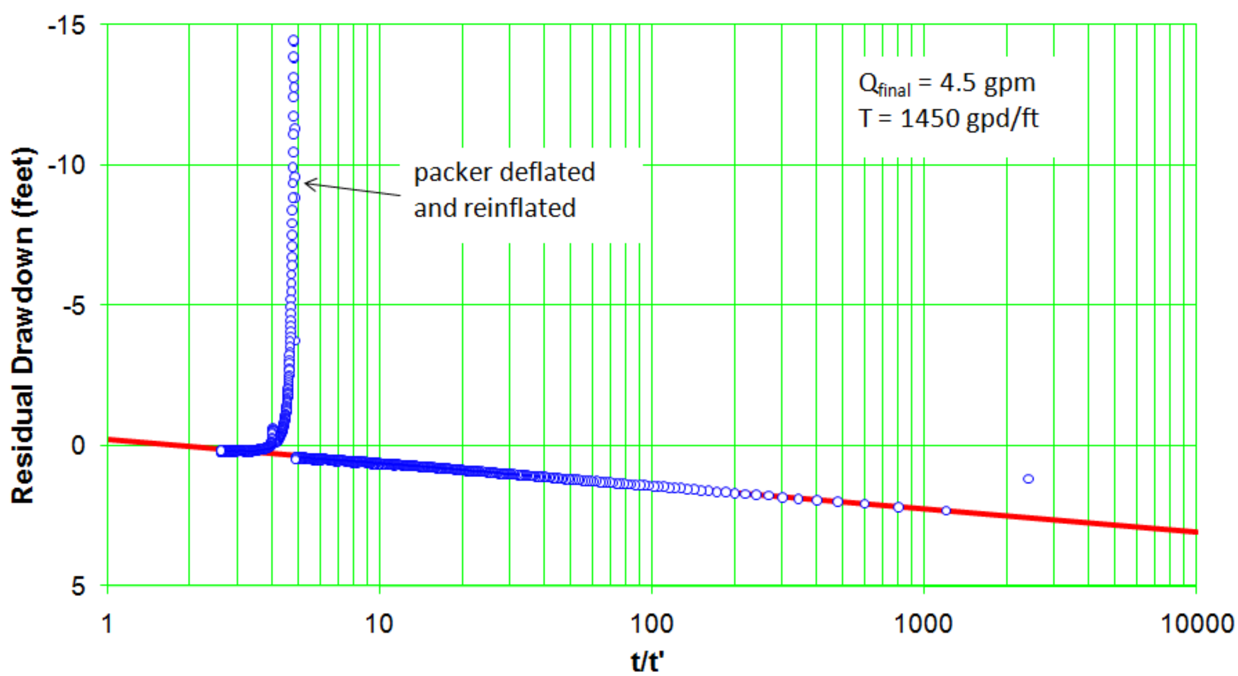


Figure C-8.2-2 Well R-3 trial 1 recovery

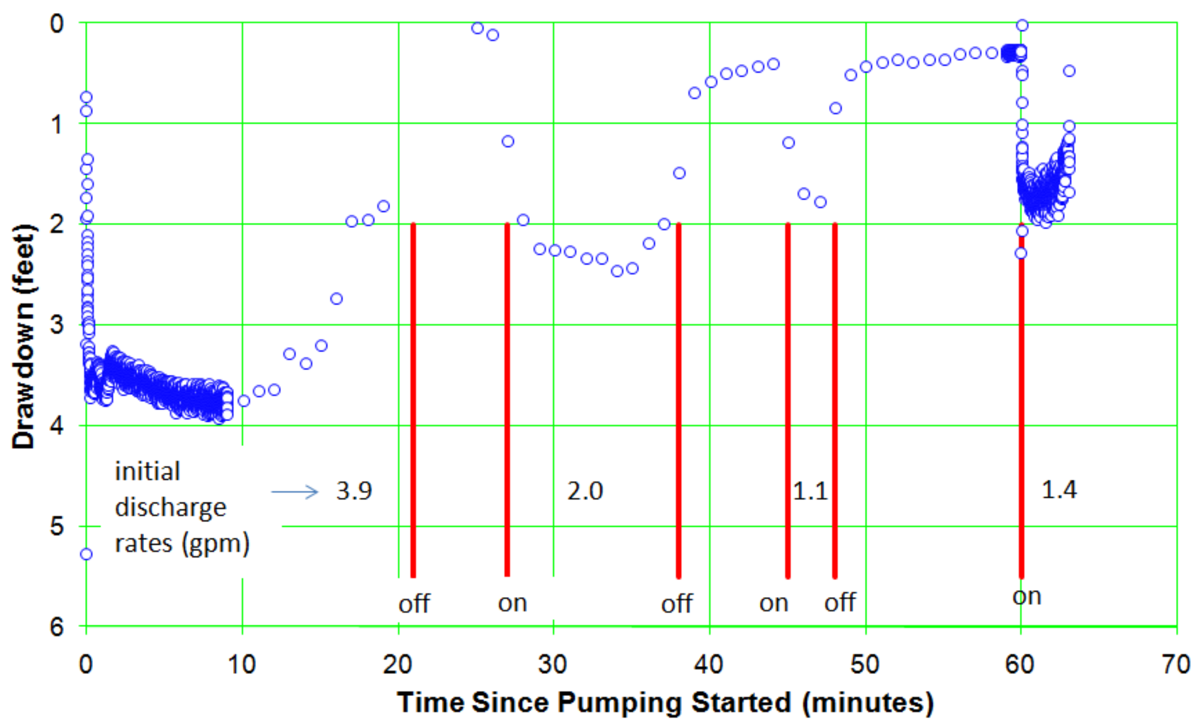


Figure C-8.3-1 Well R-3 trial 2 drawdown

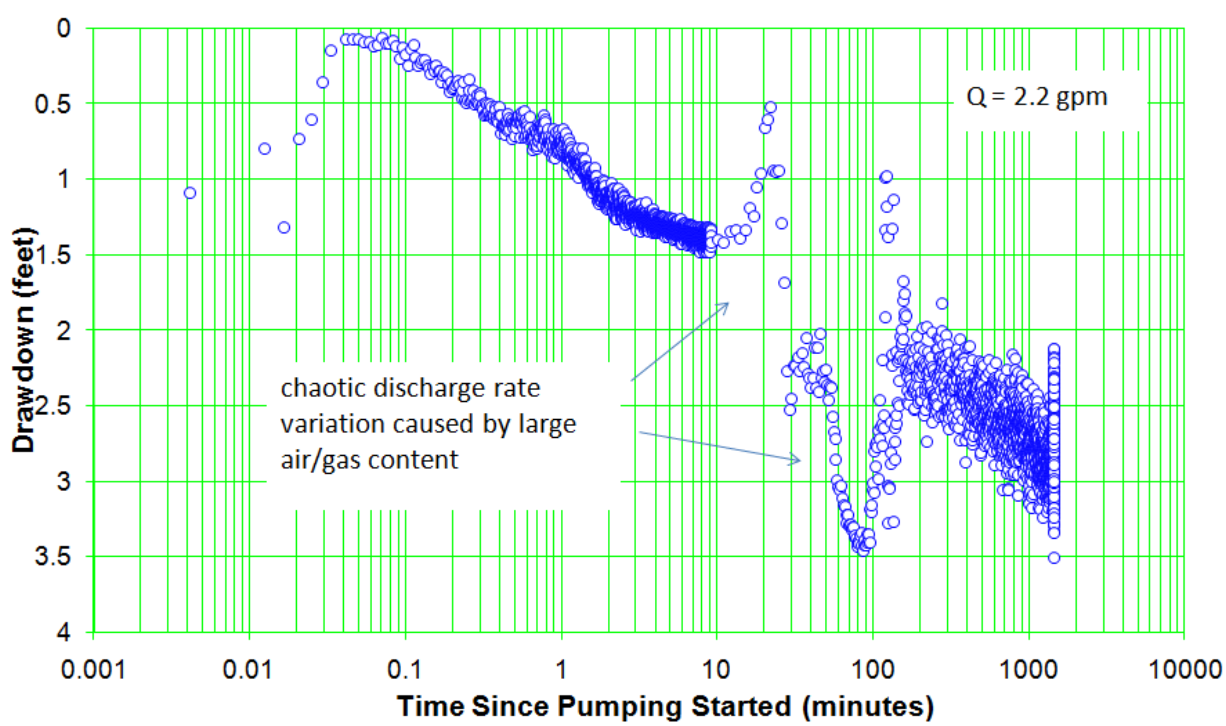


Figure C-8.4-1 Well R-3 drawdown

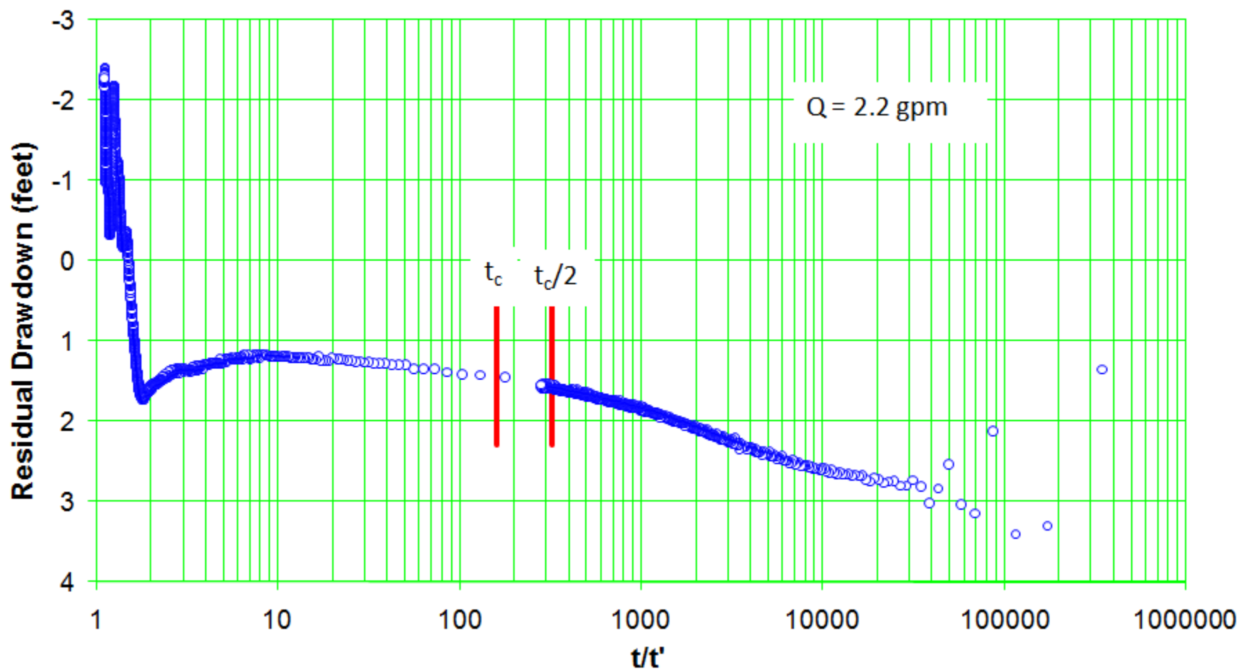


Figure C-8.4-2 Well R-3 recovery

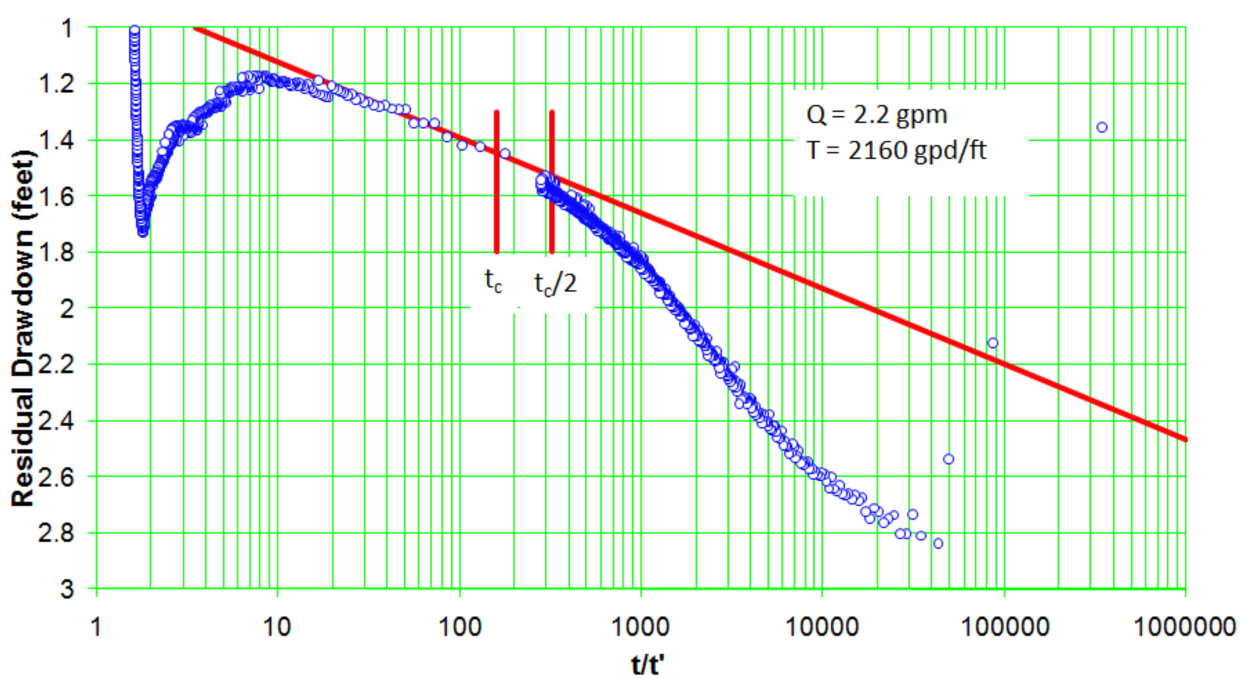


Figure C-8.4-3 Well R-3 recovery – expanded scale

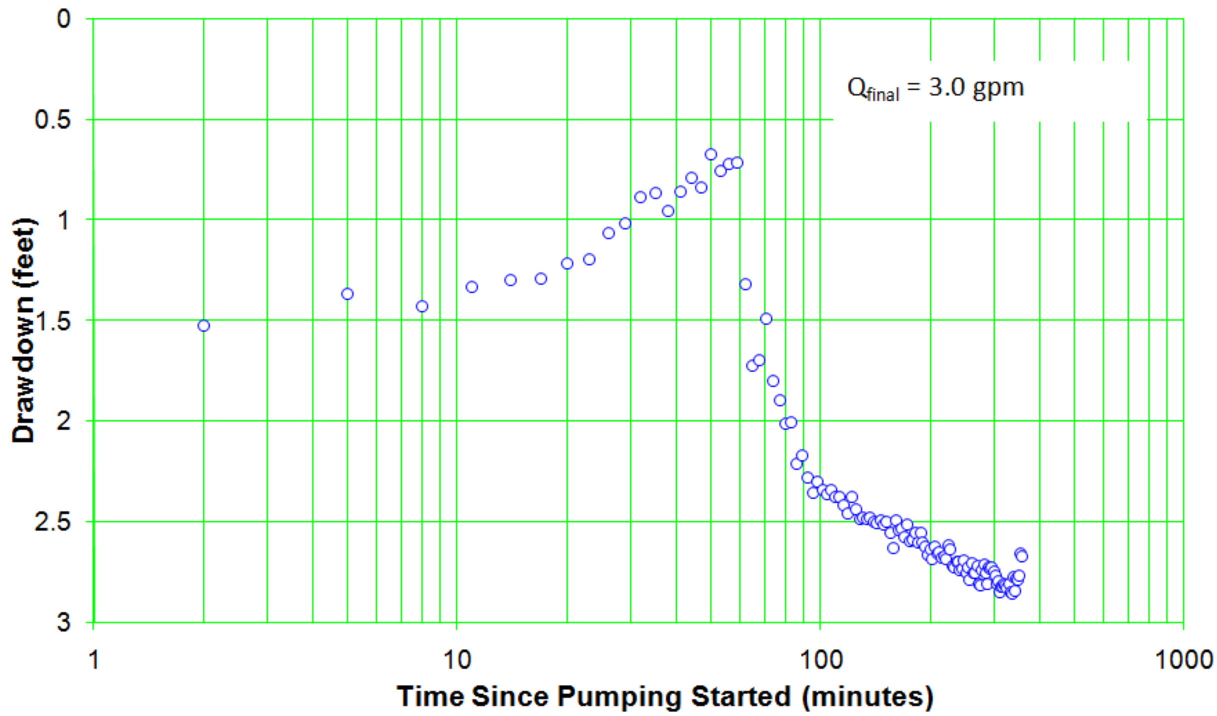


Figure C-8.5-1 Well R-3 purge drawdown

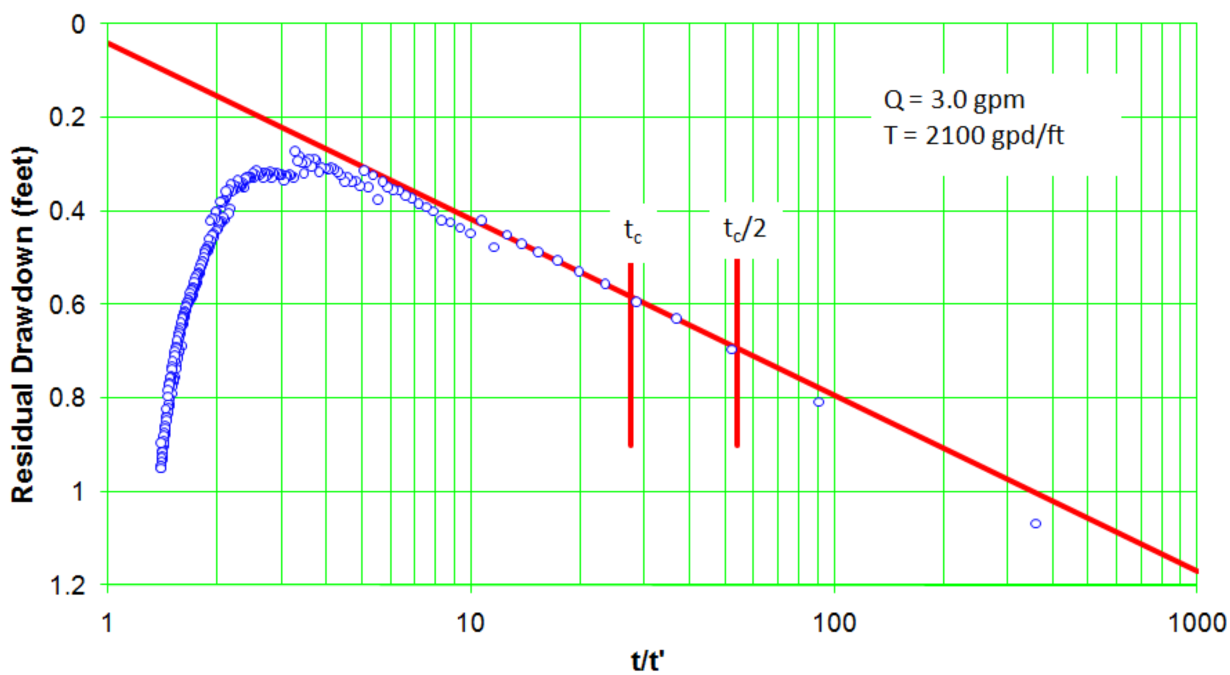


Figure C-8.5-2 Well R-3 purge recovery

Appendix D

Borehole Video Logging
(on DVD included with this document)

Appendix E

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

Appendix F

R-3 Final Well Design,
Variance Request, and NMED Approval

R-3 PROPOSED WELL DESIGN

Well Objectives

R-3 is a regional groundwater monitoring well located in Pueblo Canyon (Figure F-1). The purpose of the well is to monitor potential contamination pathways in the regional aquifer near production well Otowi-1 (O-1) and monitoring well TW-1. Contaminants detected in the regional aquifer at well O-1 include perchlorate, tritium, nitrate, and uranium. Possible contaminant sources include Acid Canyon, sewage plants in Pueblo Canyon, and Manhattan-era buildings in the Los Alamos townsite. R-3 will serve as a replacement regional aquifer monitoring well for the recently plugged and abandoned TW-1.

The R-3 well was originally planned to have two screens, one in the upper 80 ft of the regional aquifer and one in deeper productive sediments, comparable with those in the upper portion of the long screened interval at O-1. However, because of the clay-rich lithology present approximately 80 ft below the regional water level, a single deep screen is now proposed and described below. The problems with installing an upper screen in the clay-rich sediments arise from the nature of the formation itself and from drilling measures that were required to successfully penetrate the formation.

Recommended Well Design

It is recommended that a single screen in be installed in R-3 as a 20-ft stainless-steel, 20-slot, wire-wrapped well screen extending from 975 ft bgs to 995 ft bgs. The primary filter pack will consist of 10/20 sand extending 5 ft above and 5 ft below the well-screen openings. A 3-ft secondary filter pack of 20/40 sand will be placed above the primary filter pack. This screen placement would be approximately 18 ft above the elevation of the top of the screen in O-1.

There is a high likelihood that the 16-in., and perhaps the 18-in., drill casings cannot be removed from the borehole, as described below. If that is the case, bentonite seals will be used to isolate the casings from the well screen and to prevent surface water and perched groundwater from migrating through the vadose zone along the annuli of the drill casings. It is expected that the 12-in. drill casing will be successfully removed.

The proposed well design is shown in Figure F-2. This well design is based on the objectives stated above and on the information summarized below.

Well Design Considerations

Preliminary lithological logs indicate that the geologic contacts are, in descending stratigraphic order, Quaternary alluvium (0–30 ft bgs), Puye Formation (30–53 ft bgs), Cerros del Rio volcanic rocks (basalt lavas, scoria, and interflow breccias) (53–246 ft bgs), Puye Formation (246–440 ft bgs), and Santa Fe Group (440–1080 ft bgs or total depth [TD]). Highly fractured and rubbleized Miocene basalt occurs from 460 ft bgs to 530 ft bgs within the Santa Fe Group. Note that the final geologic contacts determined from closer lithologic evaluation and geophysical log interpretation may vary slightly.

Perched groundwater was expected in the lower Cerros del Rio basalts in the depth interval of approximately 190 ft bgs to 246 ft bgs, based on the occurrence of perched water in well R-3i. An open-borehole video log collected at R-3 from 4 ft bgs to 528 ft bgs showed water entering the well bore through a fracture in Cerros del Rio basalt at 208 ft bgs. Water production also was noted from 350 ft bgs to 363 ft bgs within the Puye Formation, and at 441 ft bgs within the Santa Fe Group above Miocene basalt. The top of perched water is shown at approximately 195 ft bgs in Figure F-2 because observations of first flow tend to be below the actual beginning of perched saturation. Also, a shallower depth for perched saturation would be consistent with observations in well R-3i.

Regional groundwater was predicted to occur at a depth of approximately 647 ft bgs, based on water-level maps for the area. A water level of 648.15 ft bgs was measured within a thick clay interval of the Santa Fe Group when the open borehole was approximately 848 ft deep. Later water-level measurements were complicated by the collapse of the open borehole in unstable clay and, after switching to casing-advance drilling, the movement of very fine quartz sands into the casing. The measured water level of 648.15 ft bgs is consistent with the predicted water level of 647 ft bgs. The Schlumberger neutron capture cross-section log recorded after reaching TD shows an abrupt downward increase at approximately 648.5 ft bgs, which is consistent with a transition from an air-filled to a water-filled borehole.

The Santa Fe Group in R-3 consists of interlayered gravels, clays, mudstones (silt plus clay), and fine quartz sands. The top of the regional aquifer is located within an interval of uncertain lithology, most likely clay and other fine-grained sediment extending from about 625 ft bgs to 763 ft bgs. There were no drilling returns other than a clay-water mixture from this interval. The neutron capture cross-section log suggests that this interval may contain some limited production sands. However, the first gravel and sand layer thick enough to be a potential screen target below the 16-in. drill casing is located between 805 ft bgs and 815 ft bgs, more than 150 ft below the regional water level.

Instability of the borehole while this clay-rich interval was being drilled led to an unsuccessful attempt to lower 12-in. drill casing for casing-advance below. The instability problem was addressed by switching to casing-advance (16-in.) drilling using a drilling mud with clay inhibitors, even though the drilling operations would occur less than 100 ft above the expected location of the regional water level. The 16-in. casing was advanced through the clay-rich interval to 764 ft bgs. The driller believes there is a low probability that the 16-in. casing can be retracted because the formation clay adheres tightly to the casing and because the casing shoe cannot be cut while the well assembly hangs inside the drill casing. The 18-in. casing does not extend as far into the clay layers, but it too may be difficult to retract during well construction. Attempts will be made to extract the 16-in. and 18-in. drill casings during well construction, but if they cannot be removed, bentonite seals will be installed around the casings so that they do not become conduits for surface water or perched groundwater.

Because of the nature of the clay-rich formation in the vicinity of the regional aquifer water level, water collected from a screen in this interval would likely exhibit unacceptable turbidity and very poor productivity. The proximity of unremoved drill casing and drilling additives that may not be readily flushed from the screen interval could lead to unacceptable chemical interference with water samples. For these reasons, no screen is proposed for the upper 80 ft of the regional aquifer.

Placement of a single screen in the lower section of the Santa Fe Group penetrated by the borehole appears more feasible, although there are concerns about borehole stability in this interval as well. Very fine sands with abundant well-rounded quartz grains are present in the Santa Fe Group below approximately 600 ft bgs and are abundant in many intervals. These sands are easily fluidized and have moved up tens of feet into the drill casing. Placement of a well screen within such intervals would likely present problems of borehole stability and screen clogging. The location proposed for the screen is an interval that includes coarser sands and gravels with minimal fine sand or clay content.

A dense, clay-rich layer is present from approximately 1030 ft bgs to 1040 ft bgs. This layer represents a potential aquitard and barrier to contaminant migration. Therefore, it is considered desirable that the lower screen be placed above this layer.

Other Design Considerations

Figure F-2 shows the locations of additional gravel-rich layers with minimal clay content that could be alternate candidates for lower screen placement. Most of these locations have the disadvantage of being at considerably higher elevations than the screen in O-1 and therefore might not have good hydraulic connections to the layers in O-1 where contaminants have been detected. The interval from 1020 ft bgs to 1030 ft bgs, below the location proposed for lower screen placement, has good lithologic characteristics for a well screen, but it is impractical because flowing sands have heaved up into the 12-in. drill casing from 1077 ft bgs to 1028 ft bgs. The 12-in. casing shoe will be cut off at a depth of 1025 ft bgs prior to well construction.

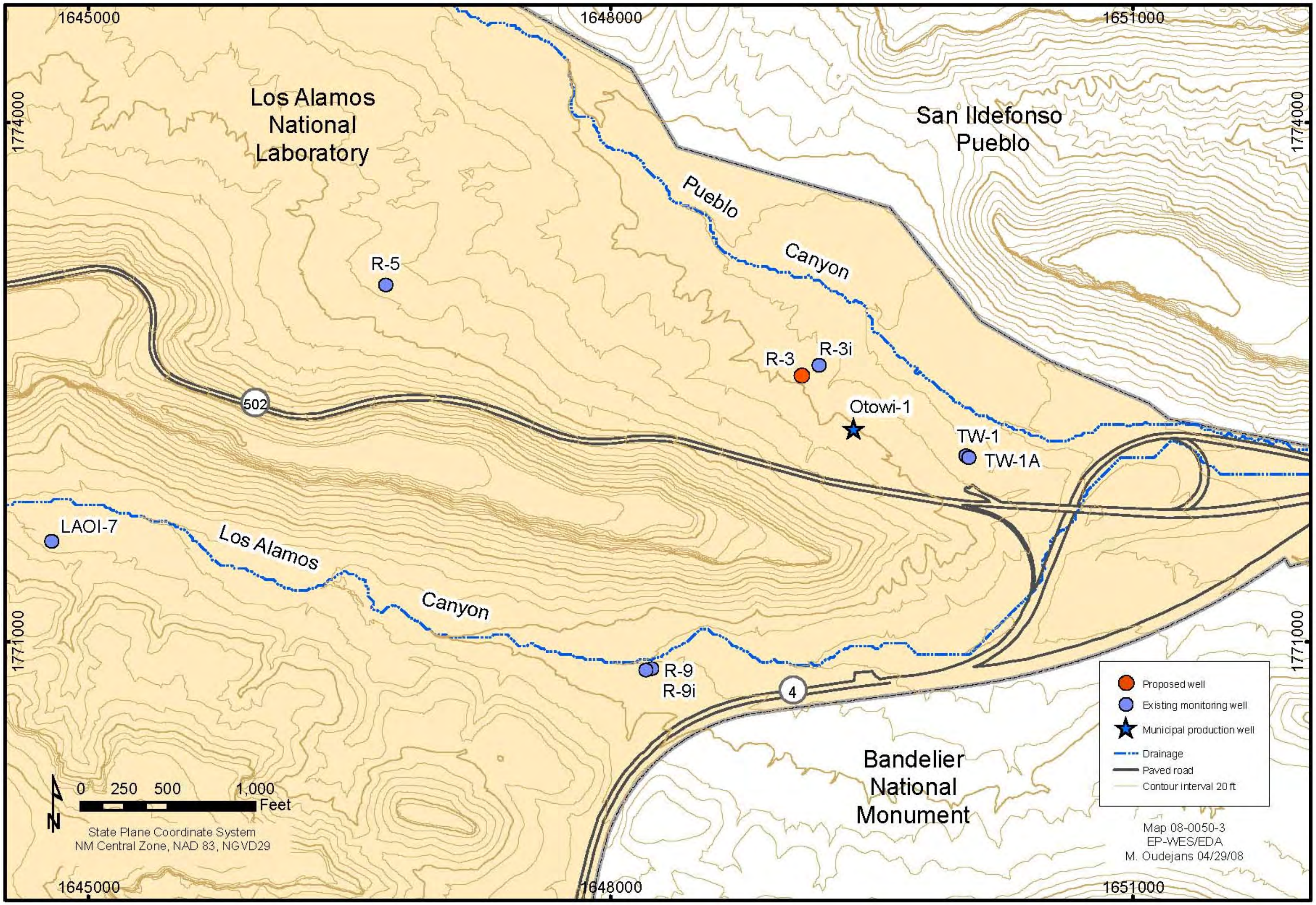


Figure F-1 Location map for R-3 showing locations of nearby monitoring and test wells

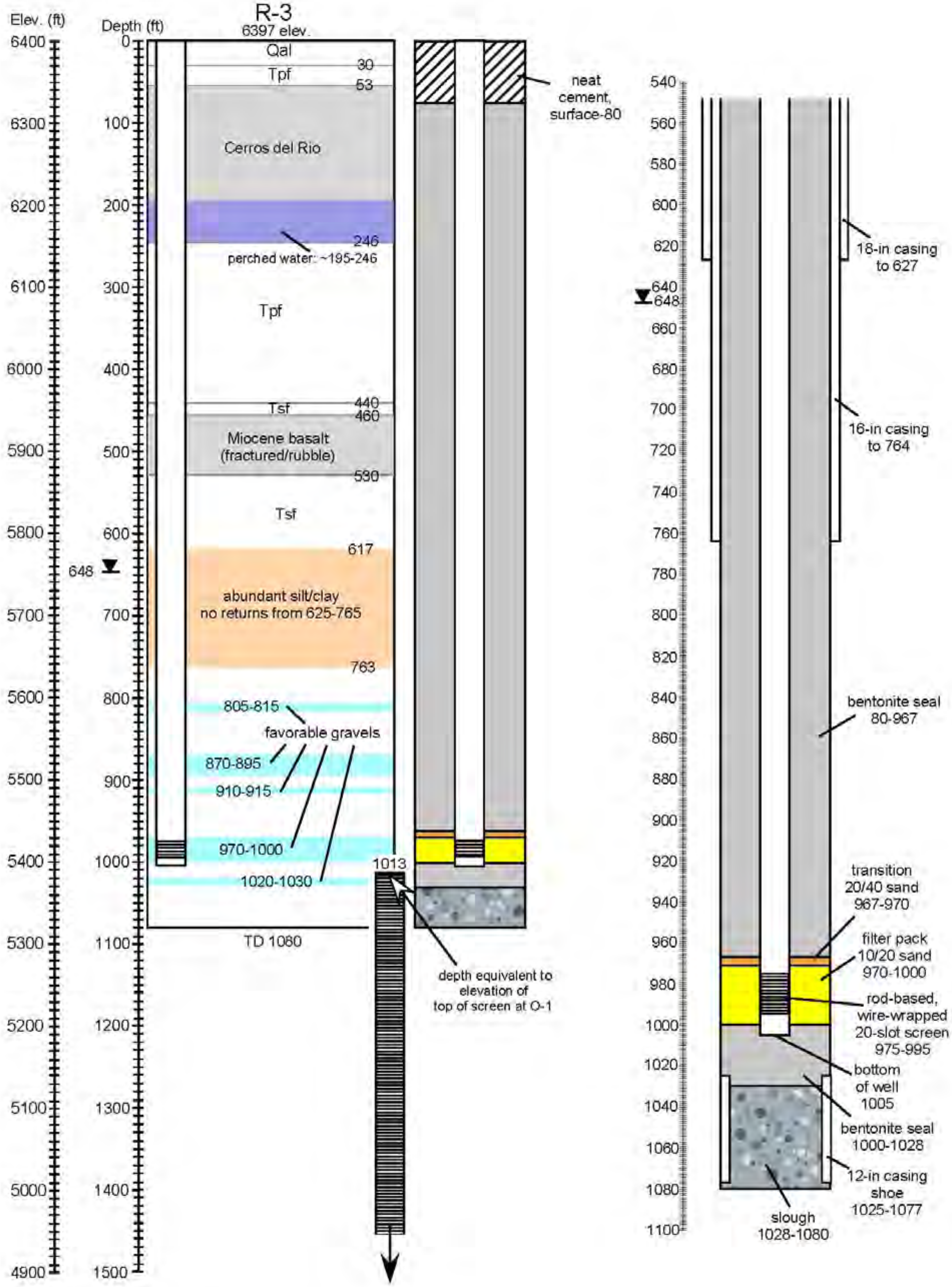


Figure F-2 Proposed well design for R-3

LANL REQUEST FOR R-3 WELL DESIGN MODIFICATION

-----Original Message-----
From: Everett, Mark C [mailto:meverett@lanl.gov]
Sent: Wed 6/2/2010 11:19 AM
To: Cobrain, Dave, NMENV; Kulis, Jerzy, NMENV; Dale, Michael, NMENV
Cc: Shen, Hai; Mignardot, Edward R Jr; Ball, Theodore T; Lynnes, Kathryn D

Subject: R-3 well design deviation request

Dave, Jerzy, and Michael,

I am writing to request a deviation in our proposed R-3 well construction design. The attached figure shows the proposed deviation which includes deletion of the bottom bentonite seal and use of coated bentonite pellets instead of the untreated chips.

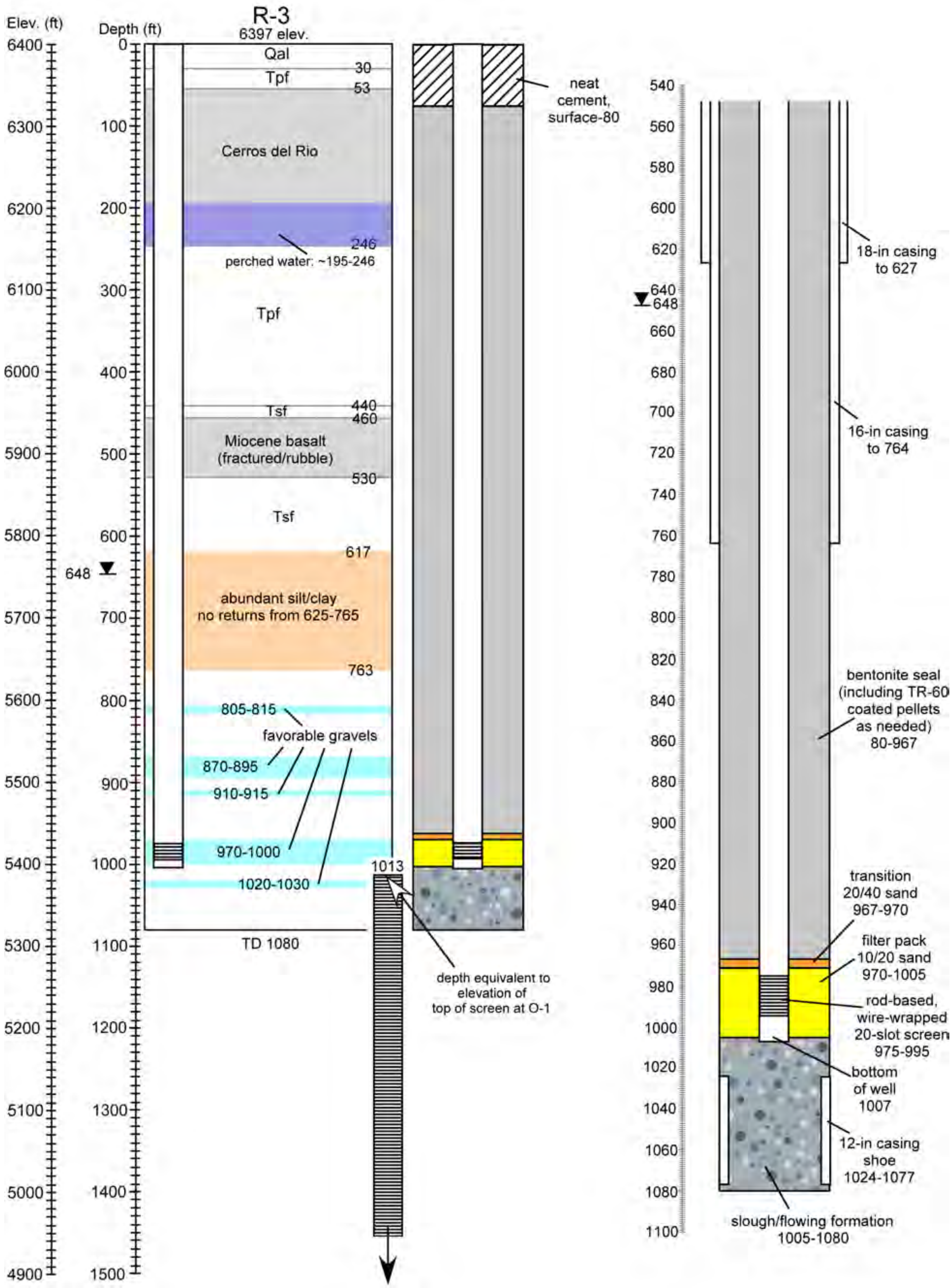
We are requesting permission to forego the lower bentonite seal because of severe formation heaving. When we reached the total borehole depth of 1077 ft repeated attempts were made, but the formation could not be kept from heaving up to 1028 ft below ground surface (bgs) inside the 12-in. drill casing. After NMED approved our well design we cut the 12-in. casing at 1024 ft bgs and the formation rose to 1021 ft bgs. To confirm that the cut was complete the 12-in. casing was lifted 1 ft resulting in the formation heaving up to 1005 ft bgs where it remains.

Well construction can proceed along one of several paths. We can pull the well casing and attempt to clean out the heaving material but based on past experience this is unlikely to be successful. We can try loading the drill casing with either water or bentonite based mud to overcome the formation pressures causing the problem, but this will lead to additional challenges during the development phase. The path that DOE/LANL feels is most likely to meet the well objectives is to forego the lower bentonite seal and to use coated pellets above the filter pack to ensure a proper seal. Leaving the lower bentonite seal out can still meet the well objectives as described below. Using coated bentonite pellets above the filter pack will allow us to extract the drill casing more slowly and carefully resulting in a better seal.

First, one of the primary purposes of the well is to see if we can determine the pathway that perchlorate follows into municipal well O-1. With a bentonite seal above the filter pack in R-3 we should be able to answer this question. If perchlorate is detected at R-3, then the perchlorate is following a deep pathway within the aquifer. If absent, then it is either moving along the top of the aquifer or in perched water and then down the O-1 filter pack. The open hole screening samples collected from 350 and 441 ft depth, in both R-3 boreholes, all came back non-detect with respect to ClO4. The shallowest perched water (~220 ft) is monitored by R-3i and does not contain ClO4. So, if ClO4 is not detected in R-3 constructed as proposed it is likely coming down-canyon higher up in the regional aquifer.

Secondly, we have a natural seal below the proposed screen at R-3 in the range of 15 to 35 ft below the slot openings. The clay-rich interval 1030-1040 has been confirmed with XRD to contain smectite (the high swelling clay found in bentonite). This provides a maximum sampled interval of 35 ft below the screen instead of the typical 5 ft. Additionally we have evidence that the 12-in. casing which extends to 1077 ft is plugged with fine grained material. When we stopped drilling, the formation heaved up to 1028 ft and the column of water inside the 12-in. drill casing stood at 29 ft below ground surface (bgs). When we cut the 12-in. at 1024 ft bgs the water level inside the casing dropped back to the anticipated static level of ~650 ft bgs instantaneously. The material inside the 12-in. casing has now heaved up to 1005 ft bgs, so we may actually have a functioning bottom seal 15 ft below the screen (see attached design figure).

Mark Everett, PG
Drilling Project Technical Lead
EP-WSP
LANL
(505) 667-5931 (office)
(505) 231-6002 (mobile)



Elev. (ft)
Depth (ft)
R-3
6397 elev.
Qal
30
Tpf
53
Cerros del Rio
246
perched water: ~195-246
Tpf
Tsf
440
460
Miocene basalt
(fractured/rubble)
530
Tsf
617
648
abundant silt/clay
no returns from 625-765
763
805-815
favorable gravels
870-895
910-915
970-1000
1020-1030
1013
TD 1080
neat
cement,
surface-80
depth equivalent to
elevation of
top of screen at O-1
18-in casing
to 627
648
16-in casing
to 764
bentonite seal
(including TR-60
coated pellets
as needed)
80-967
transition
20/40 sand
967-970
filter pack
10/20 sand
970-1005
rod-based,
wire-wrapped
20-slot screen
975-995
bottom
of well
1007
12-in casing
shoe
1024-1077
slough/flowing formation
1005-1080

NMED APPROVAL OF R-3 WELL DESIGN MODIFICATION

From: "Dale, Michael, NMENV" <Michael.Dale@state.nm.us>
To: "Everett, Mark C" <meverett@lanl.gov>
Date: Wed, 2 Jun 2010 13:15:39 -0600

Subject: RE: R-3 well design deviation request

Mark,

This e-mail serves as NMED approval for the well-design deviation request for R-3 as proposed in the e-mail (w/ attachment) below which was received by NMED today, June 2, 2010 at 11:19 AM. This approval is based on the information available to NMED at the time of the approval. As directed in the original R-3 well construction NMED approval dated May 29, 2010, LANL must apply aggressive development procedures at R-3 such as, but not limited to, swabbing and/or jetting while pumping and be protective of the regional aquifer by properly sealing off the three intermediate perched zones that were penetrated during the drilling of R-3. LANL shall discuss and propose the well-development procedures to NMED prior to developing R-3. LANL will provide the results of preliminary sampling, any modifications to the well design proposed in the e-mail below, and any additional information related to the installation of well R-3 as soon as such information becomes available. In addition, LANL shall provide results to NMED within three days of water-quality sampling at the conclusion of the aquifer-testing period at R-3. LANL shall give notice of this installation to the New Mexico Office of the State Engineer as soon as possible. Thank you.

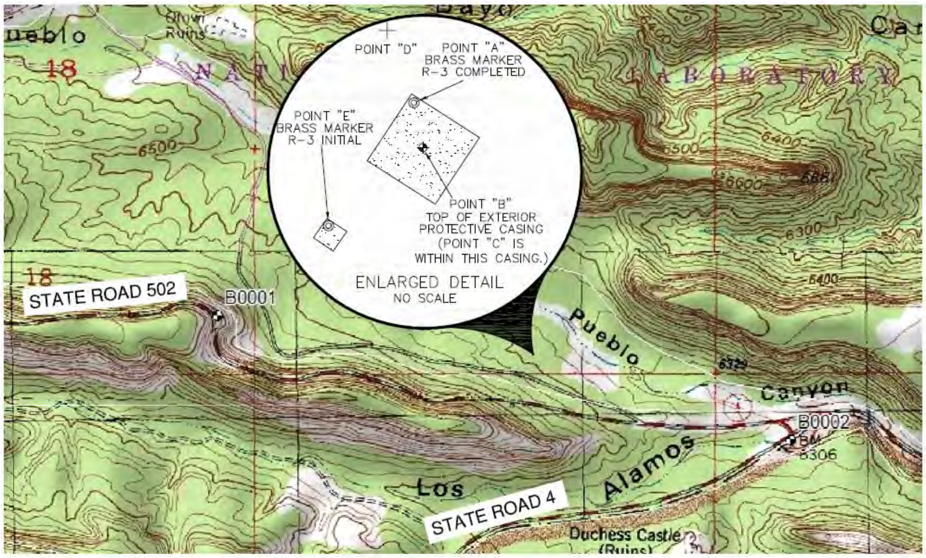
Michael Dale, NMED HWB

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) 662-2673 / Cell 660-1679

Appendix G

Geodetic Survey

LANL MONITORING WELL LOCATION REPORT
DESIGNATED R-3
WITHIN TECHNICAL AREA 74
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS COUNTY, NEW MEXICO
SEPTEMBER, 2010



POINT	DESCRIPTION	EASTING (X)	NORTHING (Y)	ELEVATION
A	BRASS MARKER R-3 COMPLETED	1649037.61	1772598.75	6395.88
B	TOP OF 16" PROTECTIVE CASING	1649038.72	1772593.20	6399.30
C	TOP OF 5 1/2" WELL	1649038.67	1772593.10	6398.35
D	GROUND	1649034.30	1772607.70	6395.31
E	BRASS MARKER R-3 INITIAL	1649027.07	1772583.54	6396.46

Notes

1.) FIELD SURVEY COMPLETED ON SEPTEMBER 2, 2010.

2.) THIS AREA LIES WITHIN LOS ALAMOS NATIONAL LABORATORY PROPERTY IN TECHNICAL AREA 74, 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 2ND DAY OF SEPTEMBER, 2010 AND FROM INSTRUCTION PROVIDED TO US BY NORTH WIN

LARRY W. MEDRANO, N.M.P.L.S. NO. 11993

DATE 09/10/2010

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

Appendix H

Initial R-3 Borehole Plugging Plan and NMOSE Approval

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER
District 6 Office, Santa Fe, NM

John R. D'Antonio, Jr., P.E.
State Engineer

PO Box 25102
Santa Fe, New Mexico 87501-5102
(505) 827-6120
FAX: (505) 827-6682

July 2, 2010

U S Department of Energy/Los Alamos Nat'l Labs.
Attn: Mark Everett
PO Box 1663
Los Alamos, NM 87545

Re: Conditionally Approved Well Plugging Plans of Operations of the initial hole drilled to complete monitoring well RG-92029-POD1 also referred to as LANL well R-3

Greetings:

Enclosed you will find the conditionally approved Well Plugging Plan of Operations for R-3. Please recognize the edited parts of the plan. All changes are made by our hydrologist and initialed. Please read the conditions of approval carefully and submit the subsequent Plugging Record on the appropriate NMOSE form.

Please call Kevin Myers or Doug Rappuhn, OSE Hydrologists, with any questions regarding the above comments.

Regards,

Jerri L. Trujillo

Jerri L. Trujillo
Upper Pecos Basin Manager
Water Rights Specialist

Page | 1

REVISED

WELL PLUGGING PLAN OF OPERATIONS

NOTE: A Well Plugging Plan of Operations shall be filed with and accepted by the Office of the State Engineer prior to plugging.

I. FILING FEE: There is no filing fee for this form.

RG-92029-POD1

II. GENERAL / WELL OWNERSHIP:

Existing Office of the State Engineer POD Number (Well Number) for well to be plugged: R-3-initial

Name of well owner: Los Alamos National Laboratory

Mailing address: TA-00, Building 1237, M992

City: Los Alamos State: New Mexico Zip code: 87544

Phone number: (505) 667-5931 E-mail: meverett@lanl.gov

III. WELL DRILLER INFORMATION:

Well Driller contracted to provide plugging services: Layne Christensen

New Mexico Well Driller License No.: WD368 Expiration Date: 12/31/2018

IV. WELL INFORMATION:

Note: A copy of the existing Well Record for the well to be plugged should be attached to this plan.

2017 JUN 25 AM 11:32

STATE ENGINEER OFFICE SANTA FE NEW MEXICO

1) GPS Well Location: Latitude: 35 deg, 52 min, 19 N sec
Longitude: 106 deg, 13 min, 16 W sec, NAD 83

2) Reason(s) for plugging well: Tools stuck in borehole - moved rig over and drilled another borehole. Tools were recovered.

3) Was well used for any type of monitoring program? Yes If yes, please use section VII of this form to detail what hydrogeologic parameters were monitored. If the well was used to monitor contaminated or poor quality water, authorization from the New Mexico Environment Department may be required prior to plugging.

4) Does the well tap brackish, saline, or otherwise poor quality water? no If yes, provide additional detail, including analytical results and/or laboratory report(s):

5) Static water level: * 648.00 feet below land surface / feet above land surface (circle one)

6) Depth of the well: 480 feet

*This is known from the second borehole drilled 10 ft away from initial.

Well Plugging Plan
Version: April 30, 2007
Page 1 of 5

7) Inside diameter of innermost casing: 23.375 inches.

8) Casing material: Mild Steel (surface casing 0-53 ft bgs)

9) The well was constructed with: N/A

_______ an open-hole production interval, state the open interval: _______

_______ a well screen or perforated pipe, state the screened interval(s): _______

10) What annular interval surrounding the artesian casing of this well is cement-grouted? N/A

11) Was the well built with surface casing? Yes If yes, is the annulus surrounding the surface casing grouted or otherwise sealed? (Yes) If yes, please describe: This was advanced using casing advance. It is the borehole from 0-53 ft bgs.
CASING SET USING CASING ADVANCE METHOD DOES NOT EMPLOY AN ANNULAR SEAL -DHA

12) Has all pumping equipment and associated piping been removed from the well? Yes If not, describe remaining equipment and intentions to remove prior to plugging in Section VII of this form.

V. DESCRIPTION OF PLANNED WELL PLUGGING:

Note: If this plan proposes to plug an artesian well in a way other than with cement grout, placed bottom to top with a tremie pipe, a detailed diagram of the well showing proposed final plugged configuration shall be attached, as well as any additional technical information, such as geophysical logs, that are necessary to adequately describe the proposal.

1) Describe the method by which cement grout shall be placed in the well, or describe requested plugging methodology proposed for the well: Bentonite chips will be pumped with water via tremie pipe.

2) Will well head be cut-off below land surface after plugging? N/A

VI. PLUGGING AND SEALING MATERIALS:

Note: The plugging of a well that taps poor quality water may require the use of a specialty cement or specialty sealant

1) For plugging intervals that employ cement grout, complete and attach Table A.

2) For plugging intervals that will employ approved non-cement based sealant(s), complete and attach Table B.

3) Theoretical volume of grout required to plug the well to land surface: ~~185.66 gallons~~ SEE EDITED TABLES A & B -DHA

4) Type of Cement proposed: ~~Portland~~

5) Proposed cement grout mix: 5 gallons of water per 94 pound sack of Portland cement. OR FOR SURFACE POUR

6) Will the grout be: _______ batch-mixed and delivered to the site

✓ mixed on site

7) Grout additives requested, and percent by dry weight relative to cement: N/A

8) Additional notes and calculations: 0-10 ft: 23.375/12 = 1.94 ÷ 2 = 0.97 (0.97)² 3.14 = 2.978
10(2.978) = 29.78 ÷ 12 = 24.82 ft³ grout

VII. ADDITIONAL INFORMATION: List additional information below, or on separate sheet(s):

This was an initial attempt for a regional well - hole was never to the regional (before tools stuck)

VIII. SIGNATURE:

I, __________________, say that I have carefully read the foregoing Well Plugging Plan of Operations and any attachments, which are a part hereof; that I am familiar with the rules and regulations of the State Engineer pertaining to the plugging of wells and will comply with them, and that each and all of the statements in the Well Plugging Plan of Operations and attachments are true to the best of my knowledge and belief.

Thomas ... Jr. — 6/25/10

Signature of Applicant — Date

FDM, NorthWind Inc. (contractor)

IX. ACTION OF THE STATE ENGINEER:

This Well Plugging Plan of Operations is:

✓ Approved subject to the attached conditions.

____ Not approved for the reasons provided on the attached letter.

Witness my hand and official seal this 2nd day of July, 2010

John R. D'Antonio, Jr., State Engineer

By: Jerri L. Trujillo

TABLE A - For plugging intervals that employ cement grout. Start with deepest interval.

	Interval 1 – deepest	Interval 2	Interval 3 – most shallow
			Note: if the well is non-artesian and breaches only one aquifer, use only this column.
Top of proposed interval of grout placement (ft bgl)	0		
Bottom of proposed interval of grout placement (ft bgl)	10.00		
Theoretical volume of grout required per interval (gallons)	24.82 ft3 * 7.48 gals = 185.66 gallons	APPROX 223 GALLONS DK	
Proposed cement grout mix gallons of water per 94-lb. sack of Portland cement	5 gallons/sack		
Mixed on-site or batch-mixed and delivered?	mix onsite		
Grout additive 1 requested	N/A		
Additive 1 percent by dry weight relative to cement	N/A		
Grout additive 2 requested	N/A		
Additive 2 percent by dry weight relative to cement	N/A		

TABLE B - For plugging intervals that will employ approved non-cement based sealant(s). Start with deepest interval.

	Interval 1 – deepest	Interval 2	Interval 3 – most shallow
	CLEANED OUT 9⅞" HOLE	REAMED 22" HOLE	Note: if the well is non-artesian and breaches only one aquifer, use only this column. 23.375" ID CASING
Top of proposed interval of sealant placement (ft bgl)	114.00	53.00	10.00
Bottom of proposed sealant of grout placement (ft bgl)	480.00	114.00	53.00
Theoretical volume of sealant required per interval (gallons)	~~290.39 ft³ × 7.48 gal/ft³ = 2172.14 gallons~~ ~1465 GALLONS	~~240.20 ft³ × 7.48 gal/ft³ 1796.70 gallons~~ ~1205 GALLONS	~~191.16 ft³ × 7.48 gal/ft³ = 1429.90 gallons~~ ~960 GALLONS
Proposed abandonment sealant (manufacturer and trade name)	WYOBen Enviro Plug 3/8" Bentonite Chips	WYOBen Enviro Plug 3/8" Bentonite Chips	WYOBen Enviro Plug 3/8" Bentonite Chips

R-3 Original Borehole Abandonment Plan

A pilot hole was drilled to 600 ft bgs at the original R-3 drilling site using a 9 7/8 tricone bit. In the course of reaming operations, the reaming tool, collars, and barrel stabilizer became stuck at a reamed depth of 114 ft on 04/29/2010. In order to meet drilling schedules, drillers twisted off and moved over to the new R-3 drilling site. They completed the well on 06/21/2010 and moved back to the original borehole. They successfully removed the bit, collars, and stabilizer on 06/23/2010. They tagged bottom at 113 ft bgs, indicating that the 9 7/8 pilot hole beneath the reamed section has backfilled from reaming slough. We propose to abandon this original hole, consistent with EP-ERSS-SOP-5034 and New Mexico Office of the State Engineer Rules and Regulations 19.27.4.31 (K), as follows.

1. Re-enter hole with drill string and clean slough to a depth of 480 ft, sufficiently below potential perched zones to prevent leakage from those zones to deeper intervals.
2. Backfill the borehole to a depth ten feet below the surface with an approved Bentonite backfill. The 24-in casing was installed as surficial conductant and is seated to 53.00 ft bgs. This casing ~~will remain in place~~. WILL BE REMOVED & THE INTERVAL PLUGGED PER ATTACHED OSE CONDITIONS JHA
3. Grout from a depth of 10 ft to the surface with neat cement.
4. Cap abandoned hole with a 3 ft X 3 ft concrete pad.

DISTRICT 1

JOHN R. D'ANTONIO, JR., P.E.

NEW MEXICO STATE ENGINEER

Materials submitted by consultant, Northwind, Inc., on behalf of Los Alamos National Laboratory (LANL) request the plugging of attempted/uncompleted LANL monitor well R-3. The plan notes the attempted well was drilled to a depth of 600' bgl (9.9" bit), reamed to 114' bgl (22" bit), and following equipment issues leading to proposed abandonment, left with reaming slough currently filling the 9.9" borehole below 114'. The plan proposes an accepted cleaning-out of slough to a depth of 480' bgl (below the 440' bgl depth of lowermost perched water inflow) prior to placement of sealant back to ground level. It is required that the ungrouted surface casing shall be extracted, and the resultant void properly sealed to comply with provisions of NMAC 19.27.4. Plugging services will be provided by Layne Christensen (WD-368).

Permittee: LANL; NMOSE File RG-92029-POD1
Location: Approximately three miles east of Los Alamos Airport
Approximate site coordinates: 35° 52' 19" N, 106° 13' 16" W

Specific Plugging Conditions of Approval for attempted LANL monitor well R-3, NMOSE File No. RG-92029-POD1

1. Water well drilling and well drilling activities, including well plugging, are regulated under 19.27.4 NMAC, which requires any person engaged in the business of well drilling within New Mexico to obtain a Well Driller License issued by the New Mexico Office of the State Engineer (NMOSE). Therefore, the firm of a New Mexico licensed Well Driller shall perform the well plugging.

2. Approximate theoretical volume of sealant required for abandonment of well intervals is: 4.0 gallons/foot of 9.9"-diameter borehole; 19.7 gallons/foot of 22"-diameter borehole; 22.3 gallons/foot of 23.375" ID casing. Total minimum volume of necessary sealant shall be calculated upon sounding the actual pluggable depth of the well (minimum depth of 480' bgl, following required clean-out of slough).

3. The Well Plugging Plan of Operations submitted requests use of bentonite chips as a sealant. NMAC 19.27.4.30.C.1 specifies placement of sealant by use of a tremie pipe. When a tremie is used, it shall extend to near total depth of the well at the initiation of the plugging. The tremie shall be incrementally removed to retain the tremie bottom a limited distance above the top of the rising column of bentonite chips throughout the plugging process.

   When placing bentonite chips above static water level, the chips shall be hydrated with sufficient potable water to allow the chips to yield. Options include: (A) use of a tremied mix of chips and water (as a carrier), or (B) dry-tremmying the chips in short intervals followed or preceded by addition of potable water increment sufficient for yielding of chips.

   Potable water shall be added to the well in increments such that the chips are discharged into a column of standing water, if possible. If borehole lithology is too permeable to retain added water prior to chip placement, potable water shall be discharged into the borehole/well following placement of short intervals of chips to provide the bentonite sufficient available water to swell and seal the borehole/casing.

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Alternately, a surface pour of the requested bentonite pellets is authorized, provided that the depth of the well be accurately determined prior to plugging, and that the top of the column of chips be sounded and column height / volume of sealant emplaced be recorded at approximate 50' intervals over the course of plugging to gauge appropriate progress of plugging and establish that the chips have not bridged inappropriately up-hole. If bridging occurs using any method of placement, the bridging shall be rectified before continuing with plugging. Sealant manufacturer's recommendations should be followed regarding screening fine particles from the chips and rate of pour to avoid bridging.

4. Extraction of the existing 53' of nominal 24" OD surface casing is required for compliance with NMAC 19.27.4. Suggested plugging of this interval includes providing sufficient amounts of bentonite chips within the casing to migrate into the void created as the casing is removed. Hydration may follow in intervals to promote an effective seal to the borehole face. Problems or concerns regarding the extraction of the surface casing shall be discussed with the NMOSE project contact.

5. The plug may be terminated below grade as necessary to allow approved redevelopment onsite, provided any plug consist of cement or concrete within 10' of ground level, and a minimum 6-inch thickness of reinforced cement grout or concrete completely covers the top of any casing cut off below grade. More stringent local building codes may apply.

6. Should the NMED, or another regulatory agency sharing jurisdiction of the project authorize, or by regulation require a more stringent well plugging procedure than herein acknowledged, the more-stringent procedure should be followed. This, in part, includes provisions regarding pre-authorization to proceed, contaminant remediation, inspection, pulling/perforating of casing, or prohibition of free discharge of any fluid from the borehole during or related to the plugging process.

7. NMOSE witnessing of the plugging will not be required, but shall be facilitated if a NMOSE observer is onsite. NMOSE witnessing may be requested during normal work hours by calling the District 6 NMOSE Office at 505-827-7848, at least 48-hours in advance. NMOSE inspection will occur dependant on personnel availability.

8. A NMOSE Plugging Record (available at: http://www.ose.state.nm.us/PDF/WellDrillers/WD-11.pdf) itemizing actual abandonment process and materials used shall be filed with the State Engineer (NMOSE, PO Box 25102, Santa Fe, NM 87504-5102), within 20 days after completion of well plugging. Please attach a copy of these plugging conditions.

The NMOSE Well Plugging Plan of Operations, as annotated, is hereby approved with the aforesaid conditions applied.

Witness my hand and seal this 2nd day of July, 2010:

By: ______________________
Jerri L. Trujillo
Water Rights Specialist
NMOSE-District 6

By: ______________________
Douglas H. Rappuhn
Hydrologist
NMOSE Hydrology Bureau

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