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DEPARTMENT OF ENERGY

Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

EMLA-2022-BF163-02-001

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NMED Hazardous
Waste Bureau

September 16, 2022

Mr. Rick Shean
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of Completion Report for Regional Aquifer Monitoring Well R-71

Dear Mr. Shean:

Enclosed please find two hard copies with electronic files of "Completion Report for Regional Aquifer Monitoring Well R-71." The dual-screen well casing and annular fill materials were installed between September 12 and December 20, 2021. Additional development of screens 1 and 2 was completed in January 2022. The screen 2 first sample was collected on January 23, 2022, and the screen 1 first sample was collected on January 30, 2022.

If you have any questions, please contact Christian Maupin (505) 695-4281 (christian.maupin@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

ARTURO DURAN

Digitally signed by ARTURO DURAN
Date: 2022.09.15 15:03:09 -06'00'

Arturo Q. Duran
Compliance and Permitting Manager
Environmental Management
Los Alamos Field Office

Enclosure(s): Two hard copies with electronic files

1. Completion Report for Regional Aquifer Monitoring Well R-71 (EM2022-0305)

cc (letter and enclosure[s] emailed):
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September 2022
EM2022-0305

Completion Report for Regional Aquifer Monitoring Well R-71

EM2022-0305

Completion Report for Regional Aquifer Monitoring Well R-71

September 2022

Responsible program director:

Printed Name	Signature	Title	Organization	Date
Ryan Flynn		Program Director	Water Program	9/8/22

Responsible N3B representative:

Printed Name	Signature	Title	Organization	Date
Troy Thomson		Program Manager	N3B Environmental Remediation Program	9/8/22

Responsible DOE EM-LA representative:

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Arturo Q. Duran	M Lee Bishop for — Digitally signed by M Lee Bishop for Date: 2022.09.15 16:09:24 -06'00'	Compliance and Permitting Manager	Office of Quality and Regulatory Compliance	

EXECUTIVE SUMMARY

This well completion report describes the drilling, well construction, development, and extended pumping for regional aquifer monitoring well R-71, located in Technical Area 05 at Los Alamos National Laboratory, Los Alamos, New Mexico. The R-71 monitoring well was installed as part of the Chromium Groundwater Project monitoring network. Well R-71 was installed at an angle of 25 degrees from vertical to a linear measured depth (MD) of 1425 ft, equating to a vertical depth below ground surface (bgs) of 1292 ft, relative to the wellhead location. Well R-71 has two screens in the Miocene pumiceous unit deposits to provide groundwater screening samples from the regional aquifer. The primary objective for R-71 is to further characterize the lateral and vertical extent of chromium contamination in the northwestern portion of the chromium plume. The need for this information was jointly identified in chromium project technical team meetings with the New Mexico Environment Department (NMED) in 2019. Work was performed in accordance with the 2016 Compliance Order on Consent, effective June 24, 2016 (Consent Order) between NMED and the U.S. Department of Energy Environmental Management Los Alamos Field Office. Characterization of the extent of chromium contamination in the R-71 location is expected to provide important information on the nature and extent of the plume.

The R-71 monitoring well was drilled using dual-rotary, casing-advance, fluid-assisted, air-drilling methods. Telescoping casing sizes between 24 in. and 14 in. were used to advance the borehole to total depth of 1425 MD. Fluid additives used included potable water, hammer oil, and foaming agent. Hammer oil was terminated at 1265 ft MD, 10 ft above the expected top of the regional aquifer at 1275 ft MD. Termination of foam-assisted drilling was attempted at 1225 ft MD, but cuttings were not able to be consistently lifted to the surface, necessitating intermittent use of foam from 1245 ft to 1425 ft MD.

The following geologic formations were encountered in R-71: Bandelier Tuff, upper Puye Formation, Cerros del Rio basalt, lower Puye Formation, pumiceous base of the Puye Formation, Miocene pumiceous unit, and Chamita Formation riverine deposits of the Santa Fe Group. No perched groundwater was encountered when the R-71 borehole was drilled.

R-71 was completed as a dual-screen well, allowing evaluation of water quality at two discrete depth intervals in the upper portion of the regional aquifer within the Miocene pumiceous unit, with a 20-ft upper screen from 1285.0 ft to 1305.0 ft MD (1164.6 ft to 1182.7 ft bgs) and a 10-ft lower screen from 1349.7 ft to 1360.0 ft MD (1223.5 ft to 1232.6 ft bgs).

The well was constructed in accordance with the NMED-approved well design. Groundwater field parameters of temperature, pH, oxidation/reduction potential, specific conductivity, and dissolved oxygen were recorded during the well development of both screened intervals until stabilized. Chromium concentration at the end of extended pumping was 4.06 ppb in screen 1 and 3.16 ppb in screen 2.

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Acronyms and Abbreviations

amsl	above mean sea level
APV	access port valve
ASTM	American Society for Testing and Materials
bgs	below ground surface
cfm	cubic feet per minute
Consent Order	Compliance Order on Consent (NMED)
DO	dissolved oxygen
DTHH	down-the-hole hammer
EM-LA	Environmental Management Los Alamos Field Office
GGRL	Geochemistry and Geomaterials Research Laboratories (LANL)
gpd	gallons per day
gpm	gallons per minute
HE	high explosives
Holt	Holt Services, Inc.
hp	horsepower
I.D.	inside diameter
IDW	investigation-derived waste
LANL	Los Alamos National Laboratory
LIC	liquid inflation chamber
MD	measured depth
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NAD	North American datum
NMED	New Mexico Environment Department
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
psi	pounds per square inch
SOP	standard operating procedure
TA	technical area
TD	total depth
TOC	total organic carbon
WCSF	waste characterization strategy form

1.0 INTRODUCTION

This well completion report summarizes borehole drilling, well construction, well development, and extended pumping for regional aquifer monitoring well R-71, in accordance with "Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71" (N3B 2020, 700776; NMED 2020, 700819; NMED 2021, 701477). The objective for well R-71 is to further characterize the lateral and vertical extent of chromium contamination in the northwestern portion of the chromium plume.

The R-71 regional aquifer monitoring well was completed with two screens in the upper portion of the regional aquifer. Because of terrain constraints, angled drilling was used to achieve the target location within the aquifer. The well was designed with an 8-in. inside diameter– (I.D.-) casing with two 0.040-slot screens. Final well design was based on data from lithology logs, water-level measurements, video logs, and geophysical logs. Specific well design recommendations were submitted to the New Mexico Environment Department (NMED) for review and approval before the well was constructed.

Secondary objectives include identifying and establishing water levels in perched-intermediate aquifers, collecting samples of drill cuttings for lithologic description, and acquiring borehole geophysical data. The R-71 borehole was drilled to a depth of 1425 ft linear measured depth (MD) down the borehole (1292 vertical ft below ground surface [bgs] at the well pad). During drilling, cuttings samples were collected at 5-ft intervals from ground surface to total depth (TD). Well R-71 was completed with a 20-ft upper screen from 1285.0 ft to 1305.0 ft MD (1164.6 ft to 1182.7 bgs) and a 10-ft lower screen from 1349.7 ft to 1360.0 ft MD (1223.5 ft to 1232.6 bgs), both within the Miocene pumiceous unit. The depth to water of 1271.60 ft MD (1152.5 ft bgs) was recorded on October 16, 2021, after drilling to total depth and before well installation.

Post-installation field activities included well development and extended pumping, collection of groundwater characterization samples, surface completion, dedicated sampling system installation, and geodetic surveying. Activities remaining to be completed at R-71 include waste management and site restoration.

The information presented in this report was compiled from field records, logbooks, and daily activity reports. Records, including field reports, field logs, and survey information, are on file at Newport News Nuclear BWXT-Los Alamos, LLC (N3B) Records Management. This report contains brief descriptions of activities and supporting figures, tables, and appendices associated with the R-71 drilling project.

2.0 ADMINISTRATIVE PLANNING

The following documents were prepared to guide the activities associated with the drilling, installation, and development of Chromium Groundwater Project monitoring network well R-71:

- "Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71" (N3B 2020, 700776)
- "Approval, Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71" (NMED 2020, 700819)
- "Final Decision: Response to Amended Approval Letter for Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71 and Amended Approval Letter for Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-72" (NMED 2021, 701477)
- "Field Implementation Plan for Regional Aquifer Well R-71" (N3B 2021, 701581)

- “Waste Characterization Strategy Form (WCSF) for Groundwater Monitoring Well R-71,” 2020, (N3B 2020, 700796)
- “Storm Water Pollution Prevention Plan: Chromium Piping and Infrastructure Project Phase 6, R-71 and R-72 Well Pad Construction and Drilling Activities, R1,” August 5, 2021 (N3B 2022, 702237)

3.0 R-71 DRILLING ACTIVITIES

The following are descriptions of the field activities that took place during the drilling of regional aquifer monitoring well R-71 in Technical Area 05 at Los Alamos National Laboratory (LANL or the Laboratory). The location of monitoring well R-71 is shown in Figure 3.0-1.

3.1 Drilling Approach

The drilling method, equipment, and drill-casing sizes for the R-71 monitoring well were selected to retain the ability to investigate and case or seal off any perched groundwater encountered above the regional aquifer. The drilling approach ensured that a sufficiently sized borehole diameter was achieved to meet the required 2-in. minimum annular thickness of the filter pack around an 8.625-in.–outside diameter (O.D.) well screen. Holt Services, Inc. (Holt) was the well drilling contractor awarded the contract to install R-71 and provide all necessary equipment, personnel, and materials.

Dual-rotary air-foam drilling methods using a Foremost DR-24HD rig reconfigured to drill angled boreholes were employed to drill the R-71 borehole. The drilling rig was equipped with conventional drilling pipe, tricone bits, downhole hammer bits, one deck-mounted 950–cubic feet per minute (cfm) air compressor, two Atlas Copco 1350-cfm auxiliary compressors, and general drilling equipment. A 2400-gal. “flatwater” rig tender, telescopic boom manlift, 4000-gal. water truck, inertial gyro survey tool with digital wireline counter, and two telehandler forklifts were also used for drilling activities. Light plants provided adequate lighting for night work. After the well was drilled to TD, the Foremost rig was used to construct the well.

A Hunke Manufacturing R36 pump hoist rig was mobilized to the site after the well was constructed. This rig was used for well development, installation of temporary pump systems for development, extended pumping, and sampling system installation.

3.2 Chronological Drilling Activities for the R-71 Well

The Foremost DR-24HD drilling rig, ancillary equipment, and materials were mobilized to the R-71 drill site on September 3, 2021. The equipment and tooling were decontaminated and inspected before mobilization to the site. Site preparation included installing polyethylene secondary containment beneath the drilling rig and ancillary equipment, welding a drive shoe to the 24-in.-diameter surface casing, connecting the centralizer plate to the bottom of the drilling rig, and setting up the discharge line from the drilling rig to the cuttings pit. The site walkdown and mast-up rig inspection for authorization to proceed was completed on September 9, 2021. Complete site setup was attained and drilling commenced on September 12, 2021.

R-71 was drilled as an angled borehole, with an average angle of 25° from vertical, trending north-northeast at an azimuth of N27E. To compensate for an anticipated loss of borehole angle with depth, the initial borehole angle was 27 from vertical.

Drilling commenced on September 12, 2021. From September 12 to September 13, 24-in. O.D. drive casing was advanced to a depth of 55 ft MD using a 23-in. shrouded tricone drill bit. The surface casing was advanced into the Tshirege Member unit 2 of the Bandelier Tuff.

On September 15, 20-in.-diameter casing was installed within the 24-in.-diameter surface casing. From September 15 to September 18, 20-in. O.D. casing was advanced using a down-the-hole hammer (DTHH) driving a 21.25-in. underreaming bit, from 55 ft MD in the Tshirege Member unit 2 of the Bandelier Tuff, through Tshirege Member unit 1v of the Bandelier Tuff, Tshirege Member unit 1g of the Bandelier Tuff, and into the Cerro Toledo interval of the Bandelier Tuff to 355.0 ft MD. The 20-in. casing shoe was mechanically cut, abandoning 8.5 ft of casing in place (355.0 to 346.5 ft MD).

From September 20 to September 21, 18-in. O.D. casing was installed within the 20-in. casing. From September 21 to September 25, 18-in. O.D. casing was advanced using a DTHH and 19.25-in. underreaming bit, from 355 ft in the Cerro Toledo interval of the Bandelier Tuff, through the Otowi Member of the Bandelier Tuff, through the Guaje Pumice Bed, and into the upper Puye Formation to 715.0 ft MD. The 18-in. casing shoe was cut, leaving 22.2 ft of casing in place (715.0 to 692.8 ft MD).

From September 26 to September 28, 16-in. O.D. casing was installed within the 18-in. casing. From September 29 to October 02, the 16-in. casing was advanced using a DTHH and 17.25-in. underreaming bit from 715 ft MD in the upper Puye Formation, through the Cerros del Rio basalt, and into the Puye Formation to 1135 ft MD. The 16-in. casing shoe was cut, leaving 19.5 ft of casing in place (1285.0 to 1135.0 ft MD).

From October 4 to October 7, 14-in. O.D. casing was installed within the 16-in. casing. From October 8 to October 10, the 14-in. casing was advanced using a DTHH and 15.25-in. underreaming bit from 1135 ft MD in the Puye Formation, through the pumiceous base of the Puye Formation, through the Miocene pumiceous unit, and into the riverine sediments of the Chamita Formation of the Santa Fe Group at TD at 1405 ft MD. Hammer oil usage was terminated at 1265 ft MD, 10 ft above the expected top of the regional aquifer at 1275 ft MD. Termination of foam-assisted drilling was attempted at 1225 ft MD, but cuttings were not able to be consistently lifted to the surface, necessitating intermittent use of foam from 1245 ft to 1425 ft MD. A geophysical logging survey run on October 12 revealed that Chamita Formation sediments had flowed or “heaved” into the 14-in. casing to a depth of approximately 1360 ft MD. From October 13 to October 14, a 13-in. tricone bit was used to remove the heaving sands from the casing to 1405 ft MD. A decision was made to advance the borehole and 14-in.-diameter casing further using the 13-in. tricone bit to 1425 ft MD to attempt to mitigate the heaving sands. Final TD of borehole at 1425 ft MD in the Chamita Formation was reached on October 14. The 14-in. casing shoe was cut.

Although care was taken to investigate potential perched-groundwater-bearing zones, particularly in and near the Cerros del Rio basalt where the occurrence of groundwater was anticipated, no perched groundwater zones were observed during the drilling of the borehole. The final static water level in the regional aquifer was recorded at 1271.60 ft MD on October 16. Table 3.2-1 presents a record of fluid quantities used during drilling and well construction.

From October 16 to October 20, a bailer and sand pump were used to remove heaved material from the borehole. The 14-in. casing shoe was cut on October 21, 2021, at 1402.7 ft MD, leaving 22.3 ft of casing in place (1425.0 to 1402.7 ft MD).

Gyroscopic deviation surveys of the borehole were conducted at 315 ft MD on September 18 and at 355 ft MD on September 21. Technical problems were encountered on both surveys. Surveys were successfully completed at 555 ft MD on September 24 and at 1405 ft MD on October 11, indicating average borehole inclination and azimuth of 24.92° (from vertical) and N26.9E, respectively, from surface to 1390 ft MD. Because of the discovery of heaved material in the hole, a geophysical survey using natural gamma and neutron logging tools was conducted on October 12 from only 1372 ft MD to surface. A second geophysical survey was completed on October 15 from TD to surface after drilling to 1425 ft MD. Figure 3.2-1 shows the as-built diagram for R-71, including stratigraphic details.

4.0 SAMPLING ACTIVITIES

This section describes the cuttings and groundwater sampling activities for monitoring well R-71. All sampling activities were conducted in accordance with applicable procedures.

4.1 Cuttings Sampling

Cuttings samples were collected from the R-71 monitoring well borehole at 5-ft intervals from ground surface to the TD of 1425 ft MD. At each interval, approximately 500 mL of bulk cuttings was collected by the site geologist from the drilling discharge hose, placed in re-sealable plastic bags, labeled, and archived in core boxes. Whole rock, +35 sieve-size fractions, and +10 sieve-size fractions were also processed, placed in chip trays, and archived for each 5-ft interval. A fraction of each cuttings sample interval was collected in an aliquot sample for aggregate sampling. Radiological control technicians screened the cuttings for radiological contamination per N3B-EP-DIR-SOP-10021, “Characterization and Management of Environmental Program Waste.” All screening measurements were below background values and/or negative. The cuttings were delivered to N3B for archiving at the conclusion of drilling activities.

4.2 Water Sampling

4.2.1 Potential Perched Water Samples

No perched groundwater screening samples were collected because no perched water zones were observed during the drilling of R-71.

4.2.2 Regional Groundwater Samples Collected During Drilling

Per NMED’s request for early analytical data, collection of groundwater samples was attempted at each 20-ft pipe connection interval in the regional aquifer from the circulation discharge. This was largely unsuccessful because of a lack of water production in the cased hole; only three samples were collected.

4.2.3 Well Development Samples

Groundwater samples were collected during well development and analyzed for total organic carbon (TOC). Three samples were collected from screen 2 on January 14, 2022, and one sample was collected from screen 1 on January 17, 2022. Field parameters collected for all samples included temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance, and turbidity.

4.2.4 Extended Pumping Samples

Groundwater screening samples were collected from each screen during extended pumping. Samples were collected from screen 2 on January 23, 2022 and from screen 1 on January 30, 2022. Samples from each screen were submitted for full groundwater characterization as described in section 4.2.5. Results of key constituents in the chromium plume area, including sulfate, chromium, nitrate, tritium, and perchlorate, are presented in Appendix B, Table B-1.1-1. Samples from each screen were also analyzed for naphthalene, sulfonic acid and disulfonic acid, rhenium, and TOC.

4.2.5 Groundwater Characterization Samples

Groundwater characterization samples were collected from the completed well at the conclusion of extended pumping for each screen in accordance with the 2016 Compliance Order on Consent (Consent Order). Samples were collected from screen 2 on January 17, 2022, and from screen 1 on January 30, 2022, consisting of full groundwater characterization analytical suites, compliant with the Consent Order, and TOC screening samples. Analytical results of these samples are in the Intellus New Mexico database (https://www.intellusnm.com/) and will also be reported in the next periodic monitoring report for the Chromium Investigation monitoring group, to be submitted in May 2023.

Analytical results are reported in Appendix B, Table B-1.1-1. Field water-quality parameters are presented in Table B-2.2-1.

5.0 GEOLOGY AND HYDROGEOLOGY

The geologic and hydrogeologic features encountered at R-71 are summarized below. The N3B geology task leader and team examined drill cuttings and the geophysical logging data to determine geologic contacts and hydrogeologic conditions. Drilling observations and water-level measurement data were considered in the identification of potential groundwater encountered in R-71.

5.1 Stratigraphy

Rock units for the R-71 borehole are presented below in order of youngest to oldest in stratigraphic occurrence. Lithologic descriptions are based on binocular microscope analysis of drill cuttings collected from the discharge hose. Depths are reported in MD since R-71 was drilled as an angled drill hole. Figure 5.1-1 illustrates the borehole stratigraphy of monitoring well R-71. A lithologic log for R-71 is presented in Appendix A.

Unit 2, Tshirege Member of the Bandelier Tuff, Qbt 2 (0–75 ft MD)

Unit 2 of the Tshirege Member of the Bandelier Tuff was encountered from 0 to 75 ft MD. Unit 2 represents a moderately to strongly welded devitrified rhyolitic ash-flow tuff (i.e., ignimbrite) that is composed of abundant quartz and sanidine crystals. Cuttings typically contain abundant fragments of indurated tuff and numerous free quartz and sanidine crystals.

Unit 1v, Tshirege Member of the Bandelier Tuff, Qbt 1v (75–190 ft MD)

Unit 1v of the Tshirege Member of the Bandelier Tuff was encountered from 75 to 190 ft MD. Unit 1v is a poorly to moderately welded, devitrified rhyolitic ash-flow tuff that is pumiceous, generally lithic poor, and crystal bearing to locally crystal rich. Abundant ash matrix is rarely preserved in cuttings. Cuttings commonly contain numerous fragments of indurated crystal-rich tuff with devitrified pumice. Abundant free quartz and sanidine crystals dominate cuttings in many intervals, and minor small (generally less than 10 mm in diameter) volcanic lithic inclusions also occur in cuttings.

Unit 1g, Tshirege Member of the Bandelier Tuff, Qbt 1g (190–355 ft MD)

Unit 1g of the Tshirege Member of the Bandelier Tuff was encountered from 190 to 355 ft MD. Unit 1g is a poorly welded vitric rhyolitic ash-flow tuff that is poorly to moderately indurated, strongly pumiceous, and crystal bearing. White to pale orange, lustrous, glassy pumice lapilli are characteristic of unit 1g. Cuttings contain abundant free quartz and sanidine crystals and glassy pumices.

Cerro Toledo Interval, Qct (355–395 ft MD)

The Cerro Toledo interval was encountered from 355 to 395 ft MD. The Cerro Toledo interval is a sequence of poorly consolidated tuffaceous and volcaniclastic sediments that occur intermediately between the Tshirege and Otowi Members of the Bandelier Tuff. Sediments are largely stained with orange oxidation on grain surfaces.

Otowi Member of the Bandelier Tuff, Qbo (395–652 ft MD)

The Otowi Member of the Bandelier Tuff was encountered from 395 to 652 ft MD. The Otowi Member is composed of poorly welded vitric rhyolitic ash-flow tuffs that are pumiceous and crystal- and lithic-bearing. Drill cuttings contain pale orange to white pumices, volcanic lithic clasts, and quartz and sanidine crystals. Lithic fragments are commonly subangular to subrounded and generally of intermediate volcanic composition, including porphyritic dacites.

Guaje Pumice Bed, Qbog (652–672 ft MD)

The Guaje Pumice Bed represents an air-fall tephra deposit of rhyolitic pumice that forms the base of the Otowi Member. The Guaje deposit was encountered from 652 to 672 ft MD. Drill cuttings in this interval contain abundant lustrous vitric pumice lapilli (up to 15 mm in diameter) with trace occurrences of small volcanic lithic fragments. The deposit is poorly consolidated.

Upper Puye Formation, Tpf (672–725 ft MD)

The Upper Puye Formation was encountered from 672 to 725 ft MD. Deposits in this interval are white to light orange/red-orange fine-grained to pebble-sized gravels and sandstones, including rounded pumice gravels. Sand-sized pumice and volcanic clasts are typically subangular to subrounded, and fine quartz grains are subrounded.

Cerros del Rio Basalts, Tb4 (725–975 ft MD)

Cerros del Rio volcanic rocks were encountered from 725 to 975 ft MD and form a complex sequence that includes both massive and vesicular basaltic lavas with minor basaltic scoria deposits. The sequence also includes thin (<5 ft) basaltic sediment layers between flows. These basaltic sediments consist of reworked fine gravel, sand, and mud.

Puye Formation, Tpf (975–1210 ft MD)

Puye Formation volcaniclastic sediments were encountered from 975 to 1210 ft MD. The Puye Formation consists of alluvial fan deposits eroded from volcanic rocks in the nearby Jemez Mountains. Cuttings from this interval consist of grey, red, and purple dacitic and rhyolitic gravels, volcaniclastic sands, and minor devitrified pumice clasts. Cuttings are generally angular to subangular.

Pumiceous Base of the Puye Formation, Tpf(p) (1210–1265 ft MD)

Puye Formation volcaniclastic sediments with subordinate pumice, varicolored grains of dacite, and rhyolite were encountered from 1210 to 1265 ft MD. Cuttings from this interval consist of poorly sorted to unsorted, medium to coarse gravels with pumice present throughout.

Miocene Pumiceous Sediments, Tjfp (1265–1370 ft MD)

The pumice-rich volcaniclastic section was encountered from 1265 ft MD to 1370 ft MD. These sediments are dominated by coarse to very coarse sands with subordinate silt and gravel. Additional subordinate components of the pumiceous sand and gravels include rhyolite lava, obsidian, and felsic crystals.

Chamita Formation, Tcar (1370–1425 MD)

Axial-river gravel deposits and fine to medium sand with silt and pebble gravel dominated by felsics were encountered from 1370 ft MD to 1425 MD. These sediments are dominated by subrounded to well-rounded clasts of diverse volcanic and Precambrian lithologies predominantly consisting of quartzites, feldspars, and quartz. Orthopyroxines are also present.

5.2 Groundwater

Drilling at R-71 proceeded without any indications of groundwater until approximately 1325 ft MD, when regional aquifer groundwater was first observed and a sample collected. The 14-in. casing was subsequently advanced to TD at 1425 ft MD. The depth to water of 1271.60 ft MD (1152.5 ft bgs at the well pad) was recorded on October 16, 2021, after drilling to TD and before well installation. No intermediate perched water was observed in the R-71 borehole.

6.0 BOREHOLE LOGGING

Gyroscopic surveys of the borehole were conducted at 315 ft MD on September 18, 2021, and at 355 ft MD on September 21, 2021, to determine borehole angle. Technical problems were encountered on both surveys and data were not valid. A third survey was successfully completed at 555 ft MD on September 24, 2021, and the final survey was completed at 1405 ft MD on October 11, 2021.

Geophysical logs were run by COLOG, Inc., on October 12 and October 15, 2021. The surveys consisted of natural gamma and neutron porosity tool runs. Heaved material was encountered in the borehole at 1372 ft MD on October 12. After TD was advanced to 1425 ft MD, a second survey was conducted on October 15 from 1425 ft MD to surface. Potable water was added to the borehole before the surveys to increase the water level to approximately 1250 ft MD.

The geophysical logs run are shown in Table 6.0-1. Figure 6.0-1 shows the gamma log overlain on the stratigraphic contacts. The geophysical logs and the gyroscopic survey are in Appendix C, on CD included with this document.

7.0 WELL INSTALLATION R-71 MONITORING WELL

The R-71 dual-screen regional well was installed between October 26 and December 22, 2021.

7.1 Well Design

The R-71 well was designed in accordance with Consent Order guidance, and NMED approved the final well design before the well was installed (Appendix D). The well was designed with two screened intervals, the first between 1285.0 ft and 1305.0 ft MD and the second between 1349.7 ft and 1360.0 ft MD, to monitor groundwater quality within two discrete zones of the regional aquifer.

7.2 Well Construction

From October 22 to October 26, 2021, well components and initial well construction materials were mobilized to the site. Stainless-steel well casing, screens, and tremie pipe were decontaminated. The 8-in.-diameter stainless-steel well casing and screens were tested for diameter and eccentricity before acceptance.

The R-71 monitoring well was constructed of 8-in. nominal I.D., 8.625-in. O.D. schedule 40, A304 stainless-steel beveled casing and fabricated to American Society for Testing and Materials (ASTM) A312 standards. The top screened section used one 20-ft length 8-in. I.D. rod-based 0.040-in. slot wire-wrapped screen to make the 20-ft-long upper screened interval. The bottom screened section used one 10-ft length screen with other dimensions identical to those described above to make the 10-ft-long lower screened interval. The screens were constructed with welded tabs at each end, between all rods and weld ring connections, to increase the rotational strength of the screen. All individual casing and screen sections were welded together using compatible 309L stainless-steel welding rods. The screens were manufactured by Johnson Screens, an Aqseptence Group company, pickled and passivated to ASTM A380-06 standards. A nominal 2-in. steel tremie pipe was used to deliver backfill and annular fill materials downhole during well construction.

The well design was approved by NMED and notice to begin construction was given on October 26, 2021. Well screens and well casing were installed in the borehole from October 27 to October 31. Stainless-steel centralizers were welded to the well casing approximately 2.0 ft above and below each screened interval, and every 42 ft along the casing body length. The centralizers used in R-71 were of a caster type to aid construction in the angled well and were fabricated of A304 stainless steel. Figure 3.2-1 presents an as-built schematic showing the construction details for the completed well.

The 14-in.-diameter casing was retracted as the annulus was backfilled with bentonite starting on November 4, 2021. Pel-Plug coated bentonite pellets were placed from 1398.2 ft (formation fill depth after well installation) to 1394.76 ft MD. After the depth sounder used during backfilling became stuck in the tremie pipe in which it was deployed on November 4, the tremie pipe was discovered to be disconnected at 340 ft MD. The depth sounder line was recovered except for the 5-ft stainless-steel sounder rod and 7 ft of line, which were abandoned and subsequently entombed in bentonite below the well sump. Reconnection of the tremie pipe was verified with a video survey on November 8.

Installation of annular fill and retraction of 14-in. casing resumed on November 12, with coated bentonite pellets installed to 1366.22 ft MD, followed by a collar of 20/40 transition sand to 1365.5 ft MD. During installation of 8/16 silica sand filter pack from 1365.5 ft MD to 1343.4 ft MD on November 14 to November 23, a significant void in the annular space was encountered. This filter pack interval required an actual volume of 177 ft^3 of material, significantly more than the calculated volume of 16.8 ft^3. Emplacement of small sand lifts, followed by retraction of the 14-in. casing and swabbing of the screened zone with a surge block, was necessary to create a stable filter pack. Once the filter pack was observed to be stable at 1343.4 ft MD, a collar of 20/40 transition sand was installed from 1343.4 ft to 1341.2 ft MD. On November 23, during installation of coated bentonite pellets, additional unexpected annular space required stabilization with a bentonite/sand fill and swabbing before another 20/40 sand collar was installed from 1338.2 ft to 1335.8 ft MD.

Following emplacement and stabilization of the fine sand transition collar, hydrated bentonite seal was installed from 1335.8 ft to 1313.6 ft MD on November 26 and November 27. On November 28, transition sand was placed from 1313.6 ft to 1311.5 ft MD. On November 28 to November 30, 8/16 filter pack sand was installed from 1311.5 ft to 1279.1 ft MD with swabbing. A transition sand collar from 1279.1 ft to 1277.2 ft MD was installed on November 30. After several feet of bentonite pellets were emplaced above the transition sand, 3/8-in. bentonite chips were used to advance the annular seal to 1180 ft MD on December 3, at which point the remaining 14-in. casing was tripped out from December 3 to December 6.

Annular bentonite seal emplacement continued December 6–11 to a depth of 1021.9 ft MD, when water standing in the 16-in. casing to a depth just below 800 ft MD caused repeated bridging of bentonite inside of the tremie pipe. The remaining 16-in. casing was tripped out December 11–12, followed by a resumption of bentonite seal installation to 684 ft MD on December 12 to December 15. Water standing in the borehole, 18-in. casing, and tremie continued to cause bridging. Because of uncertainties regarding the seal continuity, the tremie was pushed down through the bentonite seal while air was circulated. Depth sounding between 20-ft tremie joints revealed that two voids existed in the bentonite fill, estimated to be at 911 ft to 880 ft MD and at 840 ft to 805 ft MD, with an estimated combined volume of 68 ft^3. Bentonite grout was pumped into the two voids by tremie; 70.3 ft^3 of grout was required to fill the voids. Void areas were within the Cerros del Rio Basalt.

From December 16 to December 21, bentonite seal was installed from 684 ft to 60.5 ft MD while 18-in., 20-in., and 24-in. casing strings were retracted. The neat Portland cement grout surface seal was installed to 3 ft below surface on December 21 and topped off to 3 ft on December 22 after several inches of settling overnight.

Figure 3.2-1 presents the as-built diagram of monitoring well R-71, and Figure 7.2-1 presents technical completion details. Table 7.2-1 presents the annular fills used to build monitoring well R-71.

8.0 POST-INSTALLATION ACTIVITIES

Following well installation at R-71, the well was developed and extended pumping operations were conducted as described below. Groundwater produced during development and extended pumping was transported to the chromium treatment facility in Mortandad Canyon for processing before land application. Because of access restrictions during the nesting season of the endangered Mexican Spotted Owl beginning March 1, 2022, surface completion of the well and subsequent installation of the Baski dual screen sampling system were postponed until closures were lifted. The Baski system installation was completed on August 11, 2022. Geodetic surveying was conducted on August 17, 2022. Table 8.0-2 lists the geodetic survey coordinates for R-71. Finalization of surface completion, including electrical connections, is pending. Figure 7.2-1 lists the technical details of the sampling system.

Drill cuttings will be managed in accordance with the NMED-approved “Decision Tree for the Land Application of Drill Cuttings” (April 2016). Drilling, purge, and development waters will be managed in accordance with the NMED-approved Decision Tree for “Land Application of Drilling, Development, Rehabilitation, and Sampling Purge Water” (November 2016). Table 8.0-1 summarizes groundwater samples collected during well development and extended pumping of monitoring well R-71.

8.1 Well Development

The well was developed between January 8 and January 17, 2022. The well was treated with 5.4 gal. of Aqua-Clear PFD mixed with 2700 gal. of potable water on January 7 and 8. On January 8, screens 1 and 2 were surge swabbed for 4.75 hr. The sump was bailed 4 times, recovering several feet of silt and fine material. The final bottom tag was 1369.2 ft MD. On January 9, screens 1 and 2 were surge swabbed for 2.5 hr. Approximately 1–2 ft of silt and fine material was bailed from the sump. Approximately 840 gal. of water was bailed. On January 10, an additional 1–2 feet of fine sediment was bailed from the sump. Approximately 390 gal. of water was bailed.

The swabbing tool employed was a surge block composed of a 1-in.-thick nylon disc attached to a weighted steel rod. The wireline-conveyed tool was drawn repeatedly across the screened interval, causing a surging action across the screen and filter pack. Approximately 1230 gal. of water was removed from the well during bailing activities. Final well development, performed with a submersible pump and described below, involved lowering and raising the pump intake through the screen intervals.

On January 11 and 12 2022, a 30-horsepower (hp) Grundfos submersible pump, with packers above and below, was deployed into the well for final pump development. On January 12 and 13, the pump was drawn through the screen 1 section in 1-ft intervals from 1305 ft MD to 1285 ft MD, pumping for approximately 30 min at each interval. Packers were not inflated for this step development. On January 13, the lower packer was inflated to test specific capacity of screen 1. An optimal pump rate of 7.25 gallons per minute (gpm) was determined for screen 1 with intake at 1329 ft MD. With packer deflated, the pump was then lowered to begin step development of screen 2. The pump was drawn through the screen 2 section in 1-ft intervals from 1360 ft MD to 1350 ft MD, pumping for approximately 30 min at each interval. A total of 31,182 gal. of water was pumped during these stages of screen 1 and screen 2 development.

Pump development for screen 2 began on January 13 with upper packer inflated and with turbidity data collected every 30 min. A sustained flow rate of 20 gpm was determined with the intake at 1353 ft MD. On January 14, the field crew exchanged the 1-in. discharge manifold with a 3-in. manifold to reduce back pressure, and flow rate subsequently increased to 50 gpm. Pump development on screen 2 was completed when three consecutive turbidity readings below 5 nephelometric turbidity units (NTU) were recorded. Three TOC background groundwater screening samples were collected during the pump development. A total of 43,644 gal. of water was pumped from screen 2 during pump development.

Pump development of Screen 1 began on January 14 with sustained flow rate of 6.7 gpm at a pump intake depth of 1321.9 ft MD, with the lower packer inflated to isolate the screen. Turbidity readings were collected every 30 minutes. After pumping, the regional aquifer water level dropped to 1286 ft MD, 1 ft below the top of the screen interval, and stabilized at this depth. Since turbidity readings did not stabilize over 24 hr of pumping at 6.7 gpm, the decision was made to deflate the packer and step up through the screen at 1-ft intervals, then back down through the screened interval, at a sustained flow rate of 30 gpm. The intake was then set at 1304.7 ft MD and the lower packer inflated, and pumping resumed at a flow rate of 7 gpm. On January 16, the pump intake was lowered to 1325.7 ft MD and pump development continued through January 17, with turbidity continuing to fluctuate through. A lower flow rate was determined to be necessary to keep the water level above the top of the screen to achieve stable turbidity and complete development, which was achieved with a 5-hp Berkeley submersible pump during extended pumping. No development water samples were collected because of the unstable turbidity readings, and these samples were collected during extended pumping. A total of 21,442 gal. of water was pumped from screen 1 with the packer inflated and 12,500 gal. with the packer deflated during additional step development.

Table 8.1-1 presents the volumes of water produced during well development and extended pumping.

8.2 Extended Pumping

Extended pumping operations were conducted at R-71 between January 21 and January 30, 2022. Approximately 78,513 gal. of groundwater was purged during the extended pumping of both screens.

A 30-hp Grundfos submersible pump was used on screen 2 for the extended pumping operations. A short-duration test on screen 2 produced 3800 gal. of water on January 21. A 24-hr extended pumping operation produced 67,564 gal. of water from screen 2 on January 22 and 23. Flow rate averaged

47 gpm. N3B personnel collected N3B and NMED full-suite groundwater characterization samples near the end of the extended pumping operations on January 23.

From January 24 to January 27, the 30-hp Grundfos submersible pump was exchanged for a 5-hp Berkeley submersible pump for the extended pumping on screen 1 to accommodate the lower flow rate. The pump intake was set at 1282.0 ft MD. A short-duration test on screen 1 produced 234 gal. of water on January 28. A 24-hr extended pumping operation produced 6915 gal. of water from screen 1 on January 29 and 30. Flow rate averaged 4.8 gpm. N3B personnel collected N3B and NMED full-suite groundwater characterization samples near the end of the extended pumping operations on January 30.

Table 8.1-1 presents the volumes of water produced during well development and extended pumping.

Field parameters and sample analytical results are presented in Appendix B.

8.3 Total Volumes of Introduced and Purged Water

Approximately 40,041 gal. of potable water was added during drilling of the borehole to final TD of 1425 ft MD. During well construction and installation of the annular fill, approximately 75,416 gal. was added. In total, approximately 115,457 gal. of potable water was introduced to the borehole during project activities.

During development activities, a total of approximately 109,998 gal. of water was purged from both screens. During extended pumping activities, approximately 71,364 gal. was purged from screen 1 and 7149 gal. was purged from screen 2, for a total of 78,513 gal. The total amount of groundwater purged during post-installation activities was approximately 188,511 gal.

8.4 Field Parameters

During the pumping stage of well development, temperature, pH, DO, ORP, and specific conductance in µS/cm were measured. The required TOC and turbidity values for adequate well development are less than 2.0 ppm and less than 5 NTU, respectively.

Final development samples were collected and final field parameters were measured by collecting an aliquot of groundwater from the discharge pipe with the use of a flow-through cell. In screen 2 the parameters at the end of well development were pH of 7.91, temperature of 17.9°C, specific conductance of 202.7 µS/cm, DO of 3.16 mg/L, ORP of 108.5 mV, and turbidity of 4.48 NTU. In screen 1 the final development parameters at the end of development were pH of 7.96, temperature of 24.5°C, specific conductance of 184.1 µS/cm, DO of 9.54 mg/L, ORP of 221.2 mV, and turbidity of 11.4 NTU. Because of pump limitations, the required turbidity values were not achieved in screen 1. The final field parameters for screen 1 at the end of extended pumping were pH of 7.88, temperature of 19.3°C, specific conductance of 179.6 µS/cm, DO of 12.19 mg/L, ORP of 254.8 mV, and turbidity of 3.30 NTU. Appendix B, Table B-2.1-1, shows field parameters measured during well development and extended pumping.

8.5 Waste Management and Site Restoration

Waste generated from the R-71 project included drilling fluids, purged groundwater, drill cuttings, decontamination water, New Mexico Special Waste, and contact waste. A summary of the waste characterization samples collected during drilling, construction, and development at the R-71 well is presented in Table 8.0-1.

All investigation-derived waste (IDW) generated during well reconfiguration activities will be managed in accordance with applicable standard operating procedures (SOPs). These SOPs incorporate the requirements of all applicable U.S. Environmental Protection Agency and NMED regulations, U.S. Department of Energy orders, and N3B requirements. The SOP applicable to the characterization and management of IDW is N3B-AP-TRU-2150, “Waste Characterization Strategy Form.”

All waste streams produced during drilling and development activities will be sampled and characterized in accordance with the ”Waste Characterization Strategy Form for Chromium Regional Aquifer Wells Installation 2018-2020” (N3B 2019, 700198), which was approved per requirements of N3B-EP-DIR-SOP-10021, “Characterization and Management of Environmental Programs Waste.” This WCSF provides detailed information on IDW characterization methods, management, containerization, and potential volumes. R-71 construction materials (primarily polyvinyl chloride and stainless steel); fluids (purge and decontamination waters); contact waste (gloves, paper towels, plastic and/or glass sample bottles); and cement chase water will be the primary waste streams generated during the well development and drilling activities. The fluids produced will be sampled and analyzed for the suite of constituents listed in the WCSF and disposed of as appropriate. Site restoration will be conducted after all waste has been disposed of.

9.0 DEVIATIONS FROM PLANNED ACTIVITIES

Drilling, sampling, and well construction at R-71 were performed as specified in the NMED-approved “Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71,” (N3B 2020, 700776; NMED 2020, 700819; NMED 2021, 701477) with the exception of the following deviation.

- Following completion of drilling to the anticipated TD of 1405 ft MD, flowing sands heaved up into the casing. A 13-in. tricone bit was used to clean out the casing and advance the casing to 1425 ft MD to attempt to seal off the flowing sands.

10.0 ACKNOWLEDGMENTS

Holt Services, Inc., drilled and installed the R-71 monitoring well.

11.0 REFERENCES AND MAP DATA SOURCES

11.1 References

The following reference list includes documents cited in report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory’s (the Laboratory’s) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory’s Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), January 16, 2019. “Waste Characterization Strategy Form for Chromium Regional Aquifer Wells Installation 2018-2020,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2018-0123, Los Alamos, New Mexico. (N3B 2019, 700198)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), March 4, 2020. "Waste Characterization Strategy Form (WCSF) for Groundwater Monitoring Well R-71," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2020-0049, Los Alamos, New Mexico. (N3B 2020, 700796)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), August 2021. "Field Implementation Plan for Regional Aquifer Well R-71," Newport News Nuclear BWXT-Los Alamos, LLC, document, Los Alamos, New Mexico. (N3B 2021, 701581)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), May 2, 2022. "Storm Water Pollution Prevention Plan, Chromium Piping and Infrastructure Project, R-70, R-71 & R-72 Well Pad Site Completions," Newport News Nuclear BWXT-Los Alamos, LLC, document, Los Alamos, New Mexico. (N3B 2022, 702237)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), February 19, 2020 "Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2020-0026, Los Alamos, New Mexico. (N3B 202, 700766)

NMED (New Mexico Environment Department), March 26, 2020. "Approval, Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71," New Mexico Environment Department letter to A. Duran (EM-LA) from K. Pierard (NMED-HWB), Santa Fe, New Mexico. (NMED 2020, 700819)

NMED (New Mexico Environment Department), June 11, 2021. "Response to Amended Approval Letter for Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-71 and Amended Approval Letter for Drilling Work Plan for Chromium Groundwater Project Regional Aquifer Monitoring Well R-72," New Mexico Environment Department letter to A. Duran (EM-LA) from K. Pierard (NMED-HWB), Santa Fe, New Mexico. (NMED 2021, 701477)

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; 12 April 2010.

Hypsography, 100 and 20 Foot 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.

Pave Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Technical Area boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Division; 4 December 2009.

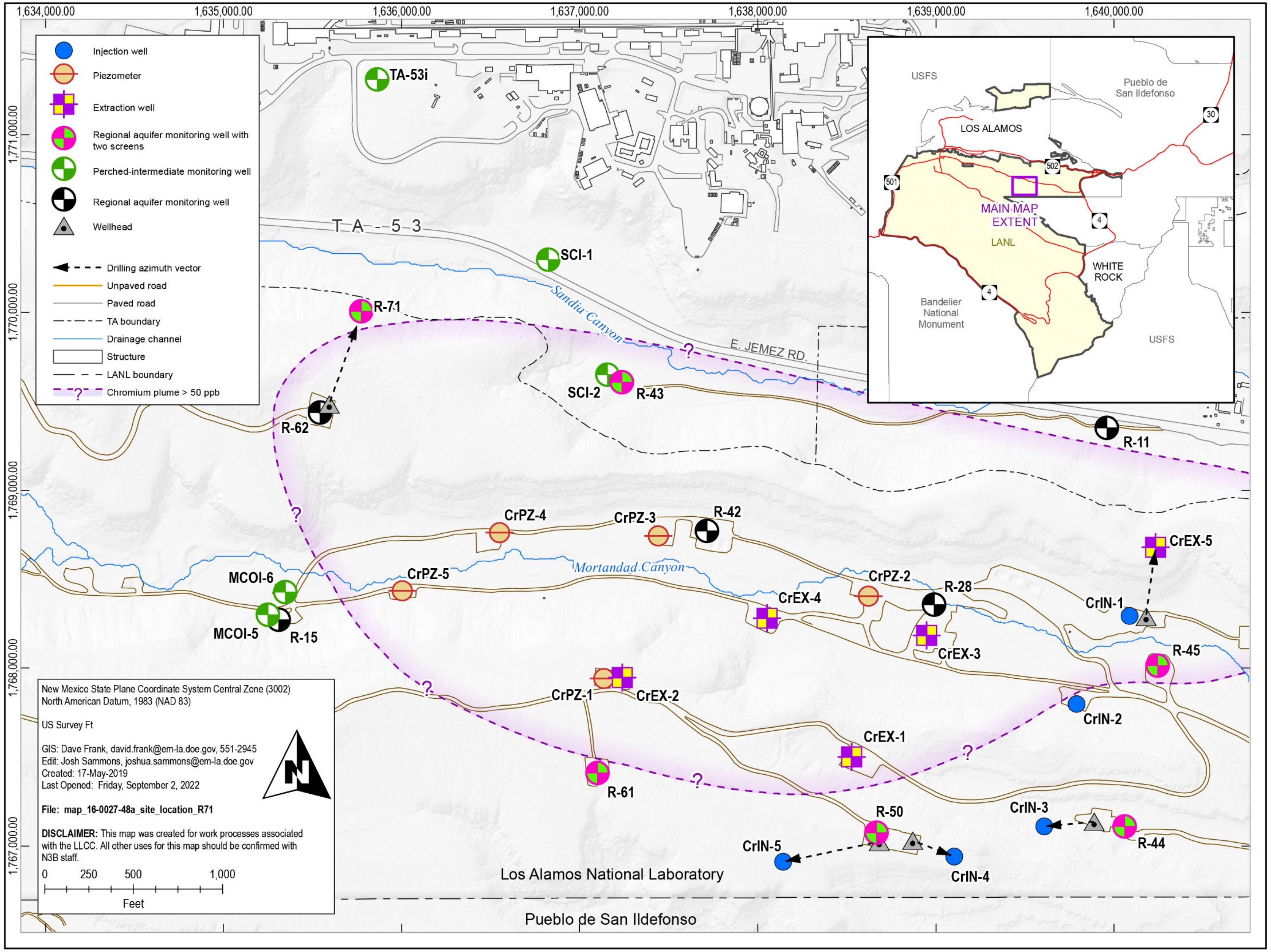

Figure 3.0-1 Location of regional monitoring well R-71

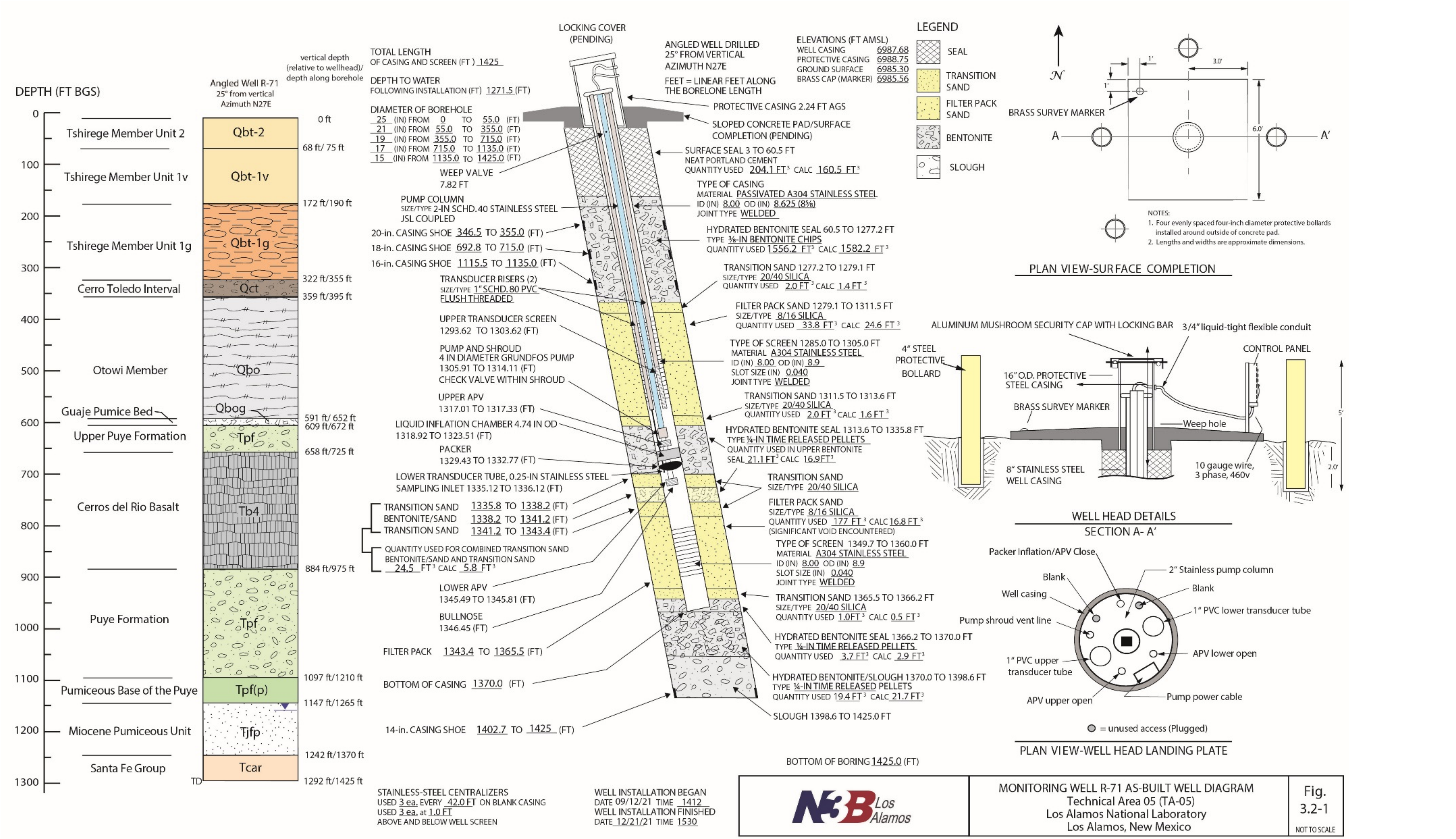

Figure 3.2-1 Monitoring well R-71 as-built construction diagram and technical well completion details

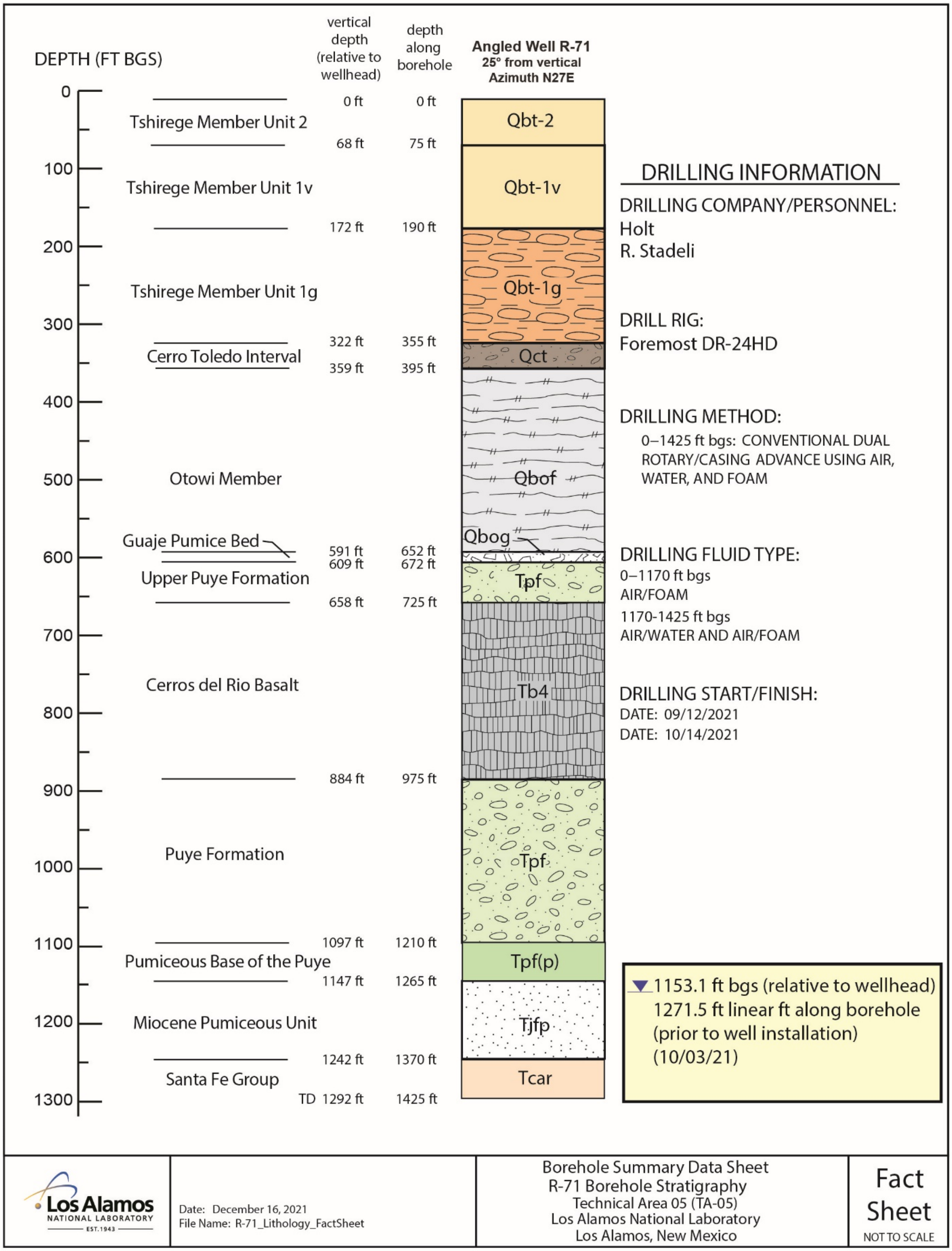

Figure 5.1-1 Monitoring well R-71 borehole stratigraphy

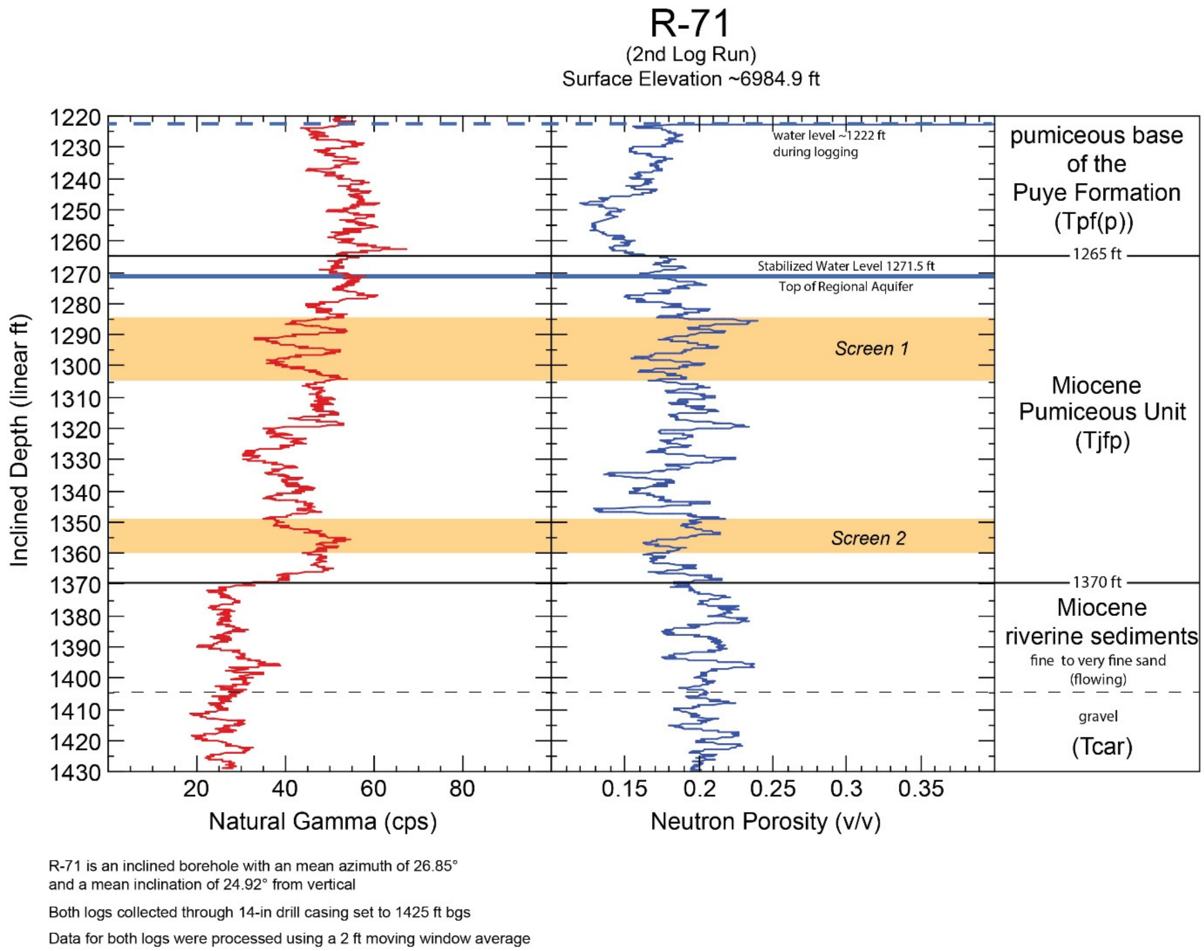

Figure 6.0-1 Gamma log correlated to borehole stratigraphy

R-71 SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES:

Survey Information

Brass Marker
Northing: 1769476.15
Easting: 1635501.06
Elevation: 6985.56

Well Casing
Northing: 1769472.18
Easting: 1635501.96
Elevation: 6987.68

Extended Pumping Data

Constant Draw Down Test (screen #1)
Specific Capacity: 0.60 gpm/ft
Performed on: 01/29–30/2022

Constant Draw Down Test (screen #2)
Specific Capacity: 1.7 gpm/ft
Performed on: 01/22–23/2022

Sampling System Materials and Product List

Pump
Grundfos 10S50-930
S/N: P12134-0001

Motor
Franklin 5046033
S/N: 21K14 20 03716C
Motor cable: 460v, 3ph

Baski Components

Shroud
Baski, 304 SS; 1305.91'-1314.51' bgs
Check Valve: 1-in. SS

Packer
Baski, S/N: 30695

Lower APV
Baski, S/N: 30722

Upper APV
Baski, S/N: 30723

Discharge column
2-in. 304 SS, JSL coupled drop pipe

Couplings
2.375 NUE / 1.315 NUE / Nitronic 60

Transducer Tubes
Upper = 1-in PVC pipe banded to SS drop pipe (1303.75' bgs)
Lower = 1-in PVC pipe banded to SS drop pipe (1305.74' bgs)

Transducers
Upper:
InSitu LT500 (30 psi)
S/N: 917913 (Manufactured 2022-04-08)
Screen: 1293.62'-1303.62' bgs

Lower:
InSitu LT500 (30 psi)
S/N: 917920 (Manufactured 2022-04-08)
Screen: 1335.12'-1336.12' bgs

Sampling tree: A304 schedule 40 stainless steel 1-in. nipples, elbows, bushings, and hose barbs

N3B Los Alamos		**R-71 SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES** Technical Area 05 (TA-05) Los Alamos National Laboratory Los Alamos, New Mexico	**Fig. 7.2-1**
Drafted By: N3B	Date: August 15, 2022		

Figure 7.2-1 R-71 technical notes

Table 3.2-1
Fluid Quantities Used During R-71 Drilling and Well Construction

Date	Depth (ft MD)	Water (gal.)	Cumulative Water (gal.)	Foam (Quik-Foam) (gal.)	Cumulative Foam (gal.)	Cumulative Hammer Oil (fl. oz)
Drilling						
9/12/2021	15	140.8	140.8	2.5	2.5	n/a*
9/13/2021	55	1220	1360.8	4	6.5	n/a
9/15/2021	106	1819	3179.8	20	26.5	40
9/16/2021	205	2955	6134.8	30	56.5	56
9/17/2021	315	2231	8365.8	30	86.5	104
9/18/2021	355	2087	10,452.8	5	91.5	200
9/22/2021	375	380	10,832.8	5	96.5	212
9/23/2021	555	2380	13,212.8	52	148.5	260
9/24/2021	655	2815	16,027.8	29	177.5	332
9/25/2021	715	1260	17,287.8	39	216.5	416
9/29/2021	735	1630	18,917.8	12	228.5	428
9/30/2021	815	2560	21,477.8	41	269.5	512
10/1/2021	975	5382	26,859.8	68	337.5	704
10/2/2021	1135	4106	30,965.8	114	451.5	896
10/8/2021	1165	560	31,525.8	14	465.5	916
10/9/2021	1365	2290	33,815.8	44	509.5	n/a
10/10/2021	1405	610	34,425.8	12	521.5	n/a
10/13/2021	1405	510	34,935.8	15	536.5	n/a
10/14/2021	1425	3110	38,045.8	50	586.5	n/a
10/15/2021	1425	540	38,585.8	0	586.5	n/a
10/18/2021	1425	180	38,765.8	0	586.5	n/a
10/19/2021	1425	100	38,865.8	0	586.5	n/a
10/20/2021	1425	1045	39,910.8	0	586.5	n/a
10/21/2021	1425	130	40,040.8	0	586.5	n/a
Well Construction						
10/22/2021	1405	1300	1300	n/a	n/a	n/a
10/23/2021	1405	3090	4390	n/a	n/a	n/a
10/24/2021	1405	30	4420	n/a	n/a	n/a
10/25/2021	1405	946	5366	n/a	n/a	n/a
11/6/2021	1400	750	6116	n/a	n/a	n/a
11/13/2021	1372	5300	11,416	n/a	n/a	n/a
11/14/2021	1360	4860	16,276	n/a	n/a	n/a
11/15/2021	1354	1930	18,206	n/a	n/a	n/a
11/16/2021	1352	5040	23,246	n/a	n/a	n/a
11/17/2021	1348	5300	28,546	n/a	n/a	n/a
11/18/2021	1348	6850	35,396	n/a	n/a	n/a

Table 3.2-1 (continued)

Date	Depth (ft MD)	Water (gal.)	Cumulative Water (gal.)	Foam (Quik-Foam) (gal.)	Cumulative Foam (gal.)	Cumulative Hammer Oil (fl. oz)
11/19/2021	1344	3155	38,551	n/a	n/a	n/a
11/20/2021	1346	384	38,935	n/a	n/a	n/a
11/21/2021	1344	692	39,627	n/a	n/a	n/a
11/22/2021	1341	1908	41,535	n/a	n/a	n/a
11/23/2021	1342	1075	42,610	n/a	n/a	n/a
11/25/2021	1337	660	43,270	n/a	n/a	n/a
11/26/2021	1323	1095	44,365	n/a	n/a	n/a
11/27/2021	1314	1550	45,915	n/a	n/a	n/a
11/28/2021	1296	1600	47,515	n/a	n/a	n/a
11/29/2021	1283	1710	49,225	n/a	n/a	n/a
11/30/2021	1267	3780	53,005	n/a	n/a	n/a
12/2/2021	1203	300	53,305	n/a	n/a	n/a
12/3/2021	1180	2200	55,505	n/a	n/a	n/a
12/6/2021	1180	52	55,557	n/a	n/a	n/a
12/7/2021	1170	2260	57,817	n/a	n/a	n/a
12/9/2021	1090	4680	62,497	n/a	n/a	n/a
12/10/2021	1057	8040	70,537	n/a	n/a	n/a
12/11/2021	1022	2520	73,057	n/a	n/a	n/a
12/16/2021	679	494	73,551	n/a	n/a	n/a
12/17/2021	506	480	74,031	n/a	n/a	n/a
12/18/2021	420	240	74,271	n/a	n/a	n/a
12/19/2021	258	550	74,821	n/a	n/a	n/a
12/20/2021	71	575	75,396	n/a	n/a	n/a
12/21/2021	3	20	75,416	n/a	n/a	n/a
Drilling + Well Construction						
					Total Water Volume (gal.)	**115,456.8**
					Total Foam Volume (gal.)	**586.5**

* n/a = Not applicable.

Table 6.0-1
R-71 Geophysical Logging Runs

Date	Logging Interval (ft)	Description
10/12/2021	0–1320	Gamma Log
10/12/2021	0–1320	Neutron Log
10/15/2021	0–1320	Gamma Log
10/15/2021	0–1320	Neutron Log

Table 7.2-1
R-71 Monitoring Well Annular Fill Materials

Material	Actual Volume (ft^3)	Calculated Volume (ft^3)
Upper surface seal: cement slurry	204.1	160.5
Upper bentonite seal: 3/8-in. chips	1556.2	1582.2
Upper transition sand: 20/40 silica sand	2	1.4
Upper filter pack: 8/16 sand	33.8	24.6
Upper transition sand: 20/40 silica sand	2	1.6
Middle bentonite seal: 1/4-in. pellets	21.1	16.9
Lower transition sand: 20/40 silica sand*	24.5	5.8
Lower filter pack: 8/16 sand	177	16.8
Lower transition sand: 20/40 silica sand	1	0.5
Lower bentonite seal: 1/4-in. pellets	3.7	2.9
Bentonite seal/formation slough: 1/4-in. pellets	19.4	21.7

* Significant void was encountered in lower screen section. After first addition of bentonite, tag depth was lower than before addition. Additional transition sand was added to fill void and increase distance from screen to bentonite seal.

Table 8.0-1
Summary of Groundwater Samples Collected During
Drilling, Well Development, and Extended Pumping of Well R-71

Location ID	Sample ID	Date Collected	Collection Depth (ft MD)	Sample Type	Analysis
Drilling					
R-71	CAMO-22-236055	10/9/2021	1325	Water	GGRL* metals, anions, alkalinity, pH, chlorate, TOC
R-71	CAMO-22-236056	10/10/2021	1345	Water	GGRL metals, anions, alkalinity, pH, chlorate, TOC
Well Development					
R-71	CAMO-22-238497	01/14/2022	1350–1360	Water	Perchlorate
R-71	CAMO-22-238499	01/14/2022	1350–1360	Water	Perchlorate
R-71	CAMO-22-238501	01/14/2022	1350–1360	Water	Perchlorate
R-71	CAMO-22-238496	01/14/2022	1350–1360	Water	TOC
R-71	CAMO-22-238498	01/14/2022	1350–1360	Water	TOC
R-71	CAMO-22-238500	01/14/2022	1350–1360	Water	TOC
R-71	CAMO-22-238493	01/17/2022	1285–1305	Water	Perchlorate
R-71	CAMO-22-238495	01/17/2022	1285–1305	Water	TOC
R-71	CAMO-22-238486	01/29/2022	1285–1305	Water	Perchlorate
R-71	CAMO-22-238488	01/29/2022	1285–1305	Water	Perchlorate
R-71	CAMO-22-238485	01/29/2022	1285–1305	Water	TOC
R-71	CAMO-22-238487	01/30/2022	1285–1305	Water	TOC

Table 8.0-1 (continued)

Location ID	Sample ID	Date Collected	Collection Depth (ft MD)	Sample Type	Analysis
Extended Pumping					
R-71	CAMO-22-236638	01/23/2022	1350–1360	Water	GGRL anions, alkalinity, pH
R-71	CAMO-22-236639	01/23/2022	1350–1360	Water	GGRL metals
R-71	CAMO-22-236938	1/30/2022	1285–1305	Water	GGRL anions, alkalinity, pH
R-71	CAMO-22-236939	1/30/2022	1285–1305	Water	GGRL metals
First Samples					
R-71	CAMO-21-235495	01/23/2022	1350–1360	Water	TOC, H_3, Al, Se, Hg, CN^-
R-71	CAMO-21-235496	01/23/2022	1350–1360	Water	NH_3, NO_2, NO_3, PO_4, anions, cations, metals
R-71	CAMO-21-237031	01/23/2022	1350–1360	Water	TOC, H_3, Al, Se, Hg, CN^-
R-71	CAMO-21-237032	01/23/2022	1350–1360	Water	NH_3, NO_2, NO_3, PO_4, anions, cations, metals
R-71	CAMO-21-237025	1/30/2022	1285–1305	Water	TOC, H_3, Al, Se, Hg, CN^-
R-71	CAMO-21-237026	1/30/2022	1285–1305	Water	NH_3, NO_2, NO_3, PO_4, anions, cations, metals
R-71	CAMO-21-237027	1/30/2022	1285–1305	Water	H_3_LL
R-71	CAMO-21-237033	1/30/2022	1285–1305	Water	NH_3, NO_2, NO_3, PO_4, anions, cations, metals
R-71	CAMO-21-237034	1/30/2022	1285–1305	Water	TOC, H_3, Al, Se, Hg, CN^-
R-71	CAMO-21-237036	1/30/2022	1285–1305	Water	H_3_LL
R-71	CAMO-21-237038	1/30/2022	1285–1305	Water	NH_3, NO_2, NO_3, PO_4, anions

* GGRL = Geochemistry and Geomaterials Research Laboratories.

Table 8.0-2
R-71 Geodetic Survey Coordinates

Survey Point	Northing	Easting	Latitude	Longitude	Elevation (ft)
Brass Cap	1769476.15	1635501.06	N35°51'47.581"	W106°15'59.725"	6985.56
Top Wellhead	1769472.18	1635501.96	N35°51'47.542"	W106°15'59.715"	6987.68
Top Protective Casing	1769471.78	1635501.72	N35°51'47.538"	W106°15'59.717"	6988.75
Ground Level	1769474.19	1635499.39	N35°51'47.560"	W106°15'59.750"	6985.3

Table 8.1-1
Water Produced During R-71 Well Development and Extended Pumping

Development and Extended Pumping	Water (gal.)
Bailing	1230
Screen 1 and 2 Combined (packers deflated)	43,682
Screen 2 (screen isolated with packers inflated)	115,008
Screen 1 (screen isolated with packers inflated)	28,591
Total	**188,511**

Appendix A

Borehole R-71 Lithologic Descriptions

BOREHOLE IDENTIFICATION (ID): R-71	**TECHNICAL AREA (TA):** 05	
DRILLING COMPANY: Holt	**START DATE/TIME:** 09/12/2021 14:12	**END DATE/TIME:** 10/14/2021 15:50
DRILLING METHOD: Dual Rotary	**MACHINE**: Foremost DR-24 HD	**SAMPLING METHOD:** Grab
GROUND ELEVATION: 6985.30 (FT AMSL)		**TOTAL DEPTH:** 1425 FT MD
DRILLERS: C. Perry, D. Sandy	**SITE GEOLOGISTS:** K. Warren, J. Coen, R. Weingarz, E. Muller	

Depth (ft MD)	Lithology	Stratigraphic Unit
0–75	Rhyolitic tuff, gray to light gray in color, moderately to strongly welded. Cuttings contain abundant welded ash flow tuff fragments most notably from 25 to 50 ft measured depth (MD). High concentration of quartz and sanidine crystals in abundance of 75% to 90% observed throughout the +35 sieved fraction. Sparse pumice fragments and trace dacitic clasts also observed. High clay continent observed from 0 to 15 ft MD.	Qbt 2
75–190	Rhyolitic tuff, light gray to buff in color. No recovery of cuttings from 175 to 185 ft MD. Cuttings are crystal rich with devitrified pumice throughout. Cuttings contain abundant fragments of indurated tuff and numerous free quartz and sanidine crystals. Quartz and sanidine crystals of up to 90% present in the 35+ sieved fraction throughout cuttings. Sparse ash matrix of <20% present in WR and +10 sieved fraction. Color changes from light gray to buff between 175 and 185 ft MD and buff to orange-brown between185 and 190 ft MD. This last color change also corresponds to beginning of presence of lustrous glassy pumice. Natural gamma log corresponds to Qbt 1v/Qbt 1g contact at 190 ft MD.	Qbt 1v
190–355	Rhyolitic tuff, poorly welded throughout. No recovery of cuttings from 190 to 195 ft MD. Several color changes occur in the section; 195–200 ft MD is orange-brown, from 195 to 200 ft MD is buff, and from 260 to 355 ft MD is gray to buff in color. Pulverized tuffaceous matrix is present throughout but in higher abundance (>75%) from 270 to 295 ft MD. Cuttings contain abundant light gray lustrous, glassy pumice lapilli ranging in size with the largest measuring about 10 mm in WR fraction. Pumice is noticeably absent from 270 to 295 ft MD. Minor felsic lava fragments are also present. The +35 sieved fraction contains abundant crystals that decrease with depth. Natural gamma log change corresponds to Qbt 1g/Qct contact at 355 ft MD.	Qbt 1g
355–395	Volcaniclastic sediments, white-gray to light buff in color. Cuttings contain rhyolite glassy lavas and rounded perlites. Sand-sized angular quartz grains and reworked white pumice clasts are present as well as dacite and rhyolite clasts. Obsidian is also present. Largest pumice clasts in WR fraction are >20 mm. WR fraction contains 50%–65% reworked pumice, 10%–25% dacite and rhyolite clasts, and 15–40% angular quartz grains. Natural gamma log corresponds to Qct/Qbo contact at 395 ft MD.	Qct
395–652	Rhyolitic tuff, light gray/dark gray in color. Tuff is poorly welded. Cuttings contain abundant white to gray rounded lustrous, glassy pumice and range in size from fine sand size to fine gravel size. The +35 sieved fraction is highly variable from predominantly pumice rich to predominantly crystal rich with distinct bipyramidal quartz present. The cuttings also contain abundant angular to subrounded medium gray to black dacite lava fragments mixed with minor perlite and obsidian fragments. The +35 sieved fraction contains 10%–90% felsic crystals, 10%–90% pumice, and <10% other volcanic lithics. Several sections within the Qbo appear to show reworking of previous events. Natural gamma log corresponds to Qbo/Qbog contact at 652 ft MD.	Qbo

Depth (ft MD)	Lithology	Stratigraphic Unit
652–672	Rhyolitic tuff, white in color. Cuttings consist of dense white pumice fragments with some glass present mixed with gray to dark gray dacite lava fragments. Minor banded rhyolite is also present. The +35 sieved fraction contains 40% quartz crystals. Natural gamma log corresponds to Qbog/Tpf contact at 672 ft MD.	Qbog
672–725	Volcaniclastic sediments, varicolored grains of dacite and rhyolite present. Trace amounts of quartzite are also present. Some pumice clasts in cuttings are likely falling from the above unit. Subangular to subrounded clasts of dacite (predominant) and rhyolite (subordinate) in all sieved fractions. Angular quartz grains present in the +35 sieved fraction from trace amounts in the upper part of the section are increasing to 50% in the lowest part (720–725 ft MD). Natural gamma log corresponds to Tpf/Tb4 contact at 725 ft MD.	Tpf
725–810	Basalt lava, dark gray basalts mixed with a matrix of gray siltstone/claystone. The gray siltstone/claystone matrix is consistent with depth within the section showing orange oxide staining from 780 to 785 ft MD. Basalts in +10 and +35 sieved fractions are gray to dark gray, angular to subrounded vesicular basaltic lavas. Partially altered massive medium gray basalt fragments are mixed with minor amounts of reddish brown clasts. Cuttings contain <15% rhyolites and dacites.	Tb4
810–815	Basalt lava, dark gray basalts mixed with a matrix of gray siltstone/claystone. Cuttings are consistent with unit described above; however, the +35 sieved fraction contains quartz in the 50% range.	Tb4
815–835	Basalt lava, dark gray in color. Unlike cuttings described above, the siltstone/claystone matrix is nearly absent. Cuttings consist of subangular to subrounded vesicular basaltic lava. No rhyolites or dacites are present. The +35 sieved fraction does not contain quartz.	Tb4
835–910	Basalt lava, dark gray basalts mixed with a matrix of gray siltstone/claystone. The gray siltstone/claystone matrix is consistent with depth within the section showing orange oxide staining from 890 to 905 ft MD. Basalts in +10 and +35 sieved fractions are gray to dark gray, angular to subrounded vesicular basaltic lavas. The +35 sieved fraction contains trace amounts of quartz. Cuttings contain sparse <5% rhyolites and dacites.	Tb4
910–975	Basalt lava, dark gray in color. Cuttings do not contain the siltstone/claystone matrix that was present in the above unit. Cuttings consist of subangular to subrounded vesicular basaltic lava with some iron staining. No rhyolites or dacites are present. The +35 sieved fraction does not contain quartz. Natural gamma log corresponds to Tb4/Tpf contact at 975 ft MD.	Tb4
975–1210	Volcaniclastic sediments, varicolored grains with predominant dacite and subordinate banded rhyolite with sparse quartzite and andesite are present. Cuttings consist of moderately sorted, moderately indurated, medium to coarse gravel with silty fine to coarse sand. Abundant pale red to gray rhyolite present at the top of the formation grading to gray Rendija Canyon dacite fragments at the base of the formation. Biotite and pyroxene phenocrysts are present throughout.	Tpf

Depth (ft MD)	Lithology	Stratigraphic Unit
1210–1265	Volcaniclastic sediments with subordinate pumice, varicolored grains of dacite and rhyolite. No recovery from 1225 to 1245 ft MD. The section from 1245 to 1265 ft MD is a composite section. Cuttings consist of poorly sorted to unsorted, medium to coarse gravels with pumice present throughout the section. The +35 sieved fraction contained 10% pumice from 1210 to 1265 ft MD while retaining the presence of Rendija Canyon volcanoclastic sediments (rhyolite and dacite) throughout the section. Rendija Canyon sediments abruptly transitioned from abundant to trace at 1265 ft MD indicating the beginning of the Tjfp.	Tpf(p)
1265–1370	Pumice-rich volcaniclastic sediments, buff in color. Composite section from 1245 to 1265 ft MD. No recovery from 1285–1290, 1325–1330, and 1360–1365 ft MD. Cuttings are poorly to moderately sorted composed of silty fine to very coarse upper sand. Cuttings contain detrital pumices ranging in size up to 0.5 mm and composing up to 45% or more of cuttings by volume. Dacite lava fragments along with flow-banded rhyolites are present. Phenocrysts are spars and consist mainly of glass lavas.	Tjfp
1370-1425	Axial-river gravel deposits, fine to medium sand with silt and pebble gravel dominated by felsics. During drilling, sands were prone to heaving. Detritus of subrounded to well-rounded clasts of diverse volcanic and Precambrian lithologies predominantly consisting of quartzites, feldspars, and quartz. Orthopyroxines are also present. The section from 1385 to 1405 ft MD is a composite section. The 35+ sieved section contains clasts that are subrounded to well-rounded gravels from 1370 to 1420 ft MD.	Tcar

Borehole Lithologic Log (continued)

ABBREVIATIONS

MD = measured depth (down the borehole)

Qbt 2 = Unit 2 of the Tshirege Member of the Bandelier Tuff

Qbt 1v = Unit 1v (vapor-phase) of the Tshirege Member of the Bandelier Tuff

Qbt 1g = Unit 1g (glassy) of the Tshirege Member of the Bandelier Tuff

Qct = Cerro Toledo interval

Qbo = Otowi Member of Bandelier Tuff

Qbog = Guaje Pumice Bed

Tb4 = Cerros del Rio Basalts

Tpf = Puye Formation

Tpf(p) = Pumiceous Base of the Puye

Tjfp = Miocene Pumiceous Unit

Tcar = Santa Fe Group

+10F = plus No. 10 sieve sample fraction

+35F = plus No. 35 sieve sample fraction

WR = whole rock (unsieved sample)

1 mm = 0.039 in.

1 in. = 25.4 mm

Appendix B

Groundwater Screening Analytical Results for Well R-71

B-1.0 GROUNDWATER SCREENING ANALYSIS AT R-72

Well R-71 is a regional aquifer monitoring well located in Technical Area 05 (TA-05) installed as part of the Chromium Groundwater Project monitoring network. R-71 was drilled at a 25° angle from the vertical with two screens from 1285 ft linear measured depth (MD) down the borehole to 1305 ft MD (screen 1) and from 1349.7 ft to 1360 ft MD (screen 2) in the Miocene pumiceous unit. This appendix presents the screening results for samples collected during well development and extended pumping at R-71.

B-1.1 Laboratory Analysis

Near the end of extended pumping of each screen, samples were collected and analyzed for the full groundwater characterization suite and total organic carbon (TOC). All TOC analyses were performed according to U.S. Environmental Protection Agency method SW-846:9060.

Six groundwater screening samples were collected during development, and four groundwater samples were collected during extended pumping. Los Alamos National Laboratory's Geophysics and Geochemistry Research Laboratory (GGRL) analyzed the development samples for TOC and perchlorate and the extended pumping samples for metals, anions, chromium, and nitrates.

Table B-1.1-1 lists the key analytical results for these samples.

B-1.2 Field Analysis

Groundwater field parameters were collected during the well development and extended pumping of both screens. Field parameters included temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), specific conductance, and turbidity. The time of sample collection and discharge rate were also recorded for each of these samples. The field parameters were subsequently monitored during 24-hr pumping tests during extended pumping. Turbidity values were collected using both YSI and Hach meters; Hach meter readings were favored for accuracy when entrained air was present in the produced water, affecting YSI readings.

Table B-1.2-1 lists the field parameters recorded during collection of the full groundwater characterization suite from each screen.

B-2.0 SCREENING ANALYTICAL RESULTS

This section presents the TOC concentrations and field parameters measured during extended pumping.

B-2.1 Field Parameters

Extended pumping was conducted on both screens using the well development pump and packers. During extended pumping, two 30-min step pumping intervals were conducted on each screen before the continuous 24-hr pumping interval for each screen. During the extended pumping, temperature, DO, specific conductance, pH, and ORP were monitored at regular intervals.

Table B-2.1-1 presents the field parameters monitored during well development and extended pumping tests of both screens.

Table B-1.1-1
Analytical Results from Well Development and Extended Pumping Samples

Field Sample ID	Sample Date	Parameter Name	Report Result	Report Unit	Lab Qualifier	Detected	Report Detection Limit
R-71 Screen 1 Well Development and Extended Pumping Samples							
CAMO-22-238495	1/17/2022	TOC	0.35	ppm	—[a]	Yes	0.200
CAMO-22-238485	1/29/2022	TOC	0.44	ppm	—	Yes	0.200
CAMO-22-238487	1/30/2022	TOC	<0.2	ppm	—	No	0.200
CAMO-21-237025	1/30/2022	Tritium	−23	pCi/L	U[b]	No	—
CAMO-21-237026	1/30/2022	Chromium	3.75	µg/L	J[c]	Yes	10.0
CAMO-21-237026	1/30/2022	Perchlorate	0.646	µg/L	—	Yes	0.200
CAMO-21-237026	1/30/2022	Sulfate	7.91	mg/L	—	Yes	0.400
CAMO-21-237034	1/30/2022	Tritium	25.2	pCi/L	U	No	—
CAMO-21-237033	1/30/2022	Chromium	4.06	µg/L	J	Yes	10.0
CAMO-21-237033	1/30/2022	Sulfate	7.88	mg/L	—	Yes	0.400
CAMO-21-237033	1/30/2022	Perchlorate	0.626	µg/L	—	Yes	0.200
CAMO-21-237033	1/30/2022	Chromium	2.57	µg/L	—	Yes	—
CAMO-22-236938	1/30/2022	Sulfate	5.06	mg/L	—	Yes	—
CAMO-21-237038	1/30/2022	Perchlorate	0.05	µg/L	U	No	0.200
CAMO-21-237038	1/30/2022	Sulfate	0.133	mg/L	U	No	0.400
CAMO-22-236938	1/30/2022	Nitrate	12.78	ppm	J	Yes	0.01
R-71 Screen 2 Well Development and Extended Pumping Samples							
CAMO-22-238496	1/14/2022	TOC	2.18	ppm	—	Yes	0.200
CAMO-22-238498	1/14/2022	TOC	2.41	ppm	—	Yes	0.200
CAMO-22-238500	1/14/2022	TOC	2.42	ppm	—	Yes	0.200
CAMO-21-235495	1/23/2022	Tritium	−16.1	pCi/L	U	No	—
CAMO-21-235496	1/23/2022	Chromium	3.16	µg/L	J	Yes	10.0
CAMO-21-235496	1/23/2022	Perchlorate	0.571	µg/L	—	Yes	0.200
CAMO-21-235496	1/23/2022	Sulfate	7.91	mg/L	—	Yes	0.400
CAMO-21-237031	1/23/2022	Tritium	33.5	pCi/L	U	No	—
CAMO-21-237032	1/23/2022	Chromium	3.01	µg/L	J	Yes	10.0
CAMO-21-237032	1/23/2022	Perchlorate	0.568	µg/L	—	Yes	0.200
CAMO-21-237032	1/23/2022	Sulfate	9.41	mg/L	—	Yes	0.400
CAMO-22-236638	1/23/2022	Nitrate	18.281	mg/L	—	Yes	—
CAMO-22-236638	1/23/2022	Sulfate	10.291	mg/L	—	Yes	—
CAMO-22-236639	1/23/2022	Chromium	2.79	µg/L	—	Yes	—
CAMO-22-236938	1/23/2022	Nitrate	12.778	mg/L	—	Yes	—

[a] — = None.

[b] U = The material was analyzed for but was not detected above the level of the detection limit.

[c] J = The material was positively identified, and the associated numerical value is the approximate concentration of the material in the sample.

Table B-1.2-1
Field Parameter Results During Collection of Full-Suite Groundwater Characterization Samples

Screen	Date	Time	Temperature (°C)	pH	ORP (mV)	DO (mg/L)	Spec. Cond. (µS/cm)	Turbidity (NTU)[a]	Discharge Rate (gpm)[b]
1	1/30/2022	0830	19.3	7.88	254.8	12.19	179.6	3.3	5.98
2	1/23/2022	0855	18.7	7.73	215.6	15.23	172.2	2.6	34.24

[a] NTU = Nephelometric turbidity unit.

[b] gpm = Gallons per minute.

Table B-2.1-1
Field Parameters Monitored During Well Development and Extended Pumping

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Well Development Parameters Screen 1										
1/15/2022	0145	23.8	83	7.01	207.4	8.12	88.2	273	115	Packer Inflated
1/15/2022	0230	23.8	90.9	7.68	200.3	8.08	103.8	190	48.3	
1/15/2022	0300	23.9	96.3	8.12	199.8	8.07	98.7	201	44.1	
1/15/2022	0330	23.9	98.6	8.32	199.4	8.07	96.7	182	50.1	
1/15/2022	0400	23.7	99.8	8.43	195.9	8.05	50.2	55.7	28.5	
1/15/2022	0430	23.9	100.8	8.5	197.2	8.05	31.4	54.5	30	
1/15/2022	0500	23.9	100.3	8.54	194.8	8.05	92.3	81.5	76.7	
1/15/2022	0530	23.8	101.9	8.6	195.3	8.06	94.1	54.8	51.4	
1/15/2022	0600	23.8	102	8.62	193.7	80.3	123.4	26.6	39.8	
1/15/2022	0630	—*	—	—	—	—	—	—	34.1	
1/15/2022	0700	—	—	—	—	—	—	—	31.3	
1/15/2022	0730	23.8	100.9	8.78	192.1	7.98	117.1	15.42	25.3	
1/15/2022	0800	24	104.9	8.83	190.8	8.01	105.4	18.23	22.3	
1/15/2022	0830	24.3	105.9	8.86	191.6	8	123.3	15.55	21.5	
1/15/2022	0900	24.4	105.3	8.8	190.6	7.98	128.1	16.04	18.1	
1/15/2022	0930	24.4	105.8	8.84	190.1	7.99	127.5	37.01	20.6	
1/15/2022	1000	24.4	106.2	8.87	190.7	7.98	126.4	14.64	18	
1/15/2022	1030	24.5	106.1	8.85	190.7	7.98	131.5	21.6	20.7	
1/15/2022	1100	24.6	107.3	8.93	190.8	7.98	129.3	14.68	22.1	
1/15/2022	1130	24.6	105.9	8.81	190	7.97	125.2	20.3	23.2	
1/15/2022	1200	24.6	106	8.82	189.5	7.97	111.8	14.12	21.3	
1/15/2022	1230	24.6	106.7	8.88	189.5	7.97	110.8	18.24	24.7	
1/15/2022	1300	24.2	106.3	8.91	189.3	7.97	118.9	17.05	24.4	
1/15/2022	1330	24.7	107.5	8.93	189	7.96	121.7	14.39	19.4	
1/15/2022	1400	24.8	106.2	8.81	189.5	7.96	126.9	19.12	15.6	
1/15/2022	1430	24.6	107.2	8.93	189	7.95	127.6	12.04	13.4	
1/15/2022	1500	24.5	106.1	8.85	189.2	7.95	129.5	13.21	14.6	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Well Development Parameters Screen 1										
1/15/2022	1530	24.4	106.9	8.94	189.1	7.96	129.1	15.41	19.1	
1/15/2022	1600	24.4	106.5	8.9	190.5	7.96	125.4	15.47	15.6	
1/15/2022	1630	24.2	106.3	8.91	190.5	7.96	132.9	15	22.6	
1/15/2022	1700	24.3	106.6	8.92	190.2	7.96	136.1	17.88	21.3	
1/15/2022	1730	24.2	107.2	8.98	109.8	7.96	136.7	14.08	19.2	
1/15/2022	1800	24.2	106.8	8.96	189.2	7.95	140.5	13.36	19.9	
1/15/2022	1830	24.2	107.1	8.98	188.9	7.96	139	13.02	18.9	
1/15/2022	1900	24	107.4	9.04	188.8	7.96	142.5	15.17	16.6	
1/15/2022	1930	24.1	107.3	9.02	190.1	7.97	134.6	17.87	16.5	
1/15/2022	2000	24	107.6	9.06	189	7.96	137.2	17.2	19.5	
1/15/2022	2030	24	107.4	9.04	188.7	7.96	137	19.05	19.3	
1/15/2022	2100	24.1	107.9	9.03	188.5	7.95	154.4	13.64	18.3	
1/15/2022	2130	24	107.8	9.06	188.9	7.96	147.6	12.83	17.5	
1/15/2022	—	—	—	—	—	—	—	—	—	Deflate packer.
1/15/2022	2310	—	—	—	—	—	—	—	55.2	Step through screen.
1/15/2022	2330	19	92.8	8.66	212	7.93	163.4	13.01	13.9	Step through screen.
1/15/2022	2350	18.9	96.2	8.97	211.3	7.93	143.6	11.88	11.4	Step through screen.
1/16/2022	0000	18.9	94	8.71	211.1	7.92	156.9	12.82	15.1	Step through screen.
1/16/2022	0010	18.9	96.6	8.97	210.2	7.91	168.3	13.95	15.2	Step through screen.
1/16/2022	0030	18.9	98.7	9.13	210	7.91	148.7	12.2	14.4	Step through screen.
1/16/2022	0040	18.9	99.2	9.21	206.9	7.9	166.7	18.83	13.5	Step through screen.
1/16/2022	0050	18.9	99.3	9.23	208.2	7.89	173.7	11.79	13.3	Step through screen.
1/16/2022	0100	18.9	101.2	9.37	207.5	7.89	176.7	13.82	16.2	Step through screen.
1/16/2022	0110	18.9	99.5	9.27	209.2	7.89	139.1	12.89	9.63	Step through screen.
1/16/2022	0120	18.9	103	9.5	209	7.88	157.6	11.6	13.4	Step through screen.
1/16/2022	0130	18.9	100.3	9.35	207.4	7.88	173.9	12.62	8.66	Step through screen.
1/16/2022	0140	18.9	99.5	9.3	202.8	7.88	177.7	12.16	8.57	Step through screen.
1/16/2022	0150	18.9	101.9	9.44	207.6	7.87	181.2	17.02	9.62	Step through screen.
1/16/2022	0200	18.9	99.3	9.22	205.8	7.87	183.5	9.67	10.2	Step through screen.
1/16/2022	0210	18.9	99.9	9.31	209.8	7.86	156.7	12.89	11.7	Step through screen.
1/16/2022	0220	18.9	100	9.31	209.6	7.85	168.8	12.37	9.62	Step through screen.
1/16/2022	0230	18.9	100.1	9.36	207.7	7.85	173.7	14.28	8.83	Step through screen.
1/16/2022	—	—	—	—	—	—	—	—	—	Re-inflate packer.
1/16/2022	0400	18.8	92.1	8.57	209.7	7.84	154.4	29.13	14	
1/16/2022	0420	18.8	92.9	8.63	211.6	7.82	167.6	20.72	17.2	
1/16/2022	0430	18.9	93.6	8.69	211.7	7.81	175.6	24.47	10.9	
1/16/2022	0440	18.9	94.2	8.81	210.5	7.82	147.3	12.99	11.6	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Well Development Parameters Screen 1										
1/16/2022	0450	18.9	95.4	8.87	210	7.82	174.4	22.85	9.05	
1/16/2022	0500	18.9	95.6	8.9	210	7.82	178.3	27.03	8.52	
1/16/2022	0510	18.9	97.1	9.03	211.6	7.81	183.5	12.43	10.6	
1/16/2022	0520	18.9	98.4	9.15	209.6	7.81	185.5	15.51	12.8	
1/16/2022	0530	18.9	99.8	9.27	211.1	7.8	186.3	15.77	12	
1/16/2022	0540	18.8	101.5	9.44	211.2	7.79	189.1	11.56	11.8	
1/16/2022	0550	18.8	101.8	9.47	211.6	7.79	193.9	15.3	9.85	
1/16/2022	0600	18.9	103.9	9.67	210.9	7.8	194.4	9.9	7.44	
1/16/2022	0610	18.9	104.9	9.76	212.4	7.79	197.7	90.8	6.55	
1/16/2022	0625	18.5	89.6	8.4	211.5	7.82	198.8	7.69	6.71	
1/16/2022	0640	18.4	92.1	8.65	211.3	7.83	206.6	8.47	9.28	
1/16/2022	0700	19.5	93	8.54	216.1	7.81	157	11.68	5.42	
1/16/2022	0730	23.8	111.2	9.39	195.2	8.04	170.2	74.63	216	
1/16/2022	0800	24.1	111.4	9.36	193.6	8.03	187.9	64.8	156	
1/16/2022	0830	24.3	112.7	9.44	192.4	8.01	192.1	39.7	63.1	
1/16/2022	0900	24.3	112.9	9.45	192	8.01	193.2	32.79	57.1	
1/16/2022	0930	24.5	112.9	9.42	191.4	8	194.2	41.51	61.3	
1/16/2022	1000	24.6	112.5	9.35	193.5	8.05	186.2	133.5	24.3	
1/16/2022	1030	24.8	112.7	9.34	191.4	7.99	184.6	59.61	188	
1/16/2022	1100	24.9	113.6	9.4	190.3	7.99	187.8	38.7	67.4	
1/16/2022	1130	24.8	105.4	8.73	194.4	8.02	187.2	145.5	252	
1/16/2022	1200	24.7	113.6	9.42	191.2	8	192.4	45.54	89.2	
1/16/2022	1230	24.7	113.8	9.45	191.2	8.01	154.9	37.99	91.1	
1/16/2022	1430	21.1	82	7.28	224.8	7.81	109.9	13.42	14.1	Lower intake to 1325, re-inflate packer.
1/16/2022	1500	24.3	112.8	9.43	191	8	160.3	65.08	124	
1/16/2022	1530	26.9	104.4	8.32	197	7.97	162.3	92.74	56.4	
1/16/2022	1600	25.3	114	9.36	189.9	7.99	168	48.42	118	
1/16/2022	1630	25.3	113.5	9.32	189	7.99	167.8	79.94	92.5	
1/16/2022	1700	25.1	113.7	9.37	188.6	7.98	170.4	46.32	88.1	
1/16/2022	1730	24.8	114.2	9.46	187.8	7.97	180.4	28.57	76.3	
1/16/2022	1800	24.7	114.4	9.5	188	7.96	180.4	38.32	46.2	
1/16/2022	1830	24.6	111.9	9.3	187.8	7.98	183.5	60.88	88.8	
1/16/2022	1900	24.5	110.9	9.26	187.9	7.98	168.1	77.9	53.5	
1/16/2022	1930	24.5	110.8	9.45	188.3	7.98	176.9	22.59	36.8	
1/16/2022	2000	24.5	113.8	9.48	187.5	7.97	186.7	35.85	35.1	
1/16/2022	2030	24.5	113.6	9.46	187.6	7.97	195.7	31.04	41.7	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Well Development Parameters Screen 1										
1/16/2022	2100	24.5	113.7	9.47	187.4	7.97	193.3	32.91	39.7	
1/16/2022	2130	24.6	113.3	9.43	188	7.96	196	17.97	31.8	
1/16/2022	2200	24.6	113.3	9.45	187.2	7.96	128.7	26.16	33.3	
1/16/2022	2230	24.6	113.7	9.47	187.3	7.96	197.9	17.58	26.9	
1/16/2022	2300	24.5	113.5	9.46	187.9	7.96	199.6	26.78	35.5	
1/16/2022	2330	24.5	113.8	9.49	188	7.96	198.9	29.52	50	
1/17/2022	0000	24.4	114.7	9.57	186.8	7.96	200.8	21.22	31.8	
1/17/2022	0030	24.5	114.2	9.53	188.4	7.96	200.5	25.66	34.9	
1/17/2022	0100	24.5	114.3	9.52	188	7.95	200.5	19.56	26.4	
1/17/2022	0130	24.5	113.9	9.49	189.8	7.95	200.5	32.27	55.4	
1/17/2022	0200	24.4	114.2	9.53	188.5	7.95	206.2	18.39	26.3	
1/17/2022	0230	24.5	114.5	9.55	186.7	7.95	209.6	16.31	19.1	
1/17/2022	0300	24.4	114	9.51	187.6	7.95	211.3	18.51	26.2	
1/17/2022	0330	24.5	113.7	9.48	188.6	7.97	171.1	66.42	80.7	
1/17/2022	0400	24.5	114.4	9.54	187.2	7.96	215.5	30.52	33.7	
1/17/2022	0430	24.5	114.7	9.56	187.5	7.95	215.9	22.21	32.5	
1/17/2022	0500	24.5	114.2	9.53	186.9	7.95	171.6	15.16	18.9	
1/17/2022	0530	24.5	114.1	9.51	186.7	7.95	209.6	13.24	16.9	
1/17/2022	0600	24.4	114.1	9.52	186.1	7.95	211.5	11.49	15.5	
1/17/2022	0630	24.4	114.5	9.56	185.6	7.95	210.6	12.35	15.2	
1/17/2022	0700	24.5	111.9	9.33	184	7.96	219.2	39.98	11.8	
1/17/2022	0730	24.5	114.2	9.53	185	7.97	209.9	26.52	36.3	
1/17/2022	0800	24.6	115.1	9.85	185.3	7.96	210.7	16.19	20.5	
1/17/2022	0830	24.6	115.6	9.62	183.8	7.95	203.4	11.11	14.1	
1/17/2022	0900	24.8	114.3	9.47	184.5	7.94	205.3	11.13	12.5	
1/17/2022	0930	24.8	113.2	9.38	184.8	7.94	210.6	14.3	11.3	
1/17/2022	1000	24.7	113.4	9.42	183.6	7.95	211.9	17.76	10.1	
1/17/2022	1030	24.8	114.5	9.53	183.4	7.94	208.8	7.57	8.86	
1/17/2022	1100	24.8	115	9.52	183.5	7.96	212.5	7.33	8.78	
1/17/2022	1130	24.8	114.2	9.47	184.3	7.94	209.7	6.84	7.89	
1/17/2022	1200	24.8	114.8	9.82	183.4	7.95	209.2	7.33	7.2	
1/17/2022	1230	24.7	114.7	9.82	183.5	7.95	200.9	7.04	7.33	
1/17/2022	1300	24.7	114.9	9.55	182.2	7.95	208.7	8	9.47	
1/17/2022	1330	24.7	114.4	9.5	183.8	7.95	214.8	20.94	8.87	
1/17/2022	1400	24.7	114.7	9.53	182.6	7.95	218.2	26.8	8.41	
1/17/2022	1430	24.7	114.7	9.53	183.7	7.95	218.1	8.2	8.89	
1/17/2022	1500	24.6	114.8	9.54	184.6	7.96	217	19.49	21.5	
1/17/2022	1530	24.6	115	9.56	183	7.96	217.6	10.17	13.8	
1/17/2022	1600	24.7	115.4	9.59	182.8	7.96	220.6	10.29	10.8	
1/17/2022	1630	24.7	115.2	9.57	183.6	7.95	224.9	7.45	7.29	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Well Development Parameters Screen 1										
1/17/2022	1700	24.6	114.5	9.53	183.2	7.95	224	11.21	10.6	
1/17/2022	1730	24.6	113.8	9.47	184.9	7.97	226.5	17.45	32.5	
1/17/2022	1800	24.5	114.7	9.57	182.7	7.96	219.6	11.36	14.1	
1/17/2022	1830	24.5	114.9	9.58	182.3	7.96	215.1	8	9.64	
1/17/2022	1900	24.5	114.4	9.54	184.1	7.96	221.2	9.21	11.4	
Well Development Parameters Screen 2										
1/13/2022	0340	—	—	—	—	—	—	—	83.9	
1/13/2022	0410	—	—	—	—	—	—	—	101	
1/13/2022	0440	—	—	—	—	—	—	—	168	
1/13/2022	0520	—	—	—	—	—	—	—	93.4	
1/13/2022	0555	—	—	—	—	—	—	—	78.7	
1/13/2022	0630	—	—	—	—	—	—	—	70.4	
1/13/2022	0700	—	—	—	—	—	—	—	45.3	
1/13/2022	0730	—	—	—	—	—	—	—	40	
1/13/2022	0800	—	—	—	—	—	—	—	99.3	
1/13/2022	0830	—	—	—	—	—	—	—	48.4	
1/13/2022	0900	—	—	—	—	—	—	—	52.2	
1/13/2022	1215	—	—	—	—	—	—	—	142	
1/13/2022	1245	19.5	41.4	3.8	245.7	8.23	16.7	48.5	88.7	
1/13/2022	1315	19.6	42.3	3.87	236.9	8.24	23.7	28.7	43.9	
1/13/2022	1345	20.4	44.2	3.97	228.4	8.19	22.1	21.5	27	
1/13/2022	1415	20.4	51.1	4.61	222.4	8.18	33.2	19.6	20.7	
1/13/2022	1445	20.3	50.1	4.52	221.9	8.17	40.7	48.9	19.2	
1/13/2022	1600	19.4	47.2	4.35	221	8.19	48.4	46.6	56.4	
1/13/2022	1645	18.7	56	5.22	214.5	8.14	51.5	61.26	63.1	
1/13/2022	2038	8.14	48.5	4.56	226.8	8.22	34	151	80.3	
1/13/2022	2100	19.7	49.1	4.51	224.7	8.23	47	273	40.4	
1/13/2022	2131	19.8	51.9	4.74	226.3	8.19	55	305	45.8	
1/13/2022	2203	19.8	52.4	4.79	219.3	8.21	40.4	372	26.5	
1/13/2022	2233	19.9	53	4.83	213.7	8.18	—	159	21.5	
1/13/2022	2300	19.8	53.9	4.92	208.8	8.16	78.6	298	19	
1/13/2022	2330	19.5	55	5.04	205	8.16	—	431	19.5	
1/14/2022	0000	19.7	55.7	5.09	201.6	8.14	77.3	405	14.4	
1/14/2022	0030	19.6	56.3	5.16	199.5	8.13	78.4	347	12.5	
1/14/2022	0100	19.6	57.6	5.28	196.5	8.13	55.3	303	12.1	
1/14/2022	0130	19.3	57.9	5.34	205	8.12	28.8	214	14.9	
1/14/2022	0315	19.5	52.2	4.79	208	8.14	50.7	105	36.1	
1/14/2022	0345	19.3	53.7	4.95	206.7	8.12	85.6	145	21.2	
1/14/2022	0415	19.3	56.2	5.18	207.3	8.12	37.7	95	14.6	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Well Development Parameters Screen 2										
1/14/2022	0445	19	51.8	4.8	205.9	8.1	48.3	210	16	
1/14/2022	0515	19.1	53.1	4.9	204.9	8.08	111.3	70	15.7	
1/14/2022	0545	19.2	43.7	4.04	204.4	8.06	136.5	35	15.8	
1/14/2022	0615	19.3	36.6	3.37	203.3	8.04	146.6	37	16.4	
1/14/2022	0700	19.1	33.5	3.1	201.4	8.06	143	29.39	15.1	
1/14/2022	0730	19.4	32.8	3.02	199.6	8.07	130.1	18.11	16.2	
1/14/2022	0800	19.7	57	5.22	196.7	8.03	143.8	21.23	19.7	
1/14/2022	0900	—	—	—	—	—	—	—	118	
1/14/2022	0930	18	55.3	5.01	198.5	8.16	140.3	17.39	27.1	
1/14/2022	1000	20.4	39.5	3.59	195.4	8.17	115.8	15.21	28.3	
1/14/2022	1030	20.6	61.9	5.56	192.8	8.14	112.4	19.8	17.8	
1/14/2022	1100	20.6	62.3	5.6	192.4	8.14	126.6	22.19	17.7	
1/14/2022	1130	20.6	62.4	5.61	191.3	8.15	126.1	44.48	14.6	
1/14/2022	1200	20.7	62.8	5.62	191.5	8.14	116.6	29.2	15.8	
1/14/2022	1230	20.4	65.7	5.91	189.9	8.14	131.4	13.37	12.4	
1/14/2022	1300	19.6	23.9	2.19	190.1	8.15	126.3	26.92	14.1	
1/14/2022	1330	19.4	23.1	2.11	188.9	8.17	118.4	33.12	13.3	
1/14/2022	1400	18.8	34.7	3.23	186.1	8.14	136.1	25.55	13.3	
1/14/2022	1430	18.6	34.5	3.22	184.4	8.11	140.5	17.75	14.5	
1/14/2022	1530	18.1	35	3.35	183.1	8.1	141.5	20.01	20.3	
1/14/2022	1600	18	36.2	3.41	183.3	8.08	142.3	23.63	21.4	
1/14/2022	1630	17.8	44.3	4.21	183.1	7.97	151.9	20.47	19	
1/14/2022	1700	17.7	38.3	3.74	184.5	7.91	157.4	17.53	18.3	
1/14/2022	1730	17.7	38.2	3.64	185.6	7.97	152.6	14.76	15.1	
1/14/2022	1800	17.7	37.2	3.54	186.8	8.02	129	11.42	13.8	
1/14/2022	1830	17.7	37	3.53	187.4	7.99	110.5	11.1	10.6	
1/14/2022	1900	17.7	41.3	3.92	189.6	7.86	117	11.12	9.92	
1/14/2022	1945	17.8	39.1	3.72	192.9	7.95	113.3	9.82	7.09	
1/14/2022	2000	17.9	37.8	3.58	193.3	7.95	120.1	11.9	7.31	
1/14/2022	2010	17.9	37.3	3.55	194	7.95	122.2	9.62	6.58	
1/14/2022	2020	17.9	37.4	3.55	195	7.93	123.5	8.9	6.25	
1/14/2022	2030	17.8	36.8	3.51	194.9	7.93	124.3	8.97	6.14	
1/14/2022	2040	17.8	36.3	3.45	194.9	7.91	123.1	11.91	6.75	
1/14/2022	2050	17.8	35.5	3.37	196.4	7.92	121.5	8.37	5.9	
1/14/2022	2100	17.8	34.7	3.3	197.5	7.91	119.9	8.84	6.13	
1/14/2022	2110	17.9	34.8	3.3	189	7.94	-	8.41	6.38	
1/14/2022	2120	17.9	34.2	3.24	199	7.92	93.7	10.92	5.92	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (μS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Well Development Parameters Screen 2										
1/14/2022	2130	17.9	33.7	3.2	198.8	7.91	103.3	7.9	5.43	
1/14/2022	2140	17.9	33.8	3.2	200.4	7.92	107.3	9.9	5.14	
1/14/2022	2200	17.8	32.8	3.11	201.8	7.9	110.2	7.8	4.97	
1/14/2022	2210	17.8	32.8	3.12	202.1	7.91	109.4	8.22	4.82	
1/14/2022	2220	17.9	33.3	3.16	202.7	7.91	108.5	7.46	4.48	
Extended Pumping Parameters Screen 1										
1/29/2022	0930	15.6	83.1	8.22	228.1	7.86	170.7	26.8	18.4	
1/29/2022	1000	17.6	83.9	8.01	212.6	8.07	155.3	17.24	13.6	
1/29/2022	1030	18.6	94.6	8.84	223	7.92	158.1	37.78	10.4	
1/29/2022	1100	18.9	104.4	9.7	211.3	7.86	153.3	50.59	16.4	
1/29/2022	1130	18.9	111.7	10.37	201.3	7.86	159.2	39.2	10.8	
1/29/2022	1200	18.9	114.8	10.66	196.7	7.87	159.1	34.32	8.01	
1/29/2022	1230	19.1	124	11.46	197.7	7.87	178	26.79	5.11	
1/29/2022	1300	19.1	119.1	11.03	195.6	7.88	187.5	15.29	6.02	
1/29/2022	1330	19.2	124	11.44	195.1	7.89	191.9	24.73	5.34	
1/29/2022	1400	19.1	125.4	11.6	194.5	7.89	183.4	18.6	6.53	
1/29/2022	1430	19.1	124.3	11.5	193.7	7.89	185.4	22.07	7.33	
1/29/2022	1500	19.1	124.5	11.51	193	7.89	188.8	18.01	5.84	
1/29/2022	1530	19.2	124.3	11.48	193.1	7.89	192.5	16.89	5.32	
1/29/2022	1600	19.2	125.9	11.67	191.5	7.89	201.4	11.83	4.57	
1/29/2022	1630	19.2	126.3	11.64	191.2	7.89	208	11.6	3.83	
1/29/2022	1700	19.1	119.9	11.1	190.4	7.91	216.2	11.4	3.71	
1/29/2022	1730	19.2	126.1	11.65	189.1	7.9	224.1	13.32	6.35	
1/29/2022	1800	19.3	127	11.72	188.6	7.89	227	15.14	2.85	
1/29/2022	1830	19.2	128.2	11.84	187.1	7.89	232.2	12.94	2.68	
1/29/2022	1900	19.2	127.2	11.74	187.7	7.89	235.3	12.99	2.75	
1/29/2022	1930	19.2	128	11.81	187	7.89	237.4	12.34	3.9	
1/29/2022	2000	19.2	124.6	11.59	177.5	7.89	236.8	9.68	3	
1/29/2022	2030	19.2	125.6	11.59	165.6	7.88	238.8	9.15	2.81	
1/29/2022	2100	19.2	126.4	11.66	152.3	7.88	241.1	8.56	3.26	
1/29/2022	2130	19.2	129.9	11.98	184.2	7.9	241.9	8.72	3.32	
1/29/2022	2200	19.2	129.1	11.93	184.5	7.9	244.1	9.53	3.86	
1/29/2022	2230	19.1	129.7	11.99	184	7.9	242.8	9.49	4.68	
1/29/2022	2300	19.1	129.6	11.99	183.8	7.9	245.5	8.82	4.85	
1/29/2022	2330	19.1	130.1	12.03	183.3	7.89	248	9.37	4.81	
1/30/2022	0000	19.1	129.9	12.02	182.8	7.9	248.2	9.62	4.69	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (μS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Extended Pumping Parameters Screen 1										
1/30/2022	0030	19.2	130.5	12.06	182.3	7.89	249.7	9.97	4.91	
1/30/2022	0100	19.1	130.5	12.08	182	7.89	250	9.78	4.85	
1/30/2022	0130	19.1	130.4	12.06	182.2	7.89	251.3	9.21	4.72	
1/30/2022	0200	19.1	130.6	12.07	181.8	7.88	253.9	8.53	4.68	
1/30/2022	0230	19.2	130.9	12.1	181.6	7.88	255.1	7.34	4.21	
1/30/2022	0300	19.1	131.1	12.12	181.2	7.88	256.9	7.25	4.23	
1/30/2022	0330	19.1	131.3	12.16	180.8	7.88	258.3	7.09	3.53	
1/30/2022	0400	19.1	131.1	12.12	181	7.88	259.3	7.16	3.7	
1/30/2022	0430	19.1	131.2	12.14	180.9	7.88	259.8	7.15	3.82	
1/30/2022	0500	19.2	131.3	12.13	180.5	7.88	259.9	6.6	3.6	
1/30/2022	0530	19.1	131.7	12.18	179.9	7.88	261.5	6.49	3.13	
1/30/2022	0600	19.1	131.3	12.15	180.3	7.88	261.5	6.94	3.59	
1/30/2022	0630	18.9	125.7	11.68	179.9	7.93	261.7	3.79	3.4	
1/30/2022	0700	19.2	131.8	12.16	179.1	7.89	262.1	7.45	3.84	
1/30/2022	0730	19.3	132	12.17	179.6	7.89	257.2	6.21	3.2	
1/30/2022	0800	19.2	131.6	12.17	179.2	7.88	256.2	6.12	2.78	
1/30/2022	0830	19.3	132.1	12.19	179.6	7.88	254.8	5.98	3.3	
1/30/2022	0900	—	—	—	—	—	—	—	—	
Extended Pumping Parameters Screen 2										
1/22/2022	0903	16.6	65.8	6.54	258.6	7.86	195.1	135.17	9.15	
1/22/2022	0915	18.3	67	6.67	238.1	7.66	164.8	60.1	5.96	
1/22/2022	0930	18.3	70.4	6.67	234.3	7.61	136.7	35.11	6.92	
1/22/2022	0945	18.4	77.1	7.24	231.4	7.58	124.6	28.81	6.69	
1/22/2022	1000	18.4	80	7.53	228.7	7.56	118	39.11	7.62	
1/22/2022	1015	18.5	85.2	9.05	22537	7.54	116	96.59	8.3	
1/22/2022	1030	18.5	122.8	11.46	222	7.53	116.7	38.73	7.3	
1/22/2022	1045	18.4	125.5	11.86	220.6	7.53	115.7	45.12	7.11	
1/22/2022	1100	18.4	128.1	12.04	220.5	7.53	115.1	39.38	6.2	
1/22/2022	1115	18.5	128	12	219.3	7.58	113.4	35.86	6.74	
1/22/2022	1130	18.5	129.7	12.19	217.8	7.58	115.6	33.42	6.27	
1/22/2022	1145	18.5	133.9	12.53	217.6	7.58	117.2	36.35	5.64	
1/22/2022	1200	18.5	134.1	12.59	215.7	7.58	120.3	32.87	5.32	
1/22/2022	1215	18.5	135.2	12.66	214.8	7.57	118.1	37.99	5.38	
1/22/2022	1245	18.5	140.2	13.11	213.1	7.57	125.6	37.77	4.24	
1/22/2022	1300	18.5	139.2	13.02	211.6	7.58	126.4	30.82	5.28	
1/22/2022	1315	18.4	140.6	13.16	211.4	7.58	126.7	27.07	4.81	
1/22/2022	1330	18.4	141.6	13.29	211.5	7.58	126.5	31.08	4.64	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Extended Pumping Parameters Screen 2										
1/22/2022	1345	18.5	146.3	13.66	107.2	7.58	129.1	57.37	4.73	
1/22/2022	1400	18.5	150.3	14.04	144.3	7.59	131.9	48.45	4.65	
1/22/2022	1415	18.5	132.6	12.41	207.3	7.58	137.2	37.11	4.3	
1/22/2022	1430	18.5	131.6	12.31	207.7	7.59	142.1	36.52	4.6	
1/22/2022	1445	18.5	135	12.67	206.3	7.59	141.8	44.14	4.81	
1/22/2022	1500	18.5	135.5	12.78	204.8	7.6	139.7	39.66	4.5	
1/22/2022	1530	18.5	135.8	12.68	204.3	7.6	144.2	38.23	4.08	
1/22/2022	1600	18.5	139.5	13.07	201.8	7.6	146.4	37.7	4.57	
1/22/2022	1630	18.5	146.7	13.77	127.9	7.61	151	38.48	3.88	
1/22/2022	1700	18.5	148.1	13.91	125.8	7.53	159.8	44.05	3.51	
1/22/2022	1730	18.5	151.2	14.18	124.7	7.58	159.3	37.17	3.96	
1/22/2022	1800	18.5	153.4	14.37	123.1	7.6	160.7	40.93	4.15	
1/22/2022	1830	18.4	153.6	14.42	121.8	7.63	164.3	38.63	3.91	
1/22/2022	1900	18.4	143	13.42	190.2	7.63	165.2	48.48	4	
1/22/2022	1930	18.4	144.4	13.55	190.1	7.64	168	42.15	387	
1/22/2022	2000	18.4	144.4	13.5	190	7.64	171.9	41.1	4.06	
1/22/2022	2030	18.4	148.3	13.89	188.2	7.65	176.1	38.08	4.03	
1/22/2022	2100	18.4	155.2	14.53	187.6	7.65	178	38.41	4.38	
1/22/2022	2130	18.5	153.8	14.31	186.2	7.66	179	38.34	4.36	
1/22/2022	2200	18.5	154.5	14.48	186	7.65	165	26.91	4.13	
1/22/2022	2230	18.5	155.7	14.59	183.9	7.67	167.1	23.41	3.14	
1/22/2022	2300	18.5	154.8	14.5	182.9	7.67	169.5	31.11	3.44	
1/22/2022	2330	18.5	157.9	14.8	183.5	7.66	172.4	27.64	4.22	
1/23/2022	0000	18.4	164.2	15.41	182.5	7.67	166.8	28.38	3.49	
1/23/2022	0030	18.4	153.5	14.4	180.3	7.69	190.1	33.14	3.7	
1/23/2022	0100	18.5	162.4	15.22	180.6	7.7	194.1	28.67	4.06	
1/23/2022	0130	18.5	153	14.37	178.8	7.7	202.9	27.8	3.77	
1/23/2022	0200	18.5	157	14.35	178.5	7.68	201.9	38.57	3.8	
1/23/2022	0230	18.5	159.2	14.94	177.9	7.7	205.2	36.26	4.23	
1/23/2022	0300	18.5	157.4	14.71	177.2	7.71	208.4	27.8	3.3	
1/23/2022	0330	—	—	—	—	—	—	—	—	
1/23/2022	0400	—	—	—	—	—	—	—	—	
1/23/2022	0430	—	—	—	—	—	—	—	—	
1/23/2022	0500	18.5	154.2	14.46	179.8	7.7	197	33.15	3.63	
1/23/2022	0530	18.5	158.7	14.96	175.3	7.71	213.1	31.01	3.74	
1/23/2022	0600	18.5	156.4	14.52	174.7	7.71	216.9	35.7	3.79	
1/23/2022	0630	18.6	158.1	14.79	174.1	7.72	219.3	40.32	3.71	

Table B-2.1-1 (continued)

Date	Time	Temp (°C)	DO%	DO (mg/L)	Spec. Cond. (µS/cm)	pH	ORP (mV)	NTU (YSI)	NTU (Hach)	Notes
Extended Pumping Parameters Screen 2										
1/23/2022	0700	—	—	—	—	—	—	—	—	
1/23/2022	0730	18.6	156.5	14.73	174	7.72	218	31.39	3.15	
1/23/2022	0800	18.6	160	14.83	172.4	7.72	214.3	30.58	3.02	
1/23/2022	0830	18.7	160.1	15.19	172.1	7.72	212.2	33.69	2.89	
1/23/2022	0855	18.7	162.5	15.23	172.2	7.73	215.6	34.24	2.6	
1/23/2022	0900	—	—	—	—	—	—	—	—	

* — = No reading recorded.

Appendix C

Geophysical Logs
(on CD included with this document)

Appendix D

Final Well Design and
New Mexico Environment Department Approval

Proposed Well Design for R-71
October 22, 2021

Well Objectives

R-71 is a regional groundwater monitoring well located on the mesa north of Mortandad Canyon (Figure 1). Because of terrain constraints directly over the target location in the regional aquifer, the R-71 borehole was drilled from the R-62 well pad and with a mean azimuth of 26.85° and a mean inclination of 24.92° from vertical. The R-71 borehole was drilled 1425 linear ft and the vertical depth is about 1292 ft relative to the drilling pad. The primary objective for R-71 is to further characterize the lateral and vertical extent of the chromium contamination in the northwestern portion of the chromium plume (Figure 1).

Conditions Encountered During Drilling

Preliminary lithological contacts from visual examination of cuttings and from natural gamma and neutron logging identified the following geologic contacts in descending stratigraphic order (in linear feet along the inclined borehole; Figure 2): Bandelier Tuff (Qbt2 to Qbog) (0–672 ft), upper Puye Formation (Tpf) (672-725 ft), Cerros del Rio Volcanics (Tb4) (725-975 ft), lower Puye Formation (Tpf) (975-1210 ft), pumiceous base of the Puye Formation (Tpf(p)) (1210-1265 ft), the Miocene pumiceous unit (Tjfp) (1265-1370 ft), and Miocene riverine deposits (Tcar) (1370-1425 ft). No perched groundwater zones were encountered when the R-71 borehole was drilled.

The top of the regional groundwater depth was predicted to occur at a depth of approximately 1270 linear ft (5834 ft elev.) based on the 2021 Q2 water table map. The groundwater level stablized in the cased borehole at 1271.5 linear ft (5833 ft elev.) after reaching the total drilling depth of 1425 linear feet.

Regional groundwater occurs near the top of the the Miocene pumiceous unit. The R-71 borehole penetrated 105 linear ft (95 vertical ft) of the Miocene pumiceous unit (Tjfp) (Figure 2). This unit is made up of tan pebbly rhyolitic tuffaceous sands containing abundant rounded to subrounded white pumices. Cuttings and the gamma log indicate lithologies and particle-size distributions making up the Miocene pumiceous unit are broadly similar. Bedding thickness within the Miocene pumiceous unit appears to be on the order of 1 ft which is similar to thicknesses observed in the sections described from the sonic coreholes.

The borehole was initially drilled to a total depth of 1405 linear feet, penetrating Miocene riverine deposits (Tcar) at a depth of 1370 linear feet (Figure 2). The Tcar deposits consist of unconsolidated very fine to fine grain sands largely made up of felsic crystals, intermediate volcanics, and minor quartzite. These sediments manifested as flowing sands that heaved 32 ft up the drill casing despite efforts to clean out the hole. The borehole was deepened to 1425 linear feet in an effort to seal off the flowing sands behind the drill casing. From 1405 to 1425 linear feet, the borehole penetrated Tcar gravels made up of rounded intermediate volcanics and minor quartzite. Potable water was added to the drill casing, raising the water level to a depth of 1220 linear feet, to prevent material from heaving into the drill casing during the collection of the natural gamma and neutron logs. The casing remained clear of heaved sediment during the geophysical logging, but formation gravels and sands heaved up 46 ft into the drill casing as the added water equilibrated with the static water level in the regional aquifer.

Well Design

Two well designs are presented for NMED's review. The first design consists of a 20-ft long upper screen (screen 1) and a 10-ft long lower screen (screen 2) (Figure 2). The second design consists of a 30-ft upper screen and a 10-ft lower screen (Figure 3).

Alternative 1

In Alternative 1, screen 1 would be set a depth of 1285 linear ft (5821 ft elev. above mean sea level) to 1305 linear ft (5802 ft elev.) near the top of the Miocene Pumiceous unit. Upper screens in Chromium-area monitoring wells are typically set 15 to 17 ft below the static water level to ensure that water levels did not fall within the filter pack and screen during well development and to provide for longevity for the well in light of the 0.5 – 1 ft/yr water-table decline in the Chromium Project area. The Alternative 1 design presented here decreases the submergence of the upper screen to 12 linear ft (11 ft vertical) so that the primary filter pack overlaps strata near the top of the Miocene pumiceous unit that have a slightly higher porosity based on the neutron porosity log (Figure 4). This proposed screen 1 position aligns with screen positions in nearby wells R-62 and R-43. R-71 screen 1 and the R-62 screen are in the Miocene Pumiceous Unit (Tjfp) whereas R-43 screen 1 is in Miocene riverine sediments (Tcar) (Figure 5).

Screen 2 would be set a depth of 1350 linear ft (5761 ft elev.) to 1360 linear ft (5751 ft elev.) near the base of the Miocene Pumiceous unit. Its position would be approximately 72 ft to 82 ft below the water table. This position is also considered favorable to a potential deeper location within the flowing sands of the Tcar unit. The proposed 10-ft length for Screen 2 would target a more discrete interval to increase confidence in characterization of the vertical distribution of contamination. R-71 screen 2 would be equivalent in elevation to R-43 screen 2 (Figure 5).

The screens and filter packs proposed in screen 1 and screen 2 share the following features. All screens will be rod-based, wire-wrapped, and 40 slot. The primary filter pack will consist of 8/16 sand extending 5 ft above and 5 ft below the well screen. A 2-ft secondary filter pack of 20/40 sand will be placed above the primary filter pack around each screen. Bentonite chips will be used to seal the well annulus above and below the filter packs.

Alternative 2

All the characteristics of the proposed design for Alternative 2 are the same as for Alternative 1, but with the exception of the proposed length for the upper screen (Figure 3). In Alternative 2, the length of Screen 1 would be 30 ft. The top of the screen would be set at a depth of 1285 linear ft (same as in Alternative 1) and the bottom would be at 1315 linear feet. The screen would be within the Miocene Pumiceous unit. Figure 4 shows the Alternative 2 screen positions in the context of the neutron porosity log.

The benefits of the longer well screen in Alternative 2 include the ability to more fully characterize the hydraulic and geochemical heterogeneity through the full length of the upper screen using down-well logging tools such as an electromagnetic borehole flow meter. Although the longer well-screen would result in integrated concentrations of groundwater constituents from samples collected during routine monitoring, the initial collection of more discrete-interval data would provide significant insight into the vertical distribution of hydraulic conductivity, geochemistry, and mass contaminant transport. Such data would provide significantly better information to guide remediation design than simple monitoring data from shorter screens in the highly heterogeneous aquifer beneath the Laboratory.

The Environmental Protection Agency (EPA) and others have published on the benefits of this methodology for characterization in heterogeneous aquifers like that beneath Los Alamos National Laboratory. An example publication includes EPA's "Application of the Electromagnetic Borehole Flowmeter" (EPA/600/R-98/058, August 1998). An excerpt from the abstract of that publication is included here.

> *A prerequisite for useful monitoring, modeling, and remedial design strategies is knowledge of the network of hydraulically active fractures in bedrock aquifers and three-dimensional hydraulic conductivity fields in granular aquifers. Due to a relative lack of practicable characterization technologies, many ground-water remediation strategies have been designed based on very little, if any, detailed information regarding fracture or hydraulic conductivity distribution. As a result, the underestimation of aquifer heterogeneity may contribute to inadequate conceptual models of contaminant transport/fate and inadequate design/performance of many remediation systems.*

Further, the reference provided in the Consent Order for well screen length (EPA, 1991, Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells) states the following (the highlighted section is intended to show consistency of that guidance with the Alternative 2 design of screen 2 in light of the objectives of R-71).

> ***Well Intake Length Selection —***
>
> *The selection of the length of a monitoring well intake depends on the purpose of the well. Most monitoring wells function as both ground-water sampling points and piezometers for a discrete interval. To accomplish these objectives, well intakes are typically 2 to 10 feet in length, and only rarely equal or exceed 20 feet in length. Shorter intakes provide more specific information about vertically-distributed water quality, hydraulic head and flow in the monitored formation. However, if the objective of the well is to monitor for the gross presence of contaminants in an aquifer, a much longer screen can be selected to monitor a greater thickness of the aquifer. This type of well can provide an integrated water sample and an integrated hydraulic head measurement as well as access for vertical profiling.*

Note that the proposed 10-foot screen 2 is consistent with the objective of monitoring within a discrete interval for the purpose of defining vertical extent.

Other Well Design Considerations

The Miocene riverine sediments (Tcar) were evaluated as a possible location for Screen 2. However, the sands and gravels of this unit are unstable, as exhibited by material having heaved upwards 32 to 46 ft into the drill casing. Similar borehole conditions were encountered when the Miocene riverine sediments were penetrated at well R-42, as described in the well completion report. There is considerably greater risk constructing a well screen in flowing sands and unstable gravels compared to risks associated placing the screen in more stable strata of the overlying Miocene pumiceous unit. Of particular concern, bentonite in the well annulus mobilized by surging flowing sands could migrate into the filter pack of screen 2, compromising the ability to collect representative groundwater samples.

At NMED's request during the October 21 meeting, a 3-screen design that placed the 3rd screen in the Tcar unit was considered. Based on follow-on discussions held with personnel at Baski, Inc., a system could conceptually be designed to support monitoring in 3 screens, but that type of system is not a routine configuration for their systems and could result in challenges with ensuring good hydraulic separation and the ability to physically fit access tubes for pressure transducers in each screen for monitoring water levels. Those considerations, and the same challenges noted above of being able to confidently complete a screen in the interval with flowing sands, leads to our recommendation to consider only the two alternatives presented here.

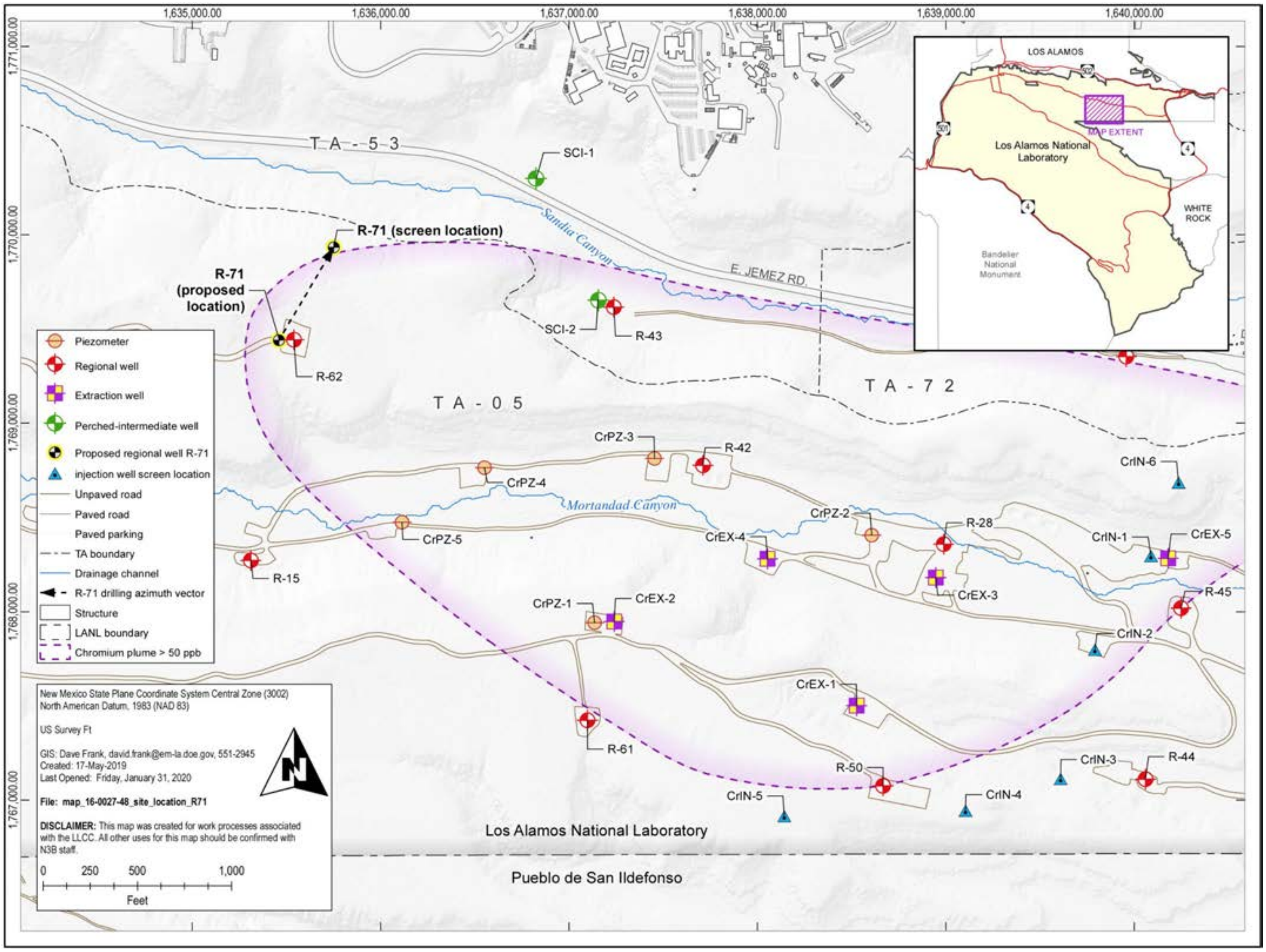

Figure 1. Location map from the Drilling Work Plan for Regional Well R-71.

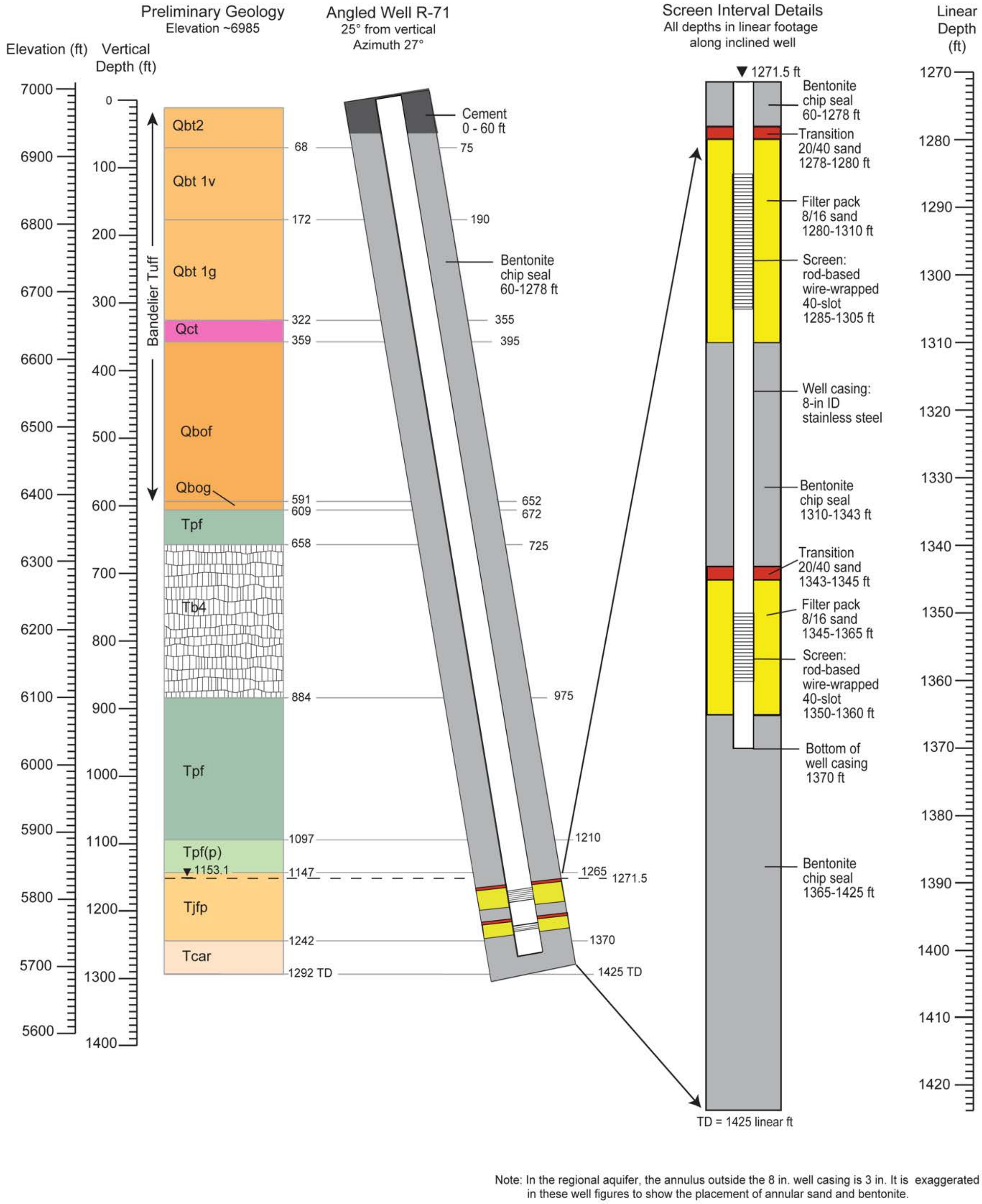

Figure 2. Stratigraphy encountered at R-71 and screen positions for Alterative 1.

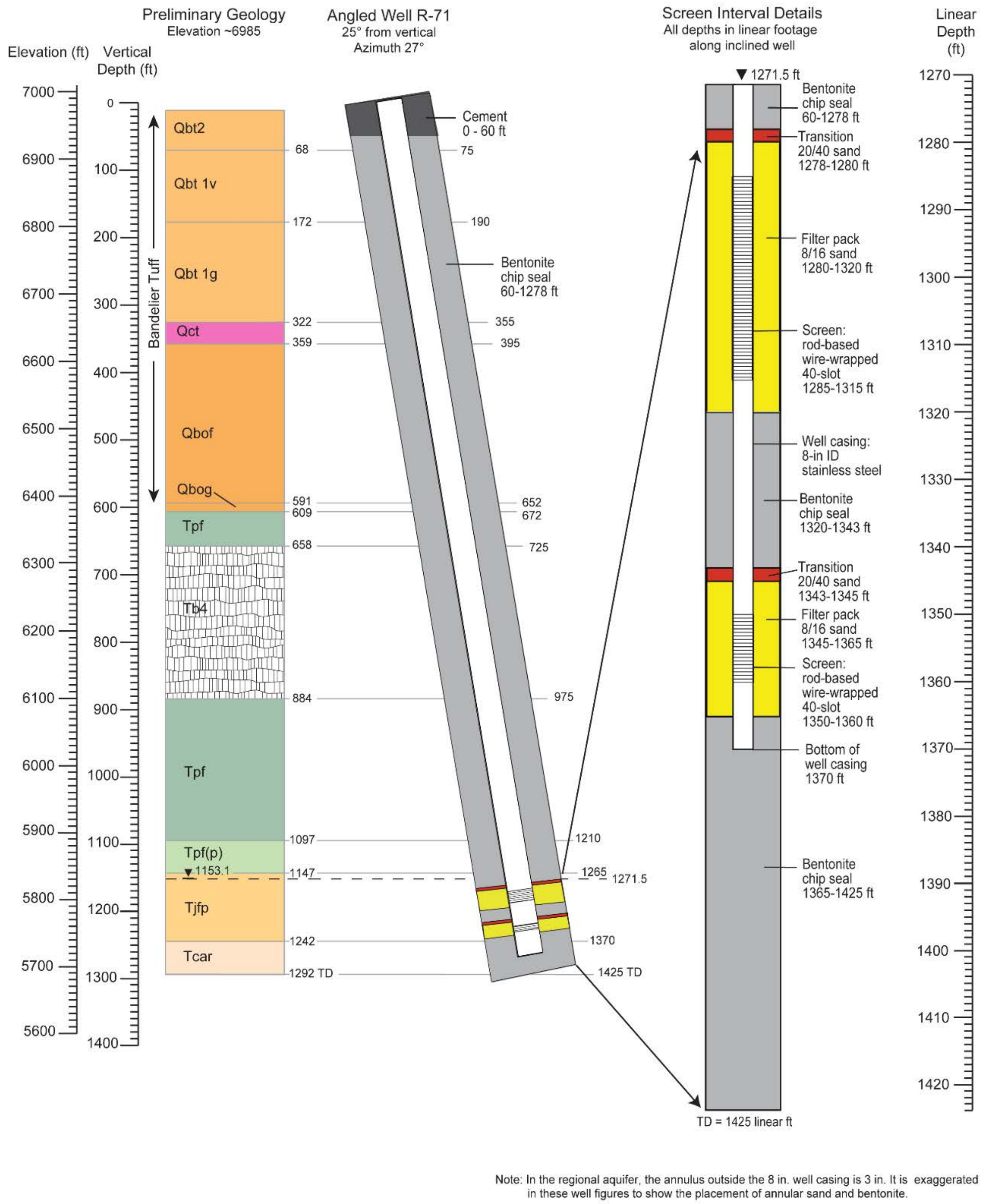

Figure 3. Stratigraphy encountered at R-71 and screen positions for Alterative 2.

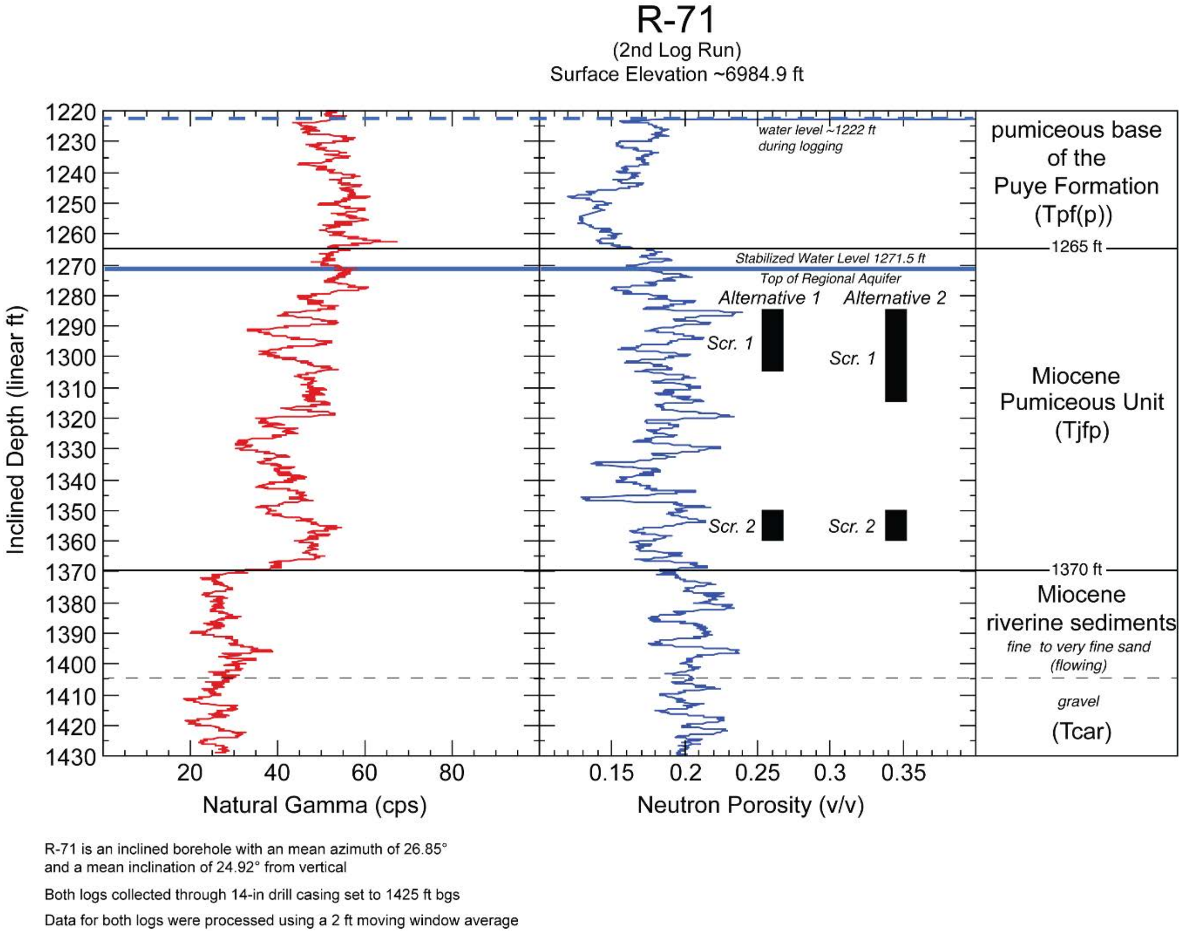

Figure 4. Gamma and neutron porosity logs for the regional aquifer at R-71 and screen positions for Alternative 1 and Alternative 2.

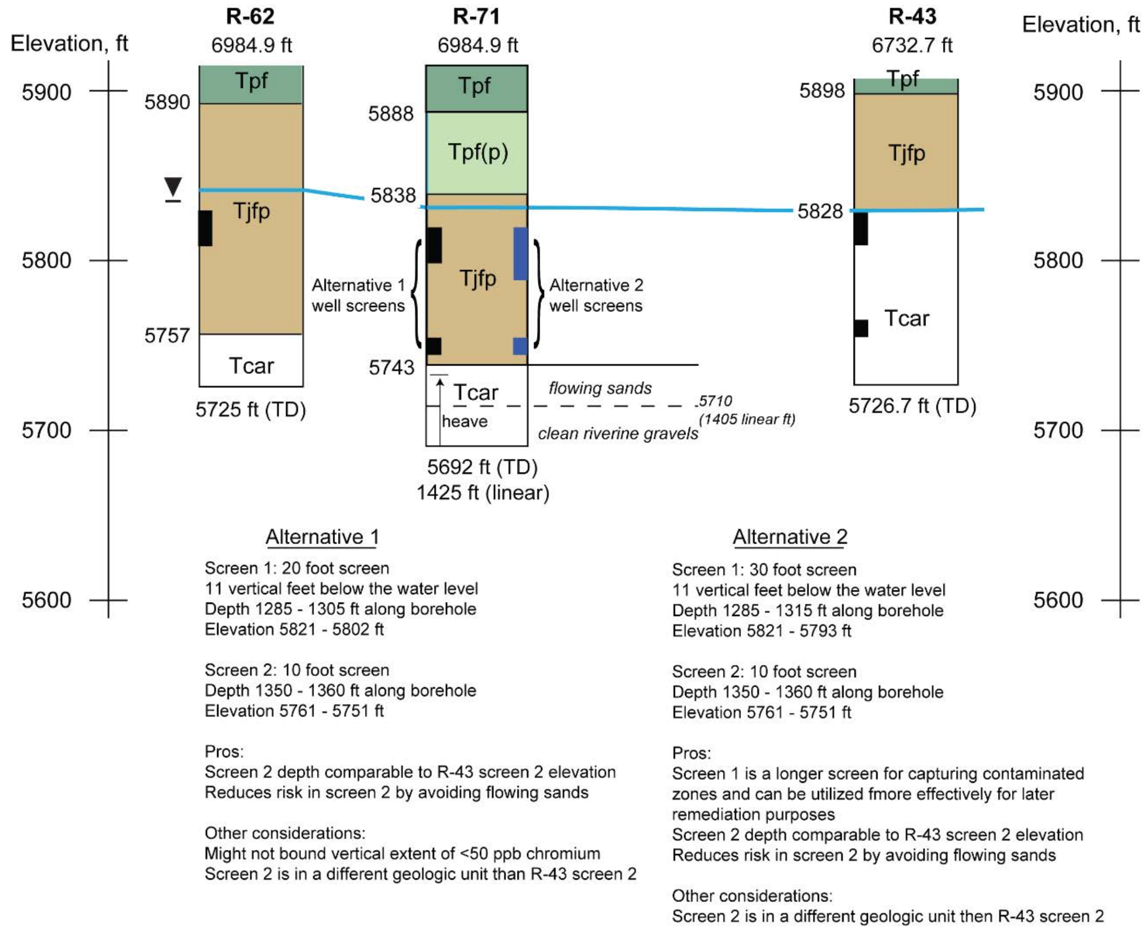

Figure 5. Geologic cross section for the upper regional aquifer at wells R-62, R-71, and R-43 showing screen positions for Alternative 1 and Alternative 2.

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Sent: Tuesday, October 26, 2021 12:53 PM
To: cheryl.rodriguez@em.doe.gov; Dhawan, Neelam, NMENV <neelam.dhawan@state.nm.us>; Petersen, Michael, NMENV <Michael.Petersen@state.nm.us>; Krambis, Christopher, NMENV <Christopher.Krambis@state.nm.us>
Cc: Maestas, Ricardo, NMENV <Ricardo.Maestas@state.nm.us>; lee.bishop@em.doe.gov; Mikolanis, Michael A <michael.mikolanis@em.doe.gov>; David Nickless <david.nickless@em.doe.gov>; Arturo Duran <arturo.duran@em.doe.gov>; Hai Shen <hai.shen@em.doe.gov>; Steve J. Veenis <Steve.Veenis@em-la.doe.gov>; Joseph T. Sena <Joseph.Sena@EM-LA.DOE.GOV>; Danny Katzman <danny.katzman@em-la.doe.gov>; Sherry L. Gaddy <Sherry.Gaddy@EM-LA.DOE.GOV>; Christian T. Maupin <Christian.Maupin@em-la.doe.gov>; Kenneth Ocker <kenneth.ocker@em.doe.gov>; Troy D. Thomson <troy.thomson@em-la.doe.gov>; Thomas McCrory <Thomas.mccrory@em.doe.gov>; Evans, John H. <John.H.Evans@em.doe.gov>
Subject: RE: [EXTERNAL] Re: R-71 Well Design Package
Importance: High

Hi Cheryl,

I reviewed and discussed with my team. The following provides NMED's comments and direction for the R-71 well design:

NMED has reviewed DOE's proposals for the well design for R-71 and accepts DOE's Alternative 1 proposed construction that includes screened intervals for Screen 1 between 1285-1305' lineal depth and Screen 2 between 1350-1360’ lineal depth for completion of the dual screened monitoring well R-71. This is a final direction from NMED, and no further discussion is needed on the subject.

After comparing borehole cuttings and geophysical logs, NMED cautions DOE on the proposed 40-slot screen and 8/16 gradation filter pack for the Screen 1 design. There are at least two thin intervals in the proposed Screen 1 section that consist predominantly of fine-grained sediments (silts, clays). Such material may cause difficulties for well development and sample purging and appear similar to the low-yielding R-61 and the upper screen at R-43.

If you should have further questions or need clarification, please do not hesitate to reach out to me.

Thank you,

Christopher S. Catechis, Acting Director
Resource Protection Division
New Mexico Environment Department
1190 St. Francis Drive |Santa Fe, New Mexico 87505
(C) 505.469-6521
www.env.nm.gov | chris.catechis@state.nm.us

From: Rodriguez, Cheryl <cheryl.rodriguez@em.doe.gov>
Sent: Tuesday, October 26, 2021 12:39 PM
To: Catechis, Chris, NMENV <Chris.Catechis@state.nm.us>; Dhawan, Neelam, NMENV <neelam.dhawan@state.nm.us>; Petersen, Michael, NMENV <Michael.Petersen@state.nm.us>; Krambis, Christopher, NMENV <Christopher.Krambis@state.nm.us>
Cc: Maestas, Ricardo, NMENV <Ricardo.Maestas@state.nm.us>; Bishop, M. Lee <lee.bishop@em.doe.gov>; Mikolanis, Michael A <michael.mikolanis@em.doe.gov>; Nickless, David <david.nickless@em.doe.gov>; Duran, Arturo Q. <arturo.duran@em.doe.gov>; Shen, Hai <hai.shen@em.doe.gov>; Veenis, Steve J <steve.veenis@em-la.doe.gov>; Sena, Joseph T <joseph.sena@em-la.doe.gov>; Katzman, Danny <danny.katzman@em-la.doe.gov>; Sherry L. Gaddy <Sherry.Gaddy@EM-LA.DOE.GOV>; Christian T. Maupin <Christian.Maupin@em-la.doe.gov>; Ocker, Kenneth <kenneth.ocker@em.doe.gov>; Thomson, Troy D <troy.thomson@em-la.doe.gov>; Mccrory, Thomas (CONTR) <thomas.mccrory@em.doe.gov>; Evans, John H. <John.H.Evans@em.doe.gov>
Subject: [EXTERNAL] Re: R-71 Well Design Package

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Hello Chris,

Do you or your staff have any questions related to the proposed designs? We are happy to meet if so. If not, will we be receiving NMED's response today; our drillers are on standby now until we receive NMED's response.

Thank you,

Cheryl

From: Rodriguez, Cheryl <cheryl.rodriguez@em.doe.gov>
Sent: Friday, October 22, 2021 5:04 PM
To: Catechis, Chris, NMENV; Dhawan, Neelam, NMENV; Petersen, Michael, NMENV; Krambis, Christopher, NMENV
Cc: Maestas, Ricardo P; Bishop, M. Lee; Mikolanis, Michael A; Nickless, David; Duran, Arturo Q.; Shen, Hai; Veenis, Steve J; Sena, Joseph T; Katzman, Danny; Sherry L. Gaddy; Christian T. Maupin; Ocker, Kenneth; Thomson, Troy D; Mccrory, Thomas (CONTR); Evans, John H.
Subject: R-71 Well Design Package

Hello Chris,

Please see attached the well design alternatives package for R-71. This design package follows from our discussion with your team on October 21. In that meeting with NMED several alternatives were discussed and NMED expressed a preference for the design with well screens of 20 ft for the upper screen and 10 ft for the lower screen (Alternative 1) and also requested that DOE consider a 3-screen design which is discussed in the design package. As with R-72, EM-LA still maintains that screen longer than 20 ft (in this case 30 ft) is a more optimal design for the upper screen, especially when coupled with use of the proposed in-well approach for characterizing stratigraphic and geochemical variability along the full length of the screen. That approach is presented as Alternative 2 in the attached design package.

Please provide your review and approval at your earliest convenience. For consideration, we can begin well construction/installation as early as Monday.

Regards,

Cheryl L. Rodriguez
Program Manager, FPD II
Department of Energy, Environmental Management
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