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

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EMLA-2020-1239-02-001

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

Subject: Submittal of the Westbay Well Reconfiguration Completion Report for R-31

Dear Mr. Pierard:

Enclosed please find two hard copies with electronic files of the "Westbay Well Reconfiguration Completion Report for R-31." Submittal of this report fulfills fiscal year (FY) 2020 Milestone #10 of Appendix B of the 2016 Compliance Order on Consent. This report includes a summary of field and as-built information for well R-31. The sampling system installed is pursuant to the design approved by the New Mexico Environment Department (NMED) as a follow-up to a meeting held between the U.S. Department of Energy (DOE) Los Alamos Field Office (EM-LA)/Newport News Nuclear BWXT-Los Alamos, LLC (N3B) and NMED on October 9, 2019.

If you have any questions, please contact Mark Everett at (505) 309-1367 (mark.everett@em-la.doe.gov) or Cheryl Rodriguez at (505) 257-7941 (cheryl.rodriguez@em.doe.gov).

Sincerely,

For: Stephen ^. Hoffman

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

Enclosures:

1. Two hard copies with electronic files – Westbay Well Reconfiguration Completion Report for R-31 (EM2020-0023)

CC (letter with CD/DVD enclosure[s]):
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February 2020
EM2020-0023

Westbay Well Reconfiguration Completion Report for R-31

N3B Los Alamos

EM2020-0023

Westbay Well Reconfiguration Completion Report for R-31

February 2020

Responsible program director:

Bruce Robinson		Program Director	Water Program	2/7/2020
Printed Name	Signature	Title	Organization	Date

Responsible N3B representative:

Joseph Legare		Acting Program Manager	N3B Environmental Remediation Program	2/10/20
Printed Name	Signature	Title	Organization	Date

Responsible DOE EM-LA representative:

Arturo Q. Duran	For:	Compliance and Permitting Manager	Office of Quality and Regulatory Compliance	2/13/20
Printed Name	Signature	Title	Organization	Date

EXECUTIVE SUMMARY

This reconfiguration completion report describes the extraction activities for the Westbay sampling system, the well reconfiguration activities, and sampling activities associated with the well reconfiguration at R-31 at Los Alamos National Laboratory, Los Alamos, New Mexico. The reconfiguration of Westbay well R-31 was completed to fulfill a milestone commitment under the 2016 Compliance Order on Consent to reconfigure the multiport Westbay systems to either a single- or dual-screen monitoring well. The work was conducted under monitoring well reconfiguration plans approved by the New Mexico Office of the State Engineer and the New Mexico Environment Department. During the conversion activities, short-term and extended aquifer tests were performed at several screens, and groundwater samples were collected at the end of each test. Screens that were reconfigured were sampled for the following analytical suites: metals and generic inorganics, volatile organic compounds, semivolatile organic compounds, perchlorate, and radionuclides (gross alpha, gross beta, and tritium).

The Westbay system was removed from well R-31 on July 10, 2019, after the packers were deflated on June 26, 2019. Following the removal of the Westbay system, a temporary packer was set at 690 ft bgs on July 12, 2019. Screens 2 and 3 were swabbed on August 14 and bailed on August 15, 2019. Screens 2 and 3 were pump-tested on August 16 and 17, 2019. Groundwater was sampled from screen 3 on August 19, 2019, following the aquifer test of that screen. Screen 2 was jetted on August 22 and 23, 2019. Screen 2 was insufficiently productive to be completed as one of two sampling intervals, as had originally been planned. With the agreement of the New Mexico Environment Department and U.S. Department of Energy Environmental Management Los Alamos Field Office, the plan for reconfiguring R-31 was changed such that screen 5 would be plugged and abandoned and screens 3 and 4 would be reconfigured for sampling. Screens 4 and 5 were swabbed and bailed on November 7 and 8, 2019. Screen 5 was pump-tested and sampled on November 9, 2019, and screen 4 was pump-tested on November 10, 2019. Screen 5 was plugged with cement and abandoned from November 11 to 15, 2019. Screens 3 and 4 were jetted on November 15, 2019. Screen 3 was aquifer tested from November 16 through 19, 2019, with groundwater samples collected on November 19, 2019. Screen 4 was step-tested from November 21 to 27, 2019, and from December 4 to 8, 2019. Groundwater samples were collected from screen 4 on December 5, 2019. The Baski sampling system was installed in R-31 from January 7 to 13, 2020. The old well pad was demolished on January 14 and 15, 2020, and the new pad was installed from January 17 to 24, 2020.

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Acronyms and Abbreviations

amsl	above mean sea level
APV	access port valve
bgs	below ground surface
Consent Order	Compliance Order on Consent
DO	dissolved oxygen
DTW	depth to water
EES	Earth and Environmental Sciences (Laboratory group)
Eh	oxidation-reduction potential
EPA	Environmental Protection Agency (U.S.)
F	filtered
FD	field duplicate
FTP	field trip blank
gpd	gallons per day
gpm	gallons per minute
HMX	octahydro-1,3,5,7-tretranitro-1,3,5,7-tetrazocine
hp	horsepower
I.D.	inside diameter
IDW	investigation-derived waste
LANL	Los Alamos National Laboratory
LAPV	lower access port valve
LIC	liquid inflation chamber
MNX	hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NAD	North American Datum
NMED	New Mexico Environment Department

NMOSE	New Mexico Office of the State Engineer
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
PVC	polyvinyl chloride
RDX	Royal Demolition Explosive
SOP	standard operating procedure
SVOC	semivolatile organic compound
TA	technical area
TD	total depth
TNT	trinitrotoluene
TOC	total organic carbon
UAPV	upper access port valve
UF	unfiltered
VOC	volatile organic compound
WCSF	waste characterization strategy form

1.0 INTRODUCTION

This Westbay wells reconfiguration activities completion report summarizes the field activities and testing associated with the well reconfiguration at R-31 at Los Alamos National Laboratory (LANL or the Laboratory) (Figure 1.0-1). Plans for the reconfiguration were presented in the "Work Plan to Reconfigure Monitoring Wells R-19 and R-31" (N3B 2018, 700130). The original fiscal year 2019 Milestone #14 for the Westbay Wells reconfiguration completion report addressed the reconfiguration of the remaining seven Westbay wells at LANL, including R-19 and R-31. However, because of subsurface conditions discovered at R-31 during the Westbay reconfiguration (screen 2 proved to be unproductive, as discussed in section 2.3), the New Mexico Environment Department (NMED) and the U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office (EM-LA) renegotiated the submittal date for this separate R-31 reconfiguration completion report now due on February 17, 2020, during the fiscal year 2020 Appendix B Milestone process (NMED 2019, 700652).

The information presented in this report was compiled from field reports, daily activity summaries, sample chain-of-custody forms, and aquifer test reports. This section includes a brief summary of the reconfiguration field activities and presents background information. Section 2 describes reconfiguration activities in detail and the current configuration of the well. Appendix A presents results of the initial pumping test and a jetting analysis for the well. Appendix B presents groundwater field parameters and analytical results. Appendix C presents an interpretation of the aquifer tests. Appendix D is a Westbay packer deflation and removal report. Appendix E includes documentation of the New Mexico Office of the State Engineer (NMOSE) and NMED approvals for reconfiguration plans.

1.1 Field Activity Summary

Field activities performed as part of the well reconfiguration included the removal of the Westbay MP55 system, selective lower well screen abandonment, well screen redevelopment, aquifer testing, groundwater sampling, and installation of a submersible pump sampling system. The field activities described occurred from May 14, 2019, to January 24, 2020. The Westbay system was removed and replaced with a dual-screen sampling system. Specific plans for the reconfiguration were presented in the "Work Plan to Reconfigure Monitoring Wells R-19 and R-31" (N3B 2018, 700130). This work plan was approved by NMED in early February 2019 (NMED 2019, 700216). An updated sampling and analysis plan for well R-31 was emailed on May 25, 2019 (Everett 2019, 700606), and NMED emailed concurrence on May 31, 2019 (Dale 2019, 700610). The information presented in this report is compiled from field reports and daily activity summaries.

The following documents were prepared to guide field activities associated with the Westbay well reconfiguration for well R-31:

- "Field Implementation Plan for Well Reconfigurations at R-5, R-7, R-8, R-9i, R-25, and R-31" (N3B 2019, 700385)
- Revised Sampling and Analysis Plan—Westbay Reconfiguration, including "Sampling and Analysis Plan for Well Reconfigurations at R-5, R-7, R-8, R-9i, R-19, R-25, R-31, Revision 1" (Everett 2019, 700606)
- "Waste Characterization Strategy Form for Westbay Well Reconfiguration Project" (N3B 2019, 700339)

Fieldwork was led by the Newport News Nuclear BWXT-Los Alamos, LLC (N3B) team with support from Holt Services, Inc. (Holt); Earth Data Northeast, Inc. (EDN); and David Schafer & Associates.

Tritium analytical data is from ARS International, LLC. Groundwater samples were submitted to GEL Laboratories, LLC. Analytical results are presented in Appendix B. A summary of data results and comparison with historical data are provided in section 5.0.

1.2 Background

Well R-31 was installed by the Laboratory in support of the Hydrogeologic Workplan (LANL 1998, 059599) during December 2000 (Vaniman et al. 2002, 072615). R-31 was designed to provide hydrogeologic, water-quality, and water-level data for potential intermediate-depth perched zones and for the regional aquifer at a site downgradient of disposal and explosives-testing sites at Technical Area 39 (TA-39).

Well R-31 was drilled using a variety of drilling fluids and additives and was constructed using rod-based screens. A Westbay MP55 sampling system was installed and consisted of modular casing, sets of packers to seal off each screened sample interval, groundwater-level measurement ports, and pumping ports within the screened intervals. The Westbay system was designed to sample only groundwater within the screened interval in real time. The system was not designed to purge multiple well volumes of water before sampling. As a result, NMED expressed uncertainty with respect to the representativeness of groundwater samples collected from such wells.

This well reconfiguration effort was initiated in response to NMED’s approval with modifications of the “Work Plan to Reconfigure Monitoring Wells R-19 and R-31” (N3B 2018, 700130; NMED 2019, 700216). Both of these documents provided guidance for the reconfiguration of R-31.

In 2012, the Laboratory prepared a well network evaluation for the TA-16 area, which included multiscreened Westbay wells. A recommendation from the evaluation report was that multiscreen wells should be converted to single-screen wells to improve the reliability and representativeness of water data through the use of purgeable sampling systems (LANL 2012, 213573). A result of the evaluations was the decision to reconfigure all of the remaining Westbay wells at LANL with either single- or dual-screen purgeable sampling systems.

The following section summarizes the original configuration of well R-31.

1.2.1 R-31

Well R-31 is located in the Weapons Facilities Operations area near the north fork of Ancho Canyon, within TA-39 of LANL (Figure 1.0-1). The R-31 borehole was drilled to a depth of 1103 ft below ground surface (bgs) using air-rotary and mud-rotary drilling with casing-advance methods. Well R-31 was constructed with five screened intervals, and the well was equipped with a Westbay MP55 multiport sampling system. The well was completed during December 2000 (Vaniman et al. 2002, 072615). Pertinent well information is as follows:

- 5.0-in.inside-diamter (I.D.) stainless-steel casing below 297.8 ft bgs, 5.0-in. I.D. mild steel casing from 297.8 ft bgs to surface
- Screen 1: 439.1–454.4 ft bgs (wire-wrapped screen) dry, perched-intermediate aquifer
- Screen 2: 515.0–545.7 ft bgs (wire-wrapped screen) wet, top of the regional water aquifer
- Screen 3: 666.3–676.3 ft bgs (wire-wrapped screen) wet, within the regional water aquifer
- Screen 4: 826.6–836.6 ft bgs (wire-wrapped screen) wet, within the regional water aquifer
- Screen 5: 1007.1–1017.7 ft bgs (wire-wrapped screen) wet, within the regional water aquifer

2.0 R-31 WELL RECONFIGURATION FIELD ACTIVITIES

The following are descriptions of the field activities that took place during the well reconfiguration. Reconfiguration activities included removal of the Westbay system, swabbing and bailing of the screens, the initial pump testing of the screens, groundwater sampling, jetting of the screens, screen abandonment, aquifer testing, and sampling system installation. Detailed descriptions of each of these activities are discussed below.

Figure 2.0-1 presents the monitoring well R-31 as-built construction diagram post-Westbay conversion. Figure 2.0-2 presents the as-built technical notes for monitoring well R-31 post-Westbay conversion. Figure 2.0-3 presents the R-31 dedicated pump performance curve.

2.1 Westbay System Removal

On June 24, 2019, the Holt hoist rig was mobilized to the R-31 well site and a pressure profile was taken in the Westbay system. The packers of the Westbay system were deflated on June 26, 2019. A post-deflation pressure profile was taken on June 26, 2019, and the bottom port was opened on June 27, 2019, to provide a discharge path for water inside the Westbay casing to exit the system when it was removed. The hoist rig was demobilized from R-31 on June 28, 2019, and remobilized back to this site on July 10, 2019. The Westbay system was removed on July 10, 2019. On July 12, 2019, a temporary packer was set at 690 ft bgs. On July 12, 2019, the Westbay system components were removed from the site and the hoist rig was demobilized from the site.

2.2 Swabbing and Bailing of Screens 2, 3, 4, and 5

The Holt hoist rig was set up on R-31 on July 10, 2019. The temporary packer was deflated and removed, and a downhole camera survey was unsuccessfully attempted (the camera did not work) on July 11, 2019. Following this unsuccessful downhole camera survey, the temporary packer was reinstalled in the well. On August 12, 2019, the hoist rig was mobilized to the R-31 site. The temporary packer was deflated and removed from 690 ft bgs, and the camera survey was completed on August 13, 2019, confirming the removal of the Westbay casing and the condition of the interior of the well casing (some corrosion was observed at 103 ft bgs). The water level was measured at 532 ft bgs and approximately 4 ft of silt was observed in the sump of R-31. Each screen was initially redeveloped using a surge block and bailer, where the surge block was lowered into the well and drawn repeatedly across each screened interval. Screen 2 (from 515.0 to 545.7 ft bgs) and screen 3 (from 666.3 to 676.3 ft bgs) were both swabbed on August 14, 2019. The sump for well R-31 was bailed on August 14 and 15, 2019, and screen 3 was bailed to remove silt from the screened interval on August 15, 2019. A temporary packer was placed back into R-31 following the completion of the swabbing and bailing. The water level was not measured immediately following the swabbing and bailing activities, although additional water levels were measured in conjunction with other conversion activities. The hoist rig was demobilized from the site on August 30, 2019.

The hoist rig was remobilized to R-31 on November 6, 2019. The temporary packer was deflated and removed from 720 ft bgs on November 7, 2019. Screen 5 (1007.1–1017.7 ft bgs) was swabbed for 71 min and screen 4 (826.6–836.6 ft bgs) was swabbed for 70 min on November 7, 2019. On November 7, 2019, 45 gal. was bailed from the sump of screen 5 and an additional 105 gal. was bailed on November 8, 2019. Table 2.2-1 records the water produced during the swabbing and bailing of screens 2, 3, 4, and 5, as well as water produced during the aquifer pump tests of screens 3 and 4. Table 2.2-2 records the water levels measured in well R-31 during reconfiguration activities.

2.3 Initial Test Pumping of Screens 2, 3, 4, and 5

Following swabbing and bailing activities, initial test pumping was performed on R-31 screens 2, 3, 4 and 5. Screen 2 extends from 515.0 to 545.7 ft bgs and straddles the regional water table within the Cerros del Rio basalt. The static water level for screen 2 was measured on August 16, 2019, at 529.98 ft bgs. On August 17, 2019, the water level for screen 2 was 535.66 ft bgs, following dewatering of the screen during the previous day's test pumping. The water level continued dropping throughout the available monitoring period and equilibration had not been achieved when testing began; thus, the actual static water level was deeper than the measured result. On November 20, 2019, the screen 2 static water level was determined to be 537.21 ft bgs, 1.55 ft lower than observed in August 2019. This is likely a more realistic estimate of the true water level as it was measured after several days of equilibration and after screen 5 was abandoned by cementing. Testing showed that screen 2 could not support continuous pumping with a conventional submersible pump. After operating briefly, the water level dropped to the pump intake, and the pump cavitated and had to be shut down. It was necessary to cycle the pump briefly after an extended shutdown period and monitor the casing refill rate in order to determine the effective pumping rate. The flow rate was measured at 0.0434 gallons per minute (gpm), or 2.60 gallons per hour (gph). Longer testing showed that the rate declined steadily, dropping in half after several hours of pumping. The long-term yield of screen 2 was estimated to be approximately 1.3 gph.

Screen 3 extends from 666.3 to 676.3 ft within the Cerros del Rio basalt. The static water level measured from August 18 to 19, 2019, was 539.69 ft bgs. During testing in November 2019, the static water level was 538.51 ft bgs. With little yield information available from the screen 3 zone, a step-drawdown test was performed. Screen 3 was tested at multiple discharge rates for 110 min on August 16, 2019. The specific capacity of screen 3 ranges from 0.10 to 0.12 gpm/ft, depending on pumping rate. Derivation of the specific capacity is discussed in detail in Appendix C.

Screen 4 extends from 826.6 to 836.6 ft within Totavi sediments. The static water level measured in November 2019 was 534.4 ft bgs. With no yield information available from the screen 4 zone, a step-drawdown test was performed. Screen 4 was tested at multiple discharge rates for 120 min on November 10, 2019. The specific capacity remained fairly constant at all pumping rates, suggesting largely laminar flow conditions. The specific capacity of screen 4 ranges from 0.39 to 0.41 gpm/ft, depending on pumping rate.

Screen 5 extends from 1007.1 to 1017.1 ft within Totavi sediments. The static water level measured in November 2019 was 534.4 ft bgs. Screen 5 was tested at the maximum discharge rate of the 3-horsepower (hp) test pump for 105 min on November 9, 2019. The inline flow meter failed during testing, so the discharge rate was estimated initially using the "bucket and stopwatch" measurement method. Subsequent analysis incorporating data from the pump performance curve and the responses observed during other tests showed that the discharge rate from screen 5 was approximately 11 gpm during the test. Screen 5 produced 11 gpm with 6.2 ft of drawdown for a specific capacity of 1.77 gpm/ft. Derivation of the specific capacity is discussed in detail in Appendix C. Water levels measured during these initial pump tests are presented in Table 2.2-2.

2.4 Groundwater Sampling of Screens 3, 4, and 5

Following the pumping test of screen 3, groundwater parameters were measured for temperature, pH, turbidity, dissolved oxygen (DO), specific conductance, and oxidation/reduction potential (ORP) on August 19, 2019. Screen 3 originally was scheduled to be plugged and abandoned, but this plan was changed when screen 2 proved to be unproductive and screens 3 and 4 were chosen to be converted to the new sampling intervals. Groundwater samples were collected from screen 5 on November 9, 2019. Groundwater samples were collected from screen 3 on November 19, 2019. Groundwater samples were collected from screen 4 on December 5, 2019. Appendix B, Table B-1.1-1, presents water-quality data as well as analytical results from screen 3. Appendix B, Table B-1.1-2, presents water-quality data as well as analytical results from screen 4. Appendix B, Table B-1.1-3, presents water-quality data as well as analytical results from screen 5. Appendix B, Table B-1.2-1 presents the field parameters monitored during aquifer testing.

2.5 Jetting of Screens 2, 3, and 4

Following swabbing and bailing and the initial testing of R-31 screens 2, 3, and 4, the well was developed further by simultaneous high-velocity jetting and pumping of screens 2, 3, and 4. The jetting and pumping were accomplished by a 10-hp submersible pump being run through each screen section with a jetting tool above the pump. While the pump was running, the assembly was raised and lowered through the screen and periodically rotated a few degrees so that the water jets eventually covered the entire well screen surface. This operation was designed to loosen sediment around the wellbore and simultaneously remove it from the well via pumping.

Screen 2 was jetted for 75 min on August 22, 2019. Jetting began at a pressure of approximately 350 psi, equivalent to the pumping lift, and increased periodically while jetting continued. Following jet development, additional pumping was performed at screen 2. The low yield of this zone was not sufficient to support continuous pumping with a submersible pump, so performance was determined by lowering the water level by pumping and monitoring the casing refill rate. The average refill rate between 90 and 120 min was 4.98 gph.

Screen 3 was jetted for 45 min on November 15, 2019. Following jet development, additional pumping was performed at screen 3 at a discharge rate of 6.6 gpm. Before jetting, screen 3 produced 6.15 gpm with 53.9 ft of drawdown corresponding to a specific capacity of 0.114 gpm/ft. Following jetting, screen 3 produced 6.6 gpm with a drawdown of 34.1 ft, yielding a specific capacity of 0.194 gpm/ft.

Screen 4 was jetted for 52 min on November 15, 2019. Following jet development, additional pumping was performed at screen 4 at a discharge rate of 10.7 gpm. Before jetting, after 40 min of pumping, screen 4 produced 10.6 gpm with 26.88 ft of drawdown corresponding to a specific capacity of 0.394 gpm/ft. Following jetting, after 40 min of pumping, screen 4 produced 10.7 gpm with a drawdown of 19.02 ft, yielding a specific capacity of 0.563 gpm/ft.

2.6 Abandonment of Screen 5

Originally, screens 3, 4, and 5 were to be abandoned under the monitoring well reconfiguration plan approved by NMOSE and NMED, which is included in Appendix E. However, when screen 2 turned out to be largely unproductive, the reconfiguration plan was modified to abandon only screen 5 and to complete screens 3 and 4 as the new sampling intervals. On August 19, 2019, a temporary packer was set at 720 ft bgs after screen 3 was sampled. The temporary packer was removed on August 21, 2019. Groundwater from screen 5 was sampled on November 9, 2019. Operations to plug screen 5, the lowest screen in the regional aquifer for well R-31, were started on November 11, 2019.The water level was measured at 530.0 ft bgs, the bottom of the well was measured at 1075.8 ft bgs, and the BQ pipe was run into the well. On November 12, 2019, cement was pumped into the 1075.8 to 957 ft bgs interval, plugging screen 5. A k-packer was set from 889.2 ft to 890.7 ft bgs. Cement-impacted water was pumped out of the well on November 14, 2019. Sand was installed from a depth of 957.0 to 890.7 ft bgs.

2.7 Aquifer Testing and Groundwater Sampling of Screens 3 and 4

Following jet development, extended hydraulic testing was performed on screens 2, 3, and 4. Pumping of screen 2 was performed from August 22, 2019, and continued intermittently for 2468 min through August 24, 2019. Screen 2 produced too little flow to support continuous pumping using a submersible pump, so testing was accomplished by pumping the water level down into the casing beneath the bottom of the screen and observing the recovery rate within the well casing. This was effectively a constant drawdown test in which maximum drawdown was applied to the zone while the “pumping rate” was determined as the rate of casing refill.

Screens 3 and 4 were tested using standard constant-rate pumping methods. Screen 3 was tested from November 16 through 20, 2019. After the pump was installed and the drop pipe filled on November 16, 2019, short trial tests were conducted on November 17, 2019. Trial 1 was conducted for 30 min at a discharge rate of 6.6 gpm. Following pump shutoff, recovery was recorded for 30 min. Trial 2 was conducted for 60 min at a discharge rate of 6.6 gpm. Following shutdown, recovery data were recorded for 2790 min until November 19, 2019. Extended testing consisted of pumping screen 3 for 660 min until November 19, 2019. The initial discharge rate was 6.7 gpm. After an hour or so, the rate gradually increased to 7 gpm for the duration of the test. There was no apparent explanation for the observed change in discharge rate. Following shutdown, recovery data were recorded for 750 min until November 20, 2019.

Screen 4 was tested from November 21 through 27, 2019, and from December 4 through 8, 2019. The testing was performed in two sessions because a mandated sitewide shutdown prevented the continuous site work that had been planned. In the initial testing session, after the pump was installed and the drop pipe filled on November 21, 2019, short trial tests were conducted on November 22, 2019. Trial 1 was conducted for 30 min at a discharge rate of 10.7 gpm. Following pump shutoff, recovery was recorded for 30 min. Trial 2 was conducted for 60 min at a discharge rate of 10.8 gpm. Following shutdown, recovery data were recorded for more than 5 days until November 27, 2019, when the original transducer programming periods timed out and the transducers ceased recording data.

Fieldwork was restricted from November 23, 2019, until December 3, 2019, when the safety stand down was lifted and fieldwork was allowed to resume. On December 3, 2019, the pump assembly was removed and the transducers were reprogramed in preparation of the extended pumping test. The extended testing was performed from December 4 through 8, 2019. After the pump was installed and the drop pipe filled on December 4, 2019, screen 4 was pumped for 720 min on December 5, 2019. Groundwater samples were collected from the screen 4 interval on December 5, 2019, at the conclusion of the 12-hr pump test. The discharge rate for the test was 10.8 gpm. Following shutdown, recovery data were recorded for 4329 min until December 8, 2019, when the data collection protocol for the transducer in the pumped zone timed out and the transducers ceased recording data.

A detailed presentation and analysis of the pumping and recovery data appears in Appendix C.

2.8 Dedicated Pumping System Installation

After redevelopment, aquifer testing, and groundwater sampling activities were completed, a permanent pumping system was installed in R-31. Before the installation of the pumping system, the protective casing was cut off on December 15, 2019, and a 1.5-ft extension placed on the existing 5-in. well casing with steel positioning brackets on December 16, 2019. The hoist rig was demobilized from the site on December 16, 2019. On December 20, 2019, an extension was welded to the well casing, thus bringing the wellhead into compliance with existing surface completion specifications. The temporary packer was deflated and removed before Baski system installation and testing. The pumping system was installed from January 7 to January 13, 2020. On January 7, 2020, the rig and equipment were mobilized to R-31 and the components of the Baski sampling system were laid out and measured. The lower access port valve (LAPV) and packer were successfully tested, and the temporary packer was deflated and pulled from the well. Components of the Baski sampling system were tested as they were assembled and installed into the well. On January 8, 2020, the lower packer and LAPV were assembled, tested, and lowered into the well. Work continued on January 9, 2020. Several failed pressure tests revealed a leak at a fitting on top of the upper liquid inflation chamber (LIC) from 643.5 ft to 638.9 ft bgs. On January 10, 2020, fittings were tightened, the UAPV was installed and successfully tested, and the pump shroud vent tube was connected. On January 11, 2020, the upper packer and the upper LIC were installed and tested. Installation of the Baski system was completed on January 12, 2020. Packers and access port valves (APVs) were eventually successfully tested, although some tests needed repeating because of leaky tank valves and ice in the tubing. On January 13, 2020, the final pressure tests of the packers and APVs were completed and the rig was demobilized from R-31. The R-31 sampling system consists of an LAPV screen from 703.3 ft to 703.0 ft bgs, a lower packer from 698.0 ft to 695.5 ft bgs, a lower LIC from 690.0 ft to 686.2 ft bgs, a UAPV from 684.5 ft to 684.2 ft bgs, a Grundfos 5S20-665 pump within a pump shroud from 680.1 ft to 673.5 ft bgs, an upper packer from 650.5 ft to 648.0 ft bgs, and an upper LIC from 643.5 ft to 638.9 ft bgs.

The new sampling system comprises an upper LIC, an upper packer, a 4-in.-diameter Grundfos pump and motor within a pump shroud, a UAPV, a lower LIC, a lower packer, an LAPV, and all of the attendant plumbing and tubing. The pump column is composed of 1-in. schedule 60 stainless-steel tubing. The upper transducer tube is 1-in. flush-threaded schedule 80 polyvinyl chloride (PVC) tubing from surface to 637.8 ft bgs, 0.25-in. stainless-steel tubing to 652.7 ft bgs, and stainless-steel mesh screen to 653.7 ft bgs. The lower transducer tube is 1-in. flush-threaded schedule 80 PVC tubing from surface to 637.8 ft bgs, 0.25-in. stainless-steel tubing to 700.2 ft bgs, and stainless-steel mesh screen to 701.2 ft bgs. Both transducers are In Situ, Inc. model Level Troll 500 30-psig transducers. All of the technical details of the sampling system are shown in Figure 2.0-2.

2.9 Well Pad Construction

The original concrete well pad had deteriorated and was not compliant with current completion specifications. The original R-31 well pad was demolished on January 14 and 15, 2020, and a new well pad was constructed from January 17 to 24, 2020. A new geodetic survey was conducted on January 25, 2020. The geodetic survey coordinates are listed in Table 2.9-1. The geodetic survey data is available in Intellus New Mexico.

3.0 WASTE MANAGEMENT

All investigation-derived waste (IDW) generated during well reconfiguration activities was 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, DOE orders, and N3B requirements. The SOP applicable to the characterization and management of IDW is N3B-EP-DIR-SOP-10021, “Characterization and Management of Environmental Program Waste.”

A waste characterization strategy form (WCSF) (N3B 2019, 700339) was prepared and approved per requirements of N3B-EP-DIR-SOP-10021, “Characterization and Management of Environmental Program Waste.” This WCSF provides detailed information on IDW characterization methods, management, containerization, and potential volumes. Westbay system components (composed of PVC and stainless steel); fluids (purge and decontamination waters); contact waste (gloves, paper towels, plastic and/or glass sample bottles); and chase water, concrete, and rebar were the primary waste streams generated during the well reconfiguration activities. The fluids produced were sampled and analyzed for the suite of constituents listed in the WCSF.

4.0 DEVIATIONS FROM PLANNED ACTIVITIES

Reconfiguration activities at R-31 were performed as specified in the NMED-approved work plans (LANL 2011, 204372; N3B 2018, 700130), with the exception of the following deviation.

- The Field implementation plan for the Westbay reconfiguration (N3B 2019, 700385) called for plugging and abandoning screens 3, 4, and 5 and reconfiguring the well to sample only screen 2. However, screen 2 was found to be largely unproductive, so a revised reconfiguration plan was approved by EM-LA and NMED (Rodriguez 2019, 700738; Rodriguez 2019, 700739). The revised plan called for plugging and abandoning only screen 5 and installing a dual Baski sampling system to sample screens 3 and 4. The details of the fieldwork completed to effect the revised reconfiguration of R-31 are provided in section 2.

5.0 COMPARISON OF ANALYTICAL DATA

Groundwater samples were collected from the retained screens 3 and 4, and from abandoned screen 5, to provide a comparison of groundwater quality from samples collected after purging with samples collected using the no-purge Westbay sampling system. For abandoned screen 5, samples were collected at the end of a relatively small-volume (105 gal.) purge that achieved stable field parameters. Retained screen 3 was sampled twice, once after a relatively short step-test and small-volume purge that achieved stable field parameters, and again after the 12-hr constant-rate aquifer test. For retained screen 4, samples were collected at the end of the 12-hr constant-rate aquifer tests. Table 5.0-1 presents a comparison of the analytical results for constituents that were detected either historically or in the most recent round of sampling.

Note that concentrations of constituents in samples collected after the Westbay systems were removed should be considered as preliminary because of potential physical and geochemical perturbations that may occur in the aquifer associated with aggressive redevelopment steps, including swabbing and jetting. This qualification of analytical results is consistent with observations from newly installed wells, which generally require multiple rounds of sampling before the geochemistry stabilizes. In accordance with the monitoring year 2020 Interim Facility-Wide Groundwater Monitoring Plan (N3B 2019, 700451), converted well R-31 will be sampled as follows:

- Quarterly for metals, volatile organic compounds, semivolatile organic compounds, low-level tritium, and general inorganics
- Annually for polychlorinated biphenyls, high explosives, dioxins/furans, radionuclides, and low-level tritium
- One-time sampling for prometon, low-level nitrosamines, and per- and polyfluoroalkyl substances to demonstrate they are not present

NMED, pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 435.1, “Radioactive Waste Management,” and DOE Order 458.1, Administrative Change 3, “Radiation Protection of the Public and the Environment.” Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

Table 5.0-1 shows that analytical results of the most recent samples primarily fall within or below historical ranges for each constituent. In some cases, the concentration of a given constituent exceeds the historical range, but is within background values for that constituent in the regional groundwater. On rare occasions, a concentration of a constituent exceeds the historical range but is consistent with concentrations observed in shallower screens of the same well, suggesting that the concentrations in the lower screen reflect small amounts of cross-flow between screens rather than ambient concentrations in the aquifer in the deeper screened interval. Examples of this potential cross-flow are silicon dioxide and zinc concentrations in screens 3 and 4. The concentrations from the post-Westbay samples are greater than the historical range but diminish slightly downward from screen 3 to screen 4, suggesting that some remnant groundwater from screen 3 was present in the sample collected from screen 4 . Whereas silicon dioxide is not considered a contaminant of primary concern (COPC), zinc sometimes is a COPC, although zinc concentrations fall well below maximum historical concentrations in screen 4.

6.0 REFERENCES AND MAP DATA SOURCES

6.1 References

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by 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). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

Dale, M., May 31, 2019. FW: Revised Sampling and Analysis Plan - Westbay Reconfiguration. E-mail message to M. Everett (N3B) from M. Dale (NMED), Santa Fe, New Mexico. (Dale 2019, 700610)

Everett, M., May 23, 2019. Revised Sampling and Analysis Plan - Westbay Reconfiguration, including "Sampling and Analysis Plan for Well Reconfigurations at R-5, R-7, R-8, R-9i, R-19, R-25, and R-31, Revision 1" attachment. E-mail message to M. Dale (NMED) from M. Everett (N3B), Los Alamos, New Mexico. (Everett 2019, 700606)

LANL (Los Alamos National Laboratory), May 22, 1998. "Hydrogeologic Workplan," Los Alamos National Laboratory document LA-UR-01-6511, Los Alamos, New Mexico. (LANL 1998, 059599)

LANL (Los Alamos National Laboratory), July 2011. "Work Plan for the Technical Area 21 Monitoring Well Network Reconfiguration," Los Alamos National Laboratory document LA-UR-11-3674, Los Alamos, New Mexico. (LANL 2011, 204372)

LANL (Los Alamos National Laboratory), March 2012. "Technical Area 16 Well Network Evaluation and Recommendations," Los Alamos National Laboratory document LA-UR-12-1082, Los Alamos, New Mexico. (LANL 2012, 213573)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), November 2018. "Work Plan to Reconfigure Monitoring Wells R-19 and R-31," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2018-0083, Los Alamos, New Mexico. (N3B 2018, 700130)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), March 6, 2019. "Waste Characterization Strategy Form for Westbay Well Reconfiguration Project," Los Alamos National Laboratory, Los Alamos, New Mexico. (N3B 2019, 700339)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), April 2019. "Field Implementation Plan for Well Reconfigurations at R-5, R-7, R-8, R-9i, R-19, R-25, and R-31," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0079, Los Alamos, New Mexico. (N3B 2019, 700385)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), May 2019. "Interim Facility-Wide Groundwater Monitoring Plan for the 2020 Monitoring Year, October 2019–September 2020," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0156, Los Alamos, New Mexico. (N3B 2019, 700451)

NMED (New Mexico Environment Department), February 5, 2019. "Approval with Modifications, Work Plan to Reconfigure Monitoring Wells R-19 and R-31," New Mexico Environment Department letter to D. Hintze (EM-LA) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2019, 700216)

NMED (New Mexico Environment Department), October 29, 2019. "Resolution, Denial of Extension Request for Westbay Wells Reconfiguration, Fiscal Year 2019 Milestone # 14, Appendix B, Consent Order," New Mexico Environment Department letter to A. Duran (EM-LA) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2019, 700652)

Rodriguez, C., October 9, 2019. R-31 Options Discussion This Afternoon at End of the AA Meeting. E-mail message to N. Dhawan (NMED), R. Murphy (NMED), T. McCrory (EM-LA), M. Everett (N3B), B. Robinson (N3B), J. Hyatt (N3B), E. Day (N3B), C. Maupin (N3B), M. Erickson (N3B), K. Rich (N3B), E. Evered (N3B), D. Nickless (EM-LA), and E. Lowes (N3B) from C. Rodriguez (EM-LA), Los Alamos, New Mexico. (Rodriguez 2019, 700739)

Rodriguez, C., October 10, 2019. RE: Groundwater Monitoring Well R-31 Configuration Options. E-mail message to N. Dhawan (NMED), R. Murphy (NMED), and P. Longmire (NMED) from C. Rodriguez (EM-LA), Los Alamos, New Mexico. (Rodriguez 2019, 700738)

Vaniman, D., J. Marin, W. Stone, B. Newman, P. Longmire, N. Clayton, R. Lewis, R. Koch, S. McLin, G. WoldeGabriel, D. Counce, D. Rogers, R. Warren, E. Kluk, S. Chipera, D. Larssen, and W. Kopp, March 2002. "Characterization Well R-31 Completion Report," Los Alamos National Laboratory report LA-13910-MS, Los Alamos, New Mexico. (Vaniman et al. 2002, 072615)

6.2 Map Data Sources

Monitoring well point features; EIM database pull; as published; October 2019.

County Boundaries: As published; N3B GIS project folder: Q:\16-Projects\16-0033\project_data.gdb\outfall_260\poly\pline_lab_county; October 2019.

Surrounding Land: As published; N3B GIS project folder: Q:\16-Projects\16-0033\project_data.gdb\polygon\pline_lab_county; October 2019.

TA Boundary: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Boundaries\PUB.Tecareas; October 2019.

Major Road: As published; Q:\16-Projects\16-0033\project_data.gdb\line\major_road; October 2019.

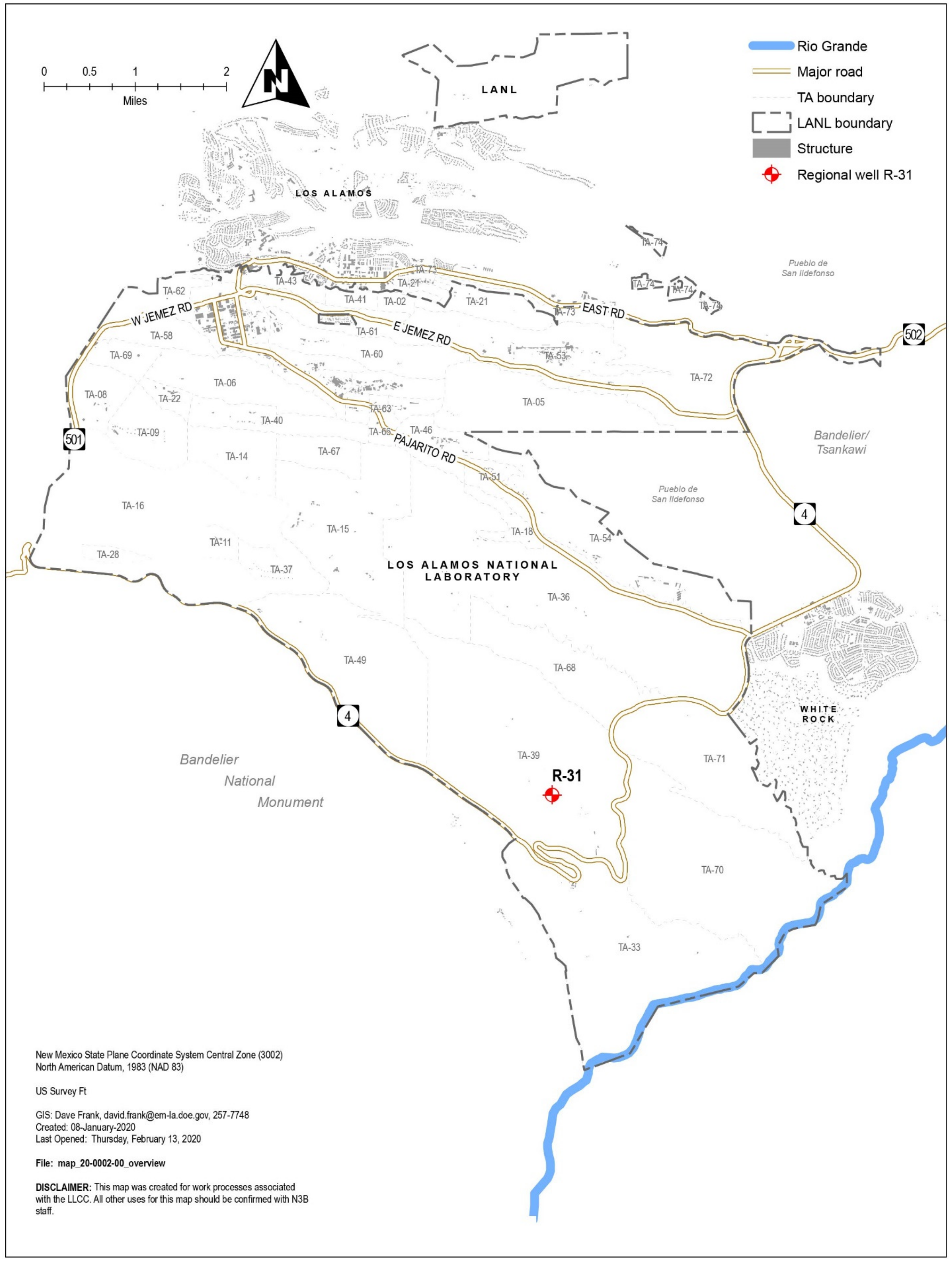


Figure 1.0-1 Location of well R-31

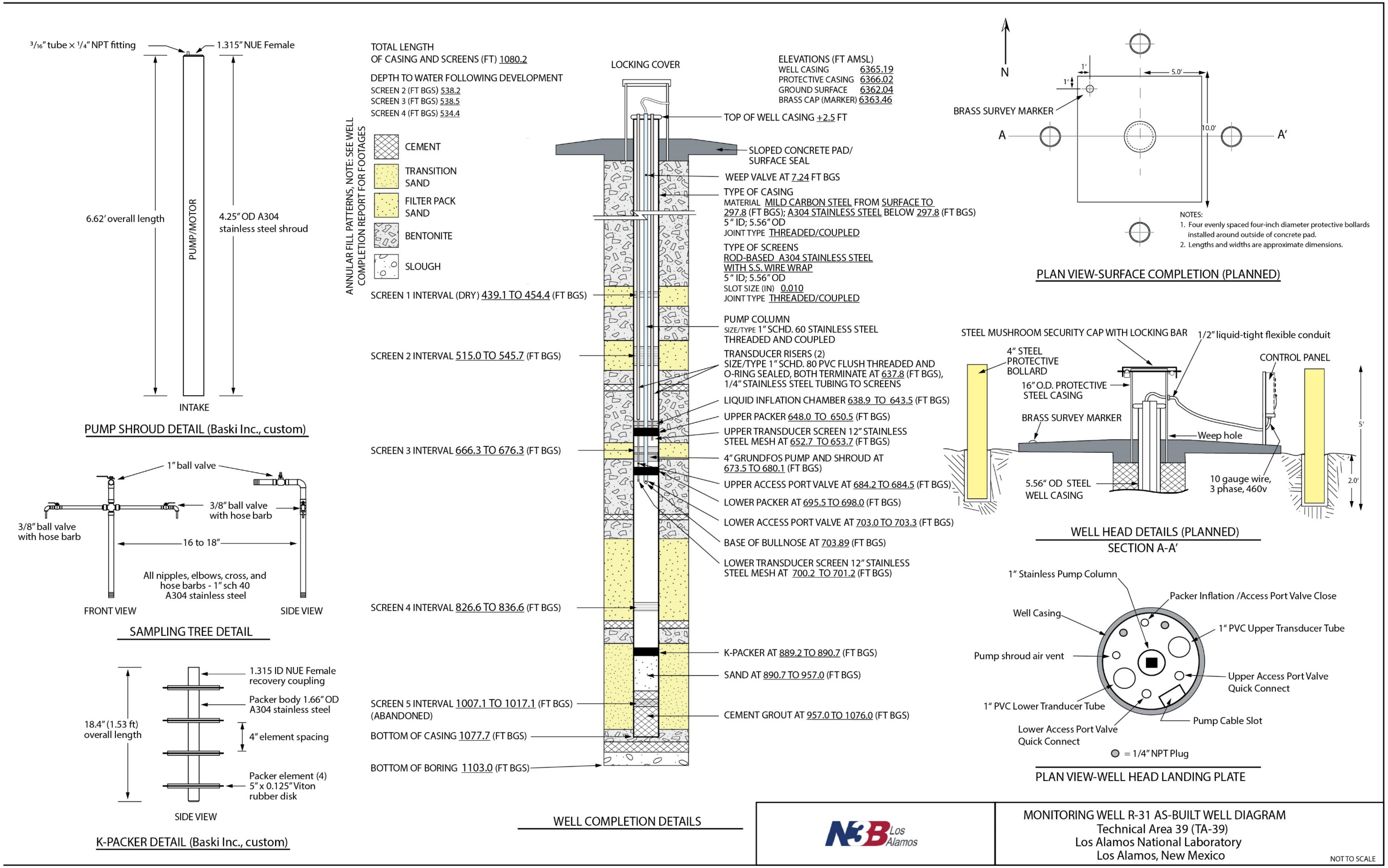


Figure 2.0-1 Monitoring well R-31 as-built construction diagram post-Westbay conversion

R-31 SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES:

SURVEY INFORMATION*

Brass Marker
Northing: 1745646.16
Easting: 1637356.32
Elevation: 6363.46

Well Casing (top of stainless steel)
Northing: 1745641.91
Easting: 1637357.04
Elevation: 6365.19

AQUIFER TESTING

11h Constant Rate Pumping Test (Screen #3)
Average Flow Rate: 7 gpm
Specific Capacity: 15.8 gpm/ft
Performed on: 11/19/2019
12h Constant Rate Pumping Test (Screen #4)
Average Flow Rate: 10.7 gpm
Specific Capacity: 47.5 gpm/ft
Performed on: 12/05/2019

DEDICATED SAMPLING SYSTEM

Screens 3 and 4

Pump (Shrouded)
Make: Grundfos
Model: 5S20-665
S/N: P11206 017
Base of shroud at 680.1 ft bgs
Environmental retrofit

Motor
Make: Franklin Electric
Model: 2343258600
2 hp, 3-phase

Motor cable
10g, 3 lead with ground,
double jacket

Pump Shroud
A304 stainless steel, 4.25-in. x 0.0120-in. wall tube, Baski Inc. custom
Swagelok check valve, 1-in. male x male, 316 stainless steel, mod. SS-CHM16-1, 5000psi

Pump Column
1-in. threaded/coupled schd. 60, nonannealed, A304 stainless steel tubing
Nitronic 60 NUE couplings

Upper Transducer Tube
1 X 1-inch flush threaded schd. 80 PVC tubing to 637.8 ft bgs; 1/4” stainless steel tubing to 652.7 ft bgs; stainless steel mesh screen at 652.7 to 653.7 ft bgs

Upper Transducer
In Situ, Inc
Model: Level Troll 500
30 psig
S/N: 712632

Lower Transducer Tube
1 X 1-inch flush threaded schd. 80 PVC tubing to 637.8 ft bgs; 1/4” stainless steel tubing to 700.2 ft bgs; stainless steel mesh screen at 700.2 to 701.2 ft bgs

Lower Transducer
In Situ, Inc
Model: Level Troll 500
30 psig
S/N: 712907

Banding
¾-inch 201 stainless
steel with 201 stainless steel buckles

Thread compound
Jet Lube, V2

Sampling tree
A304 schd. 40 stainless steel
1-in nipples, elbows, cross, bushings, hose barbs, and Apollo ball valves 1-in. (76-105-01A) and (X2) 3/8-in. (76-102-01A)

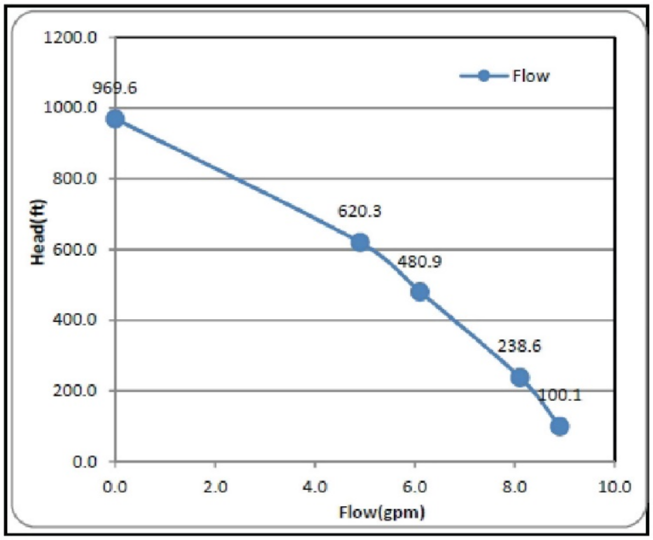
N3B Los Alamos

R-31 SAMPLING SYSTEM
DESIGN PACKAGE TECHNICAL NOTES
Technical Area 39 (TA-39) Los Alamos National Laboratory
Los Alamos, New Mexico

Figure 2.0-2 As-built technical notes for monitoring well R-31 post-Westbay conversion

R-31 PUMP CURVE

DATE: 04/30/2019
CUST: Albuquerque Pipe & Pump
WO #: 82120-4
TEST#: Well R-31 scn. 3



PUMP

MFR: GRUNDFOS
MN: 5S20-665
SN: P11206 017

MOTOR

MFR:	FRANKLIN	HP:	2	HZ:	60
MN:	2343258600	VOLTS:	460	PHASE:	3
SN:	Test motor	AMPS:	3.4	SFA:	4.1

TEST POINT	FLOW GPM	HEAD FT	HEAD PSI	AMPS L1	AMPS L2	AMPS L3
1	8.9	100.1	43.3	3.0	3.6	3.6
2	8.1	238.6	103.3	2.9	3.5	3.5
3	6.1	480.9	208.2	2.9	3.4	3.4
4	4.9	620.3	268.5	2.7	3.3	3.3
5	0.0	969.6	419.8	2.2	2.8	2.8
6						
7						
8						
9						
10						

Tested By: jw

N3B Los Alamos

R-31 DEDICATED PUMP PERFORMANCE CURVE
Technical Area 39 (TA-39)
Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.0-3 R-31 dedicated pump performance curve

Table 2.2-1
Water Quantities Produced During R-31 Reconfiguration

Date	Depth Interval (ft bgs)	Water Produced (gal.)	Cumulative Water Produced (gal.)
8/14/2019	1075	Not recorded (bailed)	na*
8/15/2019	1075	Not recorded (bailed)	na
8/15/2019	676	Not recorded (bailed)	na
8/16/2019	676	837 (pumped)	837
8/17/2019	545	25.7 (pumped)	862.7
8/19/2019	676	439 (pumped)	1301.7
8/23/2019	545	71.8 (pumped)	1373.5
11/7/2019	1017	45 (bailed)	1418.5
11/8/2019	1017	105 (bailed)	1523.5
11/9/2019	1017	360 (pumped)	1883.5
11/10/2019	836	964.6 (pumped)	2848.1
11/15/2019	676	584.2 (pumped)	3432.3
11/15/2019	836	784.1 (pumped)	4216.4
11/17/2019	836	594 (pumped	4810.4
11/19/2019	836	4597 (pumped)	9407.4
11/22/2019	1017	969 (pumped)	10,376.4
12/5/2019	1017	7776 (pumped)	18,152.4

*na = Not available.

Table 2.2-2
Water Levels Recorded During R-31 Reconfiguration

Well	Date	Water Level (ft bgs)
R-31 Screen 2	08/13/2019	532 0
R-31 Screen 2	08/16/2019	529.98
R-31 Screen 2	08/17/2019	535.66
R-31 Screen 3	08/18/2019	539.69
R-31 Screen 5	11/09/2019	534.4
R-31 Screen 4	11/10/2019	534.4
R-31 Screen 5	11/11/2019	530.0
R-31 Screen 3	11/17/2019	536.59
R-31 Screen 2	11/20/2019	537.21

Table 2.9-1
Geodetic Survey Data

Identification	Northing	Easting	Elevation
R-31 brass cap embedded in pad	1745646.16	1637356.32	6363.46 ft amsl*
R-31 ground surface near pad	1745649.43	1637354.63	6362.04 ft amsl
R-31 top of stainless-steel well casing	1745641.91	1637357.04	6365.19 ft amsl
R-31 top of 16-in. protective casing	1745642.52	1637356.92	6366.02 ft amsl

*amsl = Above mean sea level.

Table 5.0-1
Comparison of Recent Groundwater Analytical Results and Historical Results for Well R-31

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S3[a]	Regional	Acetone	8/19/2019	µg/L	REG[b]	UF[c]	1.5	No	1.73 to 12	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Acetone	8/19/2019	µg/L	FD[d]	UF	1.5	No	1.73 to 12	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Acetone	11/19/2019	µg/L	REG	UF	1.5	No	1.73 to 12	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Acetone	11/19/2019	µg/L	FD	UF	1.5	No	1.73 to 12	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Alkalinity-CO_3+HCO_3	8/19/2019	mg/L	REG	F[e]	54.8	No	81.4 to 400	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Alkalinity-CO_3+HCO_3	8/19/2019	mg/L	FD	F	54.6	Yes	81.4 to 400	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Alkalinity-CO_3+HCO_3	11/19/2019	mg/L	REG	F	59.6	Yes	81.4 to 400	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Alkalinity-CO_3+HCO_3	11/19/2019	mg/L	FD	F	59.6	Yes	81.4 to 400	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Amino-4,6-dinitrotoluene[2-]	8/19/2019	µg/L	REG	UF	0.0835	No	0.77 to 0.77	1/9	12/16/2000	9/14/2010
R-31 S3	Regional	Amino-4,6-dinitrotoluene[2-]	8/19/2019	µg/L	FD	UF	0.0868	No	0.77 to 0.77	1/9	12/16/2000	9/14/2010
R-31 S3	Regional	Amino-4,6-dinitrotoluene[2-]	11/19/2019	µg/L	REG	UF	0.0838	No	0.77 to 0.77	1/9	12/16/2000	9/14/2010
R-31 S3	Regional	Amino-4,6-dinitrotoluene[2-]	11/19/2019	µg/L	FD	UF	0.0829	No	0.77 to 0.77	1/9	12/16/2000	9/14/2010
R-31 S3	Regional	Ammonia as nitrogen	8/19/2019	mg/L	REG	F	0.0539	No	0.096 to 0.407	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Ammonia as nitrogen	8/19/2019	mg/L	FD	F	0.0627	No	0.096 to 0.407	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Ammonia as nitrogen	11/19/2019	mg/L	REG	F	0.0532	No	0.096 to 0.407	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Ammonia as nitrogen	11/19/2019	mg/L	FD	F	0.0417	No	0.096 to 0.407	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Arsenic	8/19/2019	µg/L	REG	F	2.55	Yes	3.8 to 3.8	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Arsenic	8/19/2019	µg/L	FD	F	2.43	Yes	3.8 to 3.8	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Arsenic	11/19/2019	µg/L	REG	F	2.24	Yes	3.8 to 3.8	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Arsenic	11/19/2019	µg/L	FD	F	2	No	3.8 to 3.8	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Barium	8/19/2019	µg/L	REG	F	27.8	Yes	62.5 to 240	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Barium	8/19/2019	µg/L	FD	F	28.6	Yes	62.5 to 240	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Barium	11/19/2019	µg/L	REG	F	22.1	Yes	62.5 to 240	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Barium	11/19/2019	µg/L	FD	F	21.5	Yes	62.5 to 240	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Boron	8/19/2019	µg/L	REG	F	15	No	18.7 to 37.4	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Boron	8/19/2019	µg/L	FD	F	15	No	18.7 to 37.4	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Boron	11/19/2019	µg/L	REG	F	15	No	18.7 to 37.4	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Boron	11/19/2019	µg/L	FD	F	15	No	18.7 to 37.4	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Butanone[2-]	8/19/2019	µg/L	REG	UF	1.5	No	22 to 22	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Butanone[2-]	8/19/2019	µg/L	FD	UF	1.5	No	22 to 22	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Butanone[2-]	11/19/2019	µg/L	REG	UF	1.5	No	22 to 22	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Butanone[2-]	11/19/2019	µg/L	FD	UF	1.5	No	22 to 22	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Calcium	8/19/2019	mg/L	REG	F	8.38	Yes	11 to 55	4/4	12/16/2000	5/21/2007

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S3	Regional	Calcium	8/19/2019	mg/L	FD	F	8.5	Yes	11 to 55	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Calcium	11/19/2019	mg/L	REG	F	10.7	Yes	11 to 55	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Calcium	11/19/2019	mg/L	FD	F	10.5	Yes	11 to 55	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Chloride	8/19/2019	mg/L	REG	F	1.48	Yes	2.22 to 7.9	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Chloride	8/19/2019	mg/L	FD	F	1.49	Yes	2.22 to 7.9	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Chloride	11/19/2019	mg/L	REG	F	2.03	Yes	2.22 to 7.9	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Chloride	11/19/2019	mg/L	FD	F	1.93	Yes	2.22 to 7.9	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Cobalt	8/19/2019	µg/L	REG	F	1	No	1 to 1	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Cobalt	8/19/2019	µg/L	FD	F	1	No	1 to 1	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Cobalt	11/19/2019	µg/L	REG	F	1	No	1 to 1	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Cobalt	11/19/2019	µg/L	FD	F	1	No	1 to 1	1/4	12/16/2000	5/21/2007
R-31 S3	Regional	Fluoride	8/19/2019	mg/L	REG	F	0.286	Yes	0.322 to 0.46	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Fluoride	8/19/2019	mg/L	FD	F	0.303	Yes	0.322 to 0.46	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Fluoride	11/19/2019	mg/L	REG	F	0.415	Yes	0.322 to 0.46	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Fluoride	11/19/2019	mg/L	FD	F	0.409	Yes	0.322 to 0.46	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Gross beta	11/19/2019	pCi/L	REG	UF	2.74	Yes	6.25 to 6.25	1/2	8/19/2005	11/30/2006
R-31 S3	Regional	Gross beta	11/19/2019	pCi/L	FD	UF	3.07	Yes	6.25 to 6.25	1/2	8/19/2005	11/30/2006
R-31 S3	Regional	Hardness	8/19/2019	mg/L	REG	F	31.1	Yes	41.5 to 44.5	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Hardness	8/19/2019	mg/L	FD	F	31.6	Yes	41.5 to 44.5	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Hardness	11/19/2019	mg/L	REG	F	38.8	Yes	41.5 to 44.5	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Hardness	11/19/2019	mg/L	FD	F	37.7	Yes	41.5 to 44.5	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Iron	8/19/2019	µg/L	REG	F	30	No	250 to 4170	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Iron	8/19/2019	µg/L	FD	F	30	No	250 to 4170	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Iron	11/19/2019	µg/L	REG	F	30	No	250 to 4170	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Iron	11/19/2019	µg/L	FD	F	30	No	250 to 4170	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Magnesium	8/19/2019	mg/L	REG	F	2.46	Yes	3.38 to 11	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Magnesium	8/19/2019	mg/L	FD	F	2.53	Yes	3.38 to 11	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Magnesium	11/19/2019	mg/L	REG	F	2.92	Yes	3.38 to 11	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Magnesium	11/19/2019	mg/L	FD	F	2.82	Yes	3.38 to 11	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Manganese	8/19/2019	µg/L	REG	F	19.7	Yes	257 to 3500	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Manganese	8/19/2019	µg/L	FD	F	19.9	Yes	257 to 3500	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Manganese	11/19/2019	µg/L	REG	F	3.15	Yes	257 to 3500	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Manganese	11/19/2019	µg/L	FD	F	2.99	Yes	257 to 3500	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Molybdenum	8/19/2019	µg/L	REG	F	1.35	Yes	2.8 to 30	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Molybdenum	8/19/2019	µg/L	FD	F	1.26	Yes	2.8 to 30	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Molybdenum	11/19/2019	µg/L	REG	F	2.2	Yes	2.8 to 30	3/4	12/16/2000	5/21/2007

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S3	Regional	Molybdenum	11/19/2019	µg/L	FD	F	2.19	Yes	2.8 to 30	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Nickel	8/19/2019	µg/L	REG	F	0.815	Yes	2.2 to 40	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Nickel	8/19/2019	µg/L	FD	F	0.747	Yes	2.2 to 40	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Nitrate-nitrite as nitrogen	8/19/2019	mg/L	REG	F	0.284	Yes	0.0212 to 0.032	2/4	12/16/2000	5/21/2007
R-31 S3	Regional	Nitrate-nitrite as nitrogen	8/19/2019	mg/L	FD	F	0.285	Yes	0.0212 to 0.032	2/4	12/16/2000	5/21/2007
R-31 S3	Regional	Nitrate-nitrite as nitrogen	11/19/2019	mg/L	REG	F	0.4	Yes	0.0212 to 0.032	2/4	12/16/2000	5/21/2007
R-31 S3	Regional	Nitrate-nitrite as nitrogen	11/19/2019	mg/L	FD	F	0.399	Yes	0.0212 to 0.032	2/4	12/16/2000	5/21/2007
R-31 S3	Regional	Perchlorate	8/19/2019	µg/L	REG	F	0.236	Yes	0.058 to 0.255	3/6	8/19/2005	5/21/2007
R-31 S3	Regional	Perchlorate	8/19/2019	µg/L	FD	F	0.234	Yes	0.058 to 0.255	3/6	8/19/2005	5/21/2007
R-31 S3	Regional	Perchlorate	11/19/2019	µg/L	REG	F	0.283	Yes	0.058 to 0.255	3/6	8/19/2005	5/21/2007
R-31 S3	Regional	Perchlorate	11/19/2019	µg/L	FD	F	0.265	Yes	0.058 to 0.255	3/6	8/19/2005	5/21/2007
R-31 S3	Regional	Potassium	8/19/2019	mg/L	REG	F	2.37	Yes	1.6 to 8.1	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Potassium	8/19/2019	mg/L	FD	F	2.46	Yes	1.6 to 8.1	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Potassium	11/19/2019	mg/L	REG	F	2.16	Yes	1.6 to 8.1	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Potassium	11/19/2019	mg/L	FD	F	2.13	Yes	1.6 to 8.1	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Radium-226	11/19/2019	pCi/L	REG	UF	1.97	Yes	0.816 to 0.816	1/3	12/16/2000	10/24/2008
R-31 S3	Regional	Radium-226	11/19/2019	pCi/L	FD	UF	1.12	Yes	0.816 to 0.816	1/3	12/16/2000	10/24/2008
R-31 S3	Regional	Radium-226 and radium-228	11/19/2019	pCi/L	REG	UF	1.97	Yes	1.1 to 1.1	1/2	4/16/2008	10/24/2008
R-31 S3	Regional	Radium-226 and radium-228	11/19/2019	pCi/L	FD	UF	1.12	Yes	1.1 to 1.1	1/2	4/16/2008	10/24/2008
R-31 S3	Regional	Silicon dioxide	8/19/2019	mg/L	REG	F	80.9	Yes	59.9 to 60.4	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Silicon dioxide	8/19/2019	mg/L	FD	F	84.2	Yes	59.9 to 60.4	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Silicon dioxide	11/19/2019	mg/L	REG	F	70	Yes	59.9 to 60.4	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Silicon dioxide	11/19/2019	mg/L	FD	F	68.5	Yes	59.9 to 60.4	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Sodium	8/19/2019	mg/L	REG	F	11.2	Yes	18.1 to 73	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Sodium	8/19/2019	mg/L	FD	F	11.6	Yes	18.1 to 73	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Sodium	11/19/2019	mg/L	REG	F	11.5	Yes	18.1 to 73	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Sodium	11/19/2019	mg/L	FD	F	11.3	Yes	18.1 to 73	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Specific conductance	8/19/2019	µS/cm	REG	F	113	Yes	172 to 266	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Specific conductance	8/19/2019	µS/cm	FD	F	113	Yes	172 to 266	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Specific conductance	11/19/2019	µS/cm	REG	F	109	Yes	172 to 266	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Specific conductance	11/19/2019	µS/cm	FD	F	109	Yes	172 to 266	3/3	8/19/2005	5/21/2007
R-31 S3	Regional	Strontium	8/19/2019	µg/L	REG	F	42	Yes	71.3 to 360	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Strontium	8/19/2019	µg/L	FD	F	43.1	Yes	71.3 to 360	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Strontium	11/19/2019	µg/L	REG	F	54.1	Yes	71.3 to 360	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Strontium	11/19/2019	µg/L	FD	F	53	Yes	71.3 to 360	4/4	12/16/2000	5/21/2007
R-31 S3	Regional	Sulfate	8/19/2019	mg/L	REG	F	1.63	Yes	1.26 to 1.68	3/4	12/16/2000	5/21/2007

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S3	Regional	Sulfate	8/19/2019	mg/L	FD	F	1.63	Yes	1.26 to 1.68	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Sulfate	11/19/2019	mg/L	REG	F	2.34	Yes	1.26 to 1.68	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Sulfate	11/19/2019	mg/L	FD	F	2.34	Yes	1.26 to 1.68	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Toluene	8/19/2019	µg/L	REG	UF	9.67	Yes	—[f]	0/4	12/16/2000	5/21/2007
R-31 S3	Regional	Toluene	8/19/2019	µg/L	FD	UF	9.41	Yes	—	0/4	12/16/2000	5/21/2007
R-31 S3	Regional	Toluene	11/19/2019	µg/L	REG	UF	2.06	Yes	—	0/4	12/16/2000	5/21/2007
R-31 S3	Regional	Toluene	11/19/2019	µg/L	FD	UF	2.01	Yes	—	0/4	12/16/2000	5/21/2007
R-31 S3	Regional	Total dissolved solids	8/19/2019	mg/L	REG	F	147	Yes	123 to 218	4/4	8/19/2005	5/21/2007
R-31 S3	Regional	Total dissolved solids	8/19/2019	mg/L	FD	F	107	Yes	123 to 218	4/4	8/19/2005	5/21/2007
R-31 S3	Regional	Total dissolved solids	11/19/2019	mg/L	REG	F	153	Yes	123 to 218	4/4	8/19/2005	5/21/2007
R-31 S3	Regional	Total dissolved solids	11/19/2019	mg/L	FD	F	154	Yes	123 to 218	4/4	8/19/2005	5/21/2007
R-31 S3	Regional	Total Kjeldahl nitrogen	8/19/2019	mg/L	REG	UF	0.11	Yes	0.195 to 0.305	2/2	11/30/2006	5/21/2007
R-31 S3	Regional	Total Kjeldahl nitrogen	8/19/2019	mg/L	FD	UF	0.173	Yes	0.195 to 0.305	2/2	11/30/2006	5/21/2007
R-31 S3	Regional	Total Kjeldahl nitrogen	11/19/2019	mg/L	REG	UF	0.033	No	0.195 to 0.305	2/2	11/30/2006	5/21/2007
R-31 S3	Regional	Total Kjeldahl nitrogen	11/19/2019	mg/L	FD	UF	0.0442	Yes	0.195 to 0.305	2/2	11/30/2006	5/21/2007
R-31 S3	Regional	Total organic carbon	8/19/2019	mg/L	REG	UF	0.354	Yes	1.61 to 21.9	3/3	9/27/2001	5/21/2007
R-31 S3	Regional	Total organic carbon	8/19/2019	mg/L	FD	UF	0.33	No	1.61 to 21.9	3/3	9/27/2001	5/21/2007
R-31 S3	Regional	Total organic carbon	11/19/2019	mg/L	REG	UF	0.33	No	1.61 to 21.9	3/3	9/27/2001	5/21/2007
R-31 S3	Regional	Total organic carbon	11/19/2019	mg/L	FD	UF	0.33	No	1.61 to 21.9	3/3	9/27/2001	5/21/2007
R-31 S3	Regional	Total phosphate as phosphorus	8/19/2019	mg/L	REG	F	0.0921	No	0.052 to 0.141	2/3	8/19/2005	5/21/2007
R-31 S3	Regional	Total phosphate as phosphorus	8/19/2019	mg/L	FD	F	0.0861	No	0.052 to 0.141	2/3	8/19/2005	5/21/2007
R-31 S3	Regional	Total phosphate as phosphorus	11/19/2019	mg/L	REG	F	0.0223	No	0.052 to 0.141	2/3	8/19/2005	5/21/2007
R-31 S3	Regional	Total phosphate as phosphorus	11/19/2019	mg/L	FD	F	0.0272	No	0.052 to 0.141	2/3	8/19/2005	5/21/2007
R-31 S3	Regional	Tritium	8/19/2019	pCi/L	REG	UF	2.081	No	0.1932 to 0.1932	1/11	12/16/2000	9/14/2010
R-31 S3	Regional	Tritium	8/19/2019	pCi/L	FD	UF	2.03	No	0.1932 to 0.1932	1/11	12/16/2000	9/14/2010
R-31 S3	Regional	Tritium	11/19/2019	pCi/L	REG	UF	-0.210	No	0.1932 to 0.1932	1/11	12/16/2000	9/14/2010
R-31 S3	Regional	Tritium	11/19/2019	pCi/L	FD	UF	0.591	No	0.1932 to 0.1932	1/11	12/16/2000	9/14/2010
R-31 S3	Regional	Uranium	8/19/2019	µg/L	REG	F	0.222	Yes	0.1 to 0.17	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Uranium	8/19/2019	µg/L	FD	F	0.218	Yes	0.1 to 0.17	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Uranium	11/19/2019	µg/L	REG	F	0.407	Yes	0.1 to 0.17	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Uranium	11/19/2019	µg/L	FD	F	0.386	Yes	0.1 to 0.17	3/4	12/16/2000	5/21/2007
R-31 S3	Regional	Uranium-234	11/19/2019	pCi/L	REG	UF	0.281	Yes	0.1 to 0.1	1/3	12/16/2000	11/30/2006
R-31 S3	Regional	Uranium-234	11/19/2019	pCi/L	FD	UF	0.235	Yes	0.1 to 0.1	1/3	12/16/2000	11/30/2006
R-31 S3	Regional	Uranium-238	11/19/2019	pCi/L	REG	UF	0.168	Yes	0.0398 to 0.05	2/3	12/16/2000	11/30/2006
R-31 S3	Regional	Uranium-238	11/19/2019	pCi/L	FD	UF	0.0911	Yes	.0398 to 0.05	2/3	12/16/2000	11/30/2006
R-31 S3	Regional	Vanadium	8/19/2019	µg/L	REG	F	6.13	Yes	—	0/4	12/16/2000	5/21/2007

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S3	Regional	Vanadium	8/19/2019	µg/L	FD	F	6.28	Yes	—	0/4	12/16/2000	5/21/2007
R-31 S3	Regional	Vanadium	11/19/2019	µg/L	REG	F	6.01	Yes	—	0/4	12/16/2000	5/21/2007
R-31 S3	Regional	Vanadium	11/19/2019	µg/L	FD	F	6.01	Yes	—	0/4	12/16/2000	5/21/2007
R-31 S3	Regional	Zinc	8/19/2019	µg/L	REG	F	29.3	Yes	3.2 to 6.2	2/4	12/16/2000	5/21/2007
R-31 S3	Regional	Zinc	8/19/2019	µg/L	FD	F	29.4	Yes	3.2 to 6.2	2/4	12/16/2000	5/21/2007
R-31 S3	Regional	Zinc	11/19/2019	µg/L	REG	F	5.9	Yes	3.2 to 6.2	2/4	12/16/2000	5/21/2007
R-31 S3	Regional	Zinc	11/19/2019	µg/L	FD	F	5	Yes	3.2 to 6.2	2/4	12/16/2000	5/21/2007
R-31 S4	Regional	Acetone	12/5/2019	µg/L	REG	UF	1.94	No	1.3 to 9.8	3/12	12/14/2000	3/9/2016
R-31 S4	Regional	Acetone	12/5/2019	µg/L	FD	UF	1.5	No	1.3 to 9.8	3/12	12/14/2000	3/9/2016
R-31 S4	Regional	Alkalinity-CO_3+HCO_3	12/5/2019	mg/L	REG	F	56	Yes	25.5 to 63.1	15/15	9/27/2001	3/9/2016
R-31 S4	Regional	Alkalinity-CO_3+HCO_3	12/5/2019	mg/L	FD	F	54.8	Yes	25.5 to 63.1	15/15	9/27/2001	3/9/2016
R-31 S4	Regional	Ammonia as nitrogen	12/5/2019	mg/L	FD	F	0.0439	Yes	0.105 to 0.105	1/14	8/23/2005	3/9/2016
R-31 S4	Regional	Arsenic	12/5/2019	µg/L	REG	F	2.51	Yes	1.74 to 2.9	3/16	12/14/2000	3/9/2016
R-31 S4	Regional	Arsenic	12/5/2019	µg/L	FD	F	2.23	Yes	1.74 to 2.9	3/16	12/14/2000	3/9/2016
R-31 S4	Regional	Barium	12/5/2019	µg/L	REG	F	31	Yes	11.1 to 40.1	15/16	12/14/2000	3/9/2016
R-31 S4	Regional	Barium	12/5/2019	µg/L	FD	F	30.6	Yes	11.1 to 40.1	15/16	12/14/2000	3/9/2016
R-31 S4	Regional	Benzene	12/5/2019	µg/L	REG	UF	0.3	No	0.23 to 0.23	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Benzene	12/5/2019	µg/L	FD	UF	0.3	No	0.23 to 0.23	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Bis(2-ethylhexyl)phthalate	12/5/2019	µg/L	REG	UF	0.33	Yes	2.57 to 2.57	1/7	9/27/2001	3/9/2016
R-31 S4	Regional	Bis(2-ethylhexyl)phthalate	12/5/2019	µg/L	FD	UF	0.318	No	2.57 to 2.57	1/7	9/27/2001	3/9/2016
R-31 S4	Regional	Boron	12/5/2019	µg/L	REG	F	15	No	12.6 to 175	8/16	12/14/2000	3/9/2016
R-31 S4	Regional	Boron	12/5/2019	µg/L	FD	F	15	No	12.6 to 175	8/16	12/14/2000	3/9/2016
R-31 S4	Regional	Bromide	12/5/2019	mg/L	REG	F	0.067	No	0.0781 to 0.0781	1/16	12/14/2000	3/9/2016
R-31 S4	Regional	Bromide	12/5/2019	mg/L	FD	F	0.067	No	0.0781 to 0.0781	1/16	12/14/2000	3/9/2016
R-31 S4	Regional	Calcium	12/5/2019	mg/L	REG	F	8.17	Yes	7.91 to 13	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Calcium	12/5/2019	mg/L	FD	F	8.3	Yes	7.91 to 13	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Carbon disulfide	12/5/2019	µg/L	REG	UF	1.5	No	1.2 to 1.2	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Carbon disulfide	12/5/2019	µg/L	FD	UF	1.5	No	1.2 to 1.2	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Chloride	12/5/2019	mg/L	REG	F	1.5	Yes	1.21 to 2.5	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Chloride	12/5/2019	mg/L	FD	F	1.51	Yes	1.21 to 2.5	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Chloromethane	12/5/2019	µg/L	REG	UF	0.3	No	2 to 2	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Chloromethane	12/5/2019	µg/L	FD	UF	0.3	No	2 to 2	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Chromium	12/5/2019	µg/L	REG	F	5.89	Yes	1.9 to 5.88	12/16	12/14/2000	3/9/2016
R-31 S4	Regional	Chromium	12/5/2019	µg/L	FD	F	5.6	Yes	1.9 to 5.88	12/16	12/14/2000	3/9/2016
R-31 S4	Regional	Copper	12/5/2019	µg/L	REG	F	3	No	8.4 to 8.4	1/12	12/14/2000	9/20/2010
R-31 S4	Regional	Copper	12/5/2019	µg/L	FD	F	3	No	8.4 to 8.4	1/12	12/14/2000	9/20/2010

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S4	Regional	Cyanide (total)	12/5/2019	mg/L	REG	UF	0.00167	No	0.00175 to 0.00175	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Cyanide (total)	12/5/2019	mg/L	FD	UF	0.00167	No	0.00175 to 0.00175	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Dichloroethane[1,1-]	12/5/2019	µg/L	REG	UF	0.3	No	0.82 to 0.82	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Dichloroethane[1,1-]	12/5/2019	µg/L	FD	UF	0.3	No	—	—	—	—
R-31 S4	Regional	Fluoride	12/5/2019	mg/L	REG	F	0.361	Yes	0.1 to 0.404	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Fluoride	12/5/2019	mg/L	FD	F	0.36	Yes	0.1 to 0.404	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Gross alpha	12/5/2019	pCi/L	REG	UF	2.96	Yes	—	0/11	9/27/2001	3/9/2016
R-31 S4	Regional	Gross alpha	12/5/2019	pCi/L	FD	UF	1.89	No	—	0/11	9/27/2001	3/9/2016
R-31 S4	Regional	Gross beta	12/5/2019	pCi/L	REG	UF	2.64	Yes	1.09 to 5.95	9/11	9/27/2001	3/9/2016
R-31 S4	Regional	Gross beta	12/5/2019	pCi/L	FD	UF	4.43	Yes	1.09 to 5.95	9/11	9/27/2001	3/9/2016
R-31 S4	Regional	Gross gamma	—	—	—	UF	—	—	39.7 to 70.6	2/8	9/27/2001	9/20/2010
R-31 S4	Regional	Hardness	12/5/2019	mg/L	REG	F	30.1	Yes	29.8 to 41	14/14	8/23/2005	3/9/2016
R-31 S4	Regional	Hardness	12/5/2019	mg/L	FD	F	30.6	Yes	29.8 to 41	14/14	8/23/2005	3/9/2016
R-31 S4	Regional	Iron	12/5/2019	µg/L	REG	F	35.8	Yes	19.3 to 77.5	3/16	12/14/2000	3/9/2016
R-31 S4	Regional	Iron	12/5/2019	µg/L	FD	F	30	No	19.3 to 77.5	3/16	12/14/2000	3/9/2016
R-31 S4	Regional	Lead-214	12/5/2019	pCi/L	REG	UF	90.3	Yes	—	0/1	12/14/2000	12/14/2000
R-31 S4	Regional	Lead-214	12/5/2019	pCi/L	FD	UF	84.4	Yes	—	0/1	12/14/2000	12/14/2000
R-31 S4	Regional	Magnesium	12/5/2019	mg/L	REG	F	2.37	Yes	0.63 to 2.57	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Magnesium	12/5/2019	mg/L	FD	F	2.4	Yes	0.63 to 2.57	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Manganese	12/5/2019	µg/L	REG	F	2	No	15 to 20	2/16	12/14/2000	3/9/2016
R-31 S4	Regional	Manganese	12/5/2019	µg/L	FD	F	2	No	15 to 20	2/16	12/14/2000	3/9/2016
R-31 S4	Regional	Mercury	12/5/2019	µg/L	FD	F	0.084	Yes	—	0/16	12/14/2000	3/9/2016
R-31 S4	Regional	Mercury	12/5/2019	µg/L	REG	F	0.067	No	—	0/16	12/14/2000	3/9/2016
R-31 S4	Regional	MNX[g]	—	—	—	—	—	—	0.41 to 0.41	1/9	12/6/2006	2/1/2012
R-31 S4	Regional	Molybdenum	12/5/2019	µg/L	REG	F	1.18	Yes	1.14 to 2.72	11/16	12/14/2000	3/9/2016
R-31 S4	Regional	Molybdenum	12/5/2019	µg/L	FD	F	1.18	Yes	1.14 to 2.72	11/16	12/14/2000	3/9/2016
R-31 S4	Regional	Nickel	12/5/2019	µg/L	REG	F	0.706	Yes	0.509 to 1.3	5/16	12/14/2000	3/9/2016
R-31 S4	Regional	Nickel	12/5/2019	µg/L	FD	F	0.6	No	0.509 to 1.3	5/16	12/14/2000	3/9/2016
R-31 S4	Regional	Nitrate-nitrite as nitrogen	12/5/2019	mg/L	FD	F	0.299	Yes	0.182 to 0.56	12/16	12/14/2000	3/9/2016
R-31 S4	Regional	Perchlorate	12/5/2019	µg/L	REG	F	0.232	Yes	0.219 to 0.249	13/18	9/27/2001	3/9/2016
R-31 S4	Regional	Perchlorate	12/5/2019	µg/L	FD	F	0.225	Yes	0.219 to 0.249	13/18	9/27/2001	3/9/2016
R-31 S4	Regional	Potassium	12/5/2019	mg/L	REG	F	2.94	Yes	1.34 to 3.69	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Potassium	12/5/2019	mg/L	FD	F	2.98	Yes	1.34 to 3.69	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Radium-226 and radium-228	12/5/2019	pCi/L	REG	UF	1.34	Yes	0.581 to 0.638	2/3	11/2/2007	10/21/2008
R-31 S4	Regional	Radium-226 and radium-228	12/5/2019	pCi/L	FD	UF	1.35	Yes	0.581 to 0.638	2/3	11/2/2007	10/21/2008
R-31 S4	Regional	Silicon dioxide	12/5/2019	mg/L	REG	F	79.3	Yes	67.8 to 82.7	14/14	8/23/2005	3/9/2016

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S4	Regional	Silicon dioxide	12/5/2019	mg/L	FD	F	79.8	Yes	67.8 to 82.7	14/14	8/23/2005	3/9/2016
R-31 S4	Regional	Sodium	12/5/2019	mg/L	REG	F	11.6	Yes	6.03 to 17	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Sodium	12/5/2019	mg/L	FD	F	11.7	Yes	6.03 to 17	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Specific conductance	12/5/2019	µS/cm	REG	F	101	Yes	109 to 135	14/14	8/23/2005	3/9/2016
R-31 S4	Regional	Specific conductance	12/5/2019	µS/cm	FD	F	100	Yes	109 to 135	14/14	8/23/2005	3/9/2016
R-31 S4	Regional	Strontium	12/5/2019	µg/L	REG	F	40.6	Yes	43.3 to 61.9	15/16	12/14/2000	3/9/2016
R-31 S4	Regional	Strontium	12/5/2019	µg/L	FD	F	41	Yes	43.3 to 61.9	15/16	12/14/2000	3/9/2016
R-31 S4	Regional	Strontium-90	12/5/2019	pCi/L	REG	UF	0.113	No	—	0/12	12/14/2000	3/9/2016
R-31 S4	Regional	Strontium-90	12/5/2019	pCi/L	FD	UF	-0.0491	No	—	0/12	12/14/2000	3/9/2016
R-31 S4	Regional	Sulfate	12/5/2019	mg/L	REG	F	1.37	Yes	1.28 to 7.7	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Sulfate	12/5/2019	mg/L	FD	F	1.37	Yes	1.28 to 7.7	16/16	12/14/2000	3/9/2016
R-31 S4	Regional	Thallium	12/5/2019	µg/L	REG	F	0.6	No	0.57 to 0.57	1/18	12/14/2000	3/9/2016
R-31 S4	Regional	Thallium	12/5/2019	µg/L	FD	F	0.6	No	0.57 to 0.57	1/18	12/14/2000	3/9/2016
R-31 S4	Regional	Thorium-234	12/5/2019	pCi/L	REG	UF	136	No	65 to 65	1/1	12/14/2000	12/14/2000
R-31 S4	Regional	Thorium-234	12/5/2019	pCi/L	FD	UF	126	No	65 to 65	1/1	12/14/2000	12/14/2000
R-31 S4	Regional	Tin	12/5/2019	µg/L	REG	F	2.5	No	5.71 to 5.71	1/14	8/23/2005	3/9/2016
R-31 S4	Regional	Tin	12/5/2019	µg/L	FD	F	2.5	No	5.71 to 5.71	1/14	8/23/2005	3/9/2016
R-31 S4	Regional	Toluene	12/5/2019	µg/L	REG	UF	1.08	Yes	1.3 to 1.3	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Toluene	12/5/2019	µg/L	FD	UF	1.1	Yes	1.3 to 1.3	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Total dissolved solids	12/5/2019	mg/L	REG	F	124	Yes	100 to 167	16/16	8/23/2005	3/9/2016
R-31 S4	Regional	Total dissolved solids	12/5/2019	mg/L	FD	F	169	Yes	100 to 167	16/16	8/23/2005	3/9/2016
R-31 S4	Regional	Total Kjeldahl nitrogen	12/5/2019	mg/L	REG	UF	0.0865	No	0.048 to 0.272	5/6	9/27/2001	11/2/2007
R-31 S4	Regional	Total Kjeldahl nitrogen	12/5/2019	mg/L	FD	UF	0.109	No	0.048 to 0.272	5/6	9/27/2001	11/2/2007
R-31 S4	Regional	Total Organic Carbon	12/5/2019	mg/L	REG	UF	0.33	No	0.39 to 1.82	7/14	9/27/2001	3/9/2016
R-31 S4	Regional	Total organic carbon	12/5/2019	mg/L	FD	UF	0.33	No	0.39 to 1.82	7/14	9/27/2001	3/9/2016
R-31 S4	Regional	Total phosphate as phosphorus	12/5/2019	mg/L	FD	F	0.02	No	0.034 to 0.167	9/15	9/27/2001	3/9/2016
R-31 S4	Regional	Trichlorobenzene[1,2,4-]	12/5/2019	µg/L	REG	UF	0.3	No	2.29 to 2.29	1/18	12/14/2000	3/9/2016
R-31 S4	Regional	Trichlorobenzene[1,2,4-]	12/5/2019	µg/L	REG	UF	3	No	2.29 to 2.29	1/18	12/14/2000	3/9/2016
R-31 S4	Regional	Trichlorobenzene[1,2,4-]	12/5/2019	µg/L	FD	UF	0.3	No	2.29 to 2.29	1/18	12/14/2000	3/9/2016
R-31 S4	Regional	Trichlorobenzene[1,2,4-]	12/5/2019	µg/L	FD	UF	3.18	No	2.29 to 2.29	1/18	12/14/2000	3/9/2016
R-31 S4	Regional	Tritium	12/5/2019	pCi/L	REG	UF	1.034	No	0 to 7.2128	2/12	12/14/2000	9/20/2010
R-31 S4	Regional	Tritium	12/5/2019	pCi/L	FD	UF	0.520	No	0 to 7.2128	2/12	12/14/2000	9/20/2010
R-31 S4	Regional	Uranium	12/5/2019	µg/L	REG	F	0.238	Yes	0.21 to 0.266	12/16	12/14/2000	3/9/2016
R-31 S4	Regional	Uranium	12/5/2019	µg/L	FD	F	0.242	Yes	0.21 to 0.266	12/16	12/14/2000	3/9/2016
R-31 S4	Regional	Uranium-234	12/5/2019	pCi/L	REG	UF	0.227	Yes	0.103 to 0.185	11/12	12/14/2000	3/9/2016
R-31 S4	Regional	Uranium-234	12/5/2019	pCi/L	FD	UF	0.159	Yes	0.103 to 0.185	11/12	12/14/2000	3/9/2016

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S4	Regional	Uranium-238	12/5/2019	pCi/L	REG	UF	0.139	Yes	0.0673 to 0.117	11/12	12/14/2000	3/9/2016
R-31 S4	Regional	Uranium-238	12/5/2019	pCi/L	FD	UF	0.104	No	0.0673 to 0.117	11/12	12/14/2000	3/9/2016
R-31 S4	Regional	Vanadium	12/5/2019	µg/L	REG	F	6.36	Yes	5.45 to 8.7	14/16	12/14/2000	3/9/2016
R-31 S4	Regional	Vanadium	12/5/2019	µg/L	FD	F	6.61	Yes	5.45 to 8.7	14/16	12/14/2000	3/9/2016
R-31 S4	Regional	Xylene[1,2-]	12/5/2019	µg/L	REG	UF	0.3	No	0.14 to 0.14	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Xylene[1,2-]	12/5/2019	µg/L	FD	UF	0.3	No	0.14 to 0.14	1/12	12/14/2000	3/9/2016
R-31 S4	Regional	Zinc	12/5/2019	µg/L	REG	F	6.71	Yes	2.8 to 241	10/16	12/14/2000	3/9/2016
R-31 S4	Regional	Zinc	12/5/2019	µg/L	FD	F	3.3	No	2.8 to 241	10/16	12/14/2000	3/9/2016
R-31 S5	Regional	Acetone	11/9/2019	µg/L	REG	UF	7.25	No	1.9 to 11.6	2/8	12/15/2000	3/10/2016
R-31 S5	Regional	Acetone	11/9/2019	µg/L	FD	UF	4.6	No	—	—	—	—
R-31 S5	Regional	Alkalinity-CO_3	11/9/2019	mg/L	REG	F	1.45	No	0.782 to 4.08	8/10	8/24/2005	3/10/2016
R-31 S5	Regional	Alkalinity-CO_3	11/9/2019	mg/L	FD	F	1.45	No	—	—	—	—
R-31 S5	Regional	Alkalinity-CO_3+HCO_3	11/9/2019	mg/L	REG	F	52.9	Yes	20.4 to 79	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Alkalinity-CO_3+HCO_3	11/9/2019	mg/L	FD	F	52.3	Yes	—	—	—	—
R-31 S5	Regional	Amino-4,6-dinitrotoluene[2-]	11/9/2019	µg/L	REG	UF	0.08	No	0.7 to 0.7	1/10	12/15/2000	3/18/2015
R-31 S5	Regional	Amino-4,6-dinitrotoluene[2-]	11/9/2019	µg/L	FD	UF	0.0808	No	—	—	—	—
R-31 S5	Regional	Ammonia as nitrogen	11/9/2019	mg/L	REG	F	0.095	No	0.118 to 0.118	1/10	8/24/2005	3/10/2016
R-31 S5	Regional	Ammonia as nitrogen	11/9/2019	mg/L	FD	F	0.0249	No	—	—	—	—
R-31 S5	Regional	Arsenic	11/9/2019	µg/L	REG	F	2.46	Yes	1.77 to 3.01	4/12	12/15/2000	3/10/2016
R-31 S5	Regional	Arsenic	11/9/2019	µg/L	FD	F	2.37	Yes	—	—	—	—
R-31 S5	Regional	Barium	11/9/2019	µg/L	REG	F	28.9	Yes	11.4 to 32.3	11/12	12/15/2000	3/10/2016
R-31 S5	Regional	Barium	11/9/2019	µg/L	FD	F	27.5	Yes	—	—	—	—
R-31 S5	Regional	Benzene	11/9/2019	µg/L	REG	UF	0.3	No	0.2 to 0.2	1/8	12/15/2000	3/10/2016
R-31 S5	Regional	Benzene	11/9/2019	µg/L	FD	UF	0.3	No	—	—	—	—
R-31 S5	Regional	Boron	11/9/2019	µg/L	REG	F	15	No	14.1 to 221	5/12	12/15/2000	3/10/2016
R-31 S5	Regional	Boron	11/9/2019	µg/L	FD	F	15	No	—	—	—	—
R-31 S5	Regional	Bromide	11/9/2019	mg/L	REG	F	0.067	No	0.0729 to 0.0729	1/12	12/15/2000	3/10/2016
R-31 S5	Regional	Bromide	11/9/2019	mg/L	FD	F	0.067	No	—	—	—	—
R-31 S5	Regional	Calcium	11/9/2019	mg/L	REG	F	8.31	Yes	6.88 to 13	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Calcium	11/9/2019	mg/L	FD	F	7.81	Yes	—	—	—	—
R-31 S5	Regional	Carbon disulfide	11/9/2019	µg/L	REG	UF	1.5	No	2.8 to 2.8	1/8	12/15/2000	3/10/2016
R-31 S5	Regional	Carbon disulfide	11/9/2019	µg/L	FD	UF	1.5	No	—	—	—	—
R-31 S5	Regional	Chloride	11/9/2019	mg/L	REG	F	1.47	Yes	1.16 to 1.7	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Chloride	11/9/2019	mg/L	FD	F	1.46	Yes	—	—	—	—
R-31 S5	Regional	Chloromethane	11/9/2019	µg/L	REG	UF	0.3	No	1.3 to 1.3	1/8	12/15/2000	3/10/2016
R-31 S5	Regional	Chloromethane	11/9/2019	µg/L	FD	UF	0.3	No	—	—	—	—

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S5	Regional	Chromium	11/9/2019	µg/L	REG	F	4.23	Yes	1.7 to 4.91	10/12	12/15/2000	3/10/2016
R-31 S5	Regional	Chromium	11/9/2019	µg/L	FD	F	3.9	Yes	—	—	—	—
R-31 S5	Regional	Copper	11/9/2019	µg/L	REG	F	3	No	12.1 to 12.1	1/7	12/15/2000	9/9/2010
R-31 S5	Regional	Copper	11/9/2019	µg/L	FD	F	3	No	—	—	—	—
R-31 S5	Regional	Dichloroethane[1,1-]	11/9/2019	µg/L	REG	UF	0.3	No	0.58 to 0.58	1/8	12/15/2000	3/10/2016
R-31 S5	Regional	Dichloroethane[1,1-]	11/9/2019	µg/L	FD	UF	0.3	No	—	—	—	—
R-31 S5	Regional	Fluoride	11/9/2019	mg/L	REG	F	0.417	Yes	0.11 to 0.369	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Fluoride	11/9/2019	mg/L	FD	F	0.421	Yes	—	—	—	—
R-31 S5	Regional	Gross beta	11/9/2019	pCi/L	REG	UF	5.66	Yes	1.24 to 4.64	5/9	9/28/2001	3/10/2016
R-31 S5	Regional	Gross beta	11/9/2019	pCi/L	FD	UF	1.32	No	—	—	—	—
R-31 S5	Regional	Hardness	11/9/2019	mg/L	REG	F	32.1	Yes	29.8 to 34	10/10	8/24/2005	3/10/2016
R-31 S5	Regional	Hardness	11/9/2019	mg/L	FD	F	30.1	Yes	—	—	—	—
R-31 S5	Regional	Lead-214	11/9/2019	pCi/L	REG	UF	16.4	Yes	—	0/1	12/15/2000	12/15/2000
R-31 S5	Regional	Lead-214	11/9/2019	pCi/L	FD	UF	23.8	Yes	—	—	—	—
R-31 S5	Regional	Iron	11/9/2019	µg/L	REG	F	30	No	18.6 to 76	2/12	12/15/2000	3/10/2016
R-31 S5	Regional	Iron	11/9/2019	µg/L	FD	F	30	No	—	—	—	—
R-31 S5	Regional	Magnesium	11/9/2019	mg/L	REG	F	2.74	Yes	0.56 to 3.2	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Magnesium	11/9/2019	mg/L	FD	F	2.56	Yes	—	—	—	—
R-31 S5	Regional	Manganese	11/9/2019	µg/L	REG	F	2	No	2.27 to 27.1	3/12	12/15/2000	3/10/2016
R-31 S5	Regional	Manganese	11/9/2019	µg/L	FD	F	2	No	—	—	—	—
R-31 S5	Regional	Molybdenum	11/9/2019	µg/L	REG	F	1.09	Yes	0.54 to 4	10/12	12/15/2000	3/10/2016
R-31 S5	Regional	Molybdenum	11/9/2019	µg/L	FD	F	1.17	Yes	—	—	—	—
R-31 S5	Regional	Nickel	11/9/2019	µg/L	REG	F	0.729	Yes	0.62 to 0.775	6/12	12/15/2000	3/10/2016
R-31 S5	Regional	Nickel	11/9/2019	µg/L	FD	F	0.757	Yes	—	—	—	—
R-31 S5	Regional	Nitrate-nitrite as nitrogen	11/9/2019	mg/L	REG	F	0.334	Yes	0.158 to 0.339	10/12	12/15/2000	3/10/2016
R-31 S5	Regional	Nitrate-nitrite as nitrogen	11/9/2019	mg/L	FD	F	0.331	Yes	—	—	—	—
R-31 S5	Regional	Perchlorate	11/9/2019	µg/L	REG	F	0.238	Yes	0.197 to 0.257	8/12	9/28/2001	3/10/2016
R-31 S5	Regional	Perchlorate	11/9/2019	µg/L	FD	F	0.245	Yes	—	—	—	—
R-31 S5	Regional	Potassium	11/9/2019	mg/L	REG	F	2.91	Yes	0.568 to 3.1	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Potassium	11/9/2019	mg/L	FD	F	2.71	Yes	—	—	—	—
R-31 S5	Regional	Potassium-40	11/9/2019	pCi/L	REG	UF	37.2	No	118 to 118	1/5	12/15/2000	10/22/2008
R-31 S5	Regional	Potassium-40	11/9/2019	pCi/L	FD	UF	10.1	No	—	—	—	—
R-31 S5	Regional	Radium-226	11/9/2019	pCi/L	REG	UF	0.534	Yes	—	0/1	12/15/2000	12/15/2000
R-31 S5	Regional	Radium-226	11/9/2019	pCi/L	FD	UF	0.793	Yes	—	—	—	—
R-31 S5	Regional	Radium-226 and radium-228	11/9/2019	pCi/L	REG	UF	0.615	Yes	—	—	—	—
R-31 S5	Regional	Radium-226 and radium-228	11/9/2019	pCi/L	FD	UF	1.2	Yes	—	—	—	—

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S5	Regional	Silicon dioxide	11/9/2019	mg/L	REG	F	87.8	Yes	71.9 to 88.5	10/10	8/24/2005	3/10/2016
R-31 S5	Regional	Silicon dioxide	11/9/2019	mg/L	FD	F	82.5	Yes	—	—	—	—
R-31 S5	Regional	Sodium	11/9/2019	mg/L	REG	F	12.3	Yes	2.66 to 12	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Sodium	11/9/2019	mg/L	FD	F	11.4	Yes	—	—	—	—
R-31 S5	Regional	Specific conductance	11/9/2019	µS/cm	REG	F	95.4	Yes	105 to 120	10/10	8/24/2005	3/10/2016
R-31 S5	Regional	Specific conductance	11/9/2019	µS/cm	FD	F	93.8	Yes	—	—	—	—
R-31 S5	Regional	Strontium	11/9/2019	µg/L	REG	F	45.6	Yes	42.5 to 60	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Strontium	11/9/2019	µg/L	FD	F	42	Yes	—	—	—	—
R-31 S5	Regional	Sulfate	11/9/2019	mg/L	REG	F	1.33	Yes	0.94 to 1.41	12/12	12/15/2000	3/10/2016
R-31 S5	Regional	Sulfate	11/9/2019	mg/L	FD	F	1.31	Yes	—	—	—	—
R-31 S5	Regional	Thallium	11/9/2019	µg/L	REG	F	0.6	No	0.81 to 0.81	2/15	12/15/2000	3/10/2016
R-31 S5	Regional	Thallium	11/9/2019	µg/L	FD	F	0.6	No	—	—	—	—
R-31 S5	Regional	Thorium-234	11/9/2019	pCi/L	REG	UF	-99.7	No	86 to 86	1/2	12/15/2000	9/28/2001
R-31 S5	Regional	Thorium-234	11/9/2019	pCi/L	FD	UF	140	No	—	—	—	—
R-31 S5	Regional	Tin	11/9/2019	µg/L	REG	F	2.5	No	6.99 to 6.99	1/10	8/24/2005	3/10/2016
R-31 S5	Regional	Tin	11/9/2019	µg/L	FD	F	2.5	No	—	—	—	—
R-31 S5	Regional	Toluene	11/9/2019	µg/L	REG	UF	12.3	No	1.9 to 1.9	1/8	12/15/2000	3/10/2016
R-31 S5	Regional	Toluene	11/9/2019	µg/L	FD	UF	0.3	No	—	—	—	—
R-31 S5	Regional	Total dissolved solids	11/9/2019	mg/L	REG	F	141	Yes	101 to 160	11/11	8/24/2005	3/10/2016
R-31 S5	Regional	Total dissolved solids	11/9/2019	mg/L	FD	F	154	Yes	—	—	—	—
R-31 S5	Regional	Total Kjeldahl Nitrogen	11/9/2019	mg/L	REG	UF	0.0566	No	0.12 to 0.136	2/3	9/28/2001	12/6/2006
R-31 S5	Regional	Total Kjeldahl Nitrogen	11/9/2019	mg/L	FD	UF	0.0347	No	—	—	—	—
R-31 S5	Regional	Total organic carbon	11/9/2019	mg/L	REG	UF	0.33	No	0.331 to 2.27	4/9	9/28/2001	3/10/2016
R-31 S5	Regional	Total organic carbon	11/9/2019	mg/L	FD	UF	0.33	No	—	—	—	—
R-31 S5	Regional	Total phosphate as phosphorus	11/9/2019	mg/L	REG	F	0.041	No	0.0365 to 0.0761	6/11	9/28/2001	3/10/2016
R-31 S5	Regional	Total phosphate as phosphorus	11/9/2019	mg/L	FD	F	0.0416	No	—	—	—	—
R-31 S5	Regional	Tritium	11/9/2019	pCi/L	REG	UF	0.867	No	0.4508 to 6.3112	2/7	12/15/2000	9/9/2010
R-31 S5	Regional	Tritium	11/9/2019	pCi/L	FD	UF	1.614	No	—	—	—	—
R-31 S5	Regional	Uranium	11/9/2019	µg/L	REG	F	0.139	Yes	0.091 to 0.135	7/12	12/15/2000	3/10/2016
R-31 S5	Regional	Uranium	11/9/2019	µg/L	FD	F	0.127	Yes	—	—	—	—
R-31 S5	Regional	Uranium-234	11/9/2019	pCi/L	REG	UF	0.0951	Yes	0.08 to 0.115	4/5	12/15/2000	10/22/2008
R-31 S5	Regional	Uranium-234	11/9/2019	pCi/L	FD	UF	0.0697	Yes	—	—	—	—
R-31 S5	Regional	Uranium-238	11/9/2019	pCi/L	REG	UF	0.0246	No	0.051 to 0.0558	2/5	12/15/2000	10/22/2008
R-31 S5	Regional	Uranium-238	11/9/2019	pCi/L	FD	UF	0.0521	No	—	—	—	—

Table 5.0-1 (continued)

Sample Parameter			Recent Results						Historical Results			
Location ID	Hydrostratigraphic Unit	Parameter Name	Sample Date	Report Unit	Sample Purpose	Field Preparation Code	Report Result	Detected?	Detection Range (Min-Max)	Detections (Frequency)	First Sample Date	Last Sample Date
R-31 S5	Regional	Vanadium	11/9/2019	µg/L	REG	F	7.33	Yes	4.7 to 7.17	10/12	12/15/2000	3/10/2016
R-31 S5	Regional	Vanadium	11/9/2019	µg/L	FD	F	6.95	Yes	—	—	—	—
R-31 S5	Regional	Zinc	11/9/2019	µg/L	REG	F	4.51	No	3.43 to 1730	10/12	12/15/2000	3/10/2016
R-31 S5	Regional	Zinc	11/9/2019	µg/L	FD	F	7.59	No	—	—	—	—

[a] S = Screen.
[b] REG = Regular sample.
[c] UF = Unfiltered.
[d] FD = Field duplicate.
[e] F = Filtered.
[f] — = Not applicable.
[g] MNX = hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine.

Appendix A

Initial Pumping Test and Jetting Analysis for Well R-31

A-1.0 INTRODUCTION

This appendix describes the initial step-test pumping performed at regional groundwater well R-31 in August and November 2019. The initial pump tests were conducted after the removal of the Westbay MP55 sampling system from this well, followed by swabbing and bailing, as approved by the New Mexico Environment Department (NMED). Little information existed on the hydraulic properties of the screened intervals within well R-31 before the initial installation of the Westbay MP55 sampling system. The step-testing consisted of brief trial pumping and background water-level data collection. The data thus acquired during these step-tests supported other activities associated with the reconfiguration of the well, including supporting the jetting of the screens and the subsequent aquifer tests.

As in most of the R-well pumping tests conducted on the Pajarito Plateau, an inflatable packer system was used to isolate each screened interval for step-testing. The double packer system isolated each pumped zone and was intended to eliminate casing storage effects on the test data so that early drawdown and recovery data could be used in the analysis.

Following swabbing, bailing, and the initial testing of screens, the wells were developed further by simultaneous high-velocity jetting and pumping. A 10-horsepower (hp) submersible pump with a jetting tool configured above the pump was rotated and passed through the screened zone to loosen and remove sediment around the well.

A-2.0 R-31 PUMP TESTING

Following swabbing and bailing activities, initial test pumping was performed on R-31 screens 2, 3, 4, and 5. Little was known about the yield potential of the screens, so brief testing was required to achieve several objectives:

- Support jetting tool design for subsequent jet development
- Guide selection of discharge rate for final aquifer testing
- Provide baseline production performance to support evaluation of the efficacy of the jetting procedures planned for screen 2
- Support selection of the size of the permanent pump

A-2.1 Initial Test Pumping of Screen 2

The screen 2 interval in R-31 extends from 515.0 to 545.7 ft below ground surface (bgs) and straddles the regional water table within the Cerros del Rio basalt. The static water level measured on August 17 was 535.66 ft bgs. However, the water level continued dropping throughout the available monitoring period and equilibration had not been achieved when testing began. Thus, the actual static water level was deeper than the measured result.

The observed screen 2 water level was 4.0 ft higher than that of screen 3, described below. However, during the last month of available water-level records from R-31 (December 2018), transducer data showed the screen 2 level to range from 1.42 to 1.60 ft higher than that of screen 3, averaging 1.50 ft higher from December 1, 2018, to January 1, 2019. It was likely that when the well stood open, the screen 2 interval was “flooded” with water from the deeper screens, primarily screen 5, raising the water level in screen 2 temporarily above its true static level. (Note that the composite water level in R-31 was approximately 530 ft bgs.) This raised water level was slow to subside, apparently because of the tightness of the screen 2 zone.

Of significance is that on November 20, 2019, the screen 2 static water level was determined to be 537.21 ft bgs, 1.55 ft lower than observed in August 2019. This is likely a more realistic estimate of the true water level as it was measured (1) after several days of equilibration and (2) after screen 5 (largely responsible for “flooding” screen 2 previously) was abandoned by cementing.

Testing showed that screen 2 could not support continuous pumping with a conventional submersible pump. After brief operation, the water level dropped to the pump intake and the pump cavitated and had to be shut down. It was necessary to cycle the pump briefly after an extended shutdown period and monitor the casing refill rate in order to determine the effective pumping rate. Figure A-2.1-1 shows the refill response observed during the period from 90 to 120 min after inflow began. Based on the rate of water-level rise and the annular volume between the well casing and drop pipe, the flow rate was determined to be just 0.0434 gallons per minute (gpm), or 2.60 gallons per hour (gph). Subsequent longer testing showed that the rate declined steadily, dropping in half after several hours of pumping. Thus, the long-term yield of screen 2 was estimated to be approximately 1.3 gph.

A-2.2 Initial Test Pumping of Screen 3

The screen 3 interval in R-31 extends from 666.3 to 676.3 ft bgs within the Cerros del Rio basalt. The static water level measured from August 18 to 19, 2019, was 539.69 ft bgs. During subsequent testing in November 2019, the observed static water level was 538.51 ft bgs.

With little yield information available from the screen 3 zone, a step-drawdown test was selected for initial evaluation of pumping response. Screen 3 was tested at multiple discharge rates for 110 min, from 3:30 p.m. to 5:20 p.m. on August 16, 2019. Figure A-2.2-1 shows the drawdown response observed for four different pumping rates ranging from 4.58 to 10.05 gpm.

Table A-2.2-1 lists the pumping rates and observed drawdown values from the R-31 screen 3 step-drawdown test along with the computed specific capacity (gpm per foot of drawdown) at each pumping rate.

Figure A-2.2-2 shows a plot of specific capacity versus discharge rate for the values listed in Table A-2.2-1. The specific capacity declined slightly at increasing discharge rate, indicating a minor turbulent flow component.

A-2.3 Initial Test Pumping of Screen 4

The screen 4 interval in R-31 extends from 826.6 to 836.6 ft bgs within Totavi sediments. The static water level measured in November 2019 was 534.4 ft bgs.

With no yield information available from the screen 4 zone, a step-drawdown test was selected for initial evaluation of pumping response. Screen 4 was tested at multiple discharge rates for 120 min, from 9:30 a.m. to 11:30 a.m. on November 10, 2019. Figure A-2.3-1 shows the drawdown response observed for three different pumping rates ranging from 5.14 to 10.6 gpm.

Table A-2.3-1 lists the pumping rates and observed drawdown values from the R-31 screen 4 step-drawdown test along with the computed specific capacity (gpm per foot of drawdown) at each pumping rate.

Figure A-2.3-2 shows a plot of specific capacity versus discharge rate for the values listed in Table A-2.3-1. The specific capacity remained fairly constant at all pumping rates, suggesting largely laminar flow conditions.

A-2.4 Initial Test Pumping of Screen 5

The screen 5 interval in R-31 extends from 1007.1 to 1017.1 ft bgs within Totavi sediments. The static water level measured in November 2019 was 534.4 ft bgs.

Screen 5 was tested (and sampled) at the maximum discharge rate of the 3-hp test pump for 105 min from 3:30 p.m. to 5:15 p.m. on November 9, 2019. The inline flow meter failed during testing, so the discharge rate was estimated initially using the “bucket and stopwatch” measurement method. Subsequent analysis incorporating data from the pump performance curve and the responses observed during other tests showed that the discharge rate from screen 5 was approximately 11 gpm during the test. Figure A-2.4-1 shows the drawdown observed during pumping.

Screen 5 produced 11 gpm with 6.2 ft of drawdown for a specific capacity of 1.77 gpm/ft. This amounted to 77 percent of the total capacity of all of the combined screens in R-31.

A-3.0 R-31 JETTING OF SCREENS 2, 3, AND 4

Following swabbing and bailing and the initial testing of R-31 screens 2, 3, and 4, the well was developed further by simultaneous high-velocity jetting and pumping of screen 2. This was accomplished by running a 10-hp submersible pump through each screen section with a jetting tool above the pump. While the pump was running, the assembly was raised and lowered through the screen and periodically rotated a few degrees so that the water jets eventually covered the entire well screen surface. The method is designed to loosen sediment around the wellbore and simultaneously remove it from the well via pumping. It is an extremely powerful and effective method of development and has been used several times at Los Alamos National Laboratory with good success.

A-3.1 R-31 Jetting of Screen 2

Development of screen 2 began on the morning of August 22, 2019, and continued for more than an hour from 8:33 a.m. to 9:48 a.m. The pump used for jetting had an estimated capacity of 22 to 27 gpm at the discharge pressures applied during jetting operations. Jetting began at a pressure of approximately 350 psi, equivalent to the pumping lift. Then the pressure was increased periodically by incrementally closing the discharge valve at the surface while jetting continued. The jetting pressures achieved during the process were 450 psi, 550 psi, and 630 psi.

Following jet development, additional pumping was performed at screen 2. As before, the low yield of this zone was not sufficient to support continuous pumping with a submersible pump, so performance was determined by lowering the water level by pumping and monitoring the casing refill rate. Figure A-3.1-1 shows the refill response observed from 90 to 120 min after pumping began. For comparison, the pre-jetting response is included in the plot.

The average refill rate between 90 and 120 min was 4.98 gph. This represents a 92% increase over the initial flow rate of 2.60 gph measured before jetting, demonstrating the effectiveness of the simultaneous jetting and pumping method.

A-3.2 R-31 Jetting of Screen 3

Development of screen 3 was performed on the afternoon of November 15, 2019, continuing for 45 min from 2:44 p.m. until 3:29 p.m. The pump used for jetting had an estimated capacity of 30 gpm at the discharge pressure of 250 psi applied during jetting operations.

Following jet development, additional pumping was performed at screen 3 at a discharge rate of 6.6 gpm. Figure A-3.2-1 shows the pumping response observed over two pumping cycles lasting a total of 120 min. For comparison, the pre-jetting response is included in the plot.

The pre-development discharge rate closest to the post-development rate of 6.6 gpm was the second pumping step from the original step-drawdown test, conducted at a rate of 6.15 gpm. This step was used to establish a before-and-after performance comparison to evaluate the effectiveness of the jetting procedure.

Before jetting, R-31 screen 3 produced 6.15 gpm with 53.9 ft of drawdown, corresponding to a specific capacity of 6.15/53.9 = 0.114 gpm/ft. Following jetting, screen 3 produced 6.6 gpm with a drawdown of 34.1 ft, yielding a specific capacity of 6.6/34.1 = 0.194 gpm/ft. This corresponded to a yield increase of 70%, showing that the jet development was highly effective.

A-3.3 R-31 Jetting of Screen 4

Development of screen 4 was performed on the afternoon of November 15, 2019, continuing for 52 min from 4:09 p.m. until 5:01 p.m. The pump used for jetting had an estimated capacity of 30 gpm at the discharge pressure of 250 psi applied during jetting operations.

Following jet development, additional pumping was performed at screen 4 at a discharge rate of 10.7 gpm. Figure A-3.3-1 shows the pumping response observed from a 1-hr test. For comparison, the pre-jetting response is included in the plot.

The pre-development discharge rate closest to the post-development rate of 10.7 gpm was the first pumping step from the original step-drawdown test, conducted at a rate of 10.6 gpm. This step was used to establish a before-and-after performance comparison to evaluate the effectiveness of the jetting procedure.

Before jetting, after 40 min of pumping, R-31 screen 4 produced 10.6 gpm with 26.88 ft of drawdown, corresponding to a specific capacity of 10.6/26.88 = 0.394 gpm/ft. Following jetting, after 40 min of pumping, screen 4 produced 10.7 gpm with a drawdown of 19.02 ft, yielding a specific capacity of 10.7/19.02 = 0.563 gpm/ft. This corresponded to a yield increase of 43%, showing that the jet development was highly effective.

It is evident from Figure A-3.3-1 that during the original test on screen 4, the drawdown was continuing to increase rapidly after 40 min—a trend not accounted for in the 40-min yield calculations. A better relative yield comparison was achieved by evaluating the performance after 60 min of pumping when approximate stability was achieved during both the pre-jetting and post-jetting tests.

Before jetting, after 60 min of pumping, R-31 screen 4 produced 8.3 gpm with 22.39 ft of drawdown, corresponding to a specific capacity of 8.3/22.39 = 0.371 gpm/ft. Following jetting, after 60 min of pumping, screen 4 produced 10.7 gpm with a drawdown of 19.24 ft, yielding a specific capacity of 10.7/19.24 = 0.556 gpm/ft. This corresponded to a yield increase of 50%—a more representative measure of the yield response to jetting.

In summary, jetting produced yield increases beyond those achieved with swabbing at screens 2, 3, and 4 of 92%, 70%, and 50%, respectively.

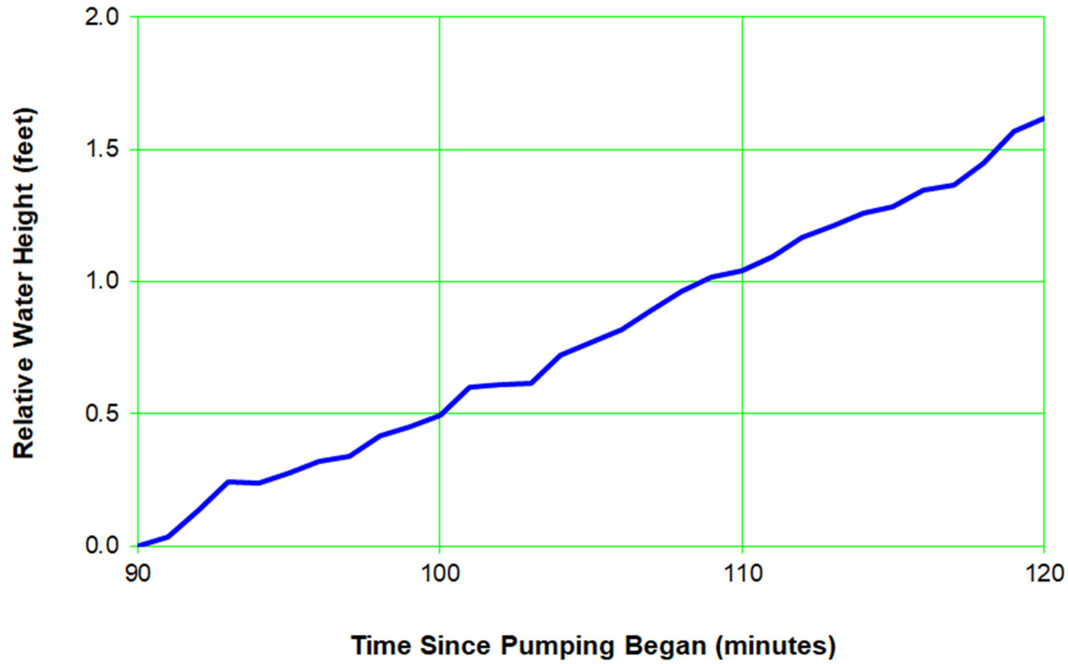


Figure A-2.1-1 Well R-31 screen 2 initial refill response

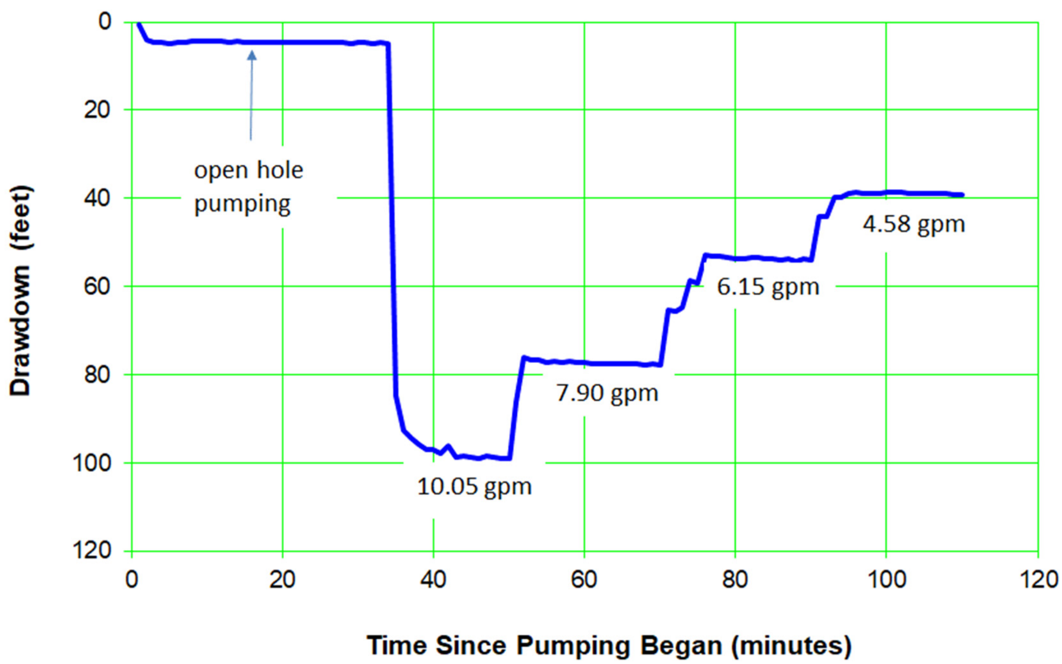


Figure A-2.2-1 Well R-31 screen 3 initial step-drawdown test response

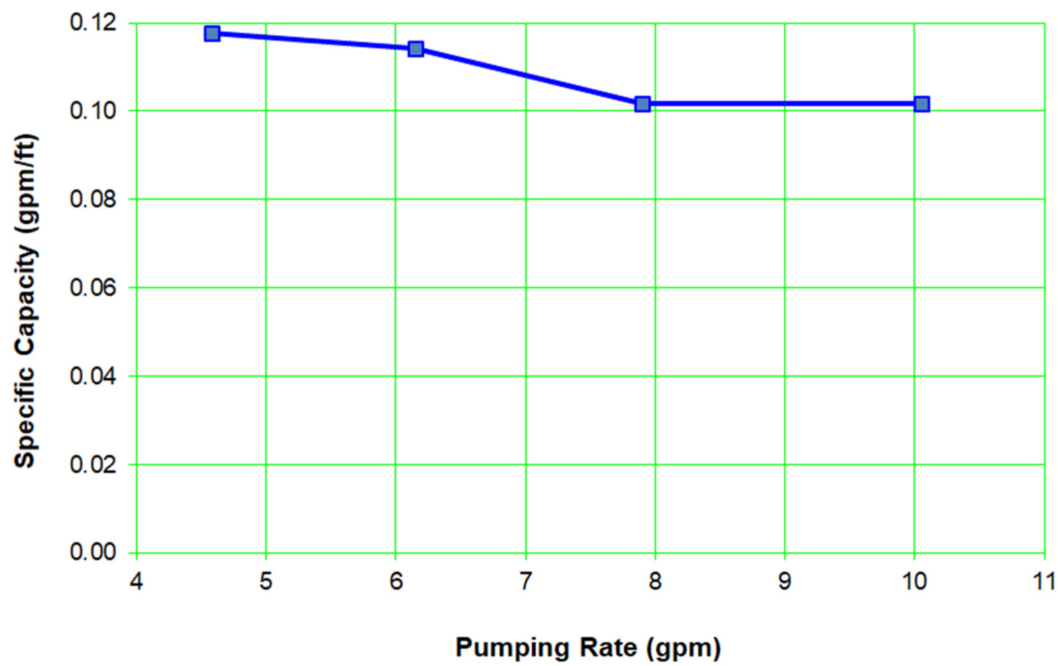


Figure A-2.2-2 Well R-31 screen 3 specific capacities

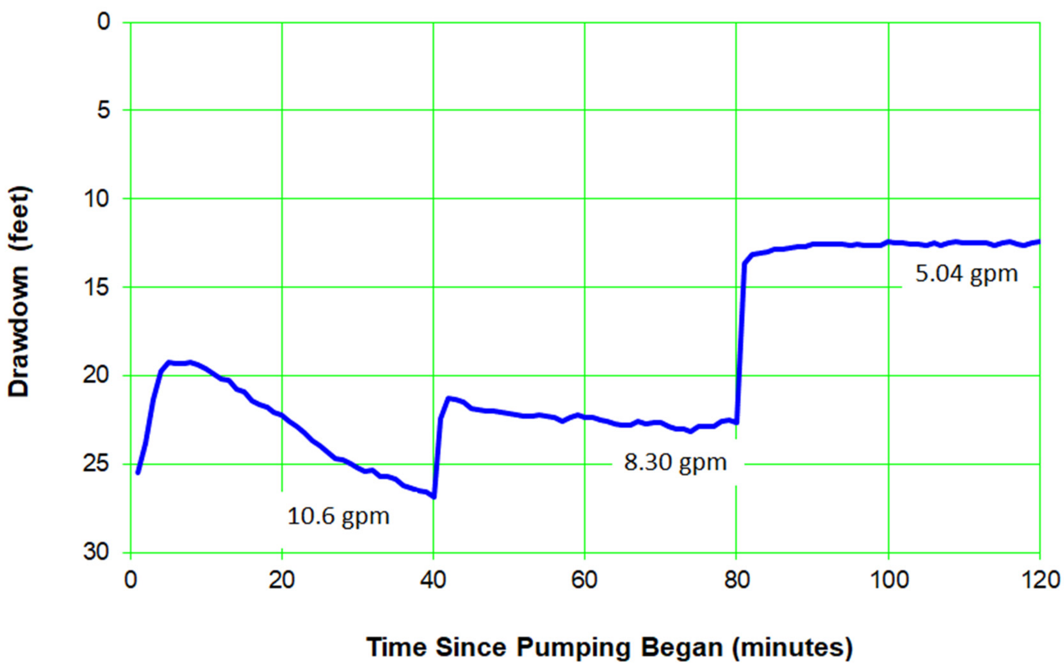


Figure A-2.3-1 Well R-31 screen 4 initial step-drawdown test response

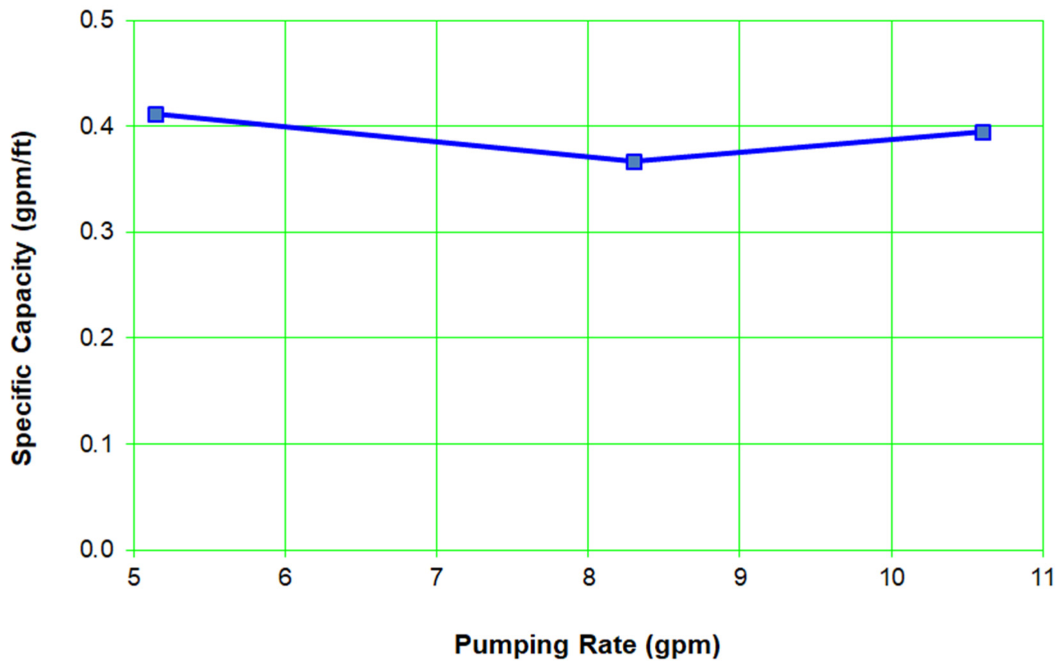


Figure A-2.3-2 Well R-31 screen 4 specific capacity

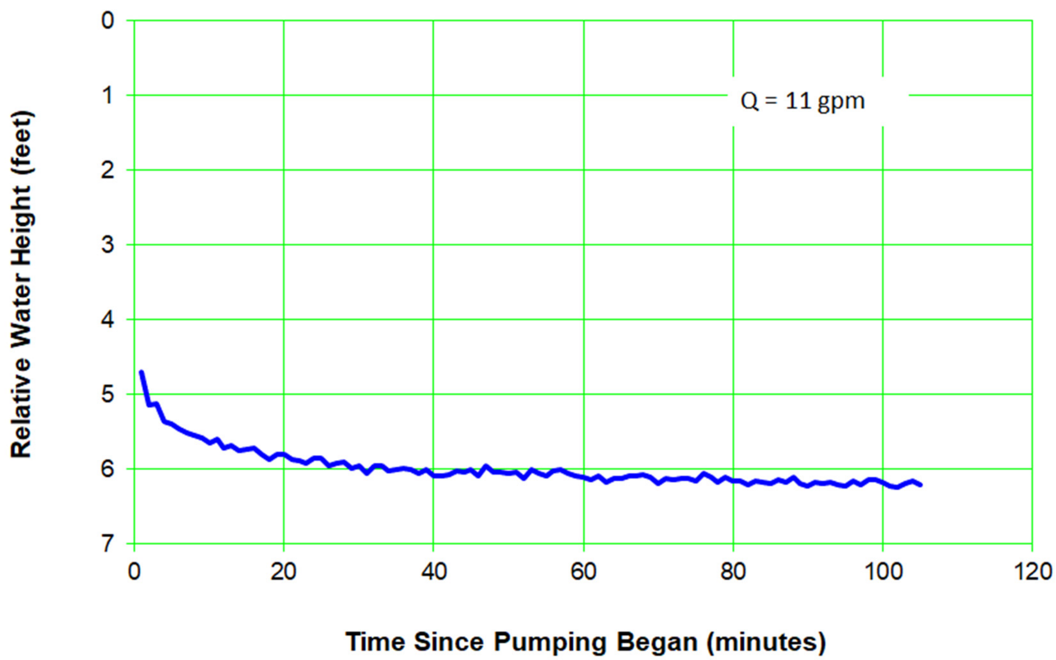


Figure A-2.4-1 Well R-31 screen 5 initial pumping response

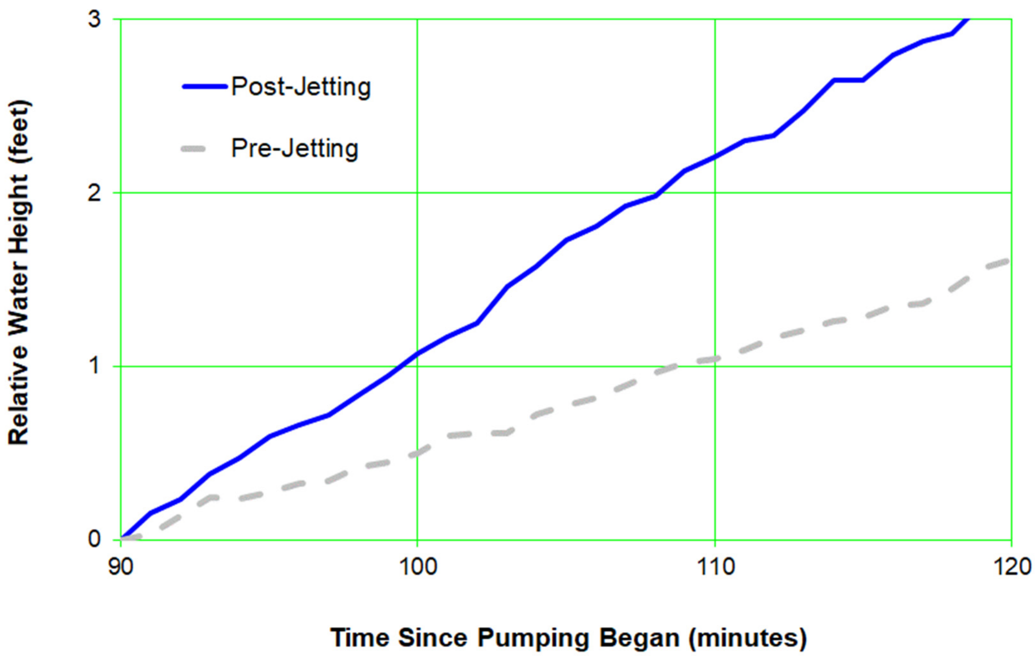


Figure A-3.1-1 Well R-31 screen 2 post-jetting refill response comparison

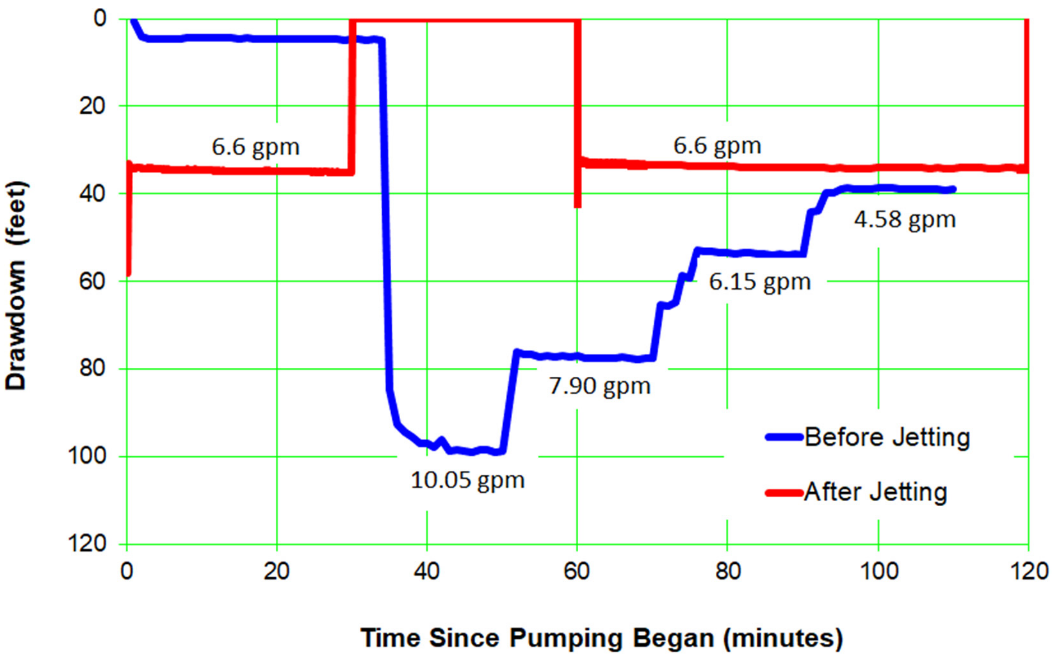


Figure A-3.2-1 Well R-31 screen 3 post-jetting pumping response comparison

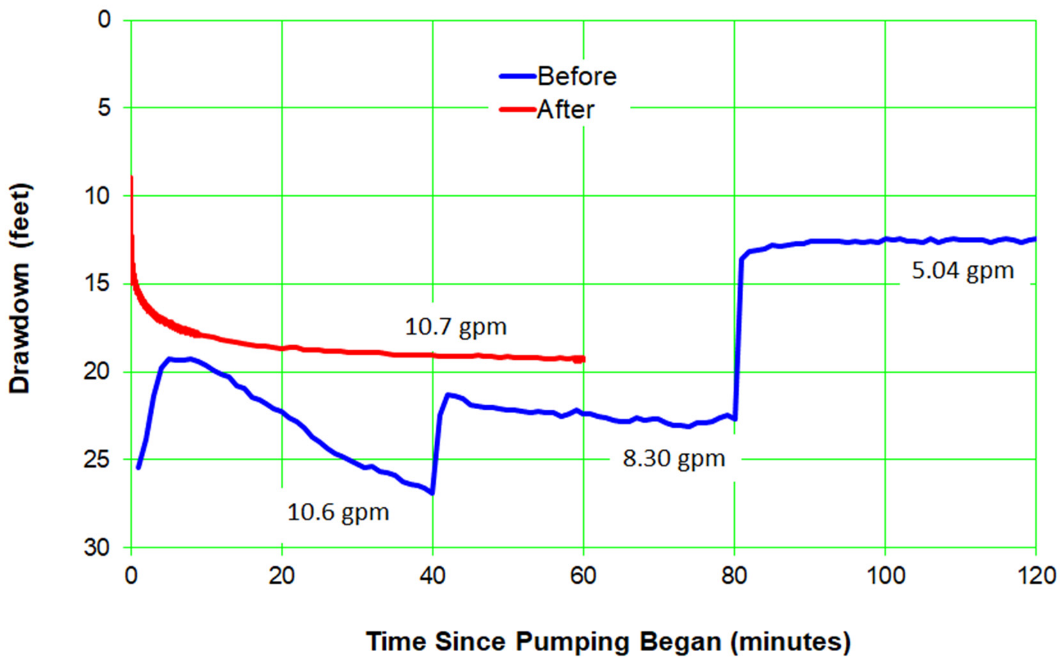


Figure A-3.3-1 Well R-31 screen 4 post-jetting pumping response comparison

Table A-2.2-1
Well R-31 Screen 3 Specific Capacities

Pumping Rate Q (gpm)	Drawdown s (ft)	Specific Capacity Q/s (gpm/ft)
10.05	98.8	0.10
7.90	77.6	0.10
6.15	53.9	0.11
4.58	38.9	0.12

Table A-2.3-1
Well R-31 Screen 4 Specific Capacities

Pumping Rate Q (gpm)	Drawdown s (ft)	Specific Capacity Q/s (gpm/ft)
10.6	26.9	0.39
8.30	22.7	0.37
5.14	12.5	0.41

Appendix B

Groundwater Field Parameters and Analytical Results for Well R-31

B-1.0 GROUNDWATER SCREENING ANALYSIS AT WELL R-31

Well R-31 is located in the Weapons Facilities Operations (WFO) area near the north fork of Ancho Canyon, within Technical Area 39 (TA-39) of Los Alamos National Laboratory (LANL), and was completed in 2000. The well was designed to provide hydrogeologic, water-quality, and water-level data for potential intermediate-depth perched zones and for the regional aquifer at a site downgradient of disposal and explosives-testing sites at TA-39. R-31 was drilled to 1103 ft below ground surface (bgs) with five screens, screen 1 from 439.1 ft to 454.4 ft bgs, screen 2 from 515.0 to 545.7 ft bgs, screen 3 from 666.3 to 676.3 ft bgs, screen 4 from 826.6 to 836.6 ft bgs, and screen 5 from 1007.1 to 1077.7 ft bgs.

This appendix presents the screening results for samples collected during well development and aquifer testing at R-31.

B-1.1 Laboratory Analysis

One groundwater sample was collected from screen 3 in August 2019 following the initial pumping test, and a second sample was collected in November 2019 following the 11-hr pumping test. A sample was collected from screen 4 in December 2019 following the 12-hr pumping test. These samples were analyzed for target analyte list (TAL) metals, alkalinity, total cyanide, gross alpha, gross beta, high explosives, perchlorate, sulfate, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total dissolved solids (TDS), total organic carbon (TOC), and total phosphate (TP).

Table B-1.1-1 lists the analytical results for the samples from screen 3, and Table B-1.1-2 lists the analytical results for the sample from screen 4.

B-1.2 Field Analysis

Groundwater field parameters were recorded for the sample collected following the initial pumping test for screen 3 in August, 2019. This sample subsequently was submitted for laboratory analysis. Field parameters included temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen, 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 11-hr pumping tests during aquifer testing.

Table B-1.2-1 lists the field parameters recorded for the sample collected from screen 3 in August 2019.

B-2.0 SCREENING ANALYTICAL RESULTS

This section presents the concentrations for all analytes that were reported at or above their detection limits as well as the field parameters measured during the aquifer testing. These include VOCs and SVOCs; TAL metals; perchlorate; and radionuclides, in this case only gross alpha, gross beta, and tritium.

B-2.1 Field Parameters

Field parameters for the sample collected from screen 3 on August 19, 2019, were 23.3°C for temperature, 7.76 for pH, 104.1 mV for ORP, 109.2 µS/cm for specific conductance, 5.90 mg/L for dissolved oxygen (DO), and 2.69 nephelometric turbidity units (NTU) for turbidity (Table B-1-2.1).

Field parameters for the sample collected from screen 3 on November 19, 2019, were 22.0°C for temperature, 8.26 for pH, 173.9 mV for ORP, 124.5 µS/cm for specific conductance, 5.26 mg/L for DO, and 1.74 NTU for turbidity (Table B-1-2.1).

Field parameters for the sample collected from screen 4 on December 5, 2019, were 22.1°C for temperature, 7.99 for pH, 153.8 mV for ORP, 116.8 µS/cm for specific conductance, 4.87 mg/L for DO, and 28.4 NTU for turbidity (Table B-1-2.1).

Field parameters for the sample collected from screen 5 on November 9, 2019, were 22.8°C for temperature, 7.88 for pH, 108.4 mV for ORP, 108.0 µS/cm for specific conductance, 5.44 mg/L for DO, and 6.23 NTU for turbidity (Table B-1-2.1).

B-2.2 Water-Quality Parameters

Water-quality parameters for screen 3 sampled in well R-31 on August 19, 2019, were 0.354 mg/L for TOC, 147 mg/L for TDS, 7.88 standard units (SU) for acidity/alkalinity, 54.8 mg/L for alkalinity as CO_3–HCO_3, 0.248 for nitrate-nitrite as nitrogen, 1.63 mg/L for sulfate, and 0.11 mg/L for total Kjeldahl nitrogen (TKN).

Water-quality parameters for screen 3 sampled in well R-31 on November 19, 2019, were 153 mg/L for TDS, 8.4 SU for acidity/alkalinity, 59.6 mg/L for alkalinity as CO_3–HCO_3, 0.4 mg/L for nitrate-nitrite as nitrogen, and 2.34 mg/L for sulfate.

Water-quality parameters for screen 4 sampled in well R-31 on December 5, 2019, were 124 mg/L for TDS, 8.13 SU for acidity/alkalinity, 56.0 mg/L for alkalinity as CO_3–HCO_3, 0.299 mg/L for nitrate-nitrite as nitrogen, and 2.34 mg/L for sulfate.

Water-quality parameters for screen 5 sampled in well R-31 on November 9, 2019, were 141 mg/L and 154 mg/L for TDS, 7.91 SU and 7.95 SU for acidity/alkalinity, 52.9 mg/L and 52.3 mg/L for alkalinity as CO_3–HCO_3, 0.334 mg/L and 0.331 mg/L for nitrate-nitrite as nitrogen, and 1.33 mg/L and 1.31 mg/L for sulfate.

B-2.3 VOCs and SVOCs

VOC and SVOC results for samples from screen 3 in well R-31 on August 19, 2019, were 9.67 µg/L for toluene. VOC and SVOC results for samples from screen 3 in well R-31 on November 19, 2019, were 2.06 µg/L for toluene.

VOC and SVOC results for samples from screen 4 in well R-31 on December 5, 2019, were 1.08 µg/L for toluene.

No VOCs or SVOCs were detected in samples from screen 5 in well R-31 on November 9, 2019.

B-2.4 Inorganic Chemistry

Analytical inorganic chemistry results for samples from screen 3 in well R-31 on August 19, 2019, were 2.55 µg/L arsenic, 27.8 µg/L barium, 8.38 mg/L calcium, 1.48 mg/L chloride, 0.286 mg/L fluoride, 2.46 mg/L magnesium, 19.7 µg/L manganese, 1.35 µg/L molybdenum, 0.815 µg/L nickel, 2.37 mg/L potassium, 80.9 mg/L silicon dioxide (dissolved silica), 11.2 mg/L sodium, 42 µg/L strontium, 0.222 µg/L uranium, 6.13 µg/L vanadium, and 29.3 µg/L zinc.

Analytical inorganic chemistry results for samples from screen 3 in well R-31 on November 19, 2019, were 2.24 µg/L arsenic, 22.1 µg/L barium, 10.7 mg/L calcium, 2.03 mg/L chloride, 0.415 mg/L fluoride, 2.92 mg/L magnesium, 3.15 µg/L manganese, 2.2 µg/L molybdenum, 2.16 mg/L potassium, 70 mg/L silicon dioxide (dissolved silica), 11.5 mg/L sodium, 54.1 µg/L strontium, 0.407 µg/L uranium, 6.01 µg/L vanadium, and 5.9 µg/L zinc.

Analytical inorganic chemistry results for samples from screen 4 in well R-31 on December 5, 2019, were 2.51 µg/L arsenic, 31 µg/L barium, 8.17 mg/L calcium, 1.50 mg/L chloride, 5.89 µg/L chromium, 0.361 mg/L fluoride, 35.8 µg/L iron, 2.37 mg/L magnesium, 1.18 µg/L molybdenum, 0.706 µg/L nickel, 2.94 mg/L potassium, 79.3 mg/L silicon dioxide (dissolved silica), 11.6 mg/L sodium, 40.6 µg/L strontium, 0.238 µg/L uranium, 6.36 µg/L vanadium, and 6.71 µg/L zinc.

Analytical inorganic chemistry results for samples from screen 5 in well R-31 on November 9, 2019, were 2.46 µg/L and 2.37 µg/L for arsenic, 28.9 µg/L and 27.5 µg/L for barium, 8.31 mg/L and 7.81 mg/L for calcium, 1.47 mg/L and 1.46 mg/L for chloride, 4.23 µg/L and 3.9 µg/L for chromium, 0.417 mg/L and 0.421 mg/L for fluoride, 2.74 mg/L and 2.56 mg/L for magnesium, 1.09 µg/L and 1.17 µg/L for molybdenum, 0.729 µg/L and 0.757 µg/L for nickel, 2.91 mg/L and 2.71 mg/L for potassium, 87.8 mg/L and 82.5 mg/L for silicon dioxide (dissolved silica), 12.3 mg/L and 11.4 mg/L for sodium, 45.6 µg/L and 42 µg/L for strontium, 0.139 µg/L and 0.127 µg/L for uranium, and 7.33 µg/L and 6.95 µg/L for vanadium.

B-2.5 Perchlorate

Perchlorate results for samples from screen 3 in well R-31 on August 19, 2019, were 0.236 µg/L. Perchlorate results for samples from screen 3 in well R-31 on November 19, 2019, were 0.283 µg/L.

Perchlorate results for samples from screen 4 in well R-31 on December 5, 2019, were 0.232 µg/L.

Perchlorate results for samples from screen 5 in well R-31 on November 9, 2019, were 0.238 µg/L and 0.245 µg/L.

B-2.6 Radionuclides

There were no analytical radionuclide results above detection limits for samples collected from screen 3 in well R-31 on August 19, 2019. However, samples collected from screen 3 in well R-31 on November 19, 2019, showed an activity of 2.74 pCi/L for gross beta, 165 pCi/L for bismuth-214, 1.97 pCi/L for radium-226 + 228, 0.281 pCi/L for uranium-234, and 0.168 pCi/L for uranium-238.

Radionuclide results for samples from screen 4 in well R-31 on December 5, 2019, showed an activity of 87.2 pCi/L for bismuth-214, 2.96 pCi/L for gross alpha, 2.64 pCi/L for gross beta, 90.3 pCi/L for lead-214, 0.227 pCi/L for uranium-234, and 0.139 pCi/L for uranium-238.

Radionuclide results for samples from screen 5 in well R-31 on November 9, 2019, showed an activity of 5.66 pCi/L for gross beta, 16.4 pCi/L and 23.8 pCi/L for lead-214, 0.534 pCi/L and 0.793 pCi/L for radium-226, 0.615 pCi/L and 1.2 pCi/L for radium-226 + 228, and 0.0951 pCi/L and 0.0697 pCi/L for uranium-234.

Table B-1.1-1
Analytical Results from Aquifer Test Samples for Well R-31, Screen 3

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
CAAN-19-182001	8/19/2019	Toluene	9.67 µg/L	NQ[b]
CAAN-20-190530	11/19/2019	Toluene	2.06 µg/L	NQ
CAAN-19-182001	8/19/2019	TOC	0.354 mg/L	J[c]
CAAN-19-181998	8/19/2019	TDS	147 mg/L	NQ
CAAN-20-190530	11/19/2019	TDS	153 mg/L	NQ
CAAN-19-181998	8/19/2019	Acidity/alkalinity	7.88 SU	NQ
CAAN-20-190530	11/19/2019	Acidity/alkalinity	8.4 SU	NQ
CAAN-19-181998	8/19/2019	Alkalinity–CO_3+HCO_3	54.8 mg/L	NQ
CAAN-20-190530	11/19/2019	Alkalinity–CO_3+HCO_3	59.6 mg/L	NQ
CAAN-19-181998	8/19/2019	Nitrate-nitrite as nitrogen	0.248 mg/L	NQ
CAAN-20-190530	11/19/2019	Nitrate-nitrite as nitrogen	0.299 mg/L	NQ
CAAN-19-181998	8/19/2019	Sulfate	1.63 mg/L	NQ
CAAN-20-190530	11/19/2019	Sulfate	2.34 mg/L	NQ
CAAN-19-182001	8/19/2019	TKN	0.11 mg/L	NQ
CAAN-19-181998	8/19/2019	Arsenic	2.55 µg/L	J
CAAN-20-190530	11/19/2019	Arsenic	2.24 µg/L	J
CAAN-19-181998	8/19/2019	Barium	27.8 µg/L	NQ
CAAN-20-190530	11/19/2019	Barium	22.1 µg/L	NQ
CAAN-20-190530	11/19/2019	Bismuth-214	165 pCi/L	NQ
CAAN-19-181998	8/19/2019	Calcium	8.38 mg/L	NQ
CAAN-20-190530	11/19/2019	Calcium	10.7 mg/L	NQ
CAAN-19-181998	8/19/2019	Chloride	1.48 mg/L	NQ
CAAN-20-190530	11/19/2019	Chloride	2.03 mg/L	NQ
CAAN-19-181998	8/19/2019	Fluoride	0.286 mg/L	NQ
CAAN-20-190530	11/19/2019	Fluoride	0.415 mg/L	NQ
CAAN-20-190530	11/19/2019	Gross beta	2.74 pCi/L	NQ
CAAN-19-181998	8/19/2019	Magnesium	2.46 mg/L	NQ
CAAN-20-190530	11/19/2019	Magnesium	2.92 mg/L	NQ
CAAN-19-181998	8/19/2019	Manganese	19.7 µg/L	NQ
CAAN-20-190530	11/19/2019	Manganese	3.15 µg/L	J
CAAN-19-181998	8/19/2019	Molybdenum	1.35 µg/L	J
CAAN-20-190530	11/19/2019	Molybdenum	2.2 µg/L	NQ
CAAN-19-181998	8/19/2019	Nickel	0.815 µg/L	NQ
CAAN-19-181998	8/19/2019	Perchlorate	0.236 µg/L	NQ
CAAN-20-190530	11/19/2019	Perchlorate	0.283 µg/L	NQ
CAAN-19-181998	8/19/2019	Potassium	2.37 mg/L	NQ
CAAN-20-190530	11/19/2019	Potassium	2.16 mg/L	NQ

Table B-1.1-1 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
CAAN-20-190530	11/19/2019	Radium-226 + radium-228	1.97 pCi/L	NQ
CAAN-19-181998	8/19/2019	Silicon dioxide	80.9 mg/L	NQ
CAAN-20-190530	11/19/2019	Silicon dioxide	70 mg/L	NQ
CAAN-19-181998	8/19/2019	Sodium	11.2 mg/L	NQ
CAAN-20-190530	11/19/2019	Sodium	11.5 mg/L	NQ
CAAN-19-181998	8/19/2019	Strontium	42 µg/L	NQ
CAAN-20-190530	11/19/2019	Strontium	54.1 µg/L	NQ
CAAN-19-181998	8/19/2019	Uranium	0.222 µg/L	NQ
CAAN-20-190530	11/19/2019	Uranium	0.407 µg/L	NQ
CAAN-20-190530	11/19/2019	Uranium-234	0.281 pCi/L	NQ
CAAN-20-190530	11/19/2019	Uranium-238	0.168 pCi/L	NQ
CAAN-19-181998	8/19/2019	Vanadium	6.13 µg/L	NQ
CAAN-20-190530	11/19/2019	Vanadium	6.01 µg/L	NQ
CAAN-19-181998	8/19/2019	Zinc	29.3 µg/L	J+[d]
CAAN-20-190530	11/19/2019	Zinc	5.6 µg/L	J

[a] Only detected regular sample results are reported; analytes below detection limits are not listed.

[b] NQ = No validation qualifier flag is associated with this result, and the analyte is classified as detected.

[c] J = The analyte is classified as detected, but the reported concentration value is expected to be more uncertain than usual.

[d] J+ = The analyte is classified as detected, but the reported concentration value is expected to be more uncertain than usual with a potential positive bias.

Table B-1.1-2
Analytical Results from Aquifer Test Samples for Well R-31, Screen 4

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
CAAN-20-190539	12/05/2019	Toluene	1.08 µg/L	NQ[b]
CAAN-20-190539	12/05/2019	TDS	124 mg/L	J[c]
CAAN-20-190539	12/05/2019	Alkalinity–CO_3+HCO_3	56.0 mg/L	NQ
CAAN-20-190539	12/05/2019	Nitrate-nitrite as nitrogen	0.299 mg/L	NQ
CAAN-20-190539	12/05/2019	Sulfate	1.37 mg/L	NQ
CAAN-20-190539	12/05/2019	Toluene	1.08 µg/L	NQ
CAAN-20-190539	12/05/2019	Bis(2-ethylhexyl)phthalate	0.33 µg/L	J
CAAN-20-190539	12/05/2019	Bismuth-214	87.2 pCi/L	NQ
CAAN-20-190539	12/05/2019	Gross alpha	2.96 pCi/L	NQ
CAAN-20-190539	12/05/2019	Gross beta	2.64 pCi/L	NQ
CAAN-20-190539	12/05/2019	Lead-214	90.3 pCi/L	NQ
CAAN-20-190539	12/05/2019	Uranium-234	0.227pCi/L	J
CAAN-20-190539	12/05/2019	Uranium-238	0.139 pCi/L	J
CAAN-20-190539	12/05/2019	Arsenic	2.51 µg/L	J
CAAN-20-190539	12/05/2019	Barium	31 µg/L	NQ

Table B-1.1-2 (continued)

Sample ID	Sample Date	Analyte	Report Result*	Lab Qualifier
CAAN-20-190539	12/05/2019	Calcium	8.17 mg/L	NQ
CAAN-20-190539	12/05/2019	Chloride	1.50 mg/L	NQ
CAAN-20-190539	12/05/2019	Perchlorate	0.232 µg/L	NQ
CAAN-20-190539	12/05/2019	Chromium	5.89 µg/L	J
CAAN-20-190539	12/05/2019	Fluoride	0.361 mg/L	NQ
CAAN-20-190539	12/05/2019	Iron	35.8 µg/L	J
CAAN-20-190539	12/05/2019	Potassium	2.94 mg/L	NQ
CAAN-20-190539	12/05/2019	Magnesium	2.37 mg/L	NQ
CAAN-20-190539	12/05/2019	Molybdenum	1.18 µg/L	NQ
CAAN-20-190539	12/05/2019	Sodium	11.6 mg/L	J-[d]
CAAN-20-190539	12/05/2019	Nickel	0.706 µg/L	J
CAAN-20-190539	12/05/2019	Silicon dioxide	79.3 mg/L	NQ
CAAN-20-190539	12/05/2019	Strontium	40.6 µg/L	NQ
CAAN-20-190539	12/05/2019	Uranium	0.238 µg/L	NQ
CAAN-20-190539	12/05/2019	Vanadium	6.36 µg/L	NQ
CAAN-20-190539	12/05/2019	Zinc	6.71 µg/L	J

[a] Only detected regular sample results are reported; analytes below detection limit are not listed.

[b] NQ = No validation qualifier flag is associated with this result, and the analyte is classified as detected.

[c] J = The analyte is classified as detected, but the reported concentration value is expected to be more uncertain than usual.

[d] J- = The analyte is classified as detected, but the reported concentration value is expected to be more uncertain than usual with a potential negative bias.

Table B-1.1-3
Analytical Results from Aquifer Test Samples for Well R-31, Screen 5

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
CAAN-20-190546	11/9/2019	Acidity/alkalinity	7.91 SU	NQ[b]
CAAN-20-190548	11/9/2019	Acidity/alkalinity	7.95 SU	NQ
CAAN-20-190546	11/9/2019	Alkalinity-CO_3+HCO_3	52.9 mg/L	NQ
CAAN-20-190548	11/9/2019	Alkalinity-CO_3+HCO_3	52.3 mg/L	NQ
CAAN-20-190546	11/9/2019	Arsenic	2.46 µg/L	J[c]
CAAN-20-190548	11/9/2019	Arsenic	2.37 µg/L	J
CAAN-20-190546	11/9/2019	Barium	28.9 µg/L	NQ
CAAN-20-190548	11/9/2019	Barium	27.5 µg/L	NQ
CAAN-20-190546	11/9/2019	Calcium	8.31 mg/L	NQ
CAAN-20-190548	11/9/2019	Calcium	7.81 mg/L	NQ
CAAN-20-190546	11/9/2019	Chloride	1.47 mg/L	NQ
CAAN-20-190548	11/9/2019	Chloride	1.46 mg/L	NQ
CAAN-20-190546	11/9/2019	Chromium	4.23 µg/L	J
CAAN-20-190548	11/9/2019	Chromium	3.9 µg/L	J

Table B-1.1-3 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
CAAN-20-190546	11/9/2019	Fluoride	0.417 mg/L	NQ
CAAN-20-190548	11/9/2019	Fluoride	0.421 mg/L	NQ
CAAN-20-190545	11/9/2019	Gross beta	5.66 pCi/L	NQ
CAAN-20-190546	11/9/2019	Hardness	32.1 mg/L	NQ
CAAN-20-190548	11/9/2019	Hardness	30.1 mg/L	NQ
CAAN-20-190545	11/9/2019	Lead-214	16.4 pCi/L	NQ
CAAN-20-190547	11/9/2019	Lead-214	23.8 pCi/L	NQ
CAAN-20-190546	11/9/2019	Magnesium	2.74 mg/L	NQ
CAAN-20-190548	11/9/2019	Magnesium	2.56 mg/L	NQ
CAAN-20-190546	11/9/2019	Molybdenum	1.09 µg/L	NQ
CAAN-20-190548	11/9/2019	Molybdenum	1.17 µg/L	NQ
CAAN-20-190546	11/9/2019	Nickel	0.729 µg/L	J
CAAN-20-190548	11/9/2019	Nickel	0.757 µg/L	J
CAAN-20-190546	11/9/2019	Nitrate-nitrite as nitrogen	0.334 mg/L	NQ
CAAN-20-190548	11/9/2019	Nitrate-nitrite as nitrogen	0.331 mg/L	NQ
CAAN-20-190546	11/9/2019	Perchlorate	0.238 µg/L	NQ
CAAN-20-190548	11/9/2019	Perchlorate	0.245 µg/L	NQ
CAAN-20-190546	11/9/2019	Potassium	2.91 mg/L	NQ
CAAN-20-190548	11/9/2019	Potassium	2.71 mg/L	NQ
CAAN-20-190545	11/9/2019	Radium-226	0.534 pCi/L	J
CAAN-20-190547	11/9/2019	Radium-226	0.793 pCi/L	NQ
CAAN-20-190545	11/9/2019	Radium-226 and radium-228	0.615 pCi/L	NQ
CAAN-20-190547	11/9/2019	Radium-226 and radium-228	1.2 pCi/L	NQ
CAAN-20-190546	11/9/2019	Silicon dioxide	87.8 mg/L	NQ
CAAN-20-190548	11/9/2019	Silicon dioxide	82.5 mg/L	NQ
CAAN-20-190546	11/9/2019	Sodium	12.3 mg/L	NQ
CAAN-20-190548	11/9/2019	Sodium	11.4 mg/L	NQ
CAAN-20-190546	11/9/2019	Strontium	45.6 µg/L	NQ
CAAN-20-190548	11/9/2019	Strontium	42 µg/L	NQ
CAAN-20-190546	11/9/2019	Sulfate	1.33 mg/L	NQ
CAAN-20-190548	11/9/2019	Sulfate	1.31 mg/L	NQ
CAAN-20-190546	11/9/2019	TDS	141 mg/L	NQ
CAAN-20-190548	11/9/2019	TDS	154 mg/L	NQ
CAAN-20-190546	11/9/2019	Uranium	0.139 µg/L	J
CAAN-20-190548	11/9/2019	Uranium	0.127 µg/L	J
CAAN-20-190545	11/9/2019	Uranium-234	0.0951 pCi/L	NQ

Table B-1.1-3 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
CAAN-20-190547	11/9/2019	Uranium-234	0.0697 pCi/L	NQ
CAAN-20-190546	11/9/2019	Vanadium	7.33 µg/L	NQ
CAAN-20-190548	11/9/2019	Vanadium	6.95 µg/L	NQ

[a] Only detected regular sample results are reported; analytes below detection limit are not listed.

[b] NQ = No validation qualifier flag is associated with this result, and the analyte is classified as detected.

[c] J = The analyte is classified as detected, but the reported concentration value is expected to be more uncertain than usual.

Table B-1.2-1
Field Parameters Monitored during Aquifer Testing

Sample ID	Location	Date	Time	Temp. (°C)	pH	ORP (mV)	DO (mg/L)	Specific Conductance (µS/cm)	Turbidity (NTU)	Discharge Rate (gpm)
CAPU-19-182001	R-31 S3*	8/19/2019	1415	23.3	7.76	104.1	5.90	109.2	2.69	6.6
CAAN-20-190545	R-31 S5	11/9/2019	1609	22.8	7.88	108.4	5.44	108.0	6.23	12.0
CAAN-20-190526	R-31 S3	11/19/2019	1746	22.0	8.26	173.9	5.26	124.5	1.74	7.0
CAAN-20-190539	R-31 S4*	12/5/2019	1745	22.1	7.99	153.8	4.87	116.8	28.4	10.7

* S = Screen.

Appendix C

Aquifer Testing Report for Well R-31

C-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of pumping tests conducted on R-31 screens 2, 3, and 4 from August to December 2019 as part of the Westbay Reconfiguration Project at Los Alamos National Laboratory (LANL or the Laboratory). The tests were conducted to characterize the saturated materials and quantify the hydraulic properties of the screened intervals. Testing consisted of brief trial pumping or step-drawdown pumping, background water-level data collection, and extended constant rate pumping and recovery tests on each of the relevant screen zones. The durations of the extended tests were 2468 min for screen 2, 660 min for screen 3, and 720 min for screen 4.

As in most of the R-well pumping tests conducted on the Pajarito Plateau, an inflatable packer system was used in the testing program. A double packer system was used to isolate each pumped zone and, where possible, to eliminate casing storage effects on the test data so that early drawdown and recovery data could be used in the analysis. This setup was largely effective at eliminating or minimizing storage effects except in the case of screen 2, which is screened across the water table.

C-2.0 BACKGROUND DATA

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

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

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

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

Barometric pressure data for most tests have been obtained from the Technical Area 54 (TA-54) tower site from the Environmental Protection and Compliance Programs (formerly the Waste and Environmental Services Division–Environmental Data and Analysis). For the R-31 screen 3 tests, however, it was necessary to use atmospheric data from TA-06 instead, as data were not recorded at TA-54 during the screen 3 tests. The TA-54 and TA-06 measurement locations are at elevations of 6548 and 6363 ft above mean sea level (amsl), respectively, whereas the wellheads and static water levels were at different elevations than these. Therefore, the measured barometric pressure data from TA-54 or TA-06 had to be adjusted to reflect the pressure at the elevation of the water table within each tested screen.

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

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

where P_{WT} = barometric pressure at the water table inside R-31

P_{TA54} = barometric pressure measured at TA-54 or TA-06

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

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

E_{WELL} = elevation at wellsite, in feet

E_{TA54} = elevation of barometric pressure measuring point at TA-54 or TA-06, in feet

E_{WT} = elevation of the water level in R-31, in feet

T_{TA54} = air temperature near TA-54 or TA-06, in degrees Kelvin

T_{WELL} = air column temperature inside R-31, in degrees Kelvin

This formula is an adaptation of an equation LANL's Environmental Protection and Compliance Programs provided. It can be derived from the ideal gas law and standard physics principles. An inherent assumption in the derivation of the equation is that the air temperature between TA-54 or TA-06 and the well is temporally and spatially constant and that the temperature of the air column in the well is similarly constant.

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

C-3.0 IMPORTANCE OF EARLY DATA

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

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

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

Equation C-2

where t_c = duration of casing storage effect, in minutes

D = inside diameter of well casing, in inches

d = outside diameter of column pipe, in inches

Q = discharge rate, in gallons per minute (gpm)

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

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

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

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

Equation C-3

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

D_B = diameter of borehole, in inches

D_C = outside diameter of well casing, in inches

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

In some instances, it is possible to eliminate casing storage effects by setting an inflatable packer above the tested screen interval before the test is conducted. This has been the standard approach used in testing the R-wells.

C-4.0 TIME-DRAWDOWN METHODS

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

$$s = \frac{114.6Q}{T} W\left(u\right)$$

Equation C-4

where

$$W(u) = \int_u^\infty \frac{e^{-x}}{x}\,dx$$

Equation C-5

and

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

Equation C-6

and where s = drawdown, in feet

Q = discharge rate, in gpm

T = transmissivity, in gallons per day per foot

S = storage coefficient (dimensionless)

t = pumping time, in days

r = distance from center of pumpage, in feet

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

$$T = \frac{114.6Q}{s} W(u)$$

Equation C-7

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

Equation C-8

where T = transmissivity, in gallons per day per foot

S = storage coefficient

Q = discharge rate, in gpm

$W(u)$ = match-point value

s = match-point value, in feet

u = match-point value

t = match-point value, in minutes

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

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

Equation C-9

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

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

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

Equation C-10

where T = transmissivity, in gallons per day per foot

Q = discharge rate, in gpm

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

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

Equation C-11

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

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

b = aquifer thickness

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

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

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

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

K_z = vertical hydraulic conductivity

K_r = horizontal hydraulic conductivity

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

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

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

Another solution for partially penetrating wells is the Neuman method (Neuman 1974, 085421), which applies to unconfined conditions and accounts for delayed yield. The relevant equations are given in Neuman (1974, 085421).

C-5.0 RECOVERY METHODS

Recovery data were analyzed using the Theis recovery method, a semilog analysis method similar to the Cooper-Jacob procedure. In this method, residual drawdown is plotted on a semilog graph versus the ratio *t/t'*, where *t* is the time since pumping began and *t'* is the time since pumping stopped. A straight line of best fit is constructed through the data points and *T* is calculated from the slope of the line as follows:

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

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

When the earliest recovery data violate the u value assumption inherent in the semilog method, the data can be analyzed using a log-log plot and Theis curve matching.

Recovery data also can be analyzed using the Hantush equation for partial penetration. This approach is generally applied to the early portion of the data set in a plot of recovery versus recovery time. In general, the semilog method for recovery versus time since pumping stopped is not valid for late recovery times.

C-6.0 SPECIFIC CAPACITY METHOD

The specific capacity of the pumped well can be used to obtain a lower-bound value of hydraulic conductivity. The hydraulic conductivity is computed using formulas that are based on the assumption that the pumped well is 100% efficient. The resulting hydraulic conductivity is the value required to sustain the observed specific capacity. If the actual well is less than 100% efficient, it follows that the actual hydraulic conductivity would have to be greater than calculated to compensate for well inefficiency. Thus, because the efficiency is not known, the computed hydraulic conductivity value represents a lower bound. The actual conductivity is known to be greater than or equal to the computed value.

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

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

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

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

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

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

To apply this procedure, a storage coefficient value must be assigned. Storage coefficient values generally range from 10^{-5} to 10^{-3} for confined aquifers and 0.01 to 0.25 for unconfined aquifers (Driscoll 1986, 104226). Semiconfined conditions generally are associated with intermediate storage coefficient values between these ranges.

The analysis also requires assigning a value for the saturated aquifer thickness, b. This parameter is not always known and must be estimated. The lower bound transmissivity calculation is not particularly sensitive to the assigned value of saturated thickness. It is only necessary to use a value well in excess of the screen length. Ignoring deeper sediments has little effect on the calculation results because sediments far from the screened interval have minimal effect on yield.

C-7.0 WELL R-31 SCREENS 2, 3, AND 4 PUMPING TESTS

C-7.1 Introduction

This section presents analysis of data obtained from the final pumping tests conducted on R-31 screen 2, 3, and 4. Previous field activities at each of the screens included Westbay equipment removal, swabbing and bailing, initial test pumping, and simultaneous jetting and pumping development. Final test pumping was performed to evaluate screen zone capacities, assess formation parameters, and document the results of jet development.

The screen 2 interval in R-31 extends from 515.0 to 545.7 ft below ground surface (bgs) and straddles the regional water table at the top of the Cerros del Rio basalt. The static water level measured on August 17, 2019, was 535.66 ft bgs. However, the water level continued dropping throughout the available monitoring period and equilibration had not been achieved when testing began. Thus, the actual static water level was deeper than the measured result.

The observed screen 2 water level was 4.0 ft higher than that of screen 3. However, during the last month of available water-level records from R-31 (December 1, 2018 to January 1, 2019), transducer data showed the screen 2 level to range from 1.42 to 1.60 ft higher than that of screen 3, averaging 1.50 ft higher for that period. It was likely that when the well stood open, the screen 2 interval was “flooded” with water from the deeper screens, raising the water level in screen 2 temporarily above its true static level. (Note that the composite water level in R-31 was approximately 530 ft bgs, well above the water levels of screens 2 and 3.) The raised water level in screen 2 was slow to subside, apparently because of the tightness of the screen 2 zone.

Figure C-7.1-1 shows equilibration data from screen 2, demonstrating that the levels were slow to equilibrate. Figure C-7.1-2 shows an expanded-scale plot of the data along with an indication of the probable actual static water level of screen 2 (538.19 ft bgs) taken as 1.50 ft shallower than the known screen 3 water level.

R-31 screen 3 extends from 666.3 to 676.3 ft bgs within the Cerros del Rio basalt. The screen 3 static water level measured on August 19, 2019, was 539.69 ft bgs. This level served as the basis for estimating the screen 2 static water level because of the slow equilibration of levels in screen 2. During subsequent testing in November 2019, the observed static water level at screen 3 was 538.51 ft bgs.

R-31 screen 4 extends from 826.6 to 836.6 ft bgs within the Puye Formation, primarily including Totavi river gravels. The static water level determined in November 2019 was 534.4 ft bgs.

R-31 screen 2 produced too little flow to support continuous pumping using a submersible pump. Therefore, testing was accomplished by pumping the water level down into the casing beneath the bottom of the screen and observing the casing refill rate. This was effectively a constant drawdown test in which maximum drawdown was applied to the zone while the "pumping rate" was determined as the rate at which the casing refilled.

Pumping of screen 2 was performed beginning at 2:50 p.m. on August 22, 2019, and continued intermittently for 2468 min until 7:58 a.m. on August 24, 2019, while the water level in the well was maintained below the bottom of screen 2.

Screens 3 and 4 were tested using standard constant rate pumping methods.

Screen 3 was tested from November 16 through 20, 2019. After the pump was installed and the drop pipe was filled on November 16, short trial tests were conducted on November 17. Trial 1 was conducted for 30 min from 8:00 a.m. to 8:30 a.m. at a discharge rate of 6.6 gpm. Following pump shutoff, recovery data were recorded for 30 min until 9:00 a.m.

Trial 2 was conducted for 60 min from 9:00 a.m. to 10:00 a.m. at a discharge rate of 6.6 gpm. Following shutdown, recovery data were recorded for 2790 min until 8:30 a.m. on November 19, 2019, when the extended test began.

Extended testing consisted of pumping screen 3 for 660 min from 8:30 a.m. until 7:30 p.m. on November 19, 2019. The initial discharge rate was 6.7 gpm. After an hour or so, the rate gradually increased to 7 gpm for the duration of the test. There was no apparent explanation for the observed change in discharge rate. However, it was possible that the rate change may have been caused by expansion of the small flow aperture in the discharge valve as its temperature increased from below freezing (ambient air temperature) at the start of the test to the groundwater temperature of around 70 degrees Fahrenheit.

Following shutdown, recovery data were recorded for 750 min until 8:00 a.m. on November 20, 2019, when the pump was pulled from the well.

Screen 4 was tested from November 21 through 27, 2019, and from December 4 through 8, 2019. The testing was performed in two sessions because of a mandated sitewide shutdown, which prevented the continuous site work that had been planned.

In the initial testing session, after the pump was installed and the drop pipe was filled on November 21, short trial tests were conducted on November 22. Trial 1 was conducted for 30 min from 8:00 a.m. to 8:30 a.m. at a discharge rate of 10.7 gpm. Following pump shutoff, recovery data were recorded for 30 min until 9:00 a.m.

Trial 2 was conducted for 60 min from 9:00 a.m. to 10:00 a.m. on November 22 at a discharge rate of 10.8 gpm. Following shutdown, recovery data were recorded for more than 5 days until November 27, when the original transducer programming periods timed out and the transducers ceased recording data.

Site access was prohibited from November 23 until December 3, 2019, when work was allowed to resume. At that time, it was necessary to pull the pump, retrieve and reprogram the transducers, and prepare for the extended pumping test.

The extended testing was performed from December 4 through 8, 2019. After the pump was installed and the drop pipe was filled on December 4, screen 4 was pumped for 720 min from 7:30 a.m. until 7:30 p.m. on December 5. The discharge rate for the test was 10.8 gpm initially, declining gradually to 10.7 halfway through the test. Following shutdown, recovery data were recorded for 4329 min until 7:39 p.m. on December 8, when the data collection protocol for the transducer in the pumped zone timed out.

C-7.2 Background Data Analysis

Background aquifer pressure data were collected from R-31 screens 2, 3, and 4 during the tests on screens 3 and 4. These data were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure C-7.2-1 shows aquifer pressure data from R-31 screen 2 during the screen 3 pumping tests, along with barometric pressure data from TA-06 that have been corrected to equivalent barometric pressure in feet of water at the water table and also corrected for barometric efficiency. Atmospheric data from TA-06 were used because no data were available from TA-54 during the screen 3 pumping tests. The R-31 screen 2 data measurements reflect the sum of the water pressure and barometric pressure that was recorded using a nonvented pressure transducer and are referred to in Figure C-7.2-1 as the adjusted hydrograph. The times of the pumping periods for the R-31 screen 3 tests are included in the figure for reference. Because of the significant data scatter evident in the plot, a rolling average of the hydrograph data is plotted in Figure C-7.2-2.

It appeared that the hydrograph and barometric pressure curve matched fairly well when the barometric pressure data were corrected for a barometric efficiency of 50%—a moderate barometric efficiency. There appeared to be no effect in screen 2 water levels from pumping screen 3.

Figure C-7.2-3 shows the analogous plot of aquifer pressure data from R-31 screen 3 during the screen 3 pumping tests, along with barometric pressure data from TA-06 that have been corrected for a barometric efficiency of 60%. In the interest of reducing data scatter, a rolling average of the hydrograph data is plotted in Figure C-7.2-4.

An alternative analysis of the screen 3 background data is shown in Figure C-7.2-5. In this plot, the barometric pressure curve has been corrected for a barometric efficiency of 43% and an assumed time delay of 12 hr between barometric pressure changes and corresponding water-level response. The curve match shown in Figure C-7.2-5 appeared to be as accurate as those in previous plots. Thus, it was not possible to obtain a unique combination of time delay and barometric efficiency describing the relationship between atmospheric pressure and screen 3 water levels. Figure C-7.2-5 is presented because it is consistent with observations made of screen 3 water levels during the screen 4 pumping tests, described below.

Figure C-7.2-6 shows a plot of aquifer pressure data from R-31 screen 4 during the screen 3 pumping tests, along with barometric pressure data from TA-06 that have been corrected for a barometric efficiency of 50%. This barometric efficiency value was selected to be consistent with analysis of screen 4 background data collected during the screen 4 trial testing, described below. There was a steady rise in screen 4 water level relative to the position of the barometric pressure curve, likely a result of ongoing water-level recovery. Any time the well stood open, screen 4 water flowed steadily into the well and exited into the other screen zones. Thus, after the inflatable packers were set around the screen zones, screen 4 water levels showed gradual recovery over time.

The screen 4 hydrograph showed a diurnal sinusoidal effect having an amplitude of several hundredths of a foot, not seen in the barometric pressure curve. This was likely caused by Earth tides. There was no evidence of a response in screen 4 due to pumping screen 3.

An extensive set of water-level and barometric pressure data was obtained during trial testing at screen 4 because of the forced sitewide shutdown that delayed the 12-hr pumping test on screen 4 as well as the follow-up retrieval of the pressure transducers. With the transducers left in place, water-level data were recorded for approximately 1 week.

Figure C-7.2-7 shows a plot of aquifer pressure data from R-31 screen 2 during the screen 4 trial tests, along with barometric pressure data from TA-54 that have been corrected for a barometric efficiency of 60%. The times of the screen 4 trial tests are indicated on the graph for reference. The correlation between water levels and atmospheric pressure shown on the plot is not particularly good. It was not possible to obtain a good data match even when applying time delays and using other barometric efficiencies in the correction calculations. There was no apparent screen 2 response to pumping screen 4 during trial testing.

Figure C-7.2-8 shows a plot of aquifer pressure data from R-31 screen 3 during the screen 4 tests along with corrected TA-54 barometric pressure data. The data match shown was obtained for a time delay of 21 hr between barometric pressure changes and screen 3 water-level response, and for a barometric efficiency of 43%, the same percentage used in the plot shown in Figure C-7.2-5 for the screen 3 pumping tests. The data match shown on Figure C-7.2-8 was quite good.

As shown in Figure C-7.2-8, there was no apparent screen 3 water-level response to pumping screen 4 other than a slight increase in data scatter caused by “noise”—either electrical or mechanical—associated with running the submersible pump.

Figure C-7.2-9 shows a plot of aquifer pressure data from R-31 screen 4 during the screen 4 trial tests, along with barometric pressure data from TA-54 that have been corrected for a barometric efficiency of 50%—the same percentage applied to the screen 4 data shown in Figure C-7.2-6. The early data shown in Figure C-7.2-9 showed water-level recovery relative to the barometric pressure curve—a response to packing off the screen zones from one another, allowing screen 4 levels to recover from antecedent flow into the other zones. Following trial testing, there again was evident recovery of screen 4 water levels relative to the barometric pressure curve. The sinusoidal diurnal pattern seen in the hydrograph was likely caused by Earth tides.

C-7.3 Well R-31 Screen 2 Pumping Test Analysis

Figure C-7.3-1 shows water levels measured in the casing beneath screen 2 from August 22 to 24, 2019. The intermittent pumping was successful in maintaining the water level beneath the bottom of screen 2 for the entire 2468-min test period. Thus, maximum drawdown was applied to screen 2 for this period resulting in maximum inflow throughout the test.

A rolling average of the water-level data shown in Figure C-7.3-1 was used to compute the inflow rate between consecutive measurements. The inflow rate was based on the volume of casing that refilled during the time between measurements. A rolling average of water levels was needed because of noise, or data scatter, in the transducer output (not noticeable at the scale of Figure C-7.3-1). The volume calculation was based on assuming 0.809 gal. of fill per foot of annulus between the 5.047-in. inside diameter well casing and the 2-in. stainless-steel drop pipe. The resulting refill rate calculations are depicted in Figure C-7.3-2.

The initial refill rate was near 50 gallons per hour ([gph] off the scale of the graph) and declined steadily, reaching approximately 14 gph after half an hour. From 90 to 120 min, the refill rate averaged 4.98 gph. The flow rate continued to decline, eventually reaching approximately 2.6 gph at late time. It was likely that the greater initial yield was attributable to the transient, greater saturated thickness of the screen 2 zone caused by antecedent flooding from deeper zones that have higher static water levels.

Remarkably, the inflow rate actually increased slightly toward the end of the monitoring period. This could have been an indication of slight ongoing well development over time. The steady water production may have helped clean the screen, filter pack, and formation fractures somewhat.

In addition to the unavoidable data scatter shown in Figure C-7.3-2 associated with the accuracy limits of the transducer pressure measurements, there were large fluctuations, both above and below the average position of the graph, corresponding to periods of pump operation. Data points well above the average level on the graph represented the exaggerated flow rate calculations corresponding to early post-pumping recovery when water levels were in the area of the pump and shroud where the actual annular water volume was less than the value of 0.809 gallon per foot used in the calculations. Data points below the average graph position represented periods of pump operation when the computed refill rate value was a negative number.

The data from Figure C-7.3-2 were used to calculate specific drawdown—the ratio of drawdown to flow rate. For these calculations, thinning of the saturated zone was assumed to have continued well after the time that the false high static water level had been observed. The effective baseline water level was assumed to have reached the estimated static level of 538.19 ft bgs, particularly at late time when the inflow rate appeared to stabilize. At this water level, the saturated length (and drawdown) at screen 2 was 7.51 ft. This drawdown was corrected for dewatering, yielding 3.76 ft of theoretical drawdown. Figure C-7.3-3 shows the resulting specific drawdown plot.

The data from Figure C-7.3-3 were replotted as a rolling average, shown in Figure C-7.3-4, to reduce the amount of data scatter. The transmissivity calculated from the line of fit shown on the graph was 4.9 gallons per day(gpd)/ft. This value represents an underestimate of the true value because of the steady thinning of the aquifer that occurred during the test. This was not unlike the effect of a negative boundary on a conventional time-drawdown graph.

Later data were not as affected by ongoing thinning of the aquifer and were used to try to improve on the transmissivity estimate. Figure C-7.3-5 shows a line of fit using intermediate data up to the point where the specific drawdown began decreasing. The transmissivity computed from the analysis was 13.7 gpd/ft—probably a more realistic value than the early-time value.

The late specific drawdown values decreased, consistent with the slight increase in inflow rate observed at late time in Figure C-7.3-2. Again, this suggested the possibility of increasing well efficiency with continued pumping.

The transmissivity value implied by this analysis may be considered approximate. However, the degree of confidence in it should not be as great as typically applied to pumping test values because of the ongoing and unknown thinning of the aquifer that occurred during the test, as well as the significant noise (data scatter) in the transducer output.

C-7.4 Well R-31 Screen 2 Specific Capacity

Specific capacity data were used along with well geometry to estimate a lower-bound transmissivity value for the permeable zone penetrated by R-31 screen 2 to provide a frame of reference for evaluating the foregoing analysis.

Fully penetrating conditions were assumed, so rather than using the Brons and Marting method (1961, 098235), the lower-bound transmissivity was calculated by iterating the Cooper-Jacob equation (Cooper and Jacob 1946, 098236). An arbitrary pumping time of 750 min was used for the analysis. Because of substantial scatter in the recorded data, numerous head readings before and after 750 min were averaged to identify a representative specific drawdown of 80.8 ft/gpm. This corresponded to an inflow rate of 0.0465 gpm with a theoretical drawdown of 3.76 ft for a specific capacity of 0.0124 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included a range of storage coefficient values from 0.001 to 0.01 and a borehole radius of 0.51 ft (based on the 12.25-in. borehole size). Even though unconfined conditions were assumed, basalt is expected to have very low porosity and, therefore, a low storage coefficient.

Applying the Cooper-Jacob method to these inputs yielded the lower-bound hydraulic transmissivity estimates shown in Figure C-7.4-1. According to the figure, they range from approximately 9 to 13 gpd/ft, consistent with the result from the specific drawdown plot.

C-7.5 Well R-31 Screen 3 Pumping Test Analysis

This section presents drawdown and recovery data recorded during the screen 3 trial tests and the 11-hr pumping test. Unfortunately, the data did not support a definitive determination of aquifer parameters for two reasons.

First, the water produced from R-31 showed effervescence, a common occurrence in many of the R-wells on the Plateau. The air/gas produced by screen 3 appeared to build up both within the well and within the pores/fractures near the borehole. Modest gas accumulation within the well caused a minor storage-like effect, effectively negating the value of the very early test data. Gas buildup within the formation near the well appeared to cause a gradual, dynamic change in well efficiency during pumping, altering the slopes of the drawdown graphs.

Second, the data suggested a highly transmissive aquifer despite the relatively modest yield of screen 3. This implied a limited hydraulic connection between the well and the transmissive portion of the aquifer, not unusual in partially penetrating fractured bedrock wells.

Figure C-7.5-1 shows a semilog plot of the drawdown data collected during trial 1 at R-31 screen 3 at a pumping rate of 6.6 gpm. The first two data points on the graph showed exaggerated drawdown while the discharge piping filled. During initial filling of the pipe, there was no artificial backpressure on the pump so the pumping rate was a maximum—likely more than 10 gpm. Once the discharge piping filled and water reached the flow control valve, backpressure built up and the discharge rate dropped to 6.6 gpm.

The drawdown data were replotted at an expanded scale shown in Figure C-7.5-2. Although a transmissivity value (2170 gpd/ft) was computed from the line of fit shown on the graph, it was identified as "apparent" because it was likely just an artifact of gradually declining well efficiency rather than a true value. (This conclusion will be illustrated below by comparing drawdown and recovery data from the trial 2 test.)

Figure C-7.5-3 shows a semilog plot of the screen 3 recovery data collected during trial 1. The transmissivity value (5320 gpd/ft) computed from the line of fit on the plot was again not considered representative of formation properties. Subsequent testing, described next, indicated that the typical recovery pattern showed a steep initial slope, gradually flattening to a horizontal line. Thus, *any transmissivity* value could be computed, depending on which portion of the data set was used in the calculations.

The recovery data were plotted on an expanded scale as a rolling average as shown in Figure C-7.5-4. The calculated transmissivity from the late data was 106,000 gpd/ft. The accuracy of this value may be in question because the magnitude of the data scatter, even using a rolling average of the data, was large in comparison with the change in water level over time.

Figure C-7.5-5 shows a semilog plot of the drawdown data collected during trial 2 at R-31 screen 3. Even though the discharge piping remained filled following trial 1, the data showed exaggerated drawdown initially (for a second or two). This may have been an indication of inertial effects. Another possible cause is gas accumulation within the drop pipe following trial 1, as residual effervescence collected at the top of the drop pipe. A tiny volume of trapped gas would temporarily negate the backpressure from the discharge valve until the void were refilled/repressurized, thus resulting in a brief, transient exaggerated discharge rate.

Figure C-7.5-6 shows an expanded-scale plot of the drawdown data. Although a transmissivity value (2060 gpd/ft) was computed from the line of fit shown on the graph, it was identified as "apparent" because it was likely just an artifact of gradually declining well efficiency rather than a true value.

Figure C-7.5-7 shows a semilog plot of the screen 3 recovery data collected during trial 2. The data showed an initial steep slope, probably a storage effect from gas buildup within the well, followed by a gradual flattening to a horizontal slope. Thus, *any transmissivity* could be calculated from the data, depending on the line of fit's placement on the graph.

Figures C-7.5-8 and C-7.5-9 show expanded scale plots of the recovery data, including a rolling average plot. These graphs highlight the fact that any arbitrary slope could be obtained from the data, as a function of which portion of the data set was used. The early data (steep slope) were not analyzable because of storage effects. The late data (flat slope) suggested a very high transmissivity for the basalt aquifer.

The trial 2 drawdown and recovery data were compared to illustrate the "non-usability" of the data for determining aquifer coefficients. Figure C-7.5-10 shows a plot of both drawdown and magnitude of recovery versus time. Figure C-7.5-11 shows the data plotted on an expanded scale for easier comparison.

Theoretically, these curves should coincide at early time. Clearly, they do not. The drawdown data should show the same slope as the recovery data but, instead, showed a much steeper slope. This discrepancy suggested an artificial dynamic increase in drawdown over time, explainable only by a gradually declining well efficiency. Consequently, the drawdown data could not be used for determining aquifer coefficients. The recovery data were unusable also, showing an initial artificially steep slope (storage related) that gradually transitioned to a horizontal slope. The flat late slope did, however, suggest a very high aquifer transmissivity.

Figure C-7.5-12 shows a semilog plot of the drawdown data collected during the 11-hr test at R-31 screen 3. Curiously, the discharge rate started out at 6.7 gpm but increased to 7.0 gpm after about 90 min. There was no obvious explanation for the unusual spontaneous rate increase. Although a transmissivity value (780 gpd/ft) was computed from the line of fit shown on the graph, it was identified as "apparent" because, as in previous drawdown plots, it was likely just an artifact of gradually declining well efficiency rather than a true transmissivity value.

Figure C-7.5-13 shows a semilog plot of the screen 3 recovery data collected following the 11-hr test. The data showed an initial steep slope, probably storage affected from gas buildup within the well, followed by a gradual flattening to a horizontal slope. Thus, as seen on the previous recovery plots, *any transmissivity* could have been calculated from the data, depending on which portion of the recovery curve was used. As in the previous tests, the flat recovery slope suggested a very high transmissivity for the Cerros del Rio Basalt.

Figure C-7.5-14 sows a comparison of recovery data from trial 2 and the 11-hr pumping test. The plot shows specific recovery (ratio of recovery to discharge rate) versus recovery time. The two curves matched, exhibiting the same response. Calculation of transmissivity using the early, steep slope yielded an impossibly low value, while the late, nearly horizontal slope led to an impossibly large value. In between, any arbitrary value of transmissivity could be computed. The transition from steep slope to flat slope was smooth and continuous, making it impossible to identify a representative section of the data set that might reveal true aquifer coefficients.

C-7.6 Well R-31 Screen 3 Specific Capacity

Specific capacity data were used along with well geometry to estimate a lower-bound hydraulic conductivity value for the permeable zone penetrated by R-31 screen 3.

An arbitrary aquifer thickness of 50 ft was assigned in the calculations. After 11 hr of operation, R-31 screen 3 produced 7.0 gpm with 36.6 ft of drawdown. In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient value of 10^{-4} and a borehole radius of 0.55 ft (based on the 13-1/8 in. borehole size).

Applying the Brons and Marting (1961, 098235) method to these inputs yielded a lower-bound hydraulic conductivity estimate for the screened interval of 15.8 gpd/ft^2, or 2.1 ft/day.

C-7.7 Well R-31 Screen 4 Pumping Test Analysis

This section presents drawdown and recovery data recorded during the R-31 screen 4 trial tests and the 12-hr pumping test.

Figure C-7.7-1 shows a semilog plot of the drawdown data collected during trial 1 at R-31 screen 4 at a pumping rate of 10.7 gpm. The transmissivity computed from the earliest data on the graph was 710 gpd/ft. This likely corresponded to a formation thickness roughly equal to the well screen length of 10 ft, making the hydraulic conductivity approximately 71 gpd/ft^2, or 9.5 ft/day. Later data showed flattening of the curve and a greater transmissivity, presumably corresponding to a greater, unknown thickness of sediments. Subsequent tests described below, having longer pumping periods, showed continued flattening corresponding to continued vertical expansion of the cone of depression over time.

Figure C-7.7-2 shows a semilog plot of screen 4 recovery data collected following trial 1. The transmissivity computed from the early slope on the graph was 520 gpd/ft, corresponding to a hydraulic conductivity of 52 gpd/ft^2, or 7.0 ft/day. Later recovery data showed the expected flattening of the curve associated with vertical expansion of the cone of impression.

Figure C-7.7-3 shows a semilog plot of the drawdown data from screen 4 collected during trial 2 at a discharge rate of 10.8 gpm. The first few data points showed inertial effects associated with pump startup. The transmissivity computed from the early slope on the graph was 530 gpd/ft, corresponding to a hydraulic conductivity of 53 gpd/ft^2, or 7.1 ft/day. Subsequent data showed flattening of the curve similar to that observed during trial 1. During the last half of the trial 2 pumping period, the slope of the drawdown graph continued to decline further in response to ongoing vertical growth of the cone of depression and leakage from adjacent water-bearing strata.

Figure C-7.7-4 shows a semilog plot of screen 4 recovery data collected following trial 2. The transmissivity computed from the early slope on the graph was 510 gpd/ft, corresponding to a hydraulic conductivity of 51 gpd/ft^2, or 6.8 ft/day. Later recovery data showed the expected flattening of the curve associated with vertical expansion of the cone of impression.

Figure C-7.7-5 shows a semilog plot of the drawdown data from screen 4 collected during the 12-hr pumping test. The initial discharge rate was 10.8 gpm but declined gradually to 10.7 gpm during the test. The transmissivity computed from the early slope on the graph was 660 gpd/ft, corresponding to a hydraulic conductivity of 66 gpd/ft^2, or 8.8 ft/day. Subsequent data showed flattening of the curve in response to vertical expansion of the cone of depression.

Figure C-7.7-6 shows a semilog plot of screen 4 recovery data collected following the 12-hr test. The transmissivity computed from the early slope on the graph was 580 gpd/ft, corresponding to a hydraulic conductivity of 58 gpd/ft^2, or 7.8 ft/day. Later recovery data showed the expected continuous flattening of the curve associated with vertical expansion of the cone of impression.

Table C-7.7-1 summarizes the transmissivity values obtained for the screened interval at R-31 screen 4. The computed values averaged 585 gpd/ft, making the estimated hydraulic conductivity 58.5 gpd/ft^2, or 7.8 ft/day.

C-7.8 Well R-31 Screen 4 Specific Capacity

Specific capacity data were used along with well geometry to estimate a lower-bound transmissivity value for the permeable zone penetrated by R-31 screen 4.

An arbitrary aquifer thickness of 50 ft was assigned in the calculations. After 12 hr of operation, R-31 screen 4 produced 10.7 gpm with 19.4 ft of drawdown. In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient value of 5×10^{-4} and a borehole radius of 0.45 ft (based on the 10-3/4 in. borehole size at screen 4).

Applying the Brons and Marting (1961, 098235) method to these inputs yielded a lower-bound hydraulic conductivity estimate for the screened interval of 47.5 gpd/ft^2, or 6.4 ft/day. This result was reasonable, providing corroboration of the pumping test value and suggesting a fairly efficient well.

C-7.9 Well R-31 Screens 2, 3 and 4 Summary

Pumping tests were conducted on R-31 screens 2, 3, and 4 to gain an understanding of the flow capacity of the screens, evaluate the effectiveness of jet development, and assess the hydraulic characteristics of the screened intervals. Several important observations and conclusions from the test pumping include the following:

- The formation is extremely tight at screen 2. The likely sustained yield is approximately 2.6 gph.
- Higher yield was obtained at early time. This was because water from screens 4 and 5 (at greater head) flows into screen 2 when the well is open, temporarily increasing the saturated thickness. For example, initially, the inflow rate was near 50 gph. After 30 min, it was approximately 14 gph and from 90 to 120 min it averaged 4.98 gph.
- Test pumping yielded a low estimated transmissivity in the range of about 14 gpd/ft.
- The saturated thickness at the outset of testing was 10.04 ft but aquifer thinning occurred during testing. The projected actual saturated thickness that would occur in the absence of flooding from screens 4 and 5 was 7.51 ft.
- Screen 2 produced a theoretical specific capacity of 0.0124 gpm/ft (after correcting for dewatering). This implied an estimated lower-bound transmissivity of 9 to 13 gpd/ft (consistent with the pumping test value) assuming a saturated thickness of 7.51 ft.
- Screens 3 and 4 showed moderate barometric efficiency, atypical of deep wells on the Pajarito Plateau.
- Screen 4 water levels showed distinct diurnal fluctuations indicative of Earth tide effects. The basalt intervals (screens 2 and 3) did not show this effect.
- The Cerros del Rio basalt at screen 3 appeared to be highly transmissive. However, the relatively low yield of screen 3 suggested that the screen zone was not well connected to the highly permeable sections of the aquifer—not unusual in partially penetrating rock wells.
- It was not possible to quantify aquifer properties at screen 3 using the pumping test results. Gas/air accumulation during pumping induced storage effects and caused dynamic reductions in well efficiency. Both phenomena altered drawdown and recovery data slopes.
- While the Cerros del Rio appeared to be enormously permeable, the low specific capacity of screen 3 implied a lower-bound hydraulic conductivity limit of just 2.1 ft/day adjacent to screen 3.
- The screen 4 pumping test suggested an average transmissivity for the 10-ft screened interval of 585 gpd/ft, making the estimated hydraulic conductivity 58.5 gpd/ft^2, or 7.8 ft/day.
- Specific capacity data for screen 4 were consistent with this result, implying a lower-bound conductivity of 47.5 gpd/ft^2, or 6.4 ft/day.
- In all tests, pumping a given screen zone had no effect on water levels in the other zones.
- Simultaneous high-velocity jetting and pumping was effective, improving the yields of screens 2, 3, and 4, beyond that achieved with swabbing, by 92%, 70%, and 50%, respectively.

C-8.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by 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). IDs are used to locate documents in Newport News Nuclear BWXT-Los Alamos, LLC's (N3B's) Records Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

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

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

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

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

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

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

Neuman, S.P., April 1974. "Effect of Partial Penetration on Flow in Unconfined Aquifers Considering Delayed Gravity Response," *Water Resources Research,* Vol. 10, No. 2, pp. 303-312. (Neuman 1974, 085421)

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

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

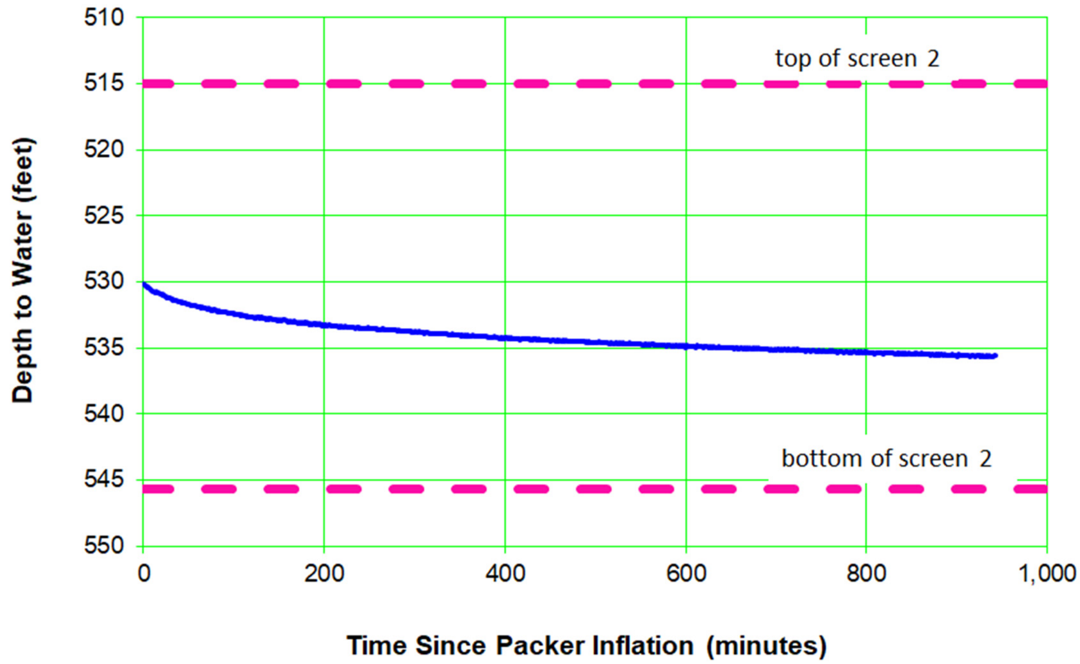


Figure C-7.1-1 R-31 screen 2 equilibration response

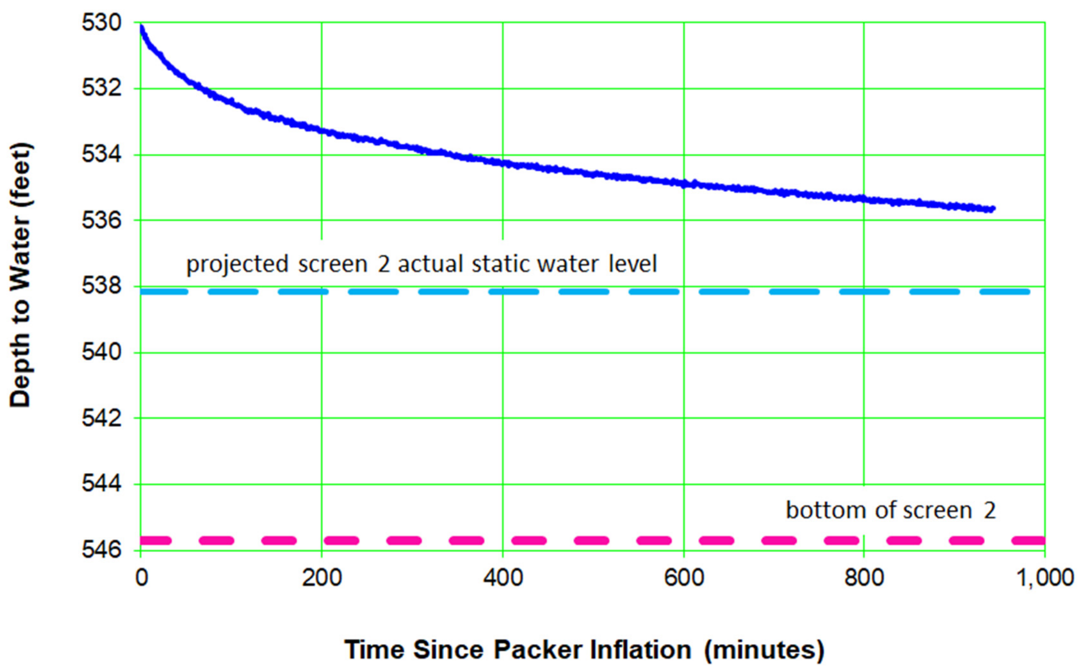


Figure C-7.1-2 R-31 screen 2 equilibration response—expanded scale

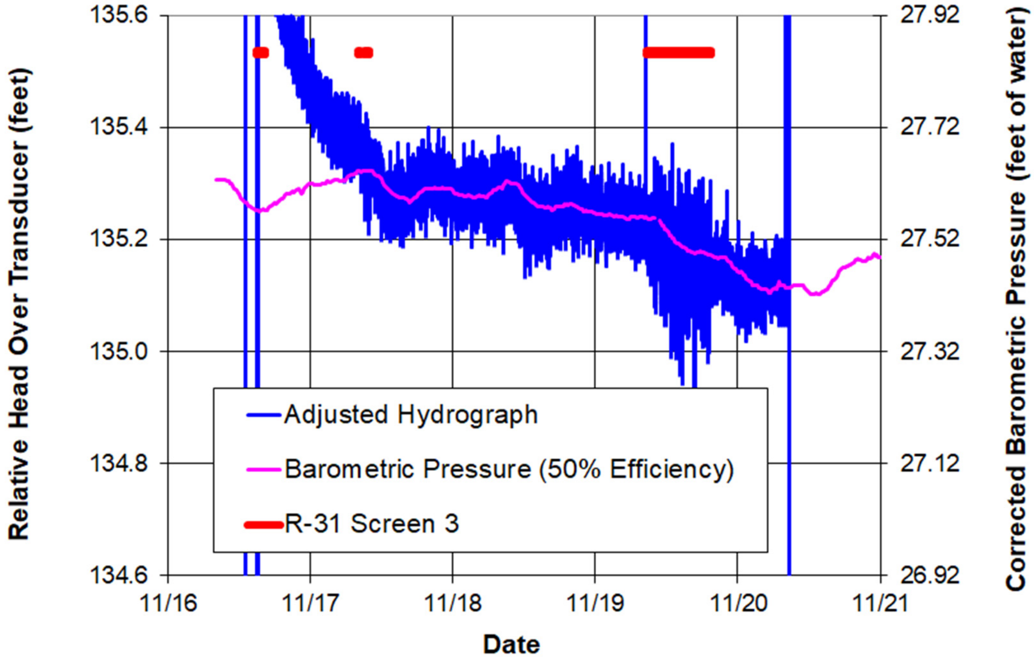


Figure C-7.2-1 R-31 screen 2 adjusted hydrograph during screen 3 pumping tests

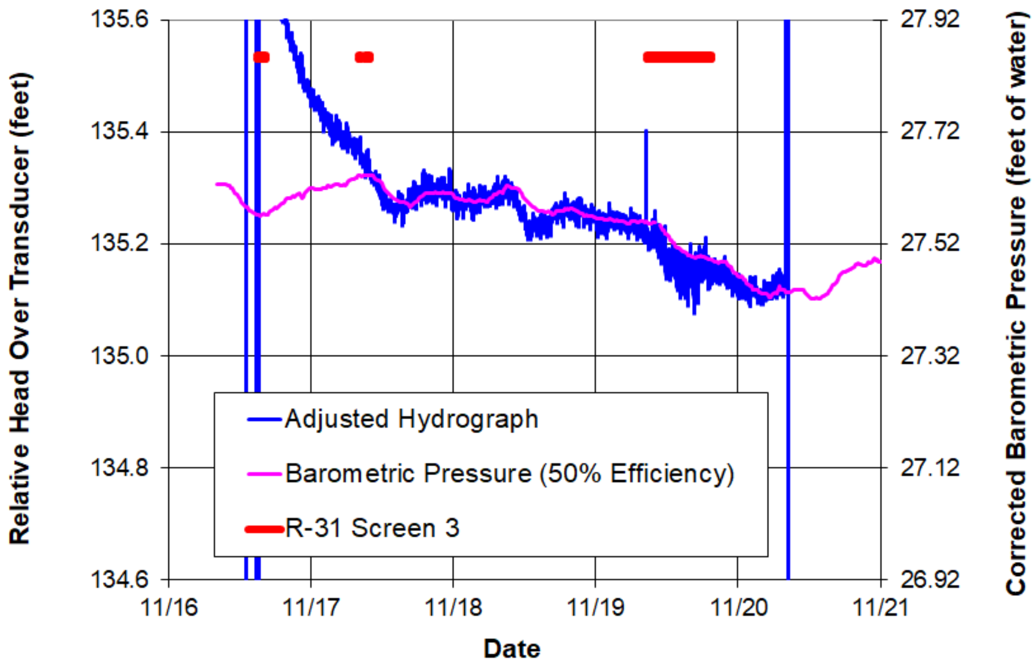


Figure C-7.2-2 R-31 screen 2 rolling average hydrograph during screen 3 pumping tests

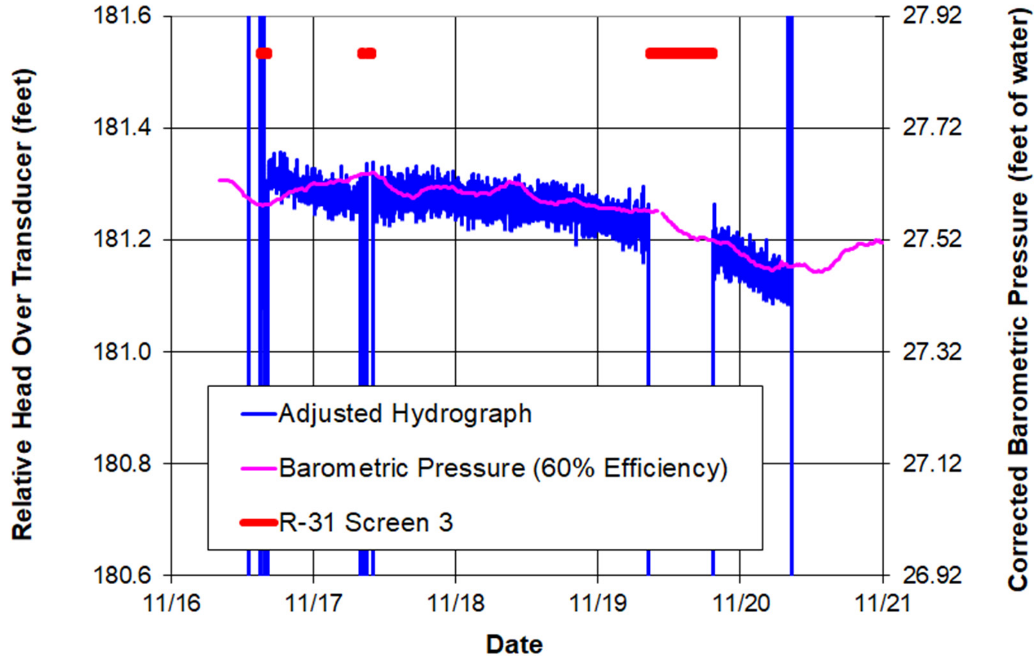


Figure C-7.2-3 R-31 screen 3 adjusted hydrograph during screen 3 pumping tests

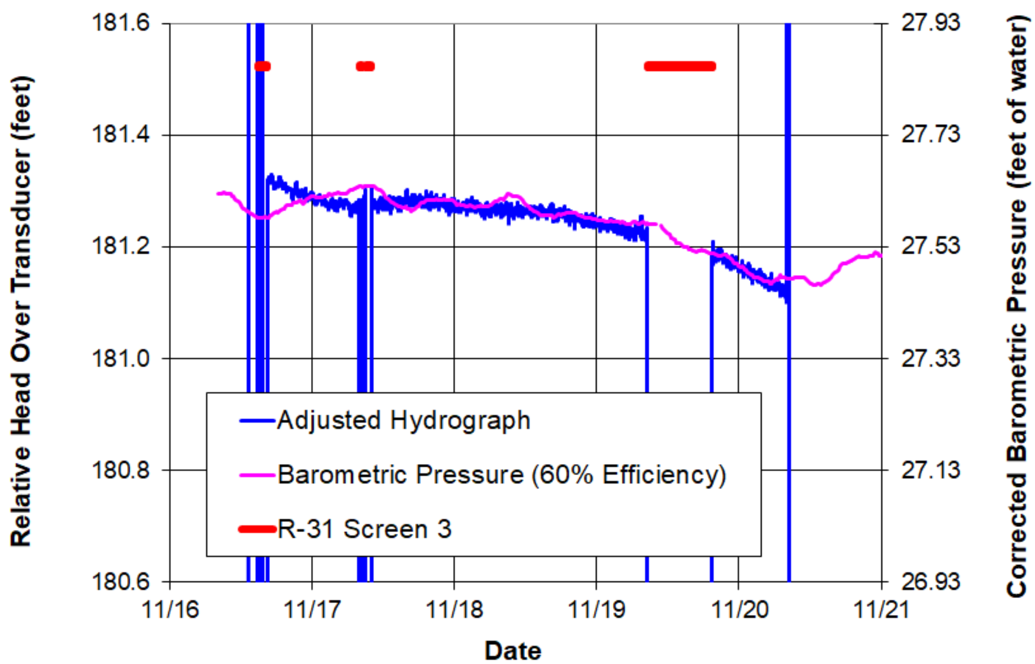


Figure C-7.2-4 R-31 screen 3 rolling average hydrograph during screen 3 pumping tests

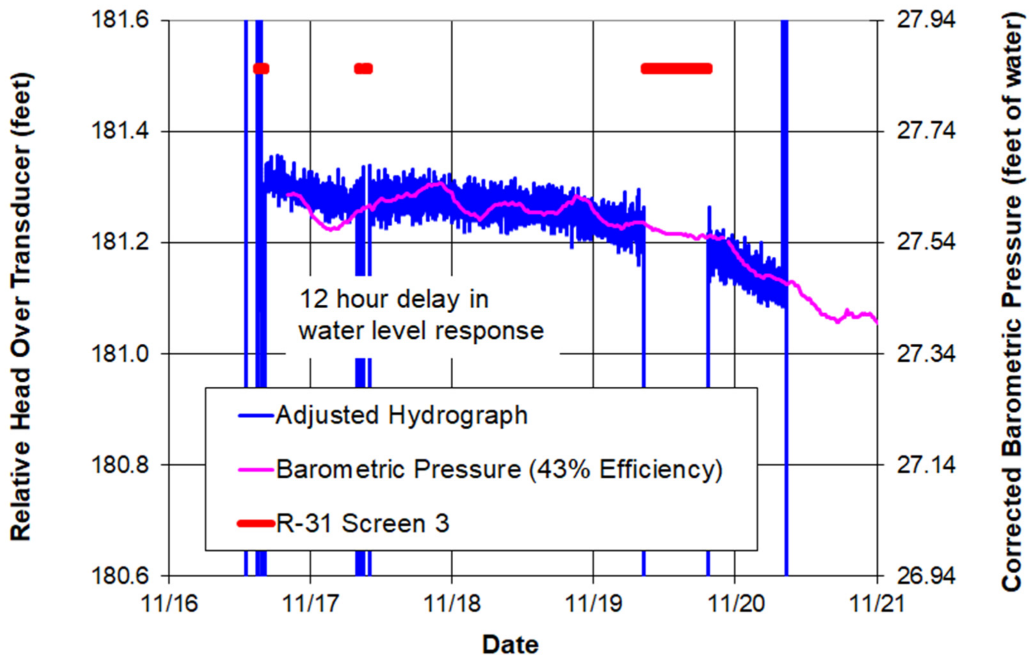


Figure C-7.2-5 R-31 screen 3 adjusted hydrograph during screen 3 pumping tests with 12-hr time delay

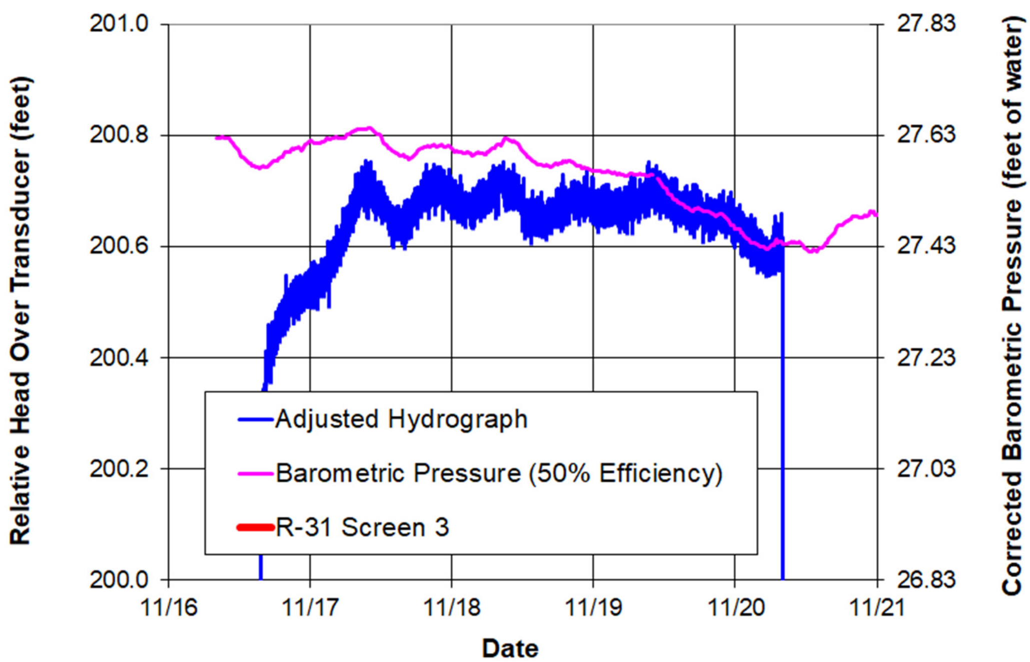


Figure C-7.2-6 R-31 screen 4 adjusted hydrograph during screen 3 pumping tests

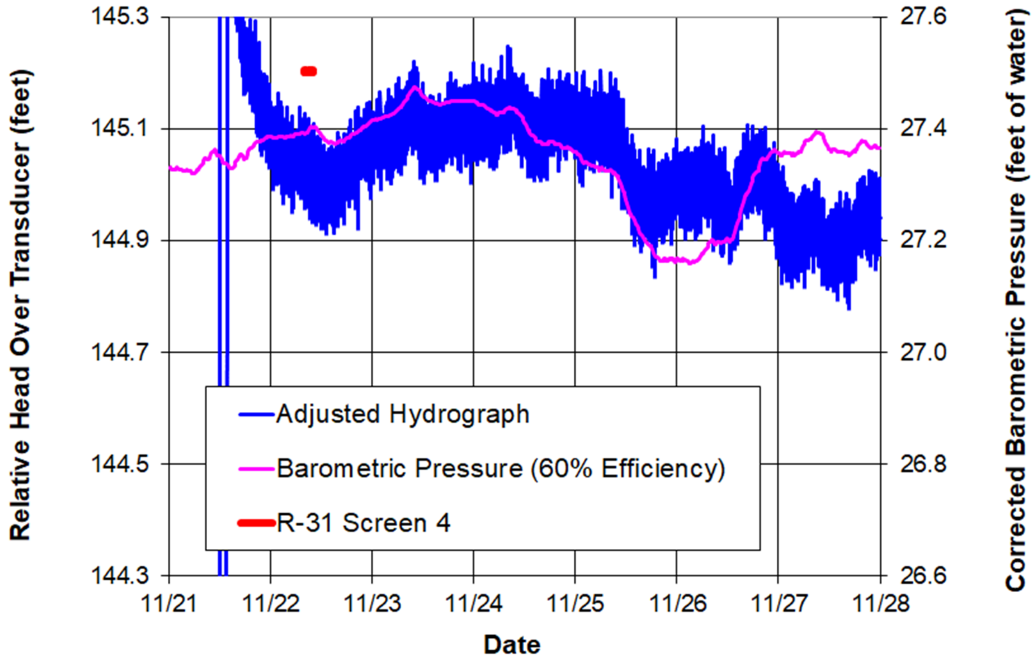


Figure C-7.2-7 R-31 screen 2 adjusted hydrograph during screen 4 trial tests

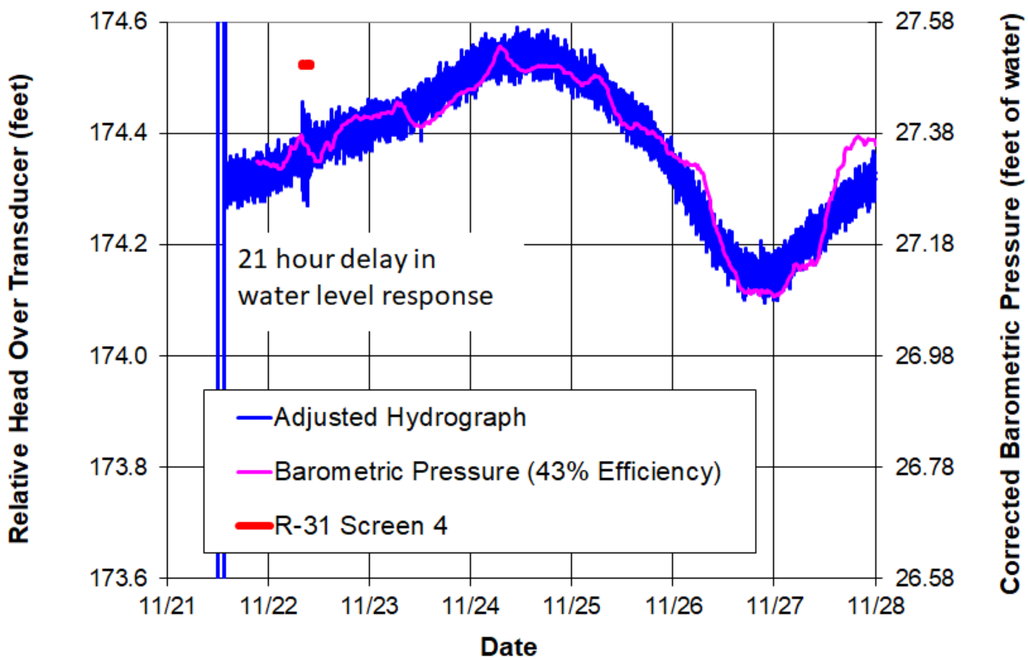


Figure C-7.2-8 R-31 screen 3 adjusted hydrograph during screen 4 trial tests with 21-hr time delay

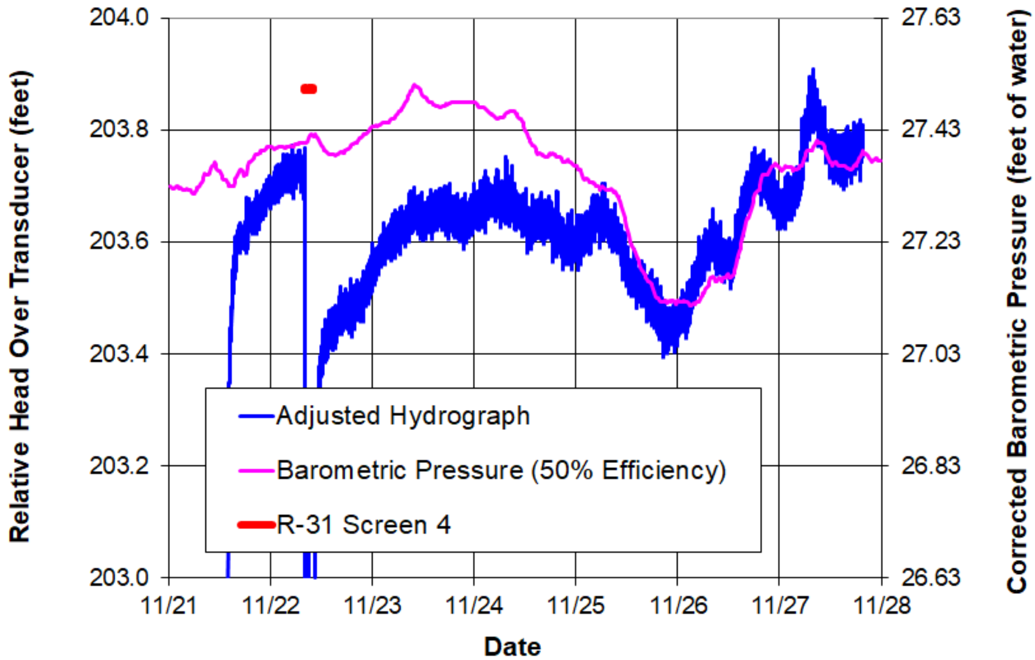


Figure C-7.2-9 R-31 screen 4 adjusted hydrograph during screen 4 trial tests

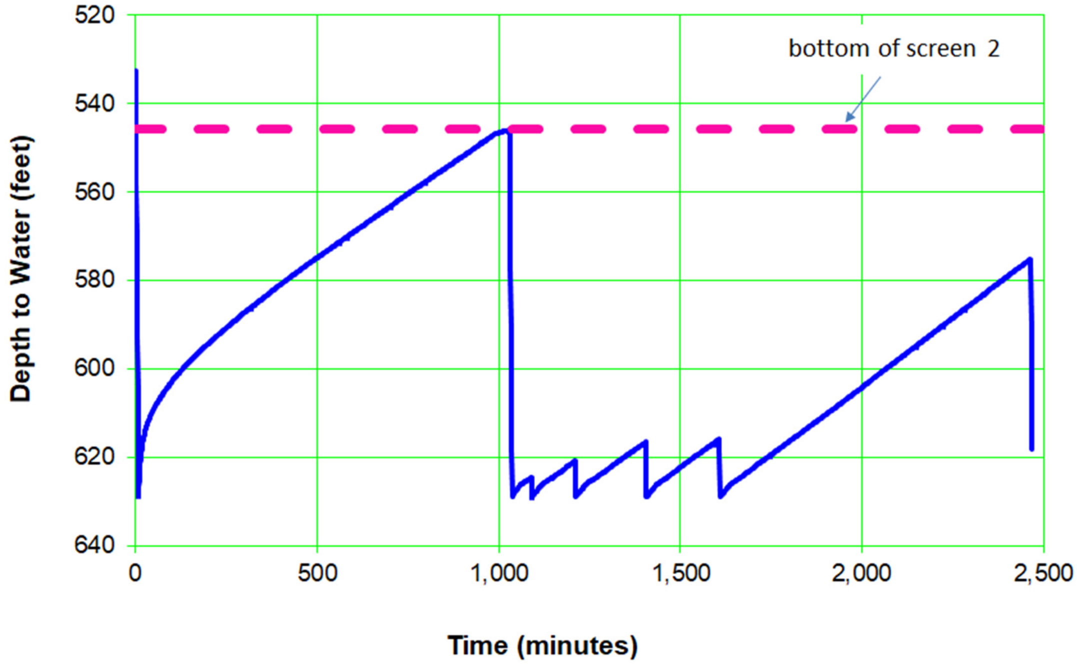


Figure C-7.3-1 R-31 screen 2 pumping and refill response

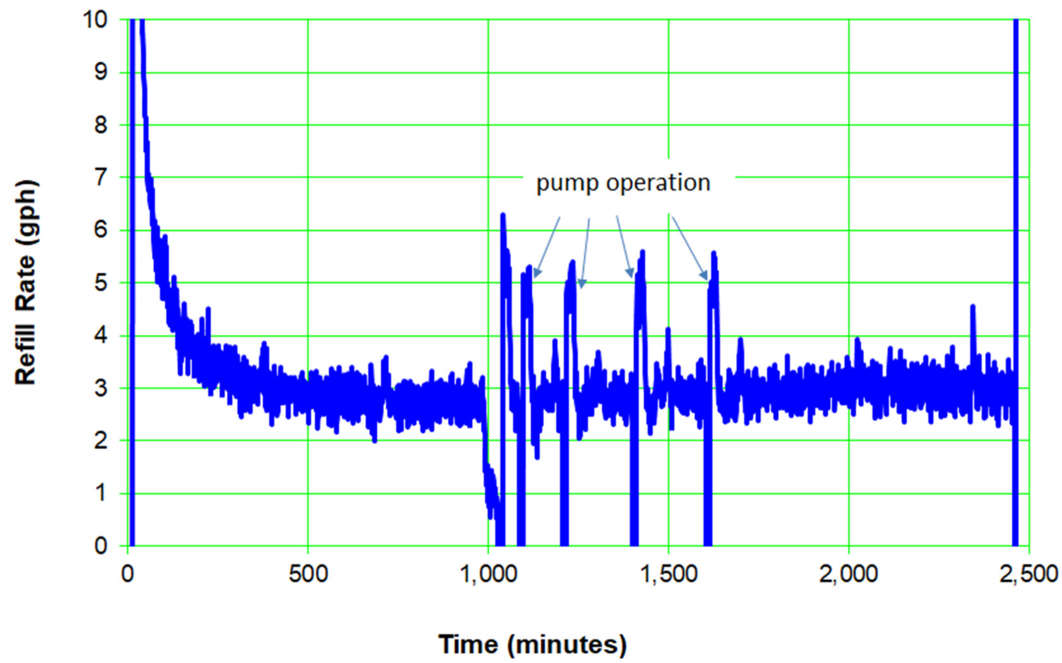


Figure C-7.3-2 R-31 screen 2 refill rate

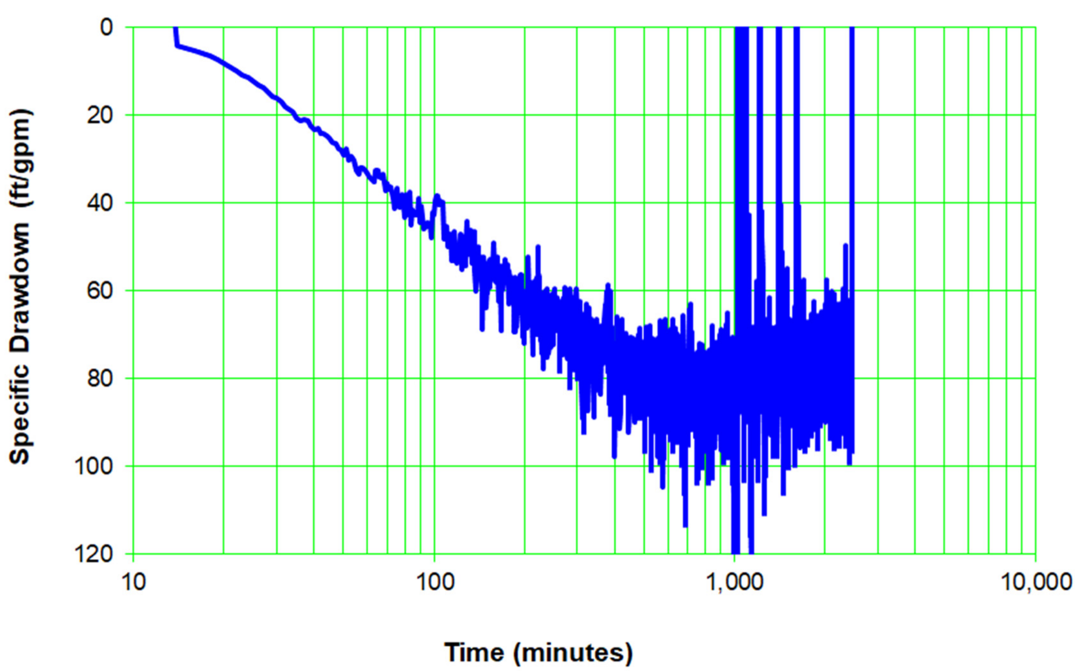


Figure C-7.3-3 R-31 screen 2 specific drawdown

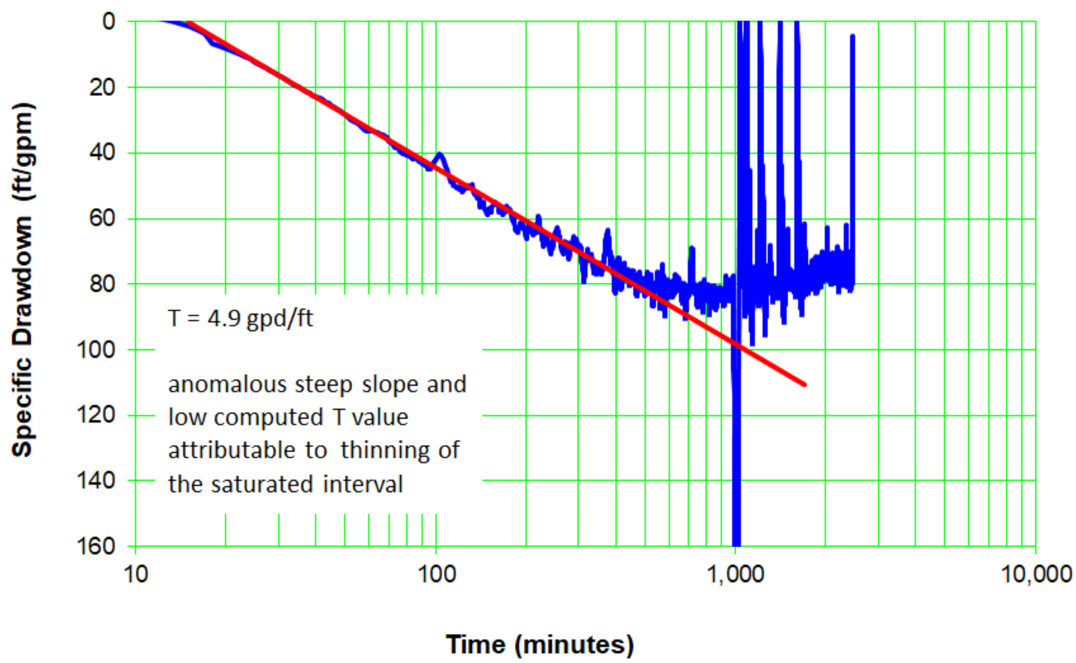


Figure C-7.3-4 R-31 screen 2 specific drawdown—rolling average

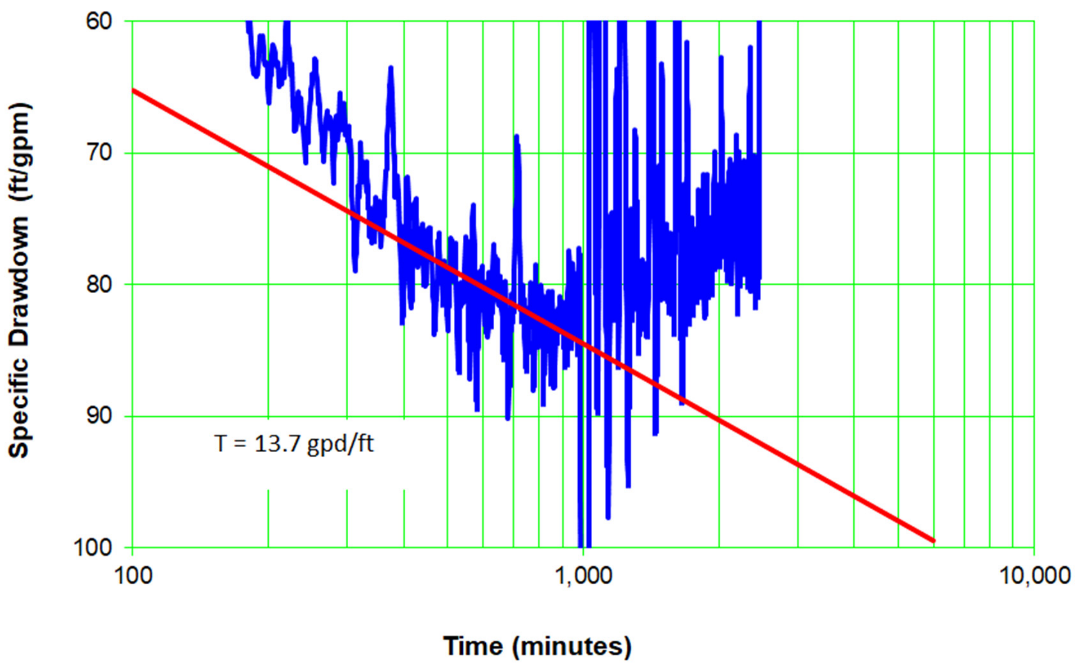


Figure C-7.3-5 R-31 screen 2 specific drawdown—intermediate data

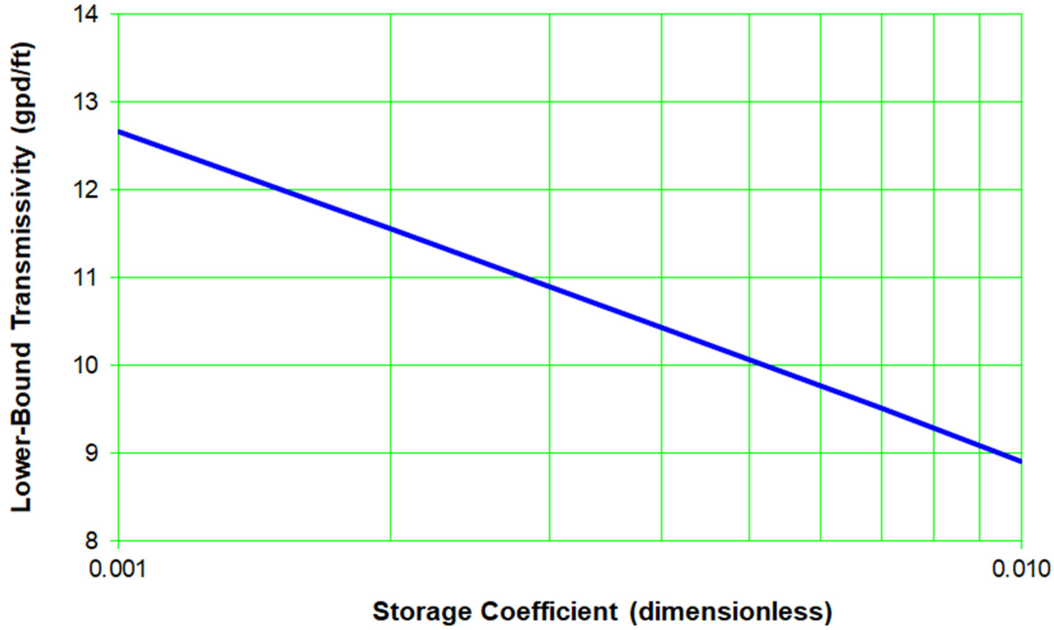


Figure C-7.4-1 R-31 screen 2 lower-bound transmissivity

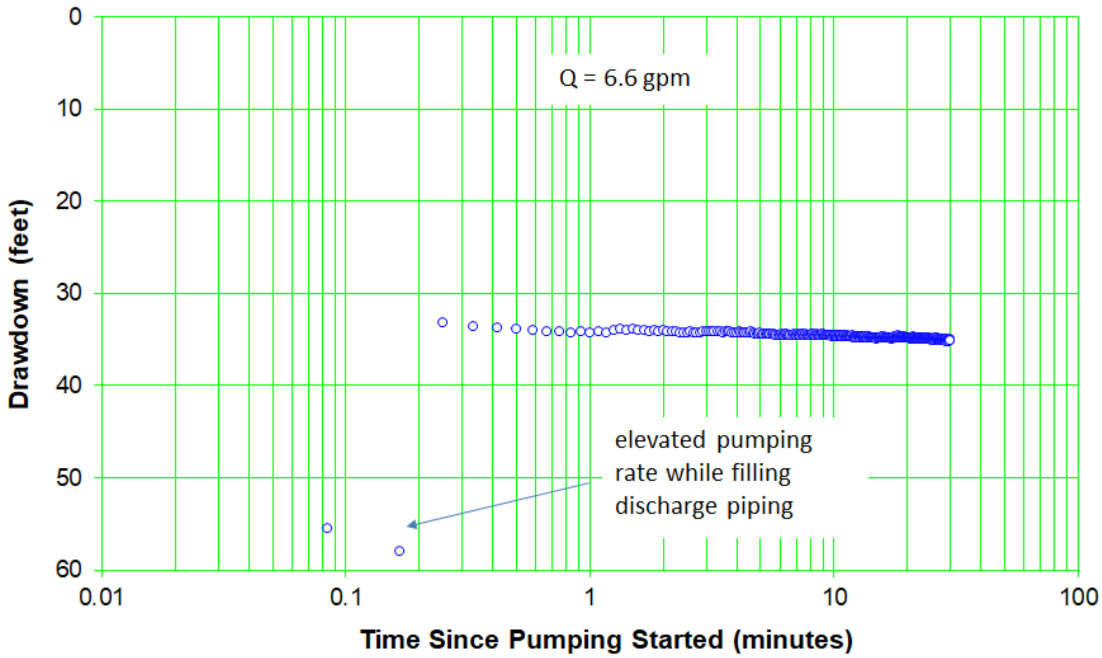


Figure C-7.5-1 Well R-31 screen 3 trial 1 drawdown

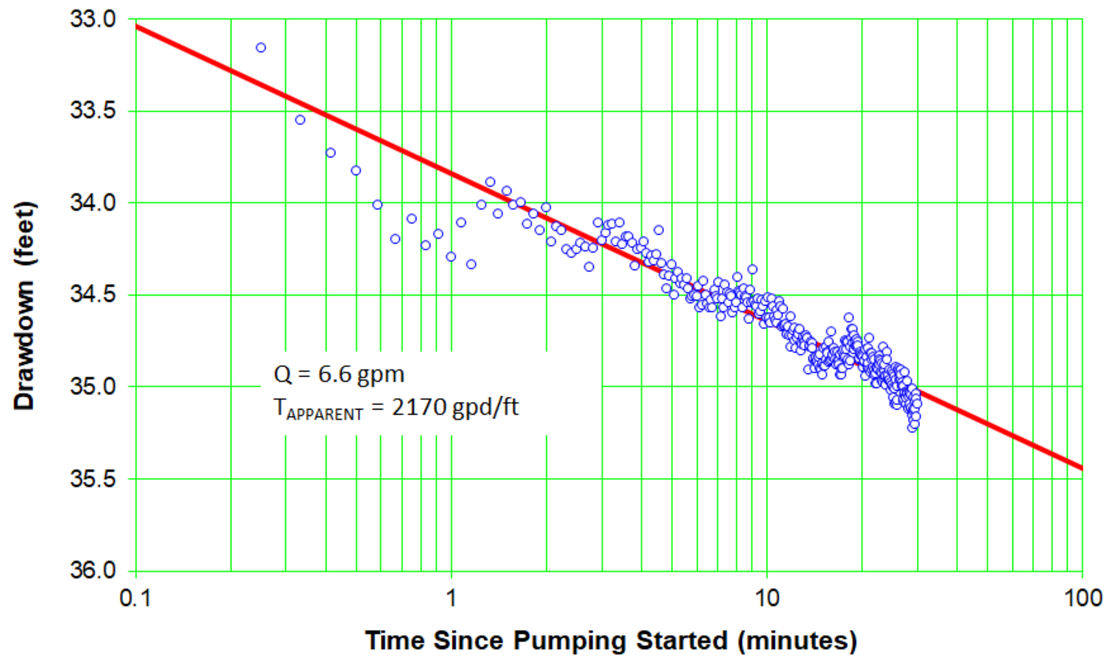


Figure C-7.5-2 Well R-31 screen 3 trial 1 drawdown—expanded scale

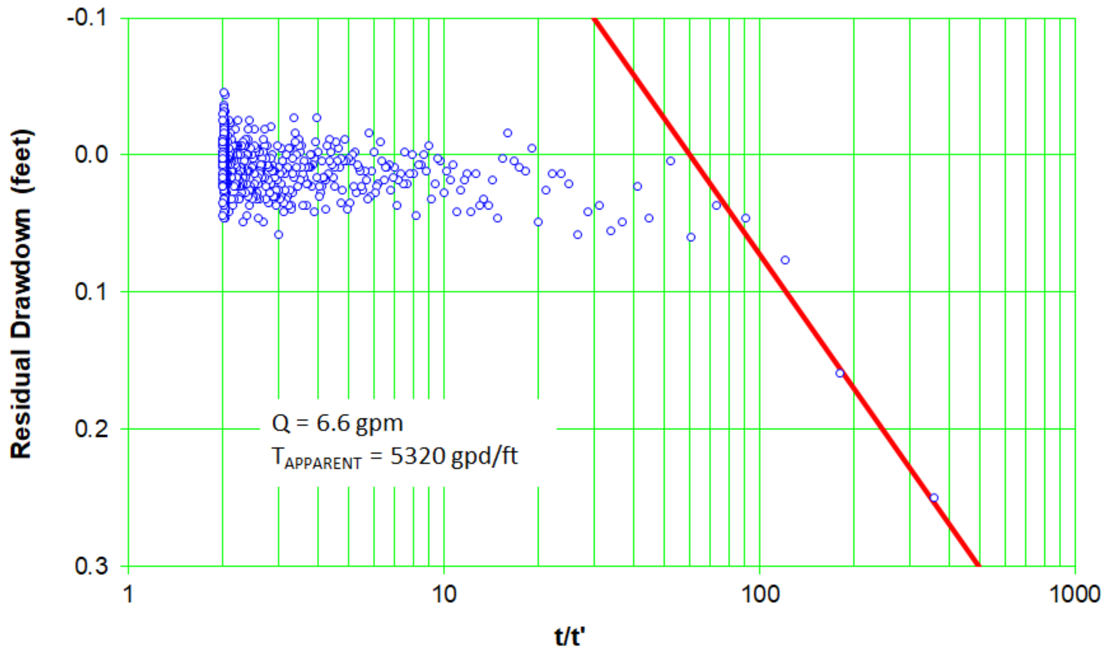


Figure C-7.5-3 Well R-31 screen 3 trial 1 recovery

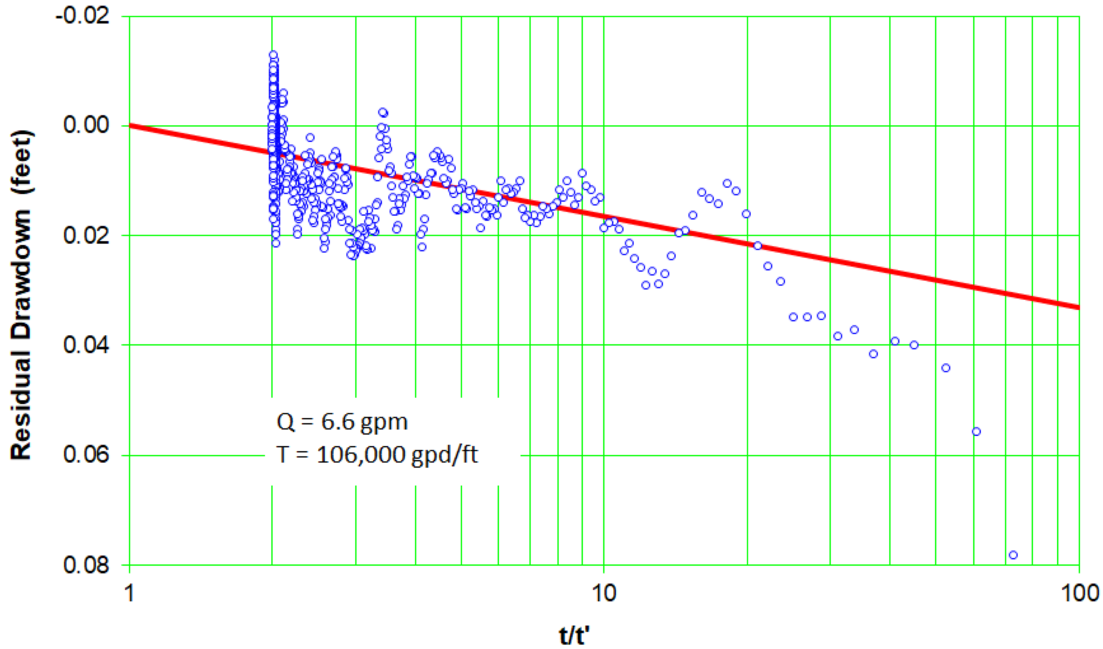


Figure C-7.5-4 Well R-31 screen 3 trial 1 recovery—rolling average

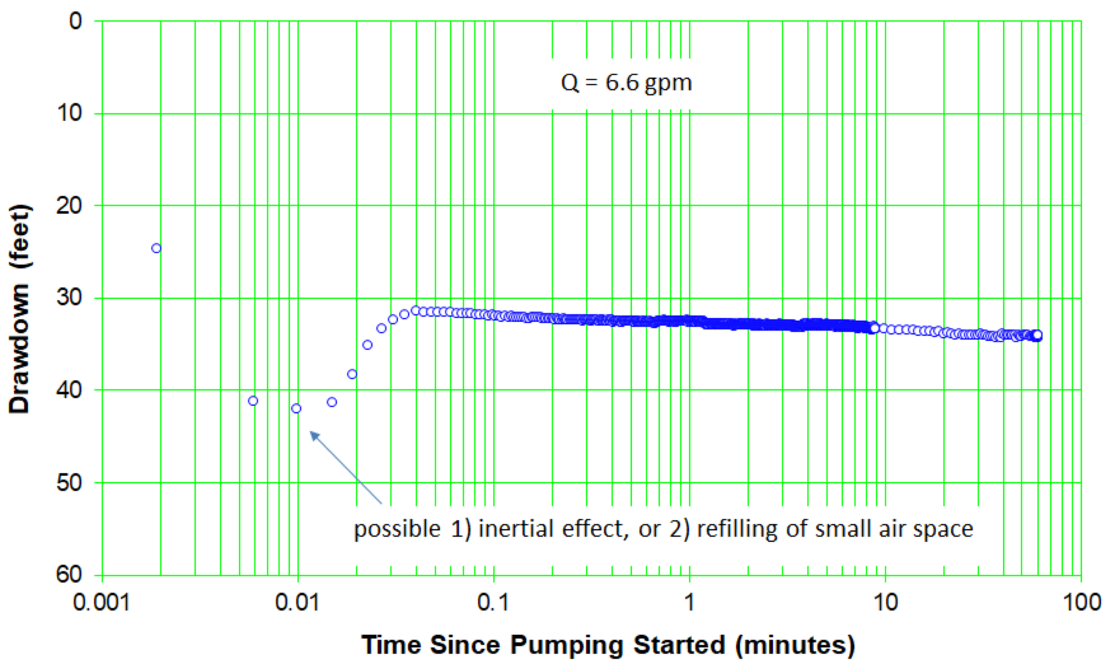


Figure C-7.5-5 Well R-31 screen 3 trial 2 drawdown

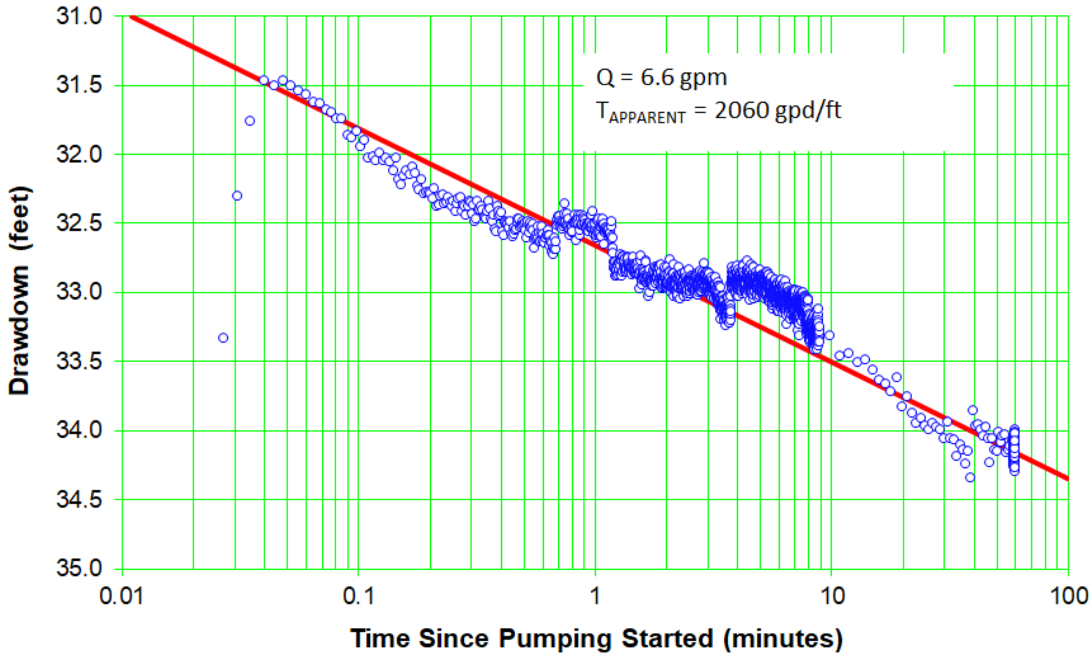


Figure C-7.5-6 Well R-31 screen 3 trial 2 drawdown—expanded scale

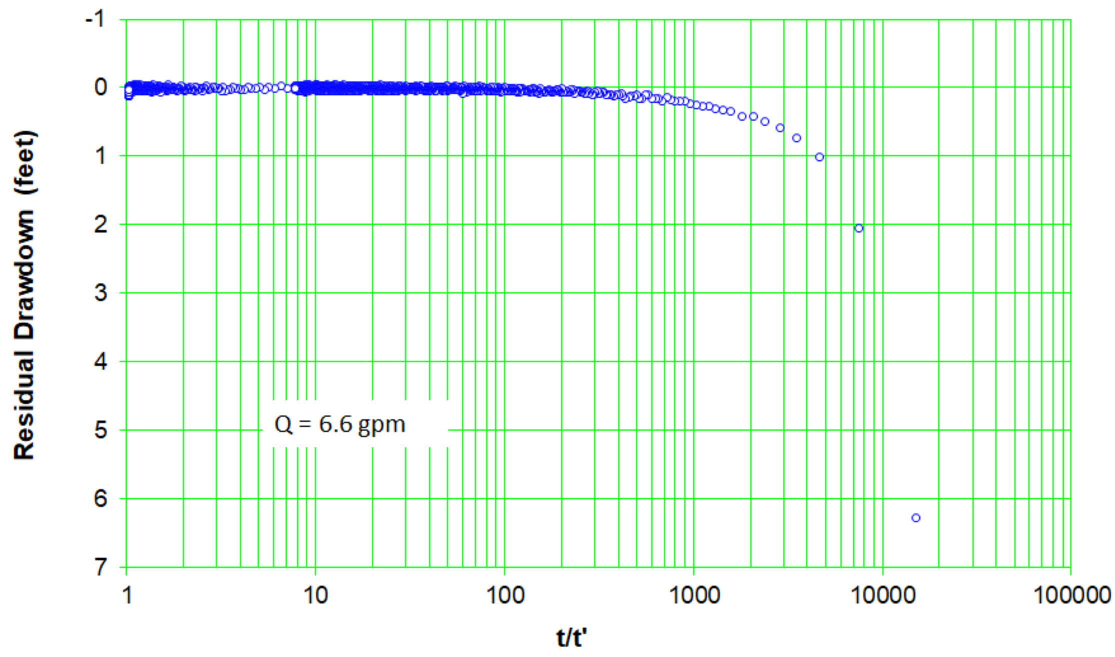


Figure C-7.5-7 Well R-31 screen 3 trial 2 recovery

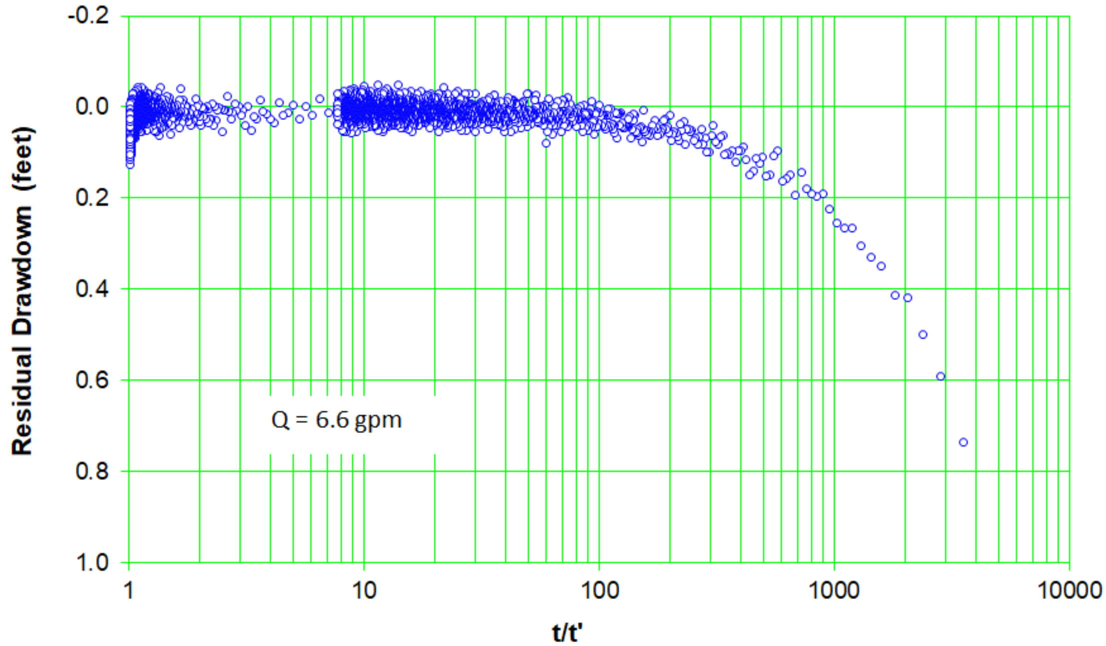


Figure C-7.5-8 Well R-31 screen 3 trial 2 recovery—expanded scale

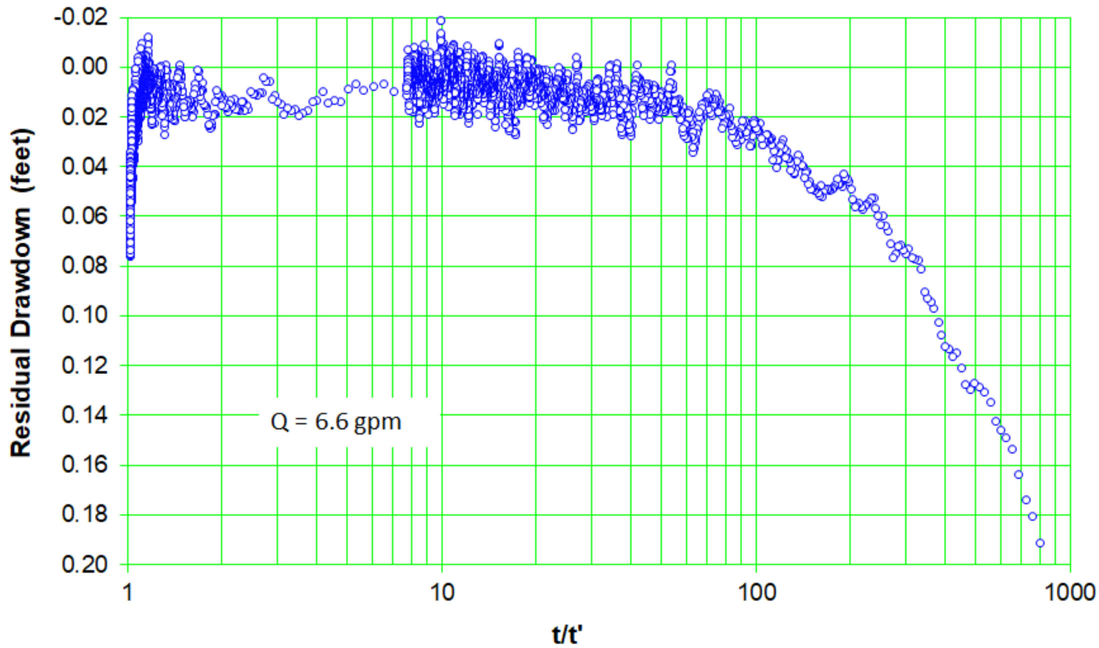


Figure C-7.5-9 Well R-31 screen 3 trial 2 recovery—rolling average

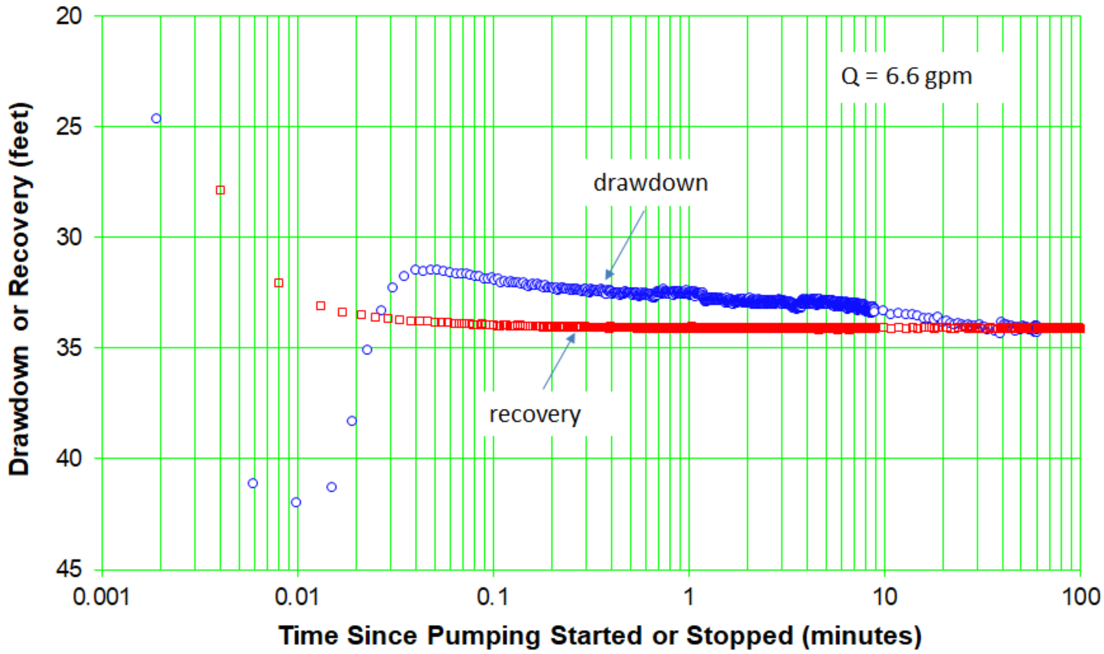


Figure C-7.5-10 Well R-31 screen 3 trial 2 drawdown and recovery comparison

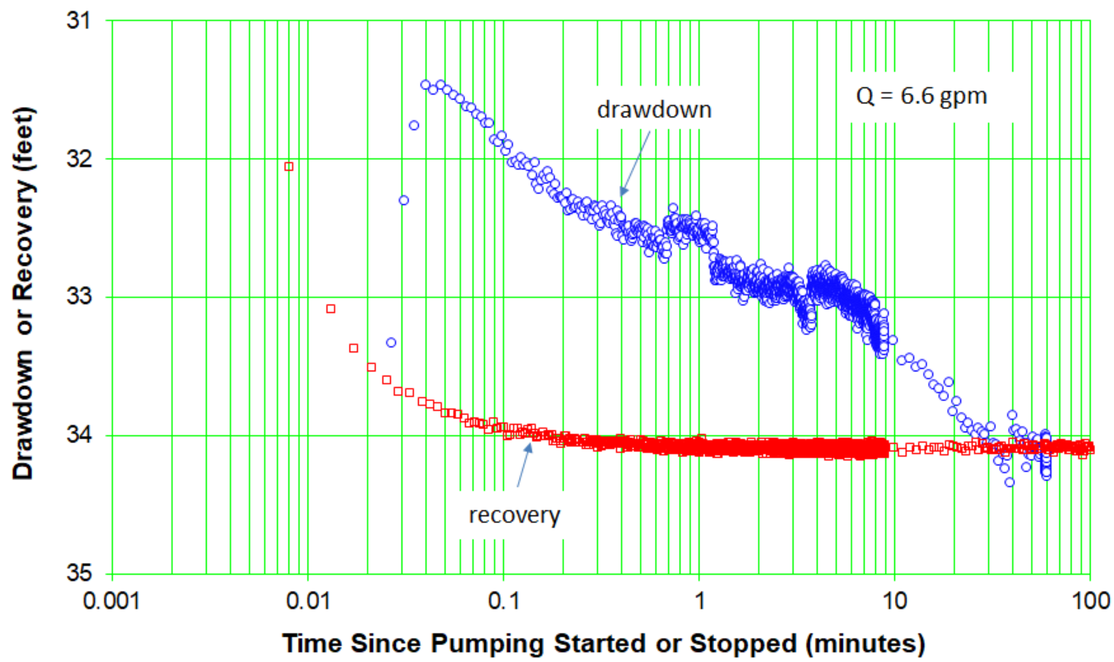


Figure C-7.5-11 Well R-31 screen 3 trial 2 drawdown and recovery comparison—expanded scale

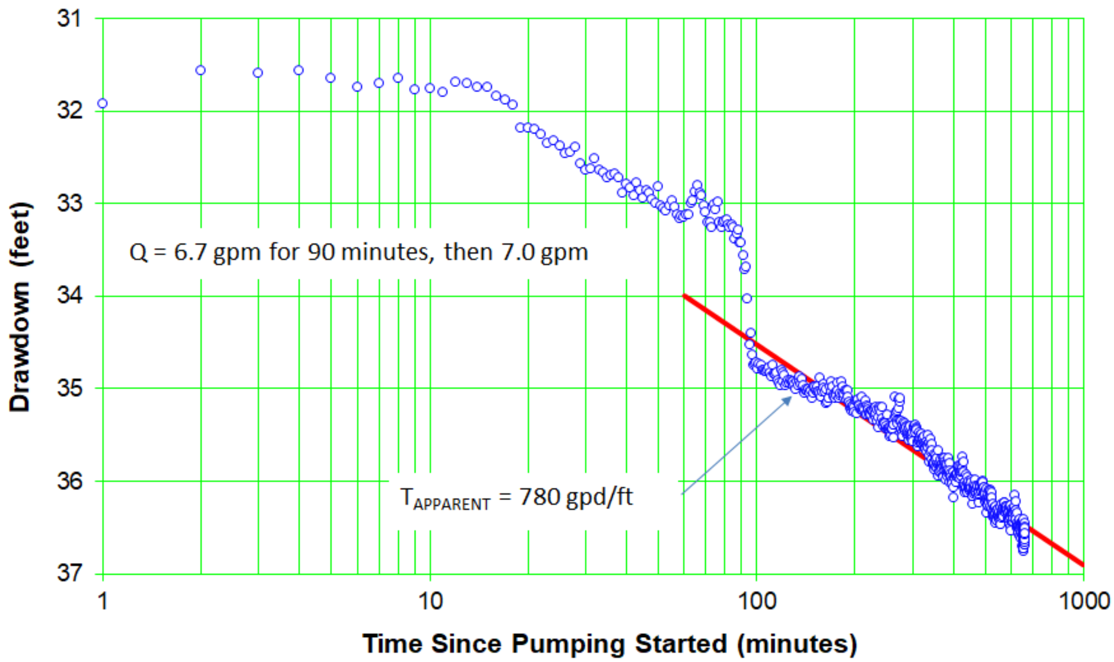


Figure C-7.5-12 Well R-31 screen 3 drawdown, 11-hr test

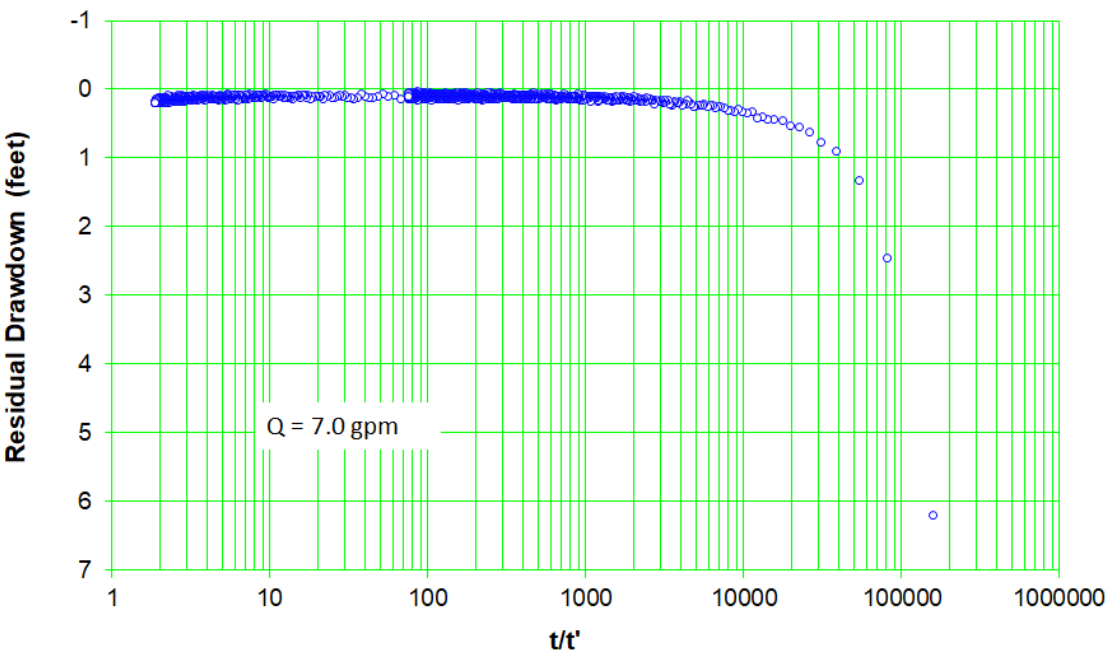


Figure C-7.5-13 Well R-31 screen 3 recovery, 11-hr test

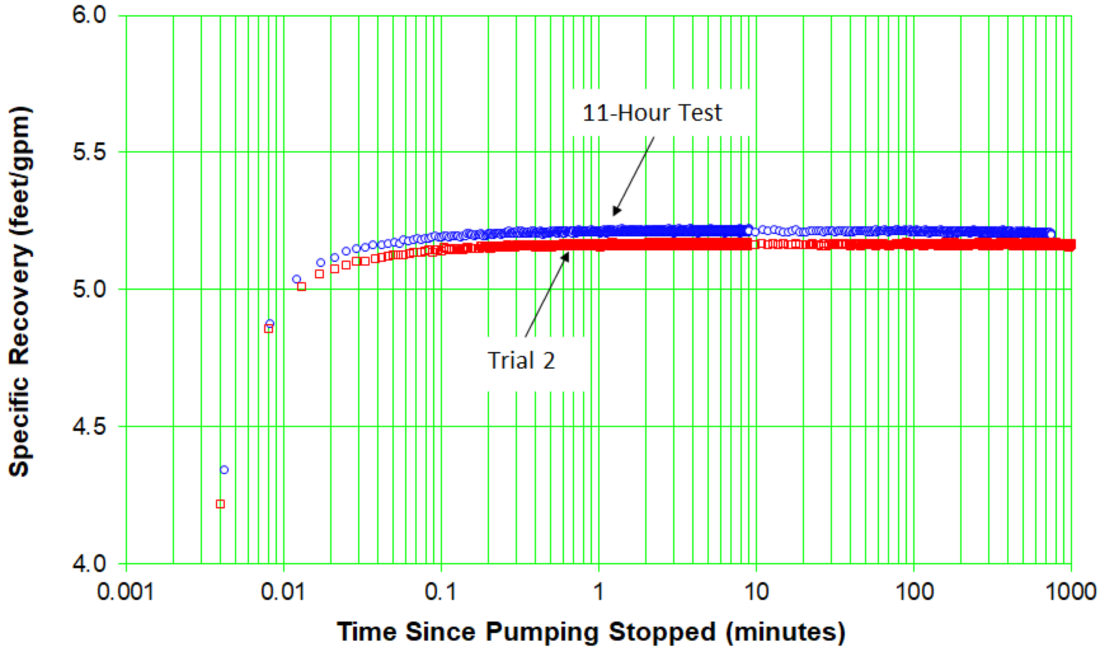


Figure C-7.5-14 Well R-31 screen 3 specific recovery comparison between trial 2 and the 11-hr test

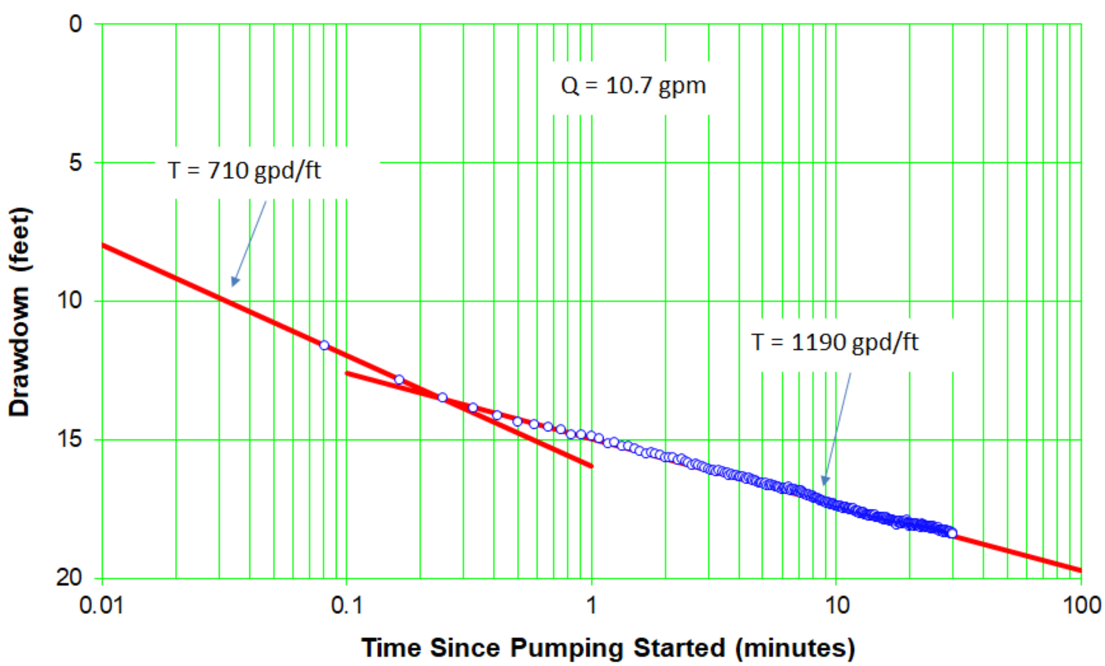


Figure C-7.7-1 Well R-31 screen 4 trial 1 drawdown

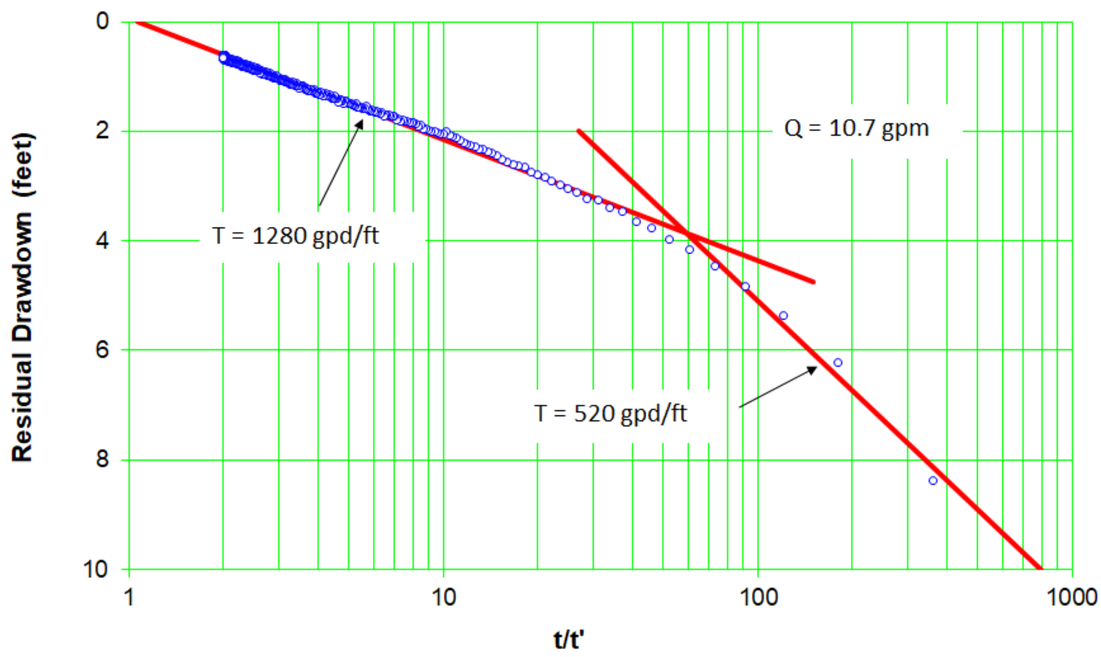


Figure C-7.7-2 Well R-31 screen 4 trial 1 recovery

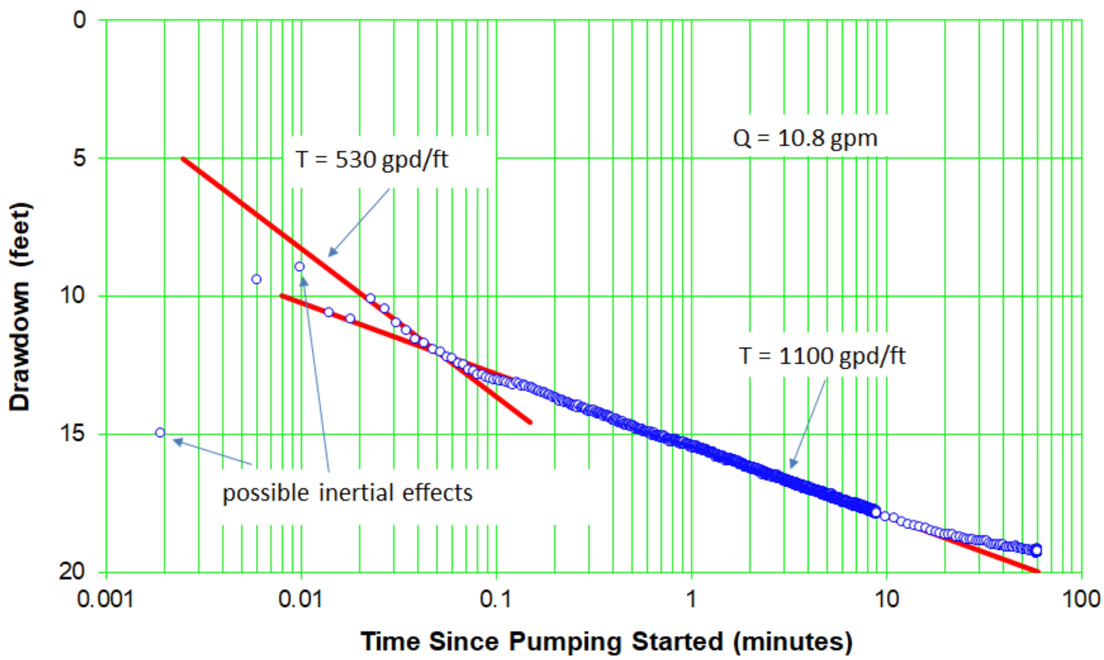


Figure C-7.7-3 Well R-31 screen 4 trial 2 drawdown

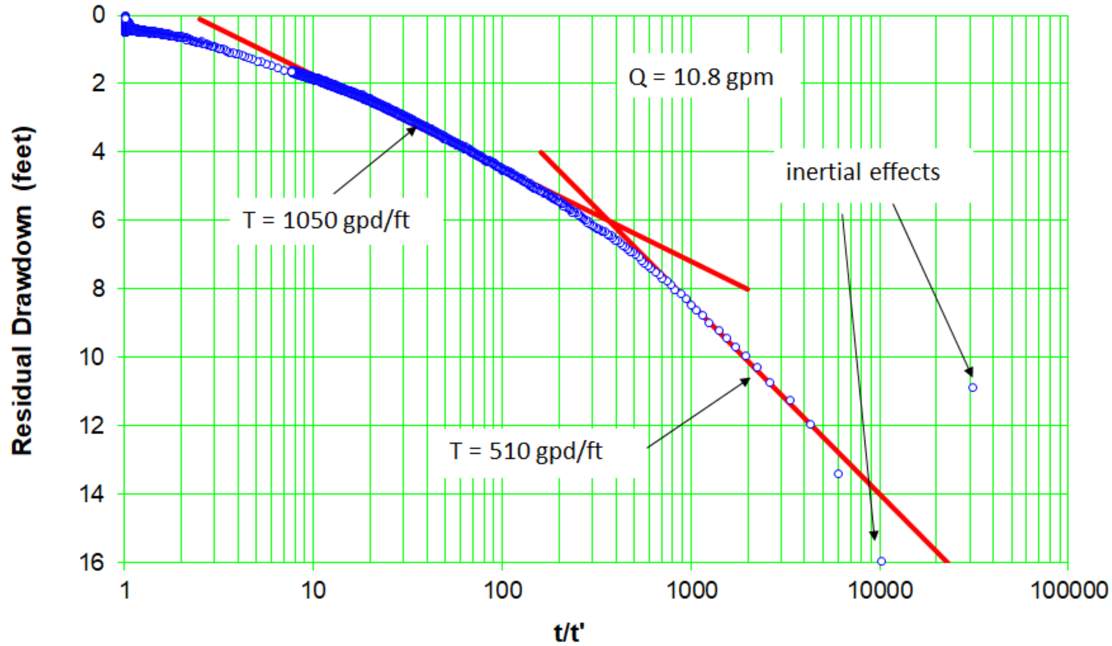


Figure C-7.7-4 Well R-31 screen 4 trial 2 recovery

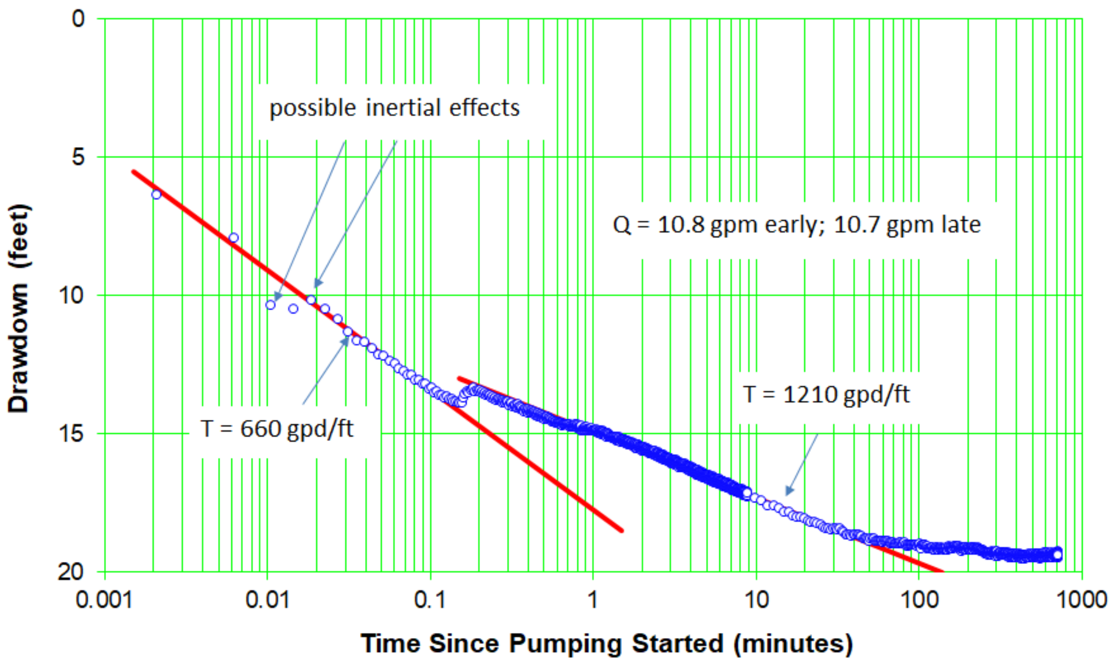


Figure C-7.7-5 Well R-31 screen 4 drawdown, 12-hr test

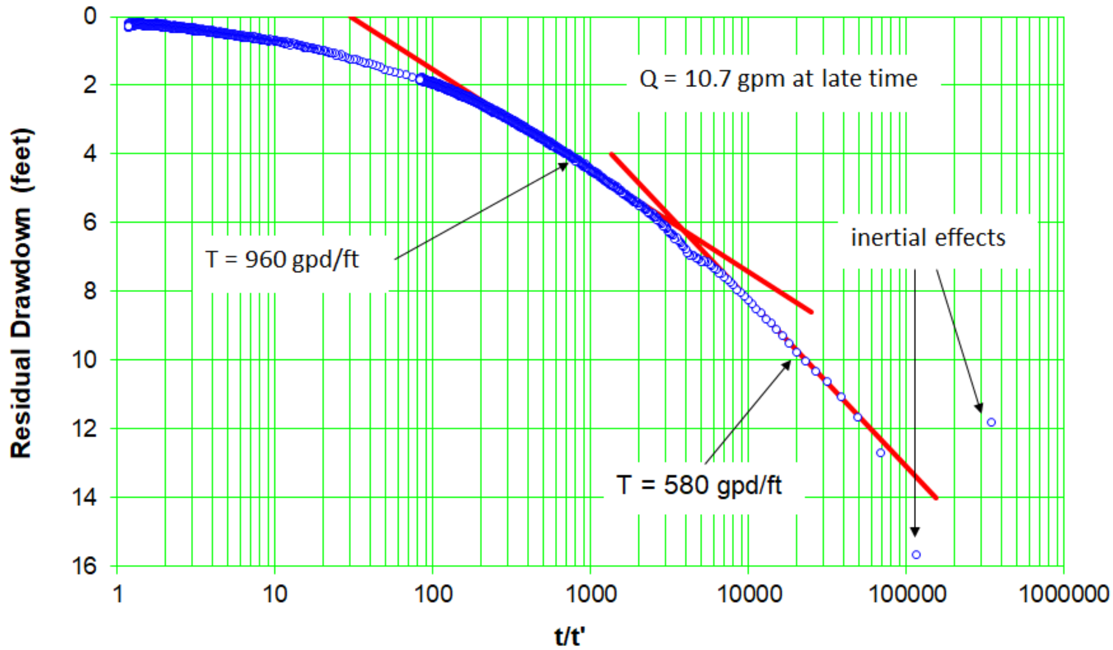


Figure C-7.7-6 Well R-31 screen 4 recovery, 12-hr test

Table C-7.7-1
Well R-31 Screen 4 Transmissivities

Test	Transmissivity (gpd/ft)
Trial 1 Drawdown	710
Trial 1 Recovery	520
Trial 2 Drawdown	530
Trial 2 Recovery	510
12-Hour Drawdown	660
12-Hour Recovery	580
Average of All Tests	585

Appendix D

Westbay Packer Deflation
and System Removal Report for Well R-31

D-1.0 INTRODUCTION

This appendix details the on-site technical services performed by Earth Data Northeast, Inc. (EDN) under subcontract to Tetra Tech, Inc. (a venturing partner in Tech2 Solutions, [T2S]), to deflate packers and complete related tasks in the Westbay System MP55 monitoring well from borehole R-31 at Los Alamos National Laboratory (LANL). EDN Westbay technicians were on-site to perform the work from April 1, 2019, through July 2, 2019. Supporting documentation is in Attachment D-1.

D-2.0 PREVIOUS SITE ACTIVITIES

The Westbay MP55 system in monitoring well R-31 was installed by Westbay Instruments, Inc., in 2000. Monitoring well R-31 was initially completed with 5.0-in. stainless-steel casing below 297.8 ft below ground surface (bgs), 5.0-in. mild steel casing from 297.8 ft bgs to surface, and five screens ranging in depth from 439.1 to 1077.7 ft bgs. Before the Westbay packer deflation process, EDN staff removed MOSDAX probe strings. Table D-2.0-1 presents a summary of the Westbay packer deflation activities.

D-3.0 WESTBAY SYSTEM EXTRACTION

The Westbay packer deflation tasks performed by EDN included pressure profiling, packer valve opening, and pumping port operation. The removal of the Westbay components was performed by Holt Services, Inc., using Westbay lifting tools provided by EDN, Holt Services, and Weatherford International.

D-3.1 Equipment and Materials

EDN used equipment provided by both Westbay Instruments and T2S to complete the Westbay system packer deflation. All work was performed using the T2S on-site Westbay trailer. Primary Westbay System deflation tooling included the following:

Westbay Instruments

- Westbay MP55 OCI tool (S/N: TIE2324)
- MAGI interface (S/N: MGI5107)
- Electric water pump (S/N: IPW2724)
- Motorized inflation reel (S/N: MIR3104)

T2S

- Westbay sampler probe (S/N: 3079)
- Westbay sampling winch
- Westbay MOSDAX transducer winch
- Laptop computer

D-3.2 Pre-Deflation Pressure Profile

The initial Westbay packer deflation task at each location was to take a pressure profile. A pressure profile consists of head pressure measurements collected from Westbay measurement ports located between packers with the use of a Westbay sampler probe and winch. The pre-deflation pressure profiles were used to confirm the location of Westbay components and to observe the head pressure differentials of the isolated intervals. The profile also was used to measure the current depth to water inside the Westbay casing.

D-3.3 Removing Water from the Westbay Casing

The results of the initial pressure profile indicated that water needed to be removed from inside the Westbay casing. When the Westbay casing pressure is lower inside than outside, the flow of water from the packers into the Westbay casing during packer deflation is facilitated. The amount of water removed should be enough to lower the water level to a point below the lowest zone pressure observed in the pressure profile.

Practical limitations did not allow the water level in R-31 to be lowered before packer deflation. The large amount of water to be removed exceeded the capabilities of the available equipment.

D-3.4 Westbay Packer Valve Operation

The Westbay packer valves were opened using a Westbay MP55 OCI tool. The OCI tool was lowered down the Westbay casing on a wireline, with an attached water hose, to the deepest packer in the Westbay System. The packers were then deflated in order from deepest to shallowest.

At each packer, the OCI tool was engaged in the packer valve using the tool’s arm and shoe out functions. Once the tool was confirmed to be properly engaged in the packer valve, the tool was pressurized to 800—900 psi using a water pump. Pressure was monitored throughout the packer deflation procedure at the surface by a pressure gauge on the pump and by a transducer in the OCI tool, which was monitored on a laptop in real time.

The inflate function of the OCI tool was then used to apply the pressure to the packer valve, causing the valve to open, though some packer valves required the pressure to be applied repeatedly for successful operation. Valve opening was indicated through a drop in pressure observed on the pressure gauge and transducer. EDN then confirmed the valve was open by pumping a small amount of water into the packer. An open valve was confirmed by a gradual increase in pressure when water was added as opposed to a sharp spike, which would indicate a closed valve.

A secondary indicator of successful packer deflation was a rise in the water level inside the Westbay casing because of water flowing in from the packer; however, since many of the packers were above the water level inside the Westbay casing, the usefulness of this confirmation method was limited.

After a packer valve was confirmed to be open, EDN proceeded to the next packer and repeated the procedure. As each packer was deflated, an increasing amount of weight was borne by the remaining inflated packers. The Westbay system weight in R-31 was low enough for a single packer or the surface clamp to bear the additional weight. Packer deflation records are included in Attachment D-1.

D-3.5 Post-Deflation Pressure Profile

Following the successful opening of all packer valves in the Westbay system, EDN performed a second pressure profile. The second profile was performed to confirm the deflation of the packers through the absence of the previously observed head pressure differentials between isolated intervals. If packer deflation was successful, all previously isolated intervals would be under hydrostatic conditions.

The post-deflation pressure profiles, with a few exceptions, confirmed the packer deflations were successful. Pressure readings that indicated a head differential was still present were likely the result of packers which had not yet pulled away from the well casing at the time the profile was performed, which was typically right after the packer valves were opened. Field records of pressure profiles and graphical representations of the data are included in Attachment D-1.

D-3.6 Hydraulic Pumping Port Operation

Once all of the packer valves in the Westbay system were opened, the deepest pumping port in the system was opened to allow the water inside the Westbay system to drain into the borehole when removed. Hydraulic pumping ports consist of a sliding valve and screen. The position of the slide valve is changed using high or low hydraulic pressure, depending on the depth below water. The pumping ports were opened using a Westbay sampler probe with a sample bottle attached.

For pumping ports under less than 400 ft of hydraulic head, high pressure was used to open the port. In these cases, the sample bottle was pressurized to 400 psi using a water pump, and lowered to the port. A special face plate was used on the sampler tool to ensure the tool engaged the high-pressure side of the slide valve. Once engaged, the sampler probe valve was opened and the pressure from the sample bottle pushed the valve into the open position. Successful pumping port opening was confirmed by a change in water level inside the Westbay casing.

In pumping ports under greater than 400 ft of hydraulic head, low pressure was used to open the port. In these cases a different face plate, designed to engage the sampler probe in the low-pressure side of the valve, was used. The sampler tool was lowered to the port with an unpressurized sample bottle. Once the sampler tool was engaged and its valve was opened, the pressure differential created by the low-pressure sample bottle caused the port to slide open. This is again confirmed by a change in water level inside the Westbay casing.

D-3.7 Westbay System Removal

After all packer valves were opened along with the deepest pumping port, the Westbay system was allowed to sit for a minimum of 24 hr to allow sufficient time for the water in the packers to drain out and the packers to return as closely as possible to their initial uninflated diameters.

Staging and final disposal of the extracted Westbay components were performed by others and were outside the scope of the services performed by EDN.

Table D-2.0-1
Summary of Westbay System Extraction

Monitoring Well No.	Packer Deflation Date	No. of Packers	MP38 Casing Depth (ft bgs)
R-31	Jun 26, 2019	15	1060

Attachment D-1

Supporting Documentation
(on CD included with this document)

Well R-31
Pressure Profiles
Packer Deflation Forms

Westbay Piezometric Pressures/Levels

Field Data and Calculation Sheet

Westbay Instruments

Well No.: R-31
Datum: GS
Elev. G.S.: –
Height of Westbay above G.S.: –
Elev. top of Westbay Casing: –
Reference Elevation: –
Borehole angle: 90°

Probe Type: Sampler
Serial No.: 3079
Probe Range: 0 - 1000
Westbay Casing Type: MP55
Sampler Valve Position: Closed

Date: 6/26/19
Client: Tetra Tech
Job No.: FS1217
Location:
Weather:
Operator: DJ, GS

Note: "Port position" in angled boreholes refer to position along drillhole. True depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz).

Ambient Reading (P_{atm}) (pressure, temperature, time)

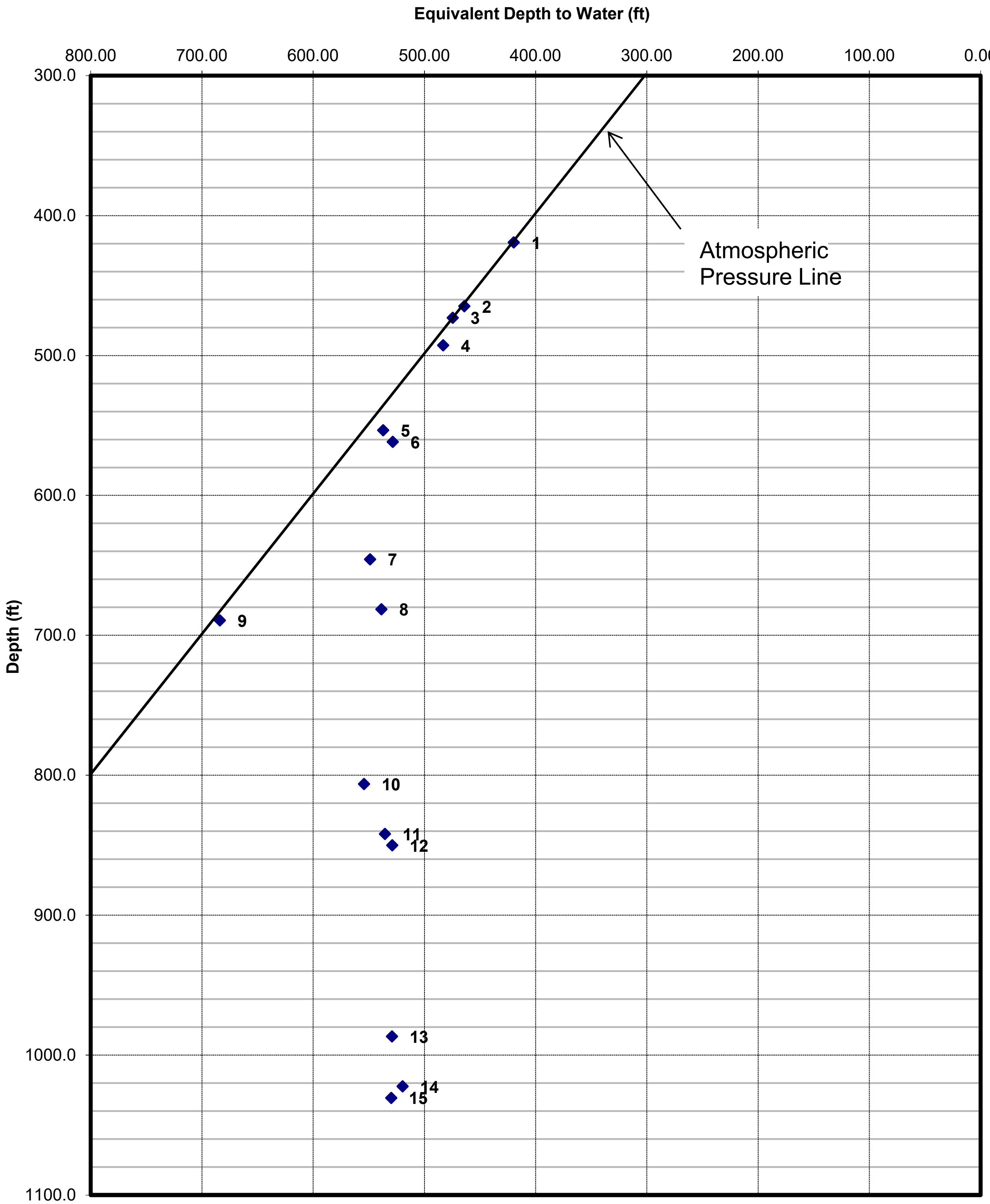
Start: Pressure 11.80 Finish: ~~11.85~~
Temp 17.94
Time

P_{atm} 11.80 psi

Port No.	Port Position From Log (ft)	Port Position From Cable (ft)	True Port Depth "Dp" (ft)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time H:M:S	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (ft) H = (P2-Patm)/w	Piez. Level Outside Port (ft) Dz = Dp - H	Comments H	Dz
15	1030.5	–	–	128.69	228.85		22.85	128.69	~~205.28~~	822.85	~~205.25~~ 500.69	529.81
14	1022.3	–	–	125.10	229.71		23.25	125.10	~~186.52~~		502.68	519.62
13	986.6	–	–	109.54	210.12		23.20	109.58	186.52	~~802.10~~	457.49	529.11
12	850.1	–	–	50.62	150.99		22.11	50.62	127.39	~~722.16~~	321.08	529.02
11	841.9	–	–	47.05	144.64		22.63	47.60	~~121.04~~	~~721.36~~	306.44	535.46
10	806.2	–	–	31.55	121.04		21.50	31.52	97.44	~~710.68~~	252.00	554.20
9	689.3	–	–	12.12	14.18		21.47	12.11	5.49	683.81	5	
8	681.3	–	–	12.14	72.63		21.39	12.14	142.62	538.68		
7	645.6	–	–	12.14	53.73		21.29	12.13	96.72	548.88		
6	561.7	–	–	12.07	26.21		21.21	12.07	33.24	528.46		
5	553.5	–	–	12.07	18.88		21.13	12.04	16.33	537.17		
4	492.7	–	–	12.01	15.97		21.05	12.04	9.62	483.08		
3	473.0	–	–	12.01	11.17		20.96	12.04	-1.45	474.45		
2	464.8	–	–	12.00	12.13		20.86	12.00	0.76	464.04		
1	419.2	–	–	12.00	11.60		20.61	12.03	-0.46	419.66		

Notes: w = 0.4335 psi/ft (1.422psi/m) of H_2O Dz = piezometric level in zone Patm = atmospheric pressure H = pressure head of water in zone Dp = true depth of measurement port

Figure 11
Well: R-31
Pre-Deflation Pressure Profile



Westbay Piezometric Pressures/Levels

Field Data and Calculation Sheet

Westbay Instruments

Well No.: R-31
Datum: CS
Elev. G.S.: –
Height of Westbay above G.S.: –
Elev. top of Westbay Casing: –
Reference Elevation: –
Borehole angle: 90°

Probe Type: Sampler
Serial No.: 3079
Probe Range: 0-1000
Westbay Casing Type: MP38
Sampler Valve Position: Closed

Date: 5/27/19
Client: TetraTech
Job No.: FS217
Location:
Weather:
Operator: CS, DJ

Note: "Port position" in angled boreholes refer to position along drillhole. True depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz).

P_{atm} 11.82 psi

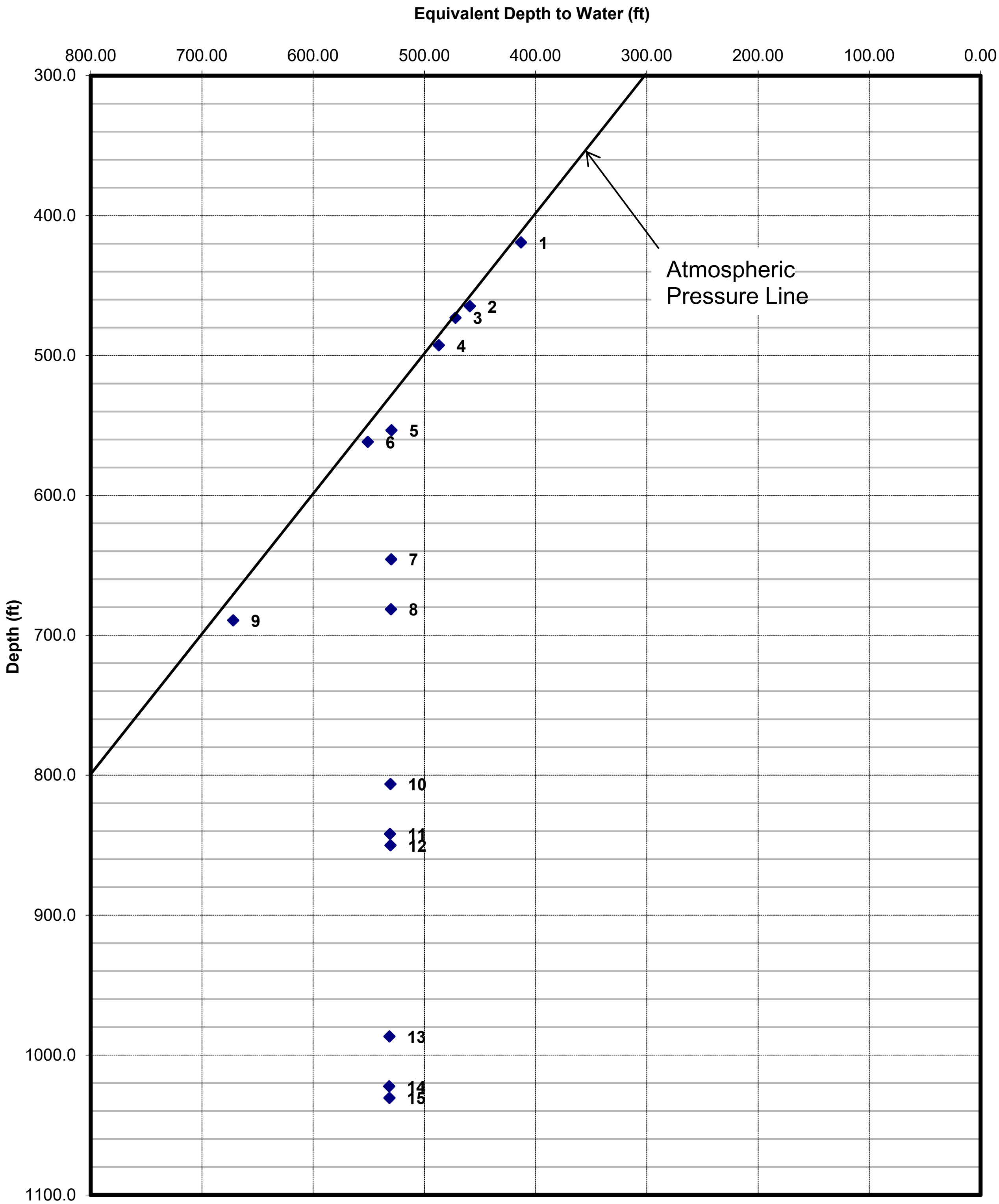
Ambient Reading (P_{atm}) (pressure, temperature, time)

	Start	Finish
Pressure	11.82	11.85
Temp	34.84°C	20.70°C
Time	1526	

Port No.	Port Position From Log (ft)	Port Position From Cable (ft)	True Port Depth "Dp" (ft)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time H:M:S	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (ft) H = (P2-Patm)/w	Piez. Level Outside Port (ft) Dz = Dp - H	Comments
15	1030.5	–	–	162.72	228.18		26.36	162.73	499.10	531.40	
14	1022.3	–	–	159.16	224.54		25.67	159.19	490.70	531.60	
13	986.6	–	–	143.47	209.17		24.15	143.46	455.25	531.35	
12	850.1	–	–	84.71	150.34		24.25	84.69	319.54	530.56	
11	841.9	–	–	81.11	146.63		24.66	81.14	310.98	530.92	
10	806.2	–	–	65.64	131.31		23.71	65.64	275.64	530.56	
9	689.5	–	–	15.22	19.38		23.31	15.19	17.44	672.06	
8	681.3	–	–	12.13	77.37		23.05	12.13	151.21	530.09	
7	645.6	–	–	12.11	61.96		22.79	12.12	115.66	529.94	
6	561.7	–	–	12.06	16.48		22.58	12.04	10.75	550.95	
5	553.5	–	–	12.09	22.16		22.48	12.06	23.85	529.65	
4	492.7	–	–	12.06	14.28		22.30	12.05	5.47	487.03	
3	473.0	–	–	12.08	12.18		21.98	12.05	0.83	472.17	
2	464.8	–	–	12.05	14.28		21.87	12.05	5.67	459.12	
1	419.20	–	–	12.02	14.49		21.58	12.02	6.15	413.04	

Notes: w = 0.4335 psi/ft (1.422psi/m) of H_2O Dz = piezometric level in zone Patm = atmospheric pressure H = pressure head of water in zone Dp = true depth of measurement port

Figure 12
Well: R-31
Post-Deflation Pressure Profile



![Westbay Instruments]

Westbay System MP55 Packer Inflation Field Record

Project ~~No. WB_932~~ Well No. R-31

Page No:

Packer No: 1 Date: 6/26/19

1026'

Pumping Information

Vol (L)	Pressure(psi) Line	Inf Tool	Close Tool	Vent Tool	Clock	Inf Valve O	I	C	Pump Off	On	Comments
	0				1044	/					CV= 2.0L , 131.19 psi Shoe in
	0				1045	/					CV= 2.0L , 545 psi filling Shoe out (20 rot)
	800				1046	/					CV= 2.85L , 528 psi
	725	1190			1048		/				CV= 2.85L
	715	₹	131.27		1049			/			CV= 2.85L
	700	1167			1049		/				CV= 2.85L
	695		131.25		1054			/			CV= 2.85L
	675	1140			1055		/				CV= 2.85L
	675					/					CV= 2.85L , 321.46 psi
	900					/					CV= 3.0L , 333.03 psi
	875	1337					/				CV= 3.0L
	850		131.16		1101			/			CV= 3.0L
	825	1134			1101		/				CV= 3.0L
	800		132.1		1102			/			CV= 3.0L
	775	1063			1102		/				CV= 3.0L
	750				1103	/					CV= 3.0L , 330 psi
	0				1104	/					CV= 2.75L 341.04 psi Shoe in (20 rot)
	0				1105	/					CV= 2.25L , 132.30 psi reland tool
	0				1106	/					CV= 2.25L , 219 psi Shoe out (20 rot)
	900				~~1108~~ 1109	/					CV= 3.0L , 220 psi
	100	225			1110		/				CV= 3.25L
	200	230			1113		/				CV= 3.65L added water
	0				1113		/				CV= 3.5L 133 psi Shoe in (20 rot)
	0				1114	/					CV= 3.5L 133 psi

Westbay Instruments

Westbay System MP55 Packer Inflation Field Record

Page No: ____________

Project No:	Client:	By:	Date: 6/26/19	Location:
Well No. R-31	Borehole Dia:		Computer Data File: ____.WD3	
Packer No: 2	Depth: 992			

Inf Tool No:	Vent Tool No:
H-B Valve (P_H):	Offset (P_V):
Vent Tool Pressure (Shoe Out,(P2)):	
Target Infl P: (P2 + PM):	
Confirm Venting (Vent Tool Data):(Yes / No)	

Volume Pumped (L):	Volume Returned (L):	Final Inf'n Vol (L):
Calc'd Element Pressure (PF +PV- PO):	Confirm Pkr Valve Closed: (Yes / No)	
Comments:		

Pumping Information

Vol (L)	Pressure (psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1120	/					CV=3.5L, 118.55psi shoe in
	0				1121	/					CV= 3.5L 859psi Shoe out (2 rot)
	850				1123	/					CV= 4.25L 829psi
	450	602			1124		/				CV = 4.25L
	550	750			1128		/				CV=4.35L added water
	0	770			1128		/				CV= 4.25L
	0				1129		/				CV=3.75L 119psi shoe in (2 rot)
	0				1129	/					CV=3.8L 119.29psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Project No. ~~WB-932~~ Well No. R-31

Page No:

Packer No: 3 982' Date: 6/26/19

Pumping Information

Vol (L)	Pressure (psi)				Clock	Inf Valve			Pump		Comments		
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On			
	0				1132	✓					CV= 3.75L,	116.26 psi	shoe in
	0				1133	✓					CV=3.75L	350	Shoe out (17 rot)
	0				1134	✓					CV=3.75L	116.79 psi	Shoe in (17 rot)
	0				1135	✓					CV=3.75L	117.13 psi	retand tool
	0				1136	✓					CV=3.75L	836 psi	Shoe out (20 rot)
	800				1139	✓					CV= 4.5L	~~8~~ 767 psi	
	475	615			1139		✓				CV= 4.5L		
	600	730			1141		✓				CV= 4.6L		added water
	0	750			1141		✓				CV= 4.4L		
	0				1142		✓				CV= 4.05L,	117.82 psi	Shoe in (20 rot)
	0				1143	✓					CV= 4.0L	118.62 psi	

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Page No:

Project No: Client: By: Date: 6/26/19 Location:

Well No. R-31 Borehole Dia: Computer Data File: .WD3

Packer No: 4 Depth: 845.6'

Inf Tool No: Vent Tool No:

H-B Valve (P_H): Offset (P_V):

Vent Tool Pressure (Shoe Out,(P2)):

Target Infl P: (P2 + PM):

Confirm Venting (Vent Tool Data):(Yes / No)

Volume Pumped (L): Volume Returned (L): Final Inf'n Vol (L):

Calc'd Element Pressure (PF +PV- PO): Confirm Pkr Valve Closed: (Yes / No)

Comments:

Pumping Information

Vol (L)	Pressure(psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1149	/					CV= 4.0L, 59.43psi Shoe in
	0				1150	/					CV= 4.0L 958psi Shoe out (20 rot)
	800				1152	/					CV= 4.75L 896.75psi
	525	552			1153		/				CV= 4.75L
	650	654			1156		/				CV= 4.85L added water
	0	680			1157		/				CV= 4.5L
	0				1158		/				CV= 4.25L 59.71psi Shoe in (20 rot
	0				1158	/					CV= 4.25L 59.71psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Project No. ~~WB_932~~ Well No. R-31

Page No: Packer No: 5 Date: 6/26/19

811.6

Pumping Information

Vol (L)	Pressure (psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1200	/					CV=4.25L, 44.96 psi Shoe in
	0				1201	/					CV=4.25L, 145 psi Shoe out (18 rot)
	0				1202	/					CV=4.25L, 45.35 psi Shoe in (18 rot)
	0				1203	/					CV=4.25L, 45.64 psi re-land tool
	0				1204	/					CV=4.25L 826 psi shoe out (19 rot)
	800				1208	/					CV=4.9L, 786 psi
	775	1136			1208		/				CV=4.9L
	350	362			1209		/				CV=4.9L
	500	486			1212		/				CV=5.15L added water
	0	550			1214		/				CV=5.0L
	0				1215		/				CV=4.75L 48.07 psi Shoe in (19 rot)
	0				1215	/					CV=4.75L 48.70 psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Page No:

Project No: Client: By: Date: 6/26/19 Location:

Well No. R-31 Borehole Dia: Computer Data File: .WD3

Packer No: 6 Depth: 801.7'

Inf Tool No: Vent Tool No:

H-B Valve (P_H): Offset (P_V):

Vent Tool Pressure (Shoe Out,(P2)):

Target Infl P: (P2 + PM):

Confirm Venting (Vent Tool Data):(Yes / No)

Volume Pumped (L): Volume Returned (L): Final Inf'n Vol (L):

Calc'd Element Pressure (PF +PV- PO): Confirm Pkr Valve Closed: (Yes / No)

Comments:

Pumping Information

Vol (L)	Pressure(psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1218	/					CV= 4.7L 46.00 psi Shoe in
	0				1219	/					CV= 4.7L 878 psi Shoe out (19 rot)
	850				1220	/					CV= 5.4L 792 psi
	400	446			1221		/				CV= 5.4L
	400	600			1223		/				CV= 5.5L added water
	0	607			1223		/				CV= 5.4L
	0				1225		/				CV= 5.1L 46.73 psi Shoe in (19 rot)
	0				1225	/					CV= 5.1L 47.16 psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Project No. ~~WB-932~~ Well No. R-31

Page No:

Packer No: 7 Date: 6/26/19

685'

Pumping Information

Vol (L)	Pressure (psi)				Clock	Inf Valve			Pump		Comments		
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On			
	0				1232	✓					CV=5.0L,	12.02psi	Shoe in
	0				1233	✓					CV=5.0L,	260 psi	Shoe out (19 ~~psi~~ rot)
	800				1234	✓					CV=5.75L,	263.5 psi	
	350	351			1234		✓				CV=5.75L		
	350	463			1235		✓				CV=5.75L		~~added water~~
	450	498			1238		✓				CV=5.85L		added water
	0	523			1238		✓				CV=5.5L		
	0				1239		✓				CV=5.45L	12.61psi	Shoe in (19 ~~psi~~ rot)
	0				1239	✓					CV=5.45L	11.93psi	

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Page No: ____________

Project No:	Client:	By:	Date: 6/26/19
Well No. R31	Borehole Dia:	Location:	Computer Data File: ______ .WD3
Packer No: 8	Depth: 650.9		

Inf Tool No: ____________ Vent Tool No: ____________

H-B Valve (P_H): ____________ Offset (P_V): ____________

Vent Tool Pressure (Shoe Out,(P2)): ____________

Target Infl P: (P2 + PM): ____________

Confirm Venting (Vent Tool Data):(Yes / No)

Volume Pumped (L): ________ Volume Returned (L): ________ Final Inf'n Vol (L): ________

Calc'd Element Pressure (PF +PV- PO): ________ Confirm Pkr Valve Closed: (Yes / No)

Comments: ____________

Pumping Information

Vol (L)	Pressure(psi) Line	Inf Tool	Close Tool	Vent Tool	Clock	Inf Valve O	I	C	Pump Off	On	Comments
	0				1304	/					CV=5.4L 11.9 psi Shoe in
	0				1305	/					CV=5.4L 21 psi Shoe out (19 rot)
	800				1307	/					CV=6.05L 20.07psi
	500	508			1308		/				CV=6.05L
	450	590			1310		/				CV=6.05L
	700	615			1311		/				CV=6.25L added water
	0	643			13.11		/				CV=6.0L
	0				1312		/				CV=5.6L 11.85psi Shoe in (19 rot)
	0				1312	/					CV=5.6L 11.90psi

Westbay Instruments

Westbay System MP55 Packer Inflation Field Record

Project No: ~~WB_932~~ Well No. R-31

Page No:

Packer No: 9 Date: 6/26/19

641.1'

Pumping Information

Vol (L)	Pressure(psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1315	/					CV= 5.6L 11.80psi Shoe in
	0				1316	/					CV= 5.6L 17psi Shoe out (20 rot)
	800				1318	/					CV= 6.3L 16.79psi
	600	525			1319		/				CV= 6.3L
	500	555			1320		/				CV= 6.3L
	725	622			1320		/				CV= 6.5L added water
	0	650			1322		/				CV= 6.3L
	0				1323		/				CV= 5.9L 11.80psi Shoe in (20 rot)
	0				1323	/					CV= 5.9L 11.80 psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Page No:__________

Project No:______ Client:________ By:________ Date: 6/26/19 Location:________

Well No. R-31 Borehole Dia:________ Computer Data File:________.WD3

Packer No: 10 Depth: 557.2

Inf Tool No: 2324 Vent Tool No:________

H-B Valve (P_H):________ Offset (P_V):________

Vent Tool Pressure (Shoe Out,(P2)):________

Target Infl P: (P2 + PM):________

Confirm Venting (Vent Tool Data):(Yes / No)

Volume Pumped (L):______ Volume Returned (L):______ Final Inf'n Vol (L):______

Calc'd Element Pressure (PF +PV- PO):________ Confirm Pkr Valve Closed: (Yes / No)

Comments:________

Pumping Information

Vol (L)	Pressure(psi) Line	Inf Tool	Close Tool	Vent Tool	Clock	Inf Valve O	I	C	Pump Off	On	Comments
	0				1328	/					CV= 5.8L 11.86 psi Shoe in
	0				1329	/					CV= 5.8L ~~11.80~~ 17.80 psi Shoe out (20 ~~psi~~ rot)
	800				1330	/					CV= 6.5L 17.04 psi
	500	464			1330		/				CV= 6.5L
	425	552			1334		/				CV= 6.5L
	575	~~7~~570			1335		/				CV= 6.65L added water
	0	595			1336		/				CV= 6.5L
	0				1337		/				CV= 6.1L 11.86 psi Shoe in (20 rot)
	0				1337	/					CV= 6.1L 11.80 psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Page No:

Project No: Client: By: Date: 6/26/19 Location:

Well No. R-31 Borehole Dia: Computer Data File: .WD3

Packer No: 11 Depth: 498.1

Inf Tool No: Vent Tool No:

H-B Valve (P_H): Offset (P_V):

Vent Tool Pressure (Shoe Out,(P2)):

Target Infl P: (P2 + PM):

Confirm Venting (Vent Tool Data):(Yes / No)

Volume Pumped (L): Volume Returned (L): Final Inf'n Vol (L):

Calc'd Element Pressure (PF +PV- PO): Confirm Pkr Valve Closed: (Yes / No)

Comments:

Pumping Information

Vol (L)	Pressure (psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1342	/					CV = 1.2L 12.0 psi Shoe in
	0				1343	/					CV = 1.2L 15.54 psi Shoe out (19 rot)
	800				1345	/					CV = 2.0L 16.17 psi
	500	441			1346		/				CV = 2.0L
	450	510			1348		/				CV = 2.0L
	550	522			1352		/				CV = 2.0L added water
	0	537			1353		/				CV = 1.8L
	0				1354		/				CV = 1.5L 11.73 psi Shoe in (19 rot)
	0				1354	/					CV = 1.5L 11.73 psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Project No. ~~WB-932~~ Well No. R-31

Page No:

Packer No: 12 Date: 6/26/19

488.2

Pumping Information

Vol (L)	Pressure(psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1357	/					CV=1.5L 11.87psi Shoe in
	0				1359	/					CV=1.5L 13.38 psi Shoe out (17 rot)
	0				1359	/					CV=1.5L 11.78 psi Shoe in (17 rot)
	0				1400	/					CV=1.5L 11.83 psi re-land tool
	0				1401	/					CV=1.5L 14.83 psi Shoe out (20 rot)
	800				1402	/					CV=2.1L 14.15 psi
	500	456			1403		/				CV= 2.1L
	475	557			1406		/				CV=2.1L
	575	606			1406		/				CV=2.25L added water
	0	665			1407		/				CV=2.0L
	0				1408		/				CV=1.75L 11.78psi Shoe in (20 rot)
	0				1408	/					CV=1.75L 11.83psi

Westbay System MP55 Packer Inflation Field Record

Westbay Instruments

Page No: ____________

Project No: ______	Client: ______	By: ______	Date: 6/26/19 Location: ______
Well No. R-31	Borehole Dia: ______	Computer Data File: ______.WD3	
Packer No: 13	Depth: 468.5		

Inf Tool No: ______ Vent Tool No: ______
H-B Valve (P_H): ______ Offset (P_V): ______
Vent Tool Pressure (Shoe Out,(P2)): ______
Target Infl P: (P2 + PM): ______
Confirm Venting (Vent Tool Data): (Yes / No)

Volume Pumped (L): ______ Volume Returned (L): ______ Final Inf'n Vol (L): ______
Calc'd Element Pressure (PF +PV- PO): ______ Confirm Pkr Valve Closed: (Yes / No)
Comments: ______

Pumping Information

Vol (L)	Pressure (psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1417	/					CV= 1.75L 11.83 psi Shoe in
	0				1418	/					CV= 1.75L 16.62 psi Shoe out (21)
	500				1420	/					CV= 2.4L 16.58 psi
	475	380			1420		/				CV= 2.4L
	450	459			1422		/				CV= 2.4L
	600	488			1422		/				CV= 2.5L added water
	0	520			1423		/				CV= 2.25L
	0				1424		/				CV= 2L 11.93 psi Shoe in (21)
	0				1424	/					CV= 2L 11.83 psi

Westbay Instruments

Westbay System MP55 Packer Inflation Field Record

Page No:

Project No. ~~WB_932~~ Well No. R-31

Packer No: 14 Date: 6/26/19

4/24.6

Pumping Information

Vol (L)	Pressure(psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1429	/					CV= 2.0L, 11.84 psi Shoe in
	0				1430	/					CV= 2.0L, 25.34 psi Shoe out (21 rot)
	800				1432	/					CV= 2.6L 26.07 psi
	500	368			1432	~~/~~	/				CV= 2.6L
	460	509			1435		/				CV= 2.6L
	600	539			1435		/				CV= 2.75L added water
	0	585			1436		/				CV= 2.5L
	0				1437		/				CV= 2.25L 11.79 psi Shoe in (21 rot)
	0				1437	/					CV= 2.25L 11.74 psi

Westbay Instruments

Westbay System MP55 Packer Inflation Field Record

Page No:

Project No:	Client:	By:	Date: 6/26/19	Location:	
Well No. R-31	Borehole Dia:	Computer Data File: .WD3			
Packer No: 15	Depth: 414.8				

Inf Tool No:	Vent Tool No:
H-B Valve (P_H):	Offset (P_V):
Vent Tool Pressure (Shoe Out,(P2)):	
Target Infl P: (P2 + PM):	
Confirm Venting (Vent Tool Data): (Yes / No)	

Volume Pumped (L): Volume Returned (L): Final Inf'n Vol (L):

Calc'd Element Pressure (PF +PV- PO): Confirm Pkr Valve Closed: (Yes / No)

Comments:

Pumping Information

Vol (L)	Pressure(psi)				Clock	Inf Valve			Pump		Comments
	Line	Inf Tool	Close Tool	Vent Tool		O	I	C	Off	On	
	0				1440	/					CV=2.25L 11.70 psi Shoe in
	0				1441	/					CV=2.25L 24.24 psi Shoe out (21 rot)
	800				1442	/					CV=2.9L 24.19 psi
	500	515			1444		/				CV=2.9L
	475	660			1447		/				CV=2.9L
	675	628			1447		/				CV=3.2L Added water
	0	655			1448		/				CV=3.0L
	0				1449		/				CV=2.5L 11.89 psi Shoe in (21 rot)
	0				1449	/					CV=2.5L 11.80 psi

Appendix E

New Mexico Office of the State Engineer and
New Mexico Environment Department Approvals

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER
DISTRICT VI - SANTA FE

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

BATAAN MEMORIAL BUILDING
POST OFFICE BOX 25102
SANTA FE, NEW MEXICO 87504-5102
(505) 827-6120
FAX: (505) 827-6682

July 5, 2019

Los Alamos National Laboratory
Attn: Mark Everett
N3B 600 Sixth Street
Los Alamos, NM 87544

Re: Monitoring Well (R-31)

Greetings:

The Office of the Engineer is returning a favorable approval, with specific reconfiguration and plugging conditions, of a Monitoring Well Permit submitted March 4, 2019, for the following wells:

- RG-97896-POD1(R-31)

Please return a completed a Well Log and Well Plugging Report that itemizes the actual abandonment process, materials used and total volume of material used within 30 days after completion of well plugging.

Please do not hesitate to contact our office with any questions regarding these plans.

Sincerely,

LAGarcia

Lorraine A. Garcia
Office of State Engineer
Water Rights Division District VI

Enclosure
cc: file

NEW MEXICO OFFICE OF THE STATE ENGINEER
PERMIT FOR MONITORING WELL
CONDITIONS OF APPROVAL

This application proposes the reconfiguration of an existing LANL monitor well, constructed prior to NMOSE administration of monitor well permitting. Upon submission of this application, a NMOSE file number has been assigned to the well for permitting and tracking. As currently configured, the multi-zone monitoring well is screened into six separate zones, including two zones in an intermediate dry zone, one zone in the upper regional aquifer, and three zones of the deeper regional aquifer. The six aquifer zones are currently kept segregated outside the well casing with intervals of annular sealant, and segregated inside the casing via the installation of a Westbay Multi-packer Sampling System.

The uppermost intermediate zones the well currently taps have gone dry while sections of the upper and lower intermediate zone remain viable, and monitoring more than one regional aquifer zone has been deemed redundant at this location. Permittee proposes to reconfigure the well by completely removing the Westbay sampling system components, back-plugging the deepest three of the six regional aquifer zones, dismissing the unsaturated upper intermediate aquifer zone, and segregating the remaining single intermediate and underlying regional aquifer screen by means of a new single packer assembly. All reconfiguration work will occur within the existing well casing.

Permittee states the NMED has approved the proposed reconfiguration of this well. The NMOSE therefore approves this application provided it is not exercised to the detriment of any others having existing rights and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare of the state; and further subject to the following conditions of approval:

Permittee: Los Alamos National Laboratory
Agent: Mark Everett

Permit Number: RG-97896-POD 1

Application File Date: March 4, 2019

Points of Diversion: RG-97896-POD1, AKA LANL R-31 (WGS84)

OSE File Number	OSE Tag No.	Applicant Well Number	Northing (Y)	Easting (X)
RG-97896	N/A	RG-97896-POD 1	1745642.3N	1637356.3E

Well will be located in Section 13, Township 18 North, Range 06 East, NMPM

Purpose of Use: Monitoring

Condition Code	Condition
B	The well shall be reconfigured by a driller licensed in the State of New Mexico in accordance with 72-12-12 NMSA 1978.
C	The well driller must file a Well Record with the State Engineer and the Permittee within 30 days after the well is reconfigured, reflecting repairs / reconfiguration conducted and final "as-reconfigured" design of the well. It is the well owner's responsibility to ensure that the well driller files the Well Record. The well driller may obtain the current Well Record form from any District Office or the Office of the State Engineer website.
G	If artesian water is encountered, the well driller shall comply with all rules and regulations pertaining to the drilling, casing, and repair of artesian wells.

NEW MEXICO OFFICE OF THE STATE ENGINEER
PERMIT FOR MONITORING WELL
CONDITIONS OF APPROVAL

MON	No water shall be diverted from the subject well(s) except for monitoring purposes.
Q	The State Engineer retains jurisdiction over this permit.
R	Pursuant to section 72-8-1 NMSA 1978, the Permittee shall allow the State Engineer and OSE representatives entry upon private property for the performance of their respective duties, including access to the ditch or acequia to measure flow and also to the well for meter reading and water level measurement.
4	No water shall be appropriated and beneficially used under this permit.
6D	Upon completion of the permitted use, well RG-97896-POD1 shall be plugged completely using the following method per Rules and Regulations Governing Well Driller Licensing, Construction, Repair and Plugging of Wells; Subsection C of 19.27.4.30 NMAC unless an alternative plugging method is proposed by the well owner and approved by the State Engineer. All pumping appurtenance shall be removed from the well prior to plugging. To plug a well, the entire well shall be filled from the bottom upwards to ground surface using a tremie pipe. The bottom of the tremie shall remain submerged in the sealant throughout the entire sealing process; other placement methods may be acceptable and approved by the state engineer. The well shall be plugged with an Office of the State Engineer approved sealant for use in the plugging of non-artesian wells. The well driller shall cut the casing off at least four (4) feet below ground surface and fill the open hole with at least two vertical feet of approved sealant. The driller must fill or cover any open annulus with sealant. Once the sealant has cured, the well driller or well owner may cover the seal with soil. A Plugging Report for said well shall be filed with the Office of the State Engineer in a District Office within 30 days of completion of the plugging.
7	The Permittee shall utilize the highest and best technology available to ensure conservation of water to the maximum extent practical.
LOG	Reconfiguration of well RG-97896-POD 1 must be completed within one year of approval date of this permit, which will otherwise expire on July 6, 2020.

1. Stated inside diameter (ID) of the existing well casing is 4.5". Theoretical volume of 4.5" ID casing is approximately 0.83 gallons/vertical foot.

2. Permittee submittals are stated to reflect a NMED-approved reconfiguration of the current seven-zone monitor well into a two-zone monitor well. Additional detail is provided in Permittee application, and is generally summarized in the following steps:

   - All existing Westbay sampling system equipment shall be removed from the well prior to reconfiguration. The well shall be further cleared of deleterious fill to the original constructed depth, stated to be approximately 1,103' bgl.
   - The existing well casing shall be partially back-plugged using neat cement grout tremied from maximum depth to approximately 617' bgl, sealing-over the three deepest existing screen sections in the process.
   - Clean sand backfill will be placed from top of cement to a depth of approximately 1,103' bgl, and topped with a K-packer to complete the proposed back-plugging / backfilling.
   - Permittee shall fit the remaining unplugged casing with a packer system within the casing that competently segregates remaining lower intermediate aquifer system screen from upper regional aquifer screen and allows installation of their choice of pumping configuration for continued discrete sampling of both aquifers.

3. Should the NMED, or another regulatory agency sharing jurisdiction of the project authorize, or by regulation require a more stringent well reconfiguration procedure than herein acknowledged, the more-stringent procedure should be followed. This,

in part, includes provisions regarding pre-authorization to proceed, contaminant remediation, inspection, pulling/perforating of casing, or prohibition of free discharge of any fluid from the borehole during or related to the reconfiguration process.

The NMOSE does not have documentation that surface or subsurface contamination exists in the area, and takes at face value that the applicant's reconfiguration intentions address known or surmised concerns regarding potential contaminant pathways. The reconfiguration method proposed addresses the NMOSE's concern that overt comingling of aquifers or draining of surface water to aquifers is prevented by partial back-plugging the well casing and packer installation.

4. NMOSE witnessing of the well reconfiguration will not be required, but shall be facilitated if a NMOSE observer is onsite. NMOSE witnessing may be requested during normal work hours by calling District VI NMOSE Office at 505-827-6120, at least 48 hours in advance. NMOSE inspection will occur dependant on personnel availability.

5. A NMOSE Well Record & Log (currently available at: http://www.ose.state.nm.us/WR/Forms/WR-20%20Well%20Record%20and%20Log_2019-4-30_final.pdf) itemizing actual <u>partial</u> back-plugging / reconfiguration process and materials used shall be filed with the State Engineer (NMOSE, P.O. Box 25102 - 407 Galisteo Street - Room 102, Santa Fe, NM 87504-5102), within 30 days after completion of reconfiguration. Please attach a copy of these permit conditions <u>and pre- and post-reconfiguration schematics of the well design</u>.

6. Should the monitoring or sampling of either or both aquifer(s) in the well be discontinued at some future time, the Permittee shall file a plan of operations with the NMOSE to further reconfigure or decommission the well by permanently sealing the unused aquifer interval(s) by placement of sealant as approved by the NMOSE.

The Permittee well reconfiguration proposal, dated March 4, 2019, is hereby approved with the aforesaid conditions applied, when signed by an authorized designee of the State Engineer:

Witness my hand and seal this 5 day of July, 2019.

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

By: LAGarcia

Lorraine A. Garcia
Water Resource Professional- District VI

STATE ENGINEER STATE OF NEW MEXICO
GREAT SEAL OF THE STATE OF NEW MEXICO
CRESCIT EUNDO
1912

File No. RG-97896

NEW MEXICO OFFICE OF THE STATE ENGINEER

Office of the State Engineer
Interstate Stream Commission

Great Seal of the State of New Mexico 1912

WR-07 APPLICATION FOR PERMIT TO DRILL A WELL WITH NO WATER RIGHT

(check applicable box):

For fees, see State Engineer website: http://www.ose.state.nm.us/ 6-44297

Purpose:	☐ Pollution Control And/Or Recovery	☐ Ground Source Heat Pump
☐ Exploratory Well (Pump test)	☐ Construction Site/Public Works Dewatering	☐ Other(Describe):
☒ Monitoring Well	☐ Mine Dewatering	

A separate permit will be required to apply water to beneficial use regardless if use is consumptive or nonconsumptive.

☐ Temporary Request - Requested Start Date: NOT TEMPORARY - Requested End Date: LONG TERM

Plugging Plan of Operations Submitted? ☐ Yes ☒ No

1. APPLICANT(S)

Name: Los Alamos National Laboratory	Name:
Contact or Agent: Mark Everett; check here if Agent ☐	Contact or Agent: check here if Agent ☐
Mailing Address: N3B 600 Sixth Street	Mailing Address:
City: Los Alamos	City:
State: New Mexico; Zip Code: 87544	State: Zip Code:
Phone: 505-309-1367 ☐ Home ☒ Cell Phone (Work):	Phone: ☐ Home ☐ Cell Phone (Work):
E-mail (optional): mark.everett@em-la.doe.gov	E-mail (optional):

FOR OSE INTERNAL USE — Application for Permit, Form WR-07, Rev 11/17/16

File No.: RG-97896	Trn. No.:	Receipt No.:
Trans Description (optional):		
Sub-Basin: URG	PCW/LOG Due Date: 7/6/19	

2. WELL(S) Describe the well(s) applicable to this application.

Location Required: Coordinate location must be reported in NM State Plane (NAD 83), UTM (NAD 83), or Latitude/Longitude (Lat/Long - WGS84).
District II (Roswell) and District VII (Cimarron) customers, provide a PLSS location in addition to above.

☐ NM State Plane (NAD83) (Feet)
- ☐ NM West Zone
- ☐ NM East Zone
- ■ NM Central Zone

■ UTM (NAD83) (Meters)
- ☐ Zone 12N
- ☐ Zone 13N

■ Lat/Long (WGS84) (to the nearest 1/10th of second)

Well Number (if known):	X or Easting or Longitude:	Y or Northing or Latitude:	**Provide if known:** -Public Land Survey System (PLSS) (*Quarters or Halves , Section, Township, Range*) OR - Hydrographic Survey Map & Tract; OR - Lot, Block & Subdivision; OR - Land Grant Name
R-31	1637356.3 E	1745642.3 N	SE1/4 NW1/4 NE1/4 NW1/4 Section 13, T18N R6E

NOTE: If more well locations need to be described, complete form WR-08 (Attachment 1 – POD Descriptions)
Additional well descriptions are attached: ☐ Yes ☐ No **If yes, how many**______

Other description relating well to common landmarks, streets, or other:

Well is on land owned by: Department of Energy

Well Information: NOTE: If more than one (1) well needs to be described, provide attachment. Attached? ☐ Yes ☐ No
If yes, how many________

Approximate depth of well (feet): 1103 feet	Outside diameter of well casing (inches): 5.25
Driller Name: Holt Services Inc; Robert Stadeli	Driller License Number: 1780

3. ADDITIONAL STATEMENTS OR EXPLANATIONS

The monitoring well was installed prior to 2005 and does not have an OSE file number. The well screens need to be reconfigured. The Well Record and Log will be submitted following the reconfiguration and will include past data on lithology and water-bearing units obtained during initial well installation in 2001.

FOR OSE INTERNAL USE

File No.: RG-97896	Trn No.:

4. SPECIFIC REQUIREMENTS: The applicant must include the following, as applicable to each well type. Please check the appropriate boxes, to indicate the information has been included and/or attached to this application:

Exploratory:	Pollution Control and/or Recovery:	Construction De-Watering:	Mine De-Watering:
☐ Include a description of any proposed pump test, if applicable. **Monitoring:** ☒ Include the reason for the monitoring well, and, ☒ The duration of the planned monitoring.	☐ Include a plan for pollution control/recovery, that includes the following: ☐ A description of the need for the pollution control or recovery operation. ☐ The estimated maximum period of time for completion of the operation. ☐ The annual diversion amount. ☐ The annual consumptive use amount. ☐ The maximum amount of water to be diverted and injected for the duration of the operation. ☐ The method and place of discharge. ☐ The method of measurement of water produced and discharged. ☐ The source of water to be injected. ☐ The method of measurement of water injected. ☐ The characteristics of the aquifer. ☐ The method of determining the resulting annual consumptive use of water and depletion from any related stream system. ☐ Proof of any permit required from the New Mexico Environment Department. ☐ An access agreement if the applicant is not the owner of the land on which the pollution plume control or recovery well is to be located.	☐ Include a description of the proposed dewatering operation, ☐ The estimated duration of the operation, ☐ The maximum amount of water to be diverted, ☐ A description of the need for the dewatering operation, and, ☐ A description of how the diverted water will be disposed of. **Ground Source Heat Pump:** ☐ Include a description of the geothermal heat exchange project, ☐ The number of boreholes for the completed project and required depths. ☐ The time frame for constructing the geothermal heat exchange project, and, ☐ The duration of the project. ☐ Preliminary surveys, design data, and additional information shall be included to provide all essential facts relating to the request.	☐ Include a plan for pollution control/recovery, that includes the following: ☐ A description of the need for mine dewatering. ☐ The estimated maximum period of time for completion of the operation. ☐ The source(s) of the water to be diverted. ☐ The geohydrologic characteristics of the aquifer(s). ☐ The maximum amount of water to be diverted per annum. ☐ The maximum amount of water to be diverted for the duration of the operation. ☐ The quality of the water. ☐ The method of measurement of water diverted. ☐ The recharge of water to the aquifer. ☐ Description of the estimated area of hydrologic effect of the project. ☐ The method and place of discharge. ☐ An estimation of the effects on surface water rights and underground water rights from the mine dewatering project. ☐ A description of the methods employed to estimate effects on surface water rights and underground water rights. ☐ Information on existing wells, rivers, springs, and wetlands within the area of hydrologic effect.

ACKNOWLEDGEMENT

I, We (name of applicant(s)), Mark Everett

Print Name(s)

affirm that the foregoing statements are true to the best of (my, our) knowledge and belief.

Mark Everett 2/28/19

Applicant Signature

Applicant Signature

ACTION OF THE STATE ENGINEER

This application is:

☑ approved ☐ partially approved ☐ denied

provided it is not exercised to the detriment of any others having existing rights, and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare and further subject to the attached conditions of approval

Witness my hand and seal this 05 day of July 20 19, for the State Engineer

John R. D'Antonio JR., State Engineer

By: LAGarcia Lorraine A Garcia

Signature Print

Title: Water Resource Professional

Print

FOR OSE INTERNAL USE Application for Permit, Form WR-07

File No.: RG-97896	Trn No.:

NEW MEXICO OFFICE OF THE STATE ENGINEER

Coordinates

UTM - NAD 83 (m) - Zone 13

Easting 386118.050
Northing 3962247.782

State Plane - NAD 83 (f) - Zone C

Easting 1637356.300
Northing 1745642.300

Degrees Minutes Seconds

Latitude 35 : 47 : 51.879669
Longitude -106 : 15 : 37.189399

Location pulled from Coordinate Search

Calculated PLSS

◆ Coord Search Location

OSE District Boundary

POD Information

File Number:
Owner:
Permit Use: NoData
POD Status: NoData
Permit Status: NoData

1:4,514

N

ft

0 90 180 360

Image Information
Source: DigitalGlobe
Date: 11/14/2015
Resolution (m): 0.31
Accuracy (m): 10.16

Author:
Purpose:
2/27/2019

Spatial Information

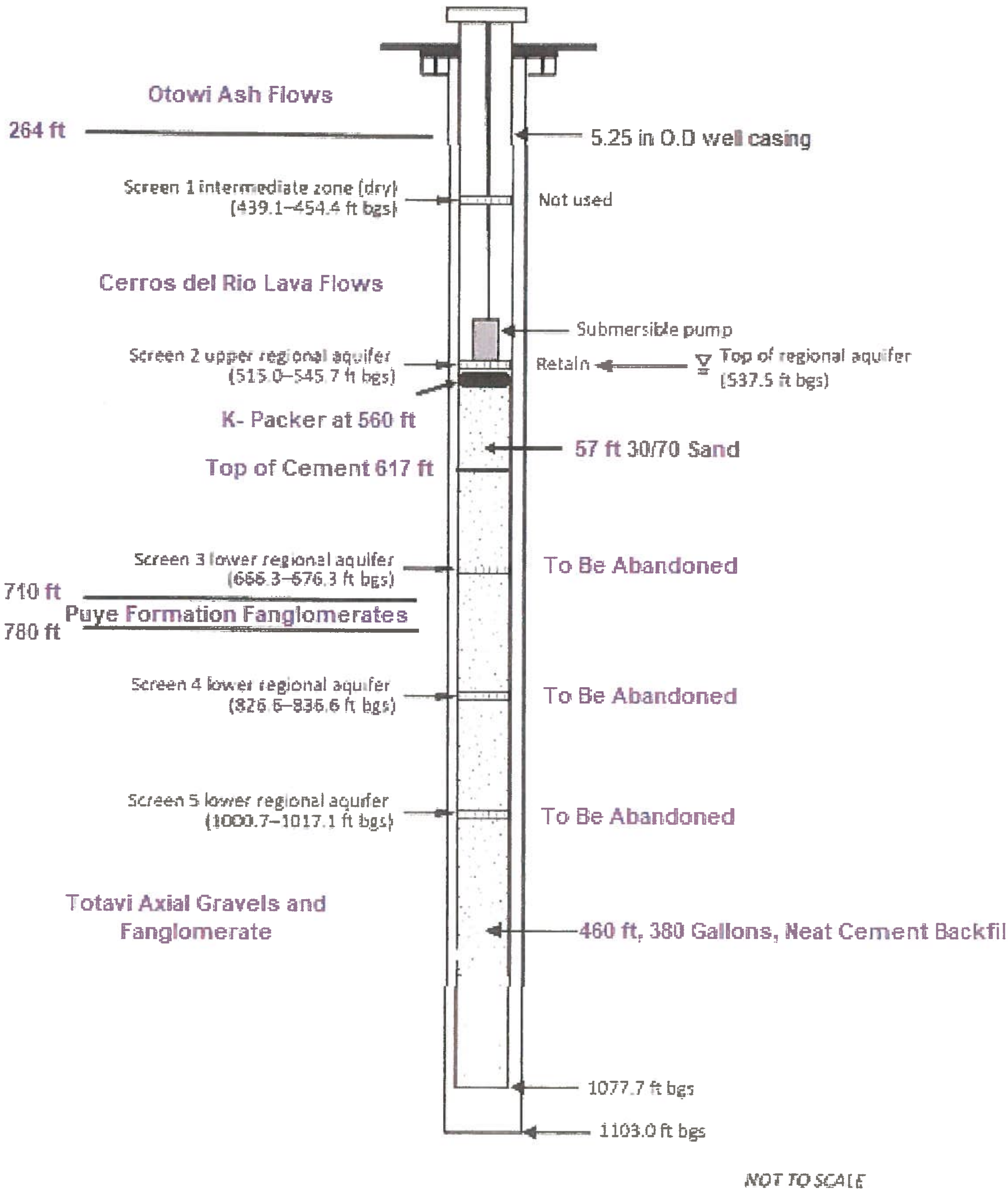
OSE Administrative Area: District
County: Los Alamos
Groundwater Basin: Rio Grande
Abstract Area: Northern Rio Grande
Sub-Basin: Rio Grande-Santa Fe
Land Grant: RAMON VIGIL
Restrictions:
NA

PLSS Description

SE NW NE NW Qtr of Sec 13 of 18N 6E

Derived from Projected PLSS - Qtr Sec. locations are calculated and are only approximations

R-31 Reconfiguration Schematic



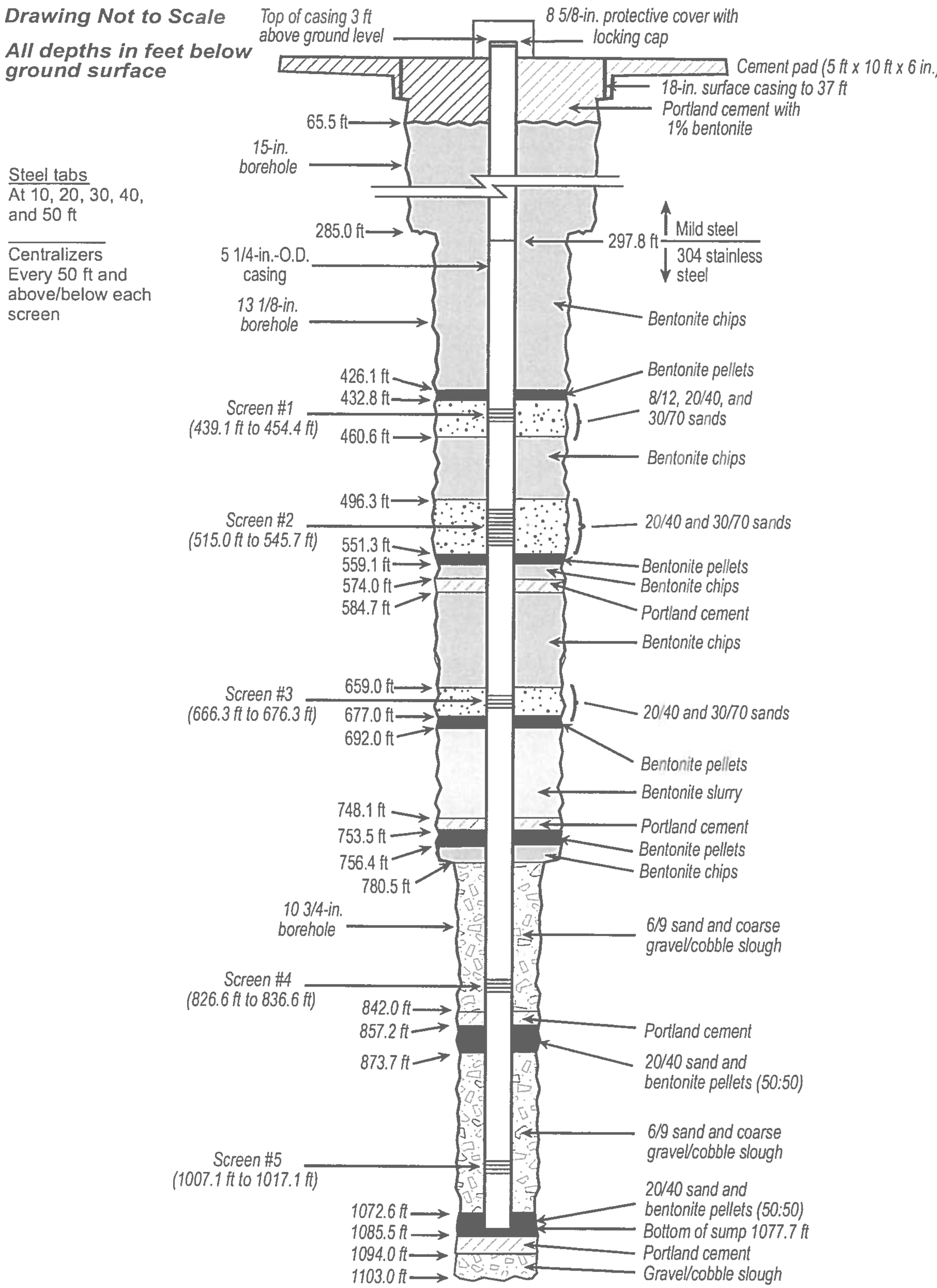
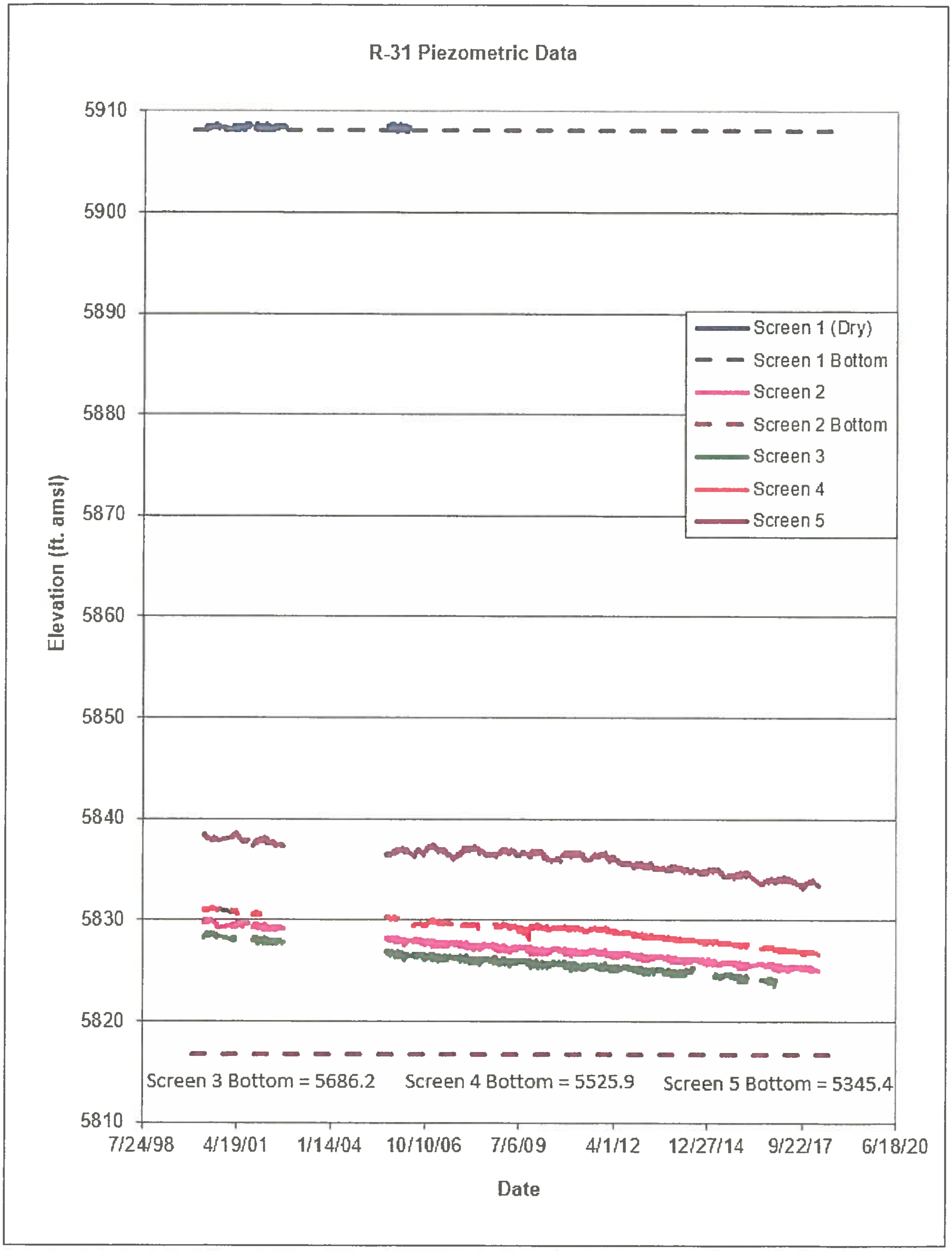


Figure 4.0-1. As-built well construction diagram for R-31


R-31 Piezometric Data
5910
5900
5890
5880
5870
5860
5850
5840
5830
5820
5810
Elevation (ft. amsl)
Screen 1 (Dry)
Screen 1 Bottom
Screen 2
Screen 2 Bottom
Screen 3
Screen 4
Screen 5
Screen 3 Bottom = 5686.2
Screen 4 Bottom = 5525.9
Screen 5 Bottom = 5345.4
7/24/98
4/19/01
1/14/04
10/10/06
7/6/09
4/1/12
12/27/14
9/22/17
6/18/20
Date

R-31 Summary Information

Monitoring Well Completed December 2000.

Location: X= 1637356.3 E; Y =1745642.3 N; New Mexico State Plane Coordinates, New Mexico Central Zone in feet, 1983 North American datum

Latitude 35 deg 47 min 51.879669 sec Longitude -106 deg 15 min 37.189399 sec

PLSS: SE NW NE NW Qtr of Section 13 T18 N R06E

As the well was installed prior to the OSE regulations including monitoring wells, the well does not have an OSE file number.

Hydrogeologic characterization well R-31 is located near the north fork of Ancho Canyon, within TA 39 of LANL. R-31 was designed to provide hydrogeologic, water-quality, and water-level data for potential intermediate-depth perched zones and for the regional aquifer. The R-31 borehole was drilled to a depth of 1103 ft bgs using air-rotary and mud rotary drilling with casing advance methods. Well R-31 was constructed with five screened intervals and a Westbay MP55 multiport sampling system was installed. The well was completed during December 2000.

The smallest borehole diameter across the well is 10.75 inches. The OD of the well casing is 5.25-in. with a 4.5-in. ID. This provides a minimum of 5.5 inches of annular space.

The well currently has multiple screens:

- Screen 1, 439.1-454.4 ft bgs, intermediate aquifer, (historic data shows this screen to be dry)
- Screen 2, 515.0-545.7 ft bgs, top of the regional water aquifer
- Screen 3, 666.3-676.3 ft bgs, within the regional water aquifer
- Screen 4, 826.6-836.6 ft bgs, within the regional water aquifer
- Screen 5, 1017.1-1077.7 ft bgs, within the regional water aquifer

Each screened interval is separated from the other with an annular seal of primarily bentonite with a minor interval of cement. (See attached as-built of R-31.)

In correspondence dated February 5, 2019, the New Mexico Environment Department approved the reconfiguration of monitoring well R-31 which is detailed in the "Work Plan to Reconfigure Monitoring Wells R-19 and R-31, Los Alamos National Laboratory."

N3B has been contracted to reconfigure the well by removing the Westbay sampling system, abandoning screens in the lower regional aquifer, and replace the Westbay system with single Grundfos pump sampling system. The three lower screens in the lower regional aquifer, Screens 3, 4, and 5, will be abandoned as it has been determined these screens are not necessary to monitor the regional aquifer. The screens will be abandoned by applying 460 ft/380 gallons of neat cement via tremie pipe from the well total depth, across the three screened intervals to approximately 49 ft above the top of Screen 3 to 617 ft bgs. A segment of the 2 inch PVC tremie will be left in the plugged interval. After curing cement, a tremie pipe will be reinstalled to near the top of cement. Fifty-seven feet of 30/70 sand will be installed through the tremie pipe above the cement interval to 560 ft bgs. A stainless steel and Viton–coated K-packer will be installed above the sand near 560 ft bgs to further isolate the plugged screens from retained Screen 2. (See the attached reconfiguration schematic.) The new sampling system will utilize a Grundfos pump and In-Situ transducer and will sample Screen 2 (top of the regional aquifer). Uppermost Screen 1 has been determined to be dry during historical groundwater monitoring events. (See the attached hydrograph for R-31.)

N3B respectfully requests to submit an OSE application for a long-term monitoring well, receive the OSE approved permit, complete activities on the reconfiguration of well R-31 and submit the Well Record and Log for R-31 with the new, long-term well completion configuration.

MICHELLE LUJAN GRISHAM
Governor

HOWIE C. MORALES
Lt. Governor

NEW MEXICO ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

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JAMES C. KENNEY
Cabinet Secretary Designate

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

February 5, 2019

Doug Hintze, Manager
Environmental Management
Los Alamos Field Office
P.O. Box 1663 MS-M984
Los Alamos, NM 87545

**RE: APPROVAL WITH MODIFICATIONS
WORK PLAN TO RECONFIGURE MONITORING WELLS
R-19 AND R-31
LOS ALAMOS NATIONAL LABORATORY
EPA ID #NM0890010515
HWB-LANL-18-061**

Dear Mr. Hintze:

The New Mexico Environment Department (NMED) has received the United States Department of Energy's (DOE) *Work plan to Reconfigure Monitoring Wells R-19 and R-31* (Work Plan), dated November 2018 and referenced by EM2018-0083. The Work Plan was received on November 19, 2018.

Pursuant to Section XXIII of the 2016 Compliance Order on Consent, a pre-submission review meeting was held with NMED and DOE on October 12, 2018 to discuss the content of the Work Plan submittal. After conducting a technical review of the Work Plan, NMED sent draft review comments on the Work Plan to DOE by electronic mail on November 30, 2018. A post-submittal meeting was held on December 17, 2018 to informally resolve NMED's comments. During the post-submittal meeting, DOE agreed to incorporate NMED's comments as modifications to the Work Plan. NMED hereby issues this approval for the Work Plan with the following modifications.

MODIFICATIONS

1. **3.6 Hydraulic Step Tests – Postjetting**

   NMED Comment: The postjetting hydraulic step tests should be conducted such that hydraulic properties data (including transmissivities and storage coefficients) can be collected at R-19 screen 3 and R-31 screen 2. These data may be very useful to site-wide and site-specific groundwater flow and contaminant transport models that may be implemented as part of future corrective actions for the RDX groundwater plume.

2. **3.8 Final Sampling System Installation**

   NMED Comment: The decision to install a Bennett pump at R-19 screen 2 should be based on whether the saturated zone yields sufficient groundwater and post-conversion analytical data. Initial characterization and subsequent monitoring data from this saturated zone will benefit the RDX 260 Outfall 16-021(c)-99 deep groundwater investigation and subsequent corrective actions (e.g., cleanup and/or monitoring strategies, numerical modeling) and may pose as a good monitoring point for other upgradient contamination sources (e.g., TAs 8, 9, 15, 18, 22, 67, etc.). The R-19 screen 2 monitoring point also has potential relevance to the site-wide groundwater monitoring program or Interim Facility-Wide Groundwater Monitoring Plan.

3. **4.0 Schedule**

   NMED Comment: The Westbay wells reconfiguration report, due August 30, 2019, should include a comparison of pre-reconfiguration Westbay well data and the new post-conversion data from all applicable screens, including data collected at wells R-5, R-7, R-8, and R-9i.

If you have any questions or comments regarding this correspondence, please contact Dane Andersen at 505-476-6056.

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

cc: N. Dhawan, NMED HWB
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File: Reading and LANL 2019, TA-00, R-19 and R-31 Reconfiguration Work Plan Approval with Mods