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

FEB 12 2020

EMLA-2020-1240-02-001

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 Wells Reconfiguration Completion Report for R-5, R-7, R-8, R-9i, and R-19, Revision 1

Dear Mr. Pierard:

Enclosed please find two hard copies with electronic files of the "Westbay Wells Reconfiguration Completion Report for R-5, R-7, R-8, R-9i, and R-19, Revision 1." Also enclosed is an electronic copy of a redline strikeout version of the report that includes all changes made.

This submittal fulfills the U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office's (EM-LA) commitment to provide the tritium and survey data, which were unavailable at the time the original report was submitted on October 16, 2019. Corrections to typographical errors have also been made and are included in the redline strikeout version.

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,

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

Enclosures:

1. Two hard copies with electronic files (including a redline strikeout version) – Westbay Wells Reconfiguration Completion Report for R-5, R-7, R-8, R-9i, and R-19, Revision 1 (EM2020-0040)

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February 2020
EM2020-0040

Westbay Wells Reconfiguration Completion Report for R-5, R-7, R-8, R-9i, and R-19, Revision 1

EM2020-0040

Westbay Wells Reconfiguration Completion Report for R-5, R-7, R-8, R-9i, and R-19, Revision 1

February 2020

Responsible program director:

Bruce Robinson	[signature]	Program Director	Water Program	2/3/2020
Printed Name	Signature	Title	Organization	Date

Responsible N3B representative:

Joseph Legare	[signature]	Acting Program Manager	N3B Environmental Remediation Program	2/5/20
Printed Name	Signature	Title	Organization	Date

Responsible DOE EM-LA representative:

Arturo Q. Duran	for [signature]	Compliance and Permitting Manager	Office of Quality and Regulatory Compliance	2/10/20
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EXECUTIVE SUMMARY

This reconfiguration completion report describes the extraction activities for the Westbay sampling apparatus, the well completion activities, and sampling activities associated with well reconfigurations at R-5, R-7, R-8, R-9i, and R-19 at Los Alamos National Laboratory, Los Alamos, New Mexico. The reconfiguration of the Westbay wells was completed to fulfill a milestone commitment under the 2016 Compliance Order on Consent to reconfigure the multiport Westbay systems as either single- or dual-screen monitoring wells. For wells R-5, R-9i, and R-19, work was conducted under monitoring well reconfiguration plans approved by the New Mexico Office of the State Engineer. Reconfiguration plans were not required for wells R-7 and R-8 because no screens were abandoned in these wells. During the conversion activities, short-term and extended aquifer tests were performed at a number of screens, and groundwater samples were obtained at the end of each aquifer test. Screens that were reconfigured were sampled for the following analytical suites: metals and general inorganics, volatile organic compounds, semivolatile organic compounds, perchlorate, and radionuclides (gross alpha, gross beta, and tritium).

Monitoring well R-5 had the Westbay system removed on May 19, 2019, after the packers were deflated from May 15 through 17, 2019. A downhole video log was completed on June 27, 2019. Screens 2, 3, and 4 were bailed and swabbed from June 27 to 28, 2019. Screens 2 and 3 were jetted on July 3, 2019. Screens 2, 3, and 4 were initially pump-tested on June 30, 2019, and July 1, 2019. Screen 4 was purged and sampled on July 2, 2019, before being plugged and abandoned. Screen 4 was plugged with cement on July 5, 2019, but cement rose higher in the annulus, invaded the lowest part of screen 3, and trapped the cement tremie pipe in the grout. A portion of the tremie pipe was freed from the cement and retrieved from the well from September 1 to 2, 2019. Because of cement in the bottom 18 ft of the 40-ft-long screen 3, this screen was plugged and abandoned from September 4 to 7, 2019. From September 8 to 11, 2019, screen 2 was step-tested, pump-tested for 24 hr, sampled, and monitored during recovery for 24 hr. While awaiting construction and delivery of the sampling system, the drilling contractor installed temporary packers to prevent cross-flow. The sampling system was installed on September 13, 2019. Varying from the approved work plan, screen 3 was plugged and abandoned because of contamination with cement grout during the plugging and abandonment of screen 4.

Monitoring well R-7 had the Westbay system removed from May 22 to 23, 2019, after the packers were deflated on May 18, 2019. Because screen 1 (from 363.2 to 379.2 ft below ground surface [bgs]) and screen 2 (from 730.4 to 746.4 ft bgs) were not productive, they were not redeveloped. Though both screens have always been dry, a transducer will monitor for the occurrence of groundwater in the vadose zone above the regional aquifer. Screen 3, in the regional aquifer (from 895.5 to 937.4 ft bgs), was retained for both water-level and water-quality monitoring purposes. A downhole video log was completed on June 7, 2019. Screen 3 was swabbed on June 12, 2019, and the sump below screen 3 was bailed on June 13, 2019. Initial pump-testing of screen 3 occurred on June 15, 2019, following a delay caused by a pump shroud that did not fit into the well casing. Screen 3 was jetted on June 18, 2019. From June 22 to 23, 2019, a 24-hr pumping test and sampling event was performed, and recovery data were collected from June 23 to 24, 2019. While awaiting construction and delivery of the sampling system, the drilling contractor installed temporary packers to prevent cross-flow. The Baski permanent sampling system was installed from September 14 to 16, 2019. All work on monitoring well R-7 was completed in accordance with the New Mexico Environment Department– (NMED-) approved work plan.

Monitoring well R-8 had the Westbay system removed from May 24 to 25, 2019, after the packers were deflated on May 20, 2019. A downhole video log was completed on June 11, 2019. Screen 1 was swabbed on June 28 and bailed on June 29, 2019, and screen 2 was swabbed and bailed on June 29, 2019. Screens 1 and 2 were initially pump-tested on July 4, 2019. Screen 1 was jetted from July 6 to 7, 2019, and screen 2 was jetted on July 8, 2019. Screen 2 was step-tested, pump-tested for

24 hr, sampled, and monitored during recovery for 24 hr from July 9 to 14, 2019. Screen 1 was step-tested, pump-tested for 24 hr, sampled, and monitored during recovery for 24 hr from July 15 to 18, 2019.

The Baski permanent sampling system was installed on August 31, 2019. All work on monitoring well R-8 was completed in accordance with the NMED-approved work plan.

Monitoring well R-9i had the Westbay system removed on May 26, 2019, after the packers were deflated on May 22, 2019. A downhole video log was completed on June 12, 2019. Screen 1 was swabbed on June 13, 2019, and screen 2 was swabbed and bailed from June 13 to 14, 2019. Screens 1 and 2 were initially pump-tested on June 15, 2019. Groundwater from screen 2 was sampled on June 16, 2019. Screen 2 was then plugged and abandoned from June 18 to 20, 2019. Screen 1 was not jetted because of concerns over plugging the fractures within the basalt. Screen 1 was step-tested, pump-tested for 24 hr, sampled, and monitored during recovery for 24 hr from June 23 to 27, 2019. While awaiting construction and delivery of the sampling system, the drilling contractor installed temporary packers to prevent cross-flow. The sampling system was installed on August 11, 2019. All work on monitoring well R-9i was completed in accordance with the NMED-approved work plan.

Monitoring well R-19 had the Westbay system removed on June 6 and 7, 2019, after the packers were deflated from June 3 to 4, 2019. A downhole video log was completed on June 20, 2019. Screen 1 was dry and was not redeveloped. Screen 2 was swabbed on July 20, 2019, and screen 3 was swabbed on July 21, 2019. The sump was bailed on July 24, 2019. After purging, screen 4 was sampled on July 29, 2019. Screens 4, 5, 6, and 7 were plugged with cement from August 5 to 8, 2019. Screens 2 and 3 were step-tested, pump-tested for 12 hr, sampled, and monitored during recovery for 12 hr from August 16 to 20, 2019. While awaiting construction and delivery of the sampling system, the drilling contractor installed temporary packers to prevent cross-flow. The Baski permanent sampling system was installed from September 5 to 6, 2019. All work on monitoring well R-19 was completed in accordance with the NMED-approved work plan.

Groundwater samples were collected from retained and uppermost abandoned screens in each of the converted wells to provide an initial comparison of groundwater quality from samples collected after purging with samples collected using the no-purge Westbay sampling system. For abandoned screens, samples were collected at the end of a relatively small-volume purge that achieved stable field parameters. For retained screens, samples were collected at the end of 24-hr or 12-hr constant-rate aquifer tests. The analytical results of the most recent samples primarily fall within or below historical ranges for each constituent. In accordance with the monitoring year 2020 Interim Facility-Wide Groundwater Monitoring Plan, these converted wells will be sampled on a quarterly basis for the next year.

CONTENTS

Figures

Tables

Appendixes

Acronyms and Abbreviations

amsl	above mean sea level
bgs	below ground surface
DO	dissolved oxygen
DOE	Department of Energy (U.S.)
DP	Delta Prime
EDN	Earth Data Northeast, Inc.
EM-LA	Environmental Management Los Alamos Field Office (DOE)
F	filtered
FD	field duplicate
gpd	gallons per day
gpm	gallons per minute
HE	high explosives
hp	horsepower
I.D.	inside diameter
IDW	investigation-derived waste
LANL	Los Alamos National Laboratory
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NA	not analyzed
NAD	North American Datum
ND	not detected

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
psi	pounds per square inch
PVC	polyvinyl chloride
RDX	Royal Demolition Explosive
SOP	standard operating procedure
SU	standard unit
SVOC	semivolatile organic compound
T2S	Tech2 Solutions
TA	technical area
TBD	to be determined
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TP	total phosphate
UF	unfiltered
VOC	volatile organic compound
WCSF	waste characterization strategy form
WFO	Weapons Facilities Operations

1.0 INTRODUCTION

This Westbay wells reconfiguration completion report summarizes the field activities and testing associated with well reconfigurations at R-5, R-7, R-8, R-9i, and R-19 at Los Alamos National Laboratory (LANL or the Laboratory) (Figure 1.0-1). As agreed between the New Mexico Environment Department (NMED) and the U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office (EM-LA), reconfiguration of the two remaining Westbay wells, R-25 and R-31, will be presented in future reports.

The information presented in this report was compiled from field reports and daily activity summaries. This section includes a brief summary of the reconfiguration field activities conducted at each well and presents background information, including the configurations of the previous wells with the Westbay system installed. Section 2 describes reconfiguration activities in detail and the current configuration of each well. Appendix A presents results of the initial pumping tests and a jetting analysis for each 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 report. Appendix E includes documentation of the New Mexico Office of the State Engineer (NMOSE) approvals for reconfiguration plans for R-5, R-9i, and R-19.

1.1 Field Activity Summary

Field activities performed as part of the well reconfiguration included the removal of the Westbay MP55 system from each well, 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 to September 23, 2019. For each well, the Westbay system was removed and replaced with either a single- or dual-screen sampling system. Specific plans for the reconfigurations were presented in the “Work Plan for the Technical Area 21 Monitoring Well Network Reconfiguration” (LANL 2011, 204372), and the “Work Plan to Reconfigure Monitoring Wells R-19 and R-31” (N3B 2018, 700130). These work plans were approved by NMED in August 2011 (NMED 2011, 206269) and early February 2019 (NMED 2019, 700216), respectively. An updated sampling and analysis plan for all five wells (plus well R-31) was emailed on May 25, 2019 (Everett 2019, 700606) and NMED emailed concurrence on May 31, 2019 (Dale 2019, 700610). On July 12, 2019 (Andersen 2019, 700611), EM-LA and NMED agreed, via email, that the milestone report would not include geodetic survey data or interpretation of the aquifer tests. Geodetic survey data are available in Intellus New Mexico (Intellus) and are included in this report. Interpretation of the aquifer test data is presented in Appendix C of this report.

The following documents were prepared to guide field activities associated with the Westbay well reconfiguration for wells R-5, R-7, R-8, R-9i, and R-19:

- “Field Implementation Plan for Well Reconfigurations at R-5, R-7, R-8, R-9i, R-25, and R-31” (N3B 2019, 700385)
- “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.

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

The Westbay wells discussed in this report were installed by the Laboratory in support of the Hydrogeologic Workplan (LANL 1998, 059599) between 2000 and 2002. Each well was installed to gather the optimum amount of information from each borehole drilled. Installation of the Westbay sampling system allowed for both discrete water-level monitoring and analytical sample collection from multiple depths within a single well.

The multiscreened wells R-5, R-7, R-8, R-9i, and R-19 were drilled using a variety of drilling fluids and additives and were constructed using pipe-based screens; not all screens were adequately developed. Westbay MP55 sampling systems were installed in each well. The Westbay system consists of modular casing, sets of packers to seal off each screened interval to be sampled, measurement ports to obtain groundwater levels, and pumping ports within the screened intervals. The Westbay system is designed to sample only groundwater within the screened interval in real time. The system is 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 these wells.

This well reconfiguration effort was initiated in response to NMED's "Approval with Modifications, Technical Area 21 Monitoring Well Network Evaluation and Recommendations," dated December 2, 2010 (NMED 2010, 111462), requesting that the Laboratory generate a plan that describes enhancements that will be made to the Technical Area 21 (TA-21) vadose zone and groundwater monitoring network. The "Work Plan for the Technical Area 21 Monitoring Well Network Reconfiguration" (LANL 2011, 204372) referred to wells R-5, R-7, R-8, and R-9i only; reconfiguration of well R-19 was described in a separate work plan for wells R-19 and R-31 (N3B 2018, 700130).

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 CdV-R-15-3 (Kopp et al. 2002, 073179) and CdV-R-37-2 (Kopp et al. 2003, 088803) 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 two network evaluations (TA-21 and TA-16) was the decision to reconfigure all of the remaining Westbay wells at LANL with either single- or dual-screen purgeable sampling systems.

The following sections summarize the original configuration of wells R-5, R-7, R-8, R-9i, and R-19.

1.2.1 R-5

Hydrogeologic characterization well R-5 was completed in May 2001 on the southern side of lower Pueblo Canyon, about 3000 ft west-northwest of water supply well Otowi-1 and about 4700 ft southeast of the Bayo Canyon sewage treatment plant. The primary purpose of this well was to provide water-quality, geochemical, hydrologic, and geologic information that would contribute to understanding the hydrogeologic setting beneath LANL. In addition, the well was designed to help determine whether Laboratory releases and sewage plant effluents may be present in the regional aquifer beneath lower Pueblo Canyon and, if so, the extent to which contaminants may have affected groundwater quality. The well is located on Los Alamos County property.

Borehole R-5 was drilled to a total depth of 902 ft below ground surface (bgs) using air-rotary drilling methods. Well installation included four screened intervals, and the well was equipped with a Westbay

MP55 multiport sampling system (LANL 2003, 080925). Screen conditions mentioned here specifically refer to those that existed when the well was completed and not to the conditions observed once the Westbay system was removed. Pertinent well information is as follows:

- 4.5-in.–inside diameter (I.D.) stainless-steel casing
- Screen 1: 326.4–331.5 ft bgs (wire-wrapped screen) dry, upper intermediate zone
- Screen 2: 372.8–388.8 ft bgs (wire-wrapped screen) wet, lower intermediate zone
- Screen 3: 676.9–720.3 ft bgs (wire-wrapped screen) wet, upper part of the regional aquifer
- Screen 4: 858.7–863.7 ft bgs (wire-wrapped screen) wet, deeper part of the regional aquifer

1.2.2 R-7

Hydrogeologic characterization well R-7 is located in the east-central portion of LANL; more specifically, the well is located in the narrow, upper part of Los Alamos Canyon, between the former Omega West reactor site and the mouth of Delta Prime (DP) Canyon. Lying east of TA-02 and south of TA-21, the location of this well was chosen to characterize groundwater occurrence and quality of water in both perched and regional zones of saturation near sites of potential contaminant effluent release. The borehole was drilled using air-rotary, reverse circulation, dual-rotary/casing-advance drilling methods to a total depth of 1097 ft bgs. Well installation, which was completed in January 2001, included three screened intervals, and the well was equipped with a Westbay MP55 multiport sampling system (Stone et al. 2002, 072717). Screen conditions mentioned here specifically refer to those that existed when the well was completed and not to the conditions observed once the Westbay system was removed. Pertinent well information is as follows:

- 4.5-in.-I.D. stainless-steel casing
- Screen 1: 363.2–379.2 ft bgs (wire-wrapped screen) wet, but not productive
- Screen 2: 730.4–746.4 ft bgs (wire-wrapped screen) wet, but not productive
- Screen 3: 895.5–937.4 ft bgs (wire-wrapped screen) wet, straddles the top of the regional aquifer

1.2.3 R-8

Hydrogeologic characterization well R-8 was installed downgradient from well R-7 to investigate the nature and extent of impacts to regional groundwater resulting from LANL activities in the Los Alamos Canyon watershed. Water-quality, geochemical, hydrologic, and geologic information collected during completion augmented knowledge of regional subsurface characteristics, and samples collected during subsequent well completion aided in understanding the distribution of any contaminants downgradient of TA-21, a potential source of groundwater contamination. Well R-8 was designed to provide water-quality and water-level monitoring data from the regional aquifer. The R-8 borehole was drilled to a total depth of 880 ft bgs using a combination of air-rotary and casing-advance drilling methods. Well installation, which was completed in January 2002, included two screened intervals, and the well was equipped with a Westbay MP55 multiport sampling system (LANL 2003, 079594). Screen conditions mentioned here specifically refer to those that existed when the well was completed and not to the conditions observed once the Westbay system was removed. Pertinent well information is as follows:

- 4.5-in.-I.D. stainless-steel casing
- Screen 1: 705.3–755.7 ft bgs (wire-wrapped screen) wet, top of the regional aquifer
- Screen 2: 821.3–828.0 ft bgs (wire-wrapped screen) wet, within the regional aquifer

1.2.4 R-9i

Hydrogeologic characterization well R-9i is located downgradient from wells R-7 and R-8 in Los Alamos Canyon within TA-72. Well R-9i is also downgradient of multiple potential contaminant source areas that include release sites in the Los Alamos Canyon watershed. Well R-9i was completed during March 2000. The R-9i borehole was drilled to a total depth of 322 ft bgs using open borehole drilling methods for all but the upper 18 ft, where surface casing was emplaced. Well installation was completed in the intermediate zone with two screened intervals, and the well was equipped with a Westbay MP55 multiport sampling system (Broxton et al. 2001, 071251). Screen conditions mentioned here specifically refer to those that existed when the well was completed and not to the conditions observed once the Westbay system was removed. Pertinent well information is as follows:

- 5.0-in.-I.D. stainless-steel casing
- Screen 1: 189.1–199.5 ft bgs (wire-wrapped screen) wet, upper intermediate zone
- Screen 2: 269.6–280.3 ft bgs (wire-wrapped screen) wet, upper intermediate zone

1.2.5 R-19

Hydrogeologic characterization well R-19 is located in the Weapons Facilities Operations (WFO) area atop the mesa separating Threemile and Potrillo Canyons, east of firing site IJ at TA-36. R-19 was drilled to a depth of 1902.5 ft bgs, and it was completed in March 2000 as a multiscreen well containing seven screened intervals that could be sampled individually with the Westbay MP55 system. R-19 was primarily designed to provide water-quality and water-level data for potential intermediate-depth perched zones and for the regional aquifer downgradient of high-explosives (HE) contaminant release sites at TA-16. The R-19 borehole was drilled using dual-rotary, casing-advance drilling methods (Broxton et al. 2001, 071254). Screen conditions mentioned here specifically refer to those that existed when the well was completed and not to the conditions observed once the Westbay system was removed. Pertinent well information is as follows:

- 4.5-in.-I.D. stainless-steel casing
- Screen 1: 827.2–843.6 ft bgs (wire-wrapped screen) wet, intermediate zone
- Screen 2: 893.3–909.6 ft bgs (wire-wrapped screen) wet, intermediate zone
- Screen 3: 1171.4–1215.4 ft bgs (wire-wrapped screen) wet, top of the regional aquifer
- Screen 4: 1410.2–1417.4 ft bgs (wire-wrapped screen) wet, within the regional aquifer
- Screen 5: 1582.6–1589.8 ft bgs (wire-wrapped screen) wet, within the regional aquifer
- Screen 6: 1726.8–1733.9 ft bgs (wire-wrapped screen) wet, within the regional aquifer
- Screen 7: 1832.4–1839.5 ft bgs (wire-wrapped screen) wet, within the regional aquifer

2.0 WELL RECONFIGURATION FIELD ACTIVITIES

2.1 R-5 Reconfiguration

Figure 2.1-1 presents the monitoring well R-5 as-built construction diagram post-Westbay conversion. Figure 2.1-2 presents the as-built technical notes for monitoring well R-5 post-Westbay conversion. Figure 2.1-3 presents the R-5 dedicated pump performance curve.

2.1.1 R-5 Westbay System Removal

A pressure profile was taken in the R-5 Westbay casing on May 14, 2019. The packers of the Westbay system were deflated from May 15 through 17, 2019. Packer deflation was delayed because the packer deflation tool became lodged in the well. A post-deflation pressure profile was taken, and the bottom pumping port was opened on May 17, 2019, to provide a discharge path for water inside the Westbay casing to exit the system when it was removed. The pump hoist rig was set up on R-5 on May 18, 2019, and 129 ft of the Westbay casing was removed. On May 19, 2019, 754 ft of Westbay casing and the sampling system (total 883 ft) were removed.

On May 22, 2019, temporary packers were set between 421.1 and 423.3 ft bgs (between screens 2 and 3) and between 742.5 and 744.5 ft bgs (between screens 3 and 4), Westbay system components were removed from the site, and the pump hoist rig was moved off-site.

2.1.2 R-5 Swabbing and Bailing of Screens 2, 3, and 4

The pump hoist rig was again set up at R-5 on June 6, 2019. The temporary packers were deflated and removed from 421.1 and 742.5 ft bgs, and the camera survey was completed on June 27, 2019, to verify the removal of the Westbay casing and the interior condition of the well casing. 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 for 2 hr. Screen 4 (from 858.7 to 863.7 ft bgs) was swabbed on June 27, 2019; screen 3 (from 676.9 to 720.3 ft bgs) was swabbed on June 27 and 28, 2019; and screen 2 (from 372.8 to 388.8 ft bgs) was swabbed on June 28, 2019. Following swabbing, on June 28 and 29, 2019, the bailer was lowered into the well in order to remove large particles that potentially could damage the submersible pump, and 150 and 50 gal. of water were bailed, respectively. Table 2.1-1 shows the quantity of water produced during the bailing of screens 2, 3, and 4 in well R-5.

2.1.3 R-5 Initial Test Pumping of Screens 2, 3, and 4

Initial pumping tests were performed on screens 2, 3, and 4 to assist in designing the jetting program for these screens. Screens 3 and 4 were step-tested on June 30, 2019. Screen 3 extends from 676.9 to 720.3 ft bgs and lies within Miocene fluvial/alluvial sediments. Screen 4 extends from 858.7 to 863.7 ft bgs and lies within Miocene basalt. Screen 2 was step-tested on July 1, 2019. It extends from 372.8 to 388.8 ft bgs and lies within Puye strata. Table 2.1-1 shows the quantity of water produced during the initial test pumping of screens 2, 3, and 4.

2.1.4 R-5 Groundwater Sampling of Screen 4 Before Abandonment

Before abandonment, screen 4 was purged for 92 min at an average rate of 3.2 gpm and sampled once field parameters stabilized on July 2, 2019. All samples, except for tritium samples, were shipped to GEL for analysis. Tritium samples were shipped to ARS International, LLC (ARS). Table 2.1-1 shows the quantity of water produced when screen 4 was purged and sampled. A comparison of R-5 screen 4 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected.

2.1.5 R-5 Abandonment of Screen 4

Abandonment of R-5 screen 4 was conducted under the monitoring well reconfiguration plan approved by NMOSE, which is included in Appendix E. Before grout was pumped to plug screen 4, the water level was measured at 662.0 ft bgs (all water levels are recorded in Table 2.1-2). Screen 4 was plugged and abandoned on July 5, 2019. The plugging procedure recommends using steel tremie pipe above and polyvinyl chloride (PVC) tremie pipe below. The intent of this arrangement was to bring the cement level up to a level just below the transition from PVC tremie to steel tremie so that the steel pipe can be rotated and detached from the PVC. The method intentionally leaves the PVC in place and prevents cement from being dragged through retained screens above. On July 8, 2019, the top of the cement within the tremie pipe was measured at 767 ft bgs. Several attempts to determine the top of the cement within the well casing but outside of the tremie pipe occurred on July 8, 19, and 21, 2019; each attempt yielded a different value, between 695 and 703 ft bgs. A temperature probe was lowered through the tremie pipe from 767.6 ft to 626.3 ft bgs to collect temperature readings on July 8, 2019, in order to determine where cement was in the annulus, which proved to be inconclusive. Unsuccessful attempts to break the steel tremie pipe free and pull it from the well occurred on July 6 and 7, 2019. On August 31, 2019, the pump hoist rig was redeployed to the R-5 well site to recommence fishing the steel tremie pipe. On September 1, 2019, a new fishing tool was lowered into R-5 to a depth of 690 ft bgs and engaged the steel tremie pipe. The tremie pipe was disconnected at a coupling above the cement. A total of 420 ft of tremie pipe was removed from the well. On September 2, 2019, removal of the steel tremie pipe from the well was complete, with a total of 700 ft of steel tremie pipe retrieved from the well, leaving 60 ft of steel tremie entombed in the cement. The top of the cement was tagged at 702 ft bgs. On September 3, 2019, a downhole video log was run in R-5 that observed the top of the steel tremie pipe at 697 ft bgs and cement at 702 ft bgs.

2.1.6 R-5 Jetting of Retained Screens 2 and 3

Following swabbing and bailing and the initial testing of R-5 screens 2, 3, and 4, the well was developed further by simultaneous high-velocity jetting and pumping. The upper two screens (screens 2 and 3) were jetted on July 3, 2019. Screen 2, at 372.8 to 388.8 ft bgs, was jetted from 09:10 to 10:40, and screen 3, at 676.9 to 720.3 ft bgs, was jetted from 16:05 to 18:20. Original plans called for abandoning screen 4 before jet development. However, the very low yields obtained from screens 2 and 3 dictated using the combined flow from screens 2, 3, and 4 to remove sediment loosened by the jetting tool. Thus, jetting was completed before cementing and abandonment of screen 4. Initial test pumping results and jetting analysis are provided in Appendix A.

2.1.7 R-5 Aquifer Testing and Groundwater Sampling of Screen 3

Because of cement emplaced into the lower 18 ft of screen 3 during the plugging of screen 4, screen 3 was determined to no longer be a viable sampling location in R-5. On September 3, 2019, NMED concurred to plug and abandon screen 3 (Dhawan 2019, 700609), so no further aquifer testing or groundwater sampling was attempted for screen 3.

2.1.8 R-5 Abandonment of Screen 3

Before grout was pumped to plug screen 3, the water level was measured at 351.6 ft bgs (all water levels are recorded in Table 2.1-2). Screen 3 was plugged and abandoned on September 4, 2019. The top of the cement was measured at 601.9 ft bgs, 75.7 ft above the top of screen 3. The top of the groundwater was measured at 342.88 ft bgs. Installation of the sand pack was completed on September 7, 2019, with the top of the sand pack tagged at 442.05 ft bgs. A permanent k-packer was placed above the sand pack, at 440.5 ft bgs, leaving a 53.9 ft sump below the bottom of screen 2.

2.1.9 R-5 Aquifer Testing and Groundwater Sampling of Screen 2

Following the plugging and abandoning of screen 3, a 30-min step-drawdown test of R-5 screen 2 was completed on September 8, 2019, with 78.2 gal. of water produced. A 23.5-hr pump test was completed from 08:30 on September 10 to 08:00 on September 11, 2019, with 3770.6 gal. produced. Groundwater sampling took place during the pumping test after monitored groundwater parameters had stabilized. All groundwater samples, except for tritium samples, were shipped to GEL for analysis. Tritium samples were shipped to ARS. Table 2.1-1 shows the quantity of water produced during the testing and sampling of screen 2. A comparison of R-5 screen 2 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected. A detailed presentation and analysis of the pumping and recovery data associated with the aquifer test appears in Appendix C.

2.1.10 R-5 Dedicated Pumping System Installation

After redevelopment, aquifer testing, and groundwater sampling activities were completed, the permanent sampling system was installed in R-5 on September 13, 2019. For R-5 the sampling system consists of a submersible pump, a stainless-steel riser pipe, and two PVC gauge tubes. The top of the pump intake was landed at 416 ft bgs, and the bottom of the pump shroud is at 420.2 ft bgs. The verified performance test sheet for the pump installed into monitoring well R-5 is displayed in Figure 2.1-3.

2.1.11 Post-Pump Installation Activities

The original concrete well pad had deteriorated. On October 15, 2020, the original R-5 well pad was demolished. A new well pad was constructed on December 5, 2019. A geodetic survey was conducted on January 18, 2020. The geodetic survey coordinates are provided for the locations listed in Table 2.1-3. The geodetic survey data are available in Intellus and are provided in this report.

2.2 R-7 Reconfiguration

Figure 2.2-1 presents the monitoring well R-7 as-built construction diagram post-Westbay conversion. Figure 2.2-2 presents the as-built technical notes for monitoring well R-7 post-Westbay conversion. Figure 2.2-3 presents the R-7 dedicated pump performance curve.

2.2.1 R-7 Westbay System Removal

A pressure profile was taken in the R-7 Westbay casing on May 18, 2019. The packers of the Westbay system were deflated on May 19, 2019. A post-deflation pressure profile was taken and the bottom pumping port was opened on May 20, 2019, to provide a discharge path for water inside the Westbay casing to exit the system when it was removed. A pump hoist rig was set up at R-7 on May 22, 2019, and three Westbay packers and approximately 400 ft of the Westbay casing were removed. On May 23, 2019, 572 ft of Westbay casing and sampling system were removed. A temporary packer was set between screens 2 and 3 at 760 ft bgs on May 24, 2019.

2.2.2 R-7 Swabbing and Bailing of Screen 3

The temporary packer was deflated and removed from a depth of 760 ft bgs on June 6, 2019, and a downhole video log was run on June 7, 2019. Because screen 1 (from 363.2 to 379.2 ft bgs) and screen 2 (from 730.4 to 746.4 ft bgs) were both dry, they were not redeveloped. Screen 3, in the regional aquifer (from 895.5 to 937.4 ft bgs), was retained for water-level and water-quality monitoring purposes.

The static water level was measured at 909.35 ft bgs on June 12, 2019 (all water levels are recorded in Table 2.1-2) before swabbing and bailing. Screen 3 was initially redeveloped using a surge block and bailer, where the surge block was lowered into the well and drawn repeatedly across the screened interval for 2 hr. Following swabbing, on June 13, 2019, the bailer was lowered into the well in order to remove large particles that potentially could damage a submersible pump, and approximately 50 gal. of water was bailed. Table 2.1-1 shows the quantity of water produced during the bailing of screen 3.

2.2.3 R-7 Initial Test Pumping of Screen 3

An initial pump test was performed to design the jetting program for screen 3. Screen 3 extends from 895.5 to 937.4 ft bgs and straddles the top of the water table at 909.0 ft within pumiceous Puye Formation strata. On June 13, 2019, a kink was discovered approximately 1.87 ft below the top of the casing that prevented the pump shroud from going into the well. The shroud was removed from the pump, and the pump assembly was lowered back into the R-7 well on June 14, 2019. The pump was set at 937.72 ft bgs, and the step test was conducted on June 15, 2019. Table 2.1-1 shows the quantity of water produced during the initial pump-testing of screen 3.

2.2.4 R-7 Jetting of Screen 3

Following swabbing, bailing, and the initial testing of screen 3, the screen was developed further by simultaneous high-velocity jetting and pumping. Screen 3, at 895.5 to 937.4 ft bgs, was jetted on June 18, 2019, when development began at 10:20 and continued until 16:00. On June 19, 2019, an additional 50 gal. was bailed. Initial test pumping results and jetting analysis are provided in Appendix A.

2.2.5 R-7 Aquifer Testing and Groundwater Sampling of Screen 3

Following jet development and follow-up step-drawdown testing of R-7 screen 3, a 24-hr constant-rate pumping and recovery test was performed. Because the well screen straddled the water table, draining of the casing and filter pack during pumping was inevitable, and thus it was not possible to eliminate storage effects on the test data. This placement of screen 3 across the top of the water table did not allow for the isolation of the zone in which it was placed. Therefore, the pump was run without the use of an inflatable packer. Also, as stated previously, it was necessary to run the pump without a shroud because the 4.25-in.–outside diameter (O.D.) shroud intended for use at R-7 would not fit through the upper few feet of the 4.5-in.–I.D. casing.

The pump was step-tested in the well on June 20, 2019. The pumping test began at 08:00 on June 22, 2019, at a discharge rate of 7.2 gallons per minute (gpm) and continued for 1440 min until 08:00 on June 23, 2019. Groundwater samples were collected at the end of the 24-hr pumping test and shipped to GEL for analysis, except for tritium samples, which were shipped to ARS. Following pump shutoff, recovery data were monitored for 1440 min until 08:00 on June 24 when the pump was pulled from the well. Table 2.1-1 shows the quantity of water produced during the testing and sampling of screen 3. A comparison of R-7 screen 3 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected. A detailed presentation and analysis of the pumping and recovery data associated with the aquifer test appears in Appendix C.

2.2.6 R-7 Dedicated Pumping System Installation

After redevelopment, aquifer testing, and groundwater sampling activities were completed, a permanent pumping system was installed in R-7 from August 14 to 16, 2019. The sampling system consists of a submersible pump, a stainless-steel riser pipe, two PVC gauge tubes, and a packer inflated above screen 3. A transducer was placed above the installed packer to monitor for future potential occurrence of perched groundwater. The verified performance test sheet for the pump installed into monitoring well R-7 is displayed in Figure 2.2-3.

2.2.7 Post-Pump Installation Activities

The original concrete well pad had deteriorated. On September 12, 2019, the original R-7 well pad was demolished. A new well pad was constructed on December 10, 2019. A new geodetic survey was conducted on January 18, 2020. The geodetic survey coordinates are provided for the locations listed in Table 2.1-3. The geodetic survey data are available in Intellus and are provided in this report.

2.3 R-8 Reconfiguration

Figure 2.3-1 presents the monitoring well R-8 as-built construction diagram post-Westbay conversion. Figure 2.3-2 presents the as-built technical notes for monitoring well R-8 post-Westbay conversion. Figure 2.3-3 presents the R-8 dedicated pump performance curve.

2.3.1 R-8 Westbay System Removal

A pressure profile was taken in the R-8 Westbay casing on May 20, 2019. The packers of the Westbay system were deflated on May 21, 2019. A post-deflation pressure profile was taken, and the bottom pumping port was opened on May 22, 2019, to provide a discharge path for water inside the Westbay casing to exit the system when it is removed. A pump hoist rig was set up at R-8 on May 24, 2019, and 360 ft of Westbay casing and one packer were removed. On May 25, 2019, 488 ft of the Westbay casing and sampling system was completely removed, a temporary packer was set at 775 ft bgs between screens 1 and 2, and the pump hoist rig was demobilized from the R-8 site.

The pump hoist rig was moved back to R-8 on June 11, 2019, and the temporary packer was removed. A downhole video log was collected to confirm the Westbay system removal and to observe the condition of the well casing and screens. The temporary packer was set at 775 ft bgs and the rig was moved off-site.

2.3.2 R-8 Swabbing and Bailing of Screens 1 and 2

The pump hoist rig was set up at R-8 on June 27, 2019, and the temporary packer was deflated and removed from 775 ft bgs. The static water level was tagged at 727.71 ft bgs before swabbing and bailing. 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 for 2 hr. Screen 1 (from 705.3 to 755.7 ft bgs) was swabbed on June 28, 2019, and screen 2 (from 821.3 to 828.0 ft bgs) was swabbed on June 29, 2019. Following swabbing, on June 29, 2019, the bailer was lowered into the well in order to remove large particles that potentially could damage the submersible pump, and 50 gal. of water was bailed. Table 2.1-1 shows the quantity of water produced during the bailing of screens 1 and 2. The water level in R-8 was measured on June 29, 2019, at 727.71 ft bgs (all water levels are recorded in Table 2.1-2).

2.3.3 R-8 Initial Test Pumping of Screens 1 and 2

Pumping tests were planned for June 30, 2019, to assist with designing the jetting program, but a malfunctioning pump shroud delayed the start of the test. Screen 1 extends from 705.3 to 755.7 ft bgs and straddles the water table. Screen 2 extends from 821.3 to 828.0 ft bgs in the Puye Formation. The initial pumping test on screen 2 failed to produce any water on July 3, 2019. Screens 1 and 2 were successfully pump-tested within the Puye pumiceous sediments on July 4, 2019. Table 2.1-1 shows the quantity of water produced during the initial pump-testing of screens 1 and 2.

2.3.4 R-8 Jetting of Screens 1 and 2

Following swabbing, bailing, and the initial testing of screens 1 and 2, the well was developed further by simultaneous high-velocity jetting and pumping. Screen 1, at 705.3 to 755.7 ft bgs, was jetted from July 6 to 7, 2019, commencing in the afternoon for 1 hr before it was shut down because of lightning. Jetting of screen 1 was completed in 3 hr the following morning. Screen 2, at 821.3 to 828.0 ft bgs, was jetted and bailed from 09:26 to 10:26 on July 8, 2019, until the water was clear. Initial test pumping results and jetting analysis are provided in Appendix A.

2.3.5 R-8 Aquifer Testing and Groundwater Sampling of Screen 1

Following jet development of the R-8 screens, aquifer testing was performed. Screen 1 was tested from July 15 through 18, 2019. Testing consisted of a step-drawdown test followed by a 24-hr pumping and recovery test.

Step-drawdown testing of R-8 screen 1 began at 07:30 on July 15, 2019, and continued for 120 min. Following shutdown, recovery data were recorded for 1350 min until 08:00 on July 16, 2019.

The 24-hr pumping test began at 08:00 on July 16, 2019, at a discharge rate of 3.25 gpm. After 480 min, the discharge rate was reduced to 2.1 gpm to minimize ongoing dewatering of the well screen. This rate was maintained for the balance of the 24-hr test. Groundwater samples were collected from screen 1 at the end of the 24-hr pumping test and shipped to GEL for analysis, except for tritium samples, which were shipped to ARS. Following pump shutoff, recovery data were monitored for 1440 min until 08:00 on July 18, 2019, when the pump was pulled from the well. Table 2.1-1 shows the quantity of water produced during the groundwater sampling of screen 1. A comparison of R-8 screen 1 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected. A detailed presentation and analysis of the pumping and recovery data associated with the aquifer test appears in Appendix C.

2.3.6 R-8 Aquifer Testing and Groundwater Sampling of Screen 2

Screen 2 was aquifer tested from July 9 through 14, 2019. Testing consisted of brief trial tests followed by a 24-hr pumping and recovery test.

After the pump was installed and water pumped to the surface on July 9, 2019, trial testing was performed on July 10. Trial testing of R-8 screen 2 (trial 1) began at 08:00 on July 10, 2019, at a discharge rate of 7.5 gpm and continued for 30 min. Following 30 min of recovery, a second trial test (trial 2) was performed at 09:00 for 60 min at a discharge rate of 7.5 gpm. Following shutdown, recovery/background data were recorded for 2760 min until the start of the 24-hr pumping test.

The 24-hr pumping test began at 08:00 on July 12, 2019, at a discharge rate of 7.5 gpm. Pumping continued for 1440 min until 08:00 on July 13, 2019. Groundwater samples were obtained from screen 2 at the end of the pumping test. Following pump shutoff, recovery data were monitored for 1440 min until 08:00 on July 14, 2019, when the pump was pulled from the well. Table 2.1-1 shows the quantity of water produced during the groundwater sampling of screen 2. A comparison of R-8 screen 2 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected. A detailed presentation and analysis of the pumping and recovery data associated with the aquifer test appears in Appendix C.

2.3.7 R-8 Dedicated Pumping System Installation

After redevelopment, aquifer testing, and groundwater sampling activities were completed, a Baski sampling system was installed in R-8 from August 28 to August 30, 2019, after removal of the temporary packer between screens 1 and 2. A Grundfos 5S20-665 submersible pump was installed in the dual-screen, single-pump system. The configuration of the new pumping system is presented in Figure 2.3-1. Technical notes are presented in Figure 2.3-2. The verified performance test sheet for the pump installed into monitoring well R-8 is displayed in Figure 2.3-3.

2.3.8 Post-Pump Installation Activities

The original concrete well pad had deteriorated. On September 12, 2019, the original R-8 well pad was demolished. and a A new well pad was constructed on December 12, 2019.A new geodetic survey was conducted January 18, 2020. The geodetic survey coordinates are provided for the locations listed in Table 2.1-3. The geodetic survey data are available in Intellus and are provided in this report.

2.4 R-9i Reconfiguration

Figure 2.4-1 presents the monitoring well R-9i as-built construction diagram post-Westbay conversion. Figure 2.4-2 presents the as-built technical notes for monitoring well R-9i post-Westbay conversion. Figure 2.4-3 presents the R-9i dedicated pump performance curve.

2.4.1 R-9i Westbay System Removal

A pressure profile was taken in the R-9i Westbay casing on May 22, 2019. The packers of the Westbay system were deflated on May 22 and 23, 2019. A post-deflation pressure profile was taken and the bottom pumping port was opened on May 23, 2019, to provide a discharge path for water inside the Westbay casing to exit the system when it was removed. The pump hoist rig was set up at R-9i on May 26, 2019, 308 ft of the Westbay sampling system was removed, and a temporary packer was set at 230 ft bgs between screens 1 and 2. To confirm the Westbay system removal and to observe the condition of the screens, a downhole video log was completed on June 12, 2019.

2.4.2 R-9i Swabbing and Bailing of Screens 1 and 2

The pump hoist rig remobilized to R-9i on June 11, 2019. The temporary packer was deflated and removed from 230 ft bgs on June 12, 2019. 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 for 2 hr. Screen 1 (from 189.1 to 199.5 ft bgs) was swabbed on June 13, 2019, and screen 2 (from 269.5 to 280.3 ft bgs) was swabbed on June 13 and 14, 2019. Following swabbing, on June 14, 2019, the bailer was lowered into the well in order to remove large particles that potentially could damage the submersible pump. Table 2.1-1 shows the quantity of water produced during the bailing of screens 1 and 2. The water level in R-9i was measured on June 19, 2019, at 144.6 ft bgs (all water levels are recorded in Table 2.1-2).

2.4.3 R-9i Initial Test Pumping of Screens 1 and 2

Screen 1 extends from 189.1 to 199.5 ft bgs in a perched aquifer within the Cerros del Rio basalt. On June 15, 2019, screen 1 was step-tested with 14.6 gpm unrestricted flow followed by 5.9 gpm. Screen 2 extends from 269.6 to 280.3 ft bgs in a perched aquifer at the base of the Cerros del Rio basalt. Screen 2 was pump-tested but produced only 0.55 gpm. Table 2.1-1 shows the quantity of water produced during the pump-testing of screens 1 and 2. Initial test pumping results are provided in Appendix A.

2.4.4 R-9i Groundwater Sampling of Screen 2 Before Abandonment

As mentioned in section 2.4.3, screen 2 was in a very low-producing zone and therefore could not sustain continuous pumping. However, an attempt was made to collect a representative sample.

On June 16, 2019, 45 gal. was pumped to purge the drop pipe; flow varied from 1.42 to 0.26 gpm. The pump was shut down for 10 min to allow for recovery before groundwater samples were collected. Groundwater samples were collected at 11:40 on June 16, 2019, and shipped to GEL for analysis, except for tritium samples, which were shipped to ARS. Table 2.1-1 shows the quantity of water produced during the purge for screen 2 sampling. A comparison of R-9i screen 2 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected.

2.4.5 R-9i Abandonment of Screen 2

Abandonment of R-9i screen 2 was conducted under the monitoring well reconfiguration plan approved by NMOSE, which is included in Appendix E. After screen 2 was sampled, the screen was plugged and abandoned from June 18 to 20, 2019. The top of the cement above plugged screen 2 was measured at 253.35 ft bgs, 16.2 ft above the top of screen 2. Sand was installed from 253.35 ft to 225.88 ft bgs. A permanent k-packer was installed above the sand fill to 224.65 ft bgs, leaving a 25.15-ft sump below the bottom of screen 1. The reconfiguration of R-9i is presented in Figure 2.4-1.

2.4.6 R-9i Aquifer Testing and Groundwater Sampling of Screen 1

Screen 1 was not jetted because of concerns over washing the filter pack into the well annulus and into fractures in the basalt. Following abandonment of screen 2, aquifer testing of R-9i screen 1 was performed from June 23 to 27, 2019. Testing consisted of brief trial testing followed by a 24-hr pumping and recovery test.

Trial 1 testing of R-9i screen 1 began at 10:00 on June 23, 2019, at a discharge rate of 14.6 gpm and continued for 30 min. Following shutdown, recovery data were recorded for 30 min until 11:00.

Trial 2 testing began at 11:00 at a discharge rate of 14.5 gpm and continued for 60 min until 12:00. Following shutdown, recovery/background data were recorded for 2640 min until the start of the 24-hr pumping test.

The 24-hr pumping test began at 08:00 on June 25, 2019, at a discharge rate of 14.7 gpm and continued for 1440 min until 08:00 on June 26, 2019. Groundwater samples were obtained from screen 1 at the end of the pumping test and shipped to GEL for analysis, except for tritium samples, which were shipped to ARS. Following pump shutoff, recovery data were monitored for 1440 min until 08:00 on June 27, 2019, when the pump was pulled from the well. Table 2.1-1 records the quantity of water produced during the testing and sampling of screen 1. A comparison of R-9i screen 2 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected. A detailed presentation and analysis of the pumping and recovery data associated with the aquifer test appears in Appendix C.

2.4.7 R-9i Dedicated Pumping System Installation

After redevelopment, aquifer testing, and groundwater sampling activities were completed, a permanent sampling system was installed in R-9i on August 11, 2019. A sampling system consists of a submersible pump, a stainless-steel riser pipe, and two PVC gauge tubes. The configuration of the new pump system is presented in Figure 2.4-1. Technical notes are presented in Figure 2.4-2. The verified performance test sheet for the pump installed into monitoring well R-9i is displayed in Figure 2.4-3.

2.4.8 Post-Pump Installation Activities

The original concrete well pad had deteriorated. On September 12, 16, and 23, 2019, the original R-9i well pad was demolished and a new well pad was constructed, and a geodetic survey was conducted on January 18, 2020. The geodetic survey coordinates are provided for the locations listed in Table 2.1-3. The geodetic survey data are available in Intellus and are provided in this report.

2.5 R-19 Reconfiguration

Figure 2.5-1 presents the monitoring well R-19 as-built construction diagram post-Westbay conversion. Figure 2.5-2 presents the as-built technical notes for monitoring well R-19 post-Westbay conversion. Figure 2.5-3 presents the R-19 dedicated pump performance curve.

2.5.1 R-19 Westbay System Removal

A pump hoist rig was set up at R-19 on May 31, 2019, to assist with the Westbay removal. The initial pressure profile was taken on the Westbay system and 4 packers were deflated by May 31, 2019. On June 1, 2019, 13 packers were deflated (packers 5 through 13 and 17 through 20), but 6 packers could not be deflated at that time (packers 14 through 16 and 19, 21, and 22). On June 3, 2019, 4 of the remaining packers were deflated, but 2 of the packers would not deflate. The post-deflation pressure profile was taken on most of the packers within the Westbay casing on June 3 through 4, 2019. The bottom pumping port was opened on June 4, 2019, to provide a discharge path for water inside the Westbay casing to exit the system when it is removed. The last 2 packers successfully deflated and the pressure profile was checked on June 5, 2019. Approximately 860 ft of Westbay casing and sampling system were removed on June 6, 2019. On June 7, 2019, approximately 1010 ft of Westbay casing and sampling system were removed from the well. A temporary packer was set at 928 ft bgs between screens 2 and 3 on June 8, 2019.

2.5.2 R-19 Swabbing and Bailing of Screens 2, 3, and 4

The pump hoist rig remobilized to R-19 on July 19, 2019, and the temporary packer was deflated and removed from 928 ft bgs on July 20, 2019. A downhole video log was completed to confirm the Westbay removal and to observe the condition of the well casing and screens. Screens 2, 3, and 4 were initially redeveloped using a surge block and bailer, where the surge block was lowered into the well and drawn repeatedly across each screened interval for 2 hr. Because screen 1 (from 827.2 to 843.6 ft bgs) was dry, it was not redeveloped. Screen 2 (from 893.3 to 909.6 ft bgs) was swabbed on July 20, 2019, and screen 3 (from 1171.4 to 1215.4 ft bgs) was swabbed on July 21, 2019. A longer cable was needed for screen 4, so the rig was reconfigured with a longer 0.375-in. cable on July 23, 2019, and screen 4 (from 1410.2 to 1417.4 ft bgs) was swabbed on July 23, 2019. Following swabbing, on July 24, 2019, the bailer was lowered into the well in order to remove large particles that potentially could damage the submersible pump, 90 gal. of water was bailed from the sump, 20 gal. was bailed from screen 4, and 10 gal. was bailed from screen 3. No water was bailed from screen 2 because it is above the standing water level in the well. Table 2.1-1 shows the quantity of water produced during the bailing of screens 2, 3, and 4. The water level in R-19 on August 5, 2019, was at 1189.0 ft bgs (all water levels are recorded in Table 2.1-2).

2.5.3 R-19 Initial Test Pumping of Screens 2, 3, and 4

Following swabbing and bailing activities, initial test pumping was performed. A straddle packer and pump string was set at each screen in an attempt to isolate each zone for the aquifer testing. Screen 2 extends from 893.3 to 909.6 ft bgs and straddles the water table within a perched zone in the upper fanglomerate facies of the Puye sediments. 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. Cycling the pump in this manner showed a short-term yield of approximately 0.2 gpm at maximum drawdown.

Screen 3 extends from 1171.4 to 1215.4 ft bgs and straddles the top of the regional aquifer water table within the lower fanglomerate facies of the Puye Formation. Step-drawdown testing of screen 3 was done at multiple discharge rates for 73 min, from 12:20 to 13:33 on July 27, 2019, and, after a brief lightning shutdown, for 30 min from 14:20 to 14:50. Four different pumping rates varied from 2.52 to 6.22 gpm. Subsequent examination of the data showed that when the pumping string was moved to screen 3, it was inadvertently set one pipe length too high, resulting in the bottom packer being set within the screen. This would have allowed leakage past the packer, resulting in hydraulic communication between screen 3 and all the deeper screens. Thus, the screen 3 tests measured the response of screens 3 through 7. Therefore, individual data from screen 3, sought to establish a baseline yield before jet development for comparison purposes, were not obtained. All of the initial data obtained from the screen 3 tests likely represent open-hole conditions. Although screen 2 was isolated, the contribution it would have provided to the yield was negligible.

Screen 4 extends from 1410.2 to 1417.4 ft bgs in the lower fanglomerate facies of the Puye Formation. Screen 4 was tested at multiple discharge rates for 90 min from 19:50 to 21:20 on July 27, 2019. Three different pumping rates varied from 2.92 to 5.74 gpm. Table 2.1-1 shows the quantity of water produced during the initial test pumping of screen 4.

2.5.4 R-19 Groundwater Sampling of Screen 4 Before Abandonment

On July 29, 2019, the pumps were turned on at 09:41 to purge the drop pipe; flow varied from 5.3 to 4.42 gpm. Screen 4 groundwater samples were collected at 10:04 on July 29, 2019 and shipped to GEL for analysis, except for tritium samples, which were shipped to ARS. Table 2.1-1 shows the quantity of water produced during the purge for screen 4 sampling. A comparison of R-19 screen 4 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected.

2.5.5 R-19 Abandonment of Screens 4, 5, 6, and 7

Abandonment of R-19 screens 4, 5, 6, and 7 was conducted under the monitoring well reconfiguration plan approved by NMOSE, which is included in Appendix E. The water level was measured at 1189 ft bgs on August 5, 2019, after the first lift of cement was pumped to plug the lowest screen. The first lift brought the top of the cement to 1734.9 ft bgs. The water level was measured at 1189.1 ft bgs at 12:00 on August 6, 2019. On August 7, 2019, the second lift of cement was pumped to an initial depth of 1730 ft bgs. The water level was measured at 1189.4 ft bgs, and the top of the cement was measured at 1633.8 ft bgs at 09:15 on August 8, 2019. On August 8, 2019, the third lift of cement was pumped, bringing the cement level up to approximately 1500.8 ft bgs. A pump was run into the hole to pump out the remaining cement water, with 250 gal. of chase water removed on August 10, 2019. The top of the cement was measured at 1502.6 ft bgs on August 11, 2019. The fourth lift of cement was pumped, bringing the cement level up to 1379 ft bgs, 31.2 ft above screen 4. The static water level was measured at 1186.6 ft bgs. A pump was run in the hole, and 423 gal. of chase water above the cement was pumped from the well. On August 13, 2019, an additional 99 gal. of chase water from above the cement was pumped from the well with no evidence of cement grout or fines. The final determination of the top of the cement was 1381.2 ft bgs.

On August 14, 2019, sand was tremied into the well from the top of the cement to 1257.6 ft bgs. The next day, August 15, 2019, a k-packer was set on top of the sand pack. The top of the packer was measured at 1256.35 ft bgs to set the base of the sump for screen 3, leaving 40.9 ft of sump for screen 3.

2.5.6 R-19 Jetting of Retained Screens 2 and 3

Screens 2 and 3 were swabbed and bailed as previously detailed in section 2.5.2. The screens were step-tested to assist the design of the jetting procedures. Following swabbing, bailing, and the initial testing of screens 2 and 3, the well was developed further by simultaneous high-velocity jetting and pumping. Screen 2, from 893.3 to 909.6 ft bgs, was jetted on July 31, 2019. Screen 3, from 1171.4 to 1215.4 ft bgs, was jetted on August 1, 2019. Initial test pumping results and jetting analysis are provided in Appendix A.

2.5.7 R-19 Aquifer Testing and Groundwater Sampling of Screen 2

Following jet development and abandonment of screens 4, 5, 6, and 7, hydraulic testing was performed on R-19 screen 2. The zone 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 well beneath the bottom of the screen and observing the recharge rate as the casing refilled. 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.

Testing of screen 2 was performed twice. Initially, on August 16, 2019, when the pump was deployed to test screen 3 and the packers were inflated, the refill rate above the upper packer (flow from screen 2) was monitored. After the packers were inflated around screen 3, the water level above the upper packer rose steadily within the casing between the upper transducer and the bottom of screen 2 for 344 min from 15:40 to 21:24 on August 16, 2019.

Subsequently, on August 20, 2019, screen 2 was packed off, and several pumping cycles were applied successively to lower the water level into the sump beneath screen 2 so that the refill rate could be monitored. The initial pumping cycle began at 08:00 on August 20, 2019, and additional pumping and recovery cycles were applied. Useful blocks of recovery data were obtained intermittently for 652 min from 08:07 until 18:59. On August 21, 2019, the well was pumped for 18 min, based on the low recovery rate, and groundwater samples were collected and shipped to GEL for analysis, except for tritium samples, which were shipped to ARS. A comparison of R-19 screen 2 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected. A detailed presentation and analysis of the pumping and recovery data associated with the aquifer test appears in Appendix C.

2.5.8 R-19 Aquifer Testing and Groundwater Sampling of Screen 3

Following the initial aquifer testing of screen 2, hydraulic testing of screen 3 was performed. Screen 3 was tested from August 16 through 19, 2019. Testing consisted of a 12-hr constant-rate test followed by background data collection and a final step-drawdown test. After brief background data collection overnight, the 12-hr test on R-19 screen 3 began at 08:00 on August 17, 2019, and continued until 20:00. Following shutdown, recovery/background data were recorded for 2200 min until 08:40 on

August 19, 2019. The final step-drawdown test began at 08:40 on August 19, 2019, and continued for 150 min until 11:10. At the end of this step-drawdown test, groundwater samples were collected and shipped to GEL for analysis, except for tritium samples, which were shipped to ARS. A comparison of R-19 screen 3 analytical data with historical data is found in section 5.0. Appendix B presents the field parameter data collected and a summary of analytes detected. A detailed presentation and analysis of the pumping and recovery data associated with the aquifer test appears in Appendix C.

2.5.9 R-19 Dedicated Pumping System Installation

After redevelopment, aquifer testing, groundwater sampling, and plugging and abandoning activities were completed, a permanent Baski pump and packer system was installed in screens 2 and 3. The Baski system was composed of a Grundfos 10S50-930 submersible pump and a Bennett pump. The packer was successfully tested on August 9, 2019, with confirmation that pressure was holding on August 11, 2019. The configuration of the new pump system is presented in Figure 2.5-1. Technical notes are presented in Figure 2.5-2. The verified performance test sheet for the pump installed into monitoring well R-19 is displayed in Figure 2.5-3.

2.5.10 Post-Pump Installation Activities

The original concrete well pad had deteriorated. On October 24, 2019, the original R-19 well pad was demolished. A new well pad was constructed on January 21, 2020. A new geodetic survey was conducted on January 25, 2019. The geodetic survey coordinates are provided for the locations listed in Table 2.1-3. The geodetic survey data are available in Intellus and are provided in this report.

3.0 WASTE MANAGEMENT

All investigation-derived waste (IDW) generated during well reconfiguration activities will be managed in accordance with applicable standard operating procedures (SOPs). These SOPs incorporate the requirements of all applicable U.S. Environmental Protection Agency and NMED regulations, 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 Programs 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 cement chase water, concrete, and rebar will be the primary waste streams generated during the well reconfiguration activities. The fluids produced will be sampled and analyzed for the suite of constituents listed in the WCSF.

4.0 DEVIATIONS FROM PLANNED ACTIVITIES

Reconfiguration activities at R-5, R-7, R-8, R-9i, and R-19 were performed as specified in the NMED approved work plans (LANL 2011, 204372; N3B 2018, 700130), with the exception of the following deviation.

- The work plan stated that screen 4 in R-5, located from 858.7 ft to 863.7 ft bgs, was to be plugged and abandoned by filling the well with grout from the well total depth at 884 ft bgs up to

784 ft bgs. This would have placed the top of the grout approximately 80 ft above the top of screen 4 and approximately 64 ft below the base of screen 3. During plugging and abandoning activities, 82 gal. of grout was pumped down the wellbore with the top of the grout targeted to be at 767.1 ft bgs. The top of the grout, however, was measured 18 ft up into the bottom of screen 3 at 702 ft bgs. This rendered screen 3 unusable, and on September 3, 2019, NMED concurred to move forward with the abandonment of screen 3 (Dhawan 2019, 700609). This decision also drove additional variances from the NMED approved work plan for well reconfigurations at R-5, such as aquifer testing and groundwater sampling from screen 3.

5.0 COMPARISON OF ANALYTICAL DATA

Groundwater samples were collected from retained and uppermost abandoned screens in each of the converted wells to provide a comparison of groundwater quality from samples collected after purging with samples collected using the no-purge Westbay sampling system. For abandoned screens, samples were collected at the end of a relatively small-volume purge that achieved stable field parameters. For retained screens, samples were collected at the end of 24-hr or 12-hr constant-rate aquifer tests. Table 5.0-1 presents the analytical results for each constituent for which samples were collected following the Westbay system removals and compares these results with the historical range of concentrations.

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, each of these converted wells will be sampled as follows:

- Quarterly for metals, VOCs, SVOCs, low-level tritium, and general inorganics
- Annually for prometon, low-level nitrosamines, per- and polyfluoroalkyl substances, polychlorinated biphenyls, HE, dioxins/furans, radionuclides, and low-level tritium

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, a concentration of a given constituent in an abandoned screen exceeds the historical range but is consistent with concentrations observed in shallower screens in the same well, suggesting that the concentrations in lower abandoned screens reflect small amounts of cross-flow between screens rather than ambient concentrations in the aquifer in the deeper screened interval. An example of this potential cross-flow is nitrate and perchlorate concentrations in R-5 screen 4. The concentrations of each of those constituents from the post-Westbay samples are greater than the historical range but consistent with (and slightly lower than) the concentrations in overlying R-5 screen 2, suggesting that some remnant groundwater from R-5 screen 2 was present in the sample collected from R-5 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.

Andersen, D., July 12, 2019. RE: Westbay CO Milestone report content. E-mail message to M. Everett (N3B) and N. Dhawan (NMED) from D. Andersen (NMED), Santa Fe, New Mexico. (Andersen 2019, 700611)

Broxton, D., D. Vaniman, W. Stone, S. McLin, M. Everett, and A. Crowder, May 2001. "Characterization Well R-9i Completion Report," Los Alamos National Laboratory report LA-13821-MS, Los Alamos, New Mexico. (Broxton et al. 2001, 071251)

Broxton, D., D. Vaniman, W. Stone, S. McLin, J. Marin, R. Koch, R. Warren, P. Longmire, D. Rogers, and N. Tapia, May 2001. "Characterization Well R-19 Completion Report," Los Alamos National Laboratory report LA-13823-MS, Los Alamos, New Mexico. (Broxton et al. 2001, 071254)

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)

Dhawan, N., September 3, 2019. RE: Proposed R-5 email to Neelam. E-mail message to A. Duran (EM-LA) and R. Murphy (NMED) from N. Dhawan (NMED), Santa Fe, New Mexico. (Dhawan 2019, 700609)

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)

Kopp, B., A. Crowder, M. Everett, D. Vaniman, D. Hickmott, W. Stone, N. Clayton, S. Pearson, and D. Larssen, April 2002. "Well CdV-R-15-3 Completion Report," Los Alamos National Laboratory report LA-13906-MS, Los Alamos, New Mexico. (Kopp et al. 2002, 073179)

Kopp, B., M. Everett, J.R. Lawrence, G. WoldeGabriel, D. Vaniman, J. Heikoop, W. Stone, S. McLin, N. Clayton, and D. Larssen, April 2003. "Well CdV-R-37-2 Completion Report," Los Alamos National Laboratory report LA-14023-MS, Los Alamos, New Mexico. (Kopp et al. 2003, 088803)

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), June 2003. "Characterization Well R-5 Completion Report," Los Alamos National Laboratory document LA-UR-03-1600, Los Alamos, New Mexico. (LANL 2003, 080925)

LANL (Los Alamos National Laboratory), June 2003. "Characterization Well R-8 Completion Report," Los Alamos National Laboratory document LA-UR-03-1162, Los Alamos, New Mexico. (LANL 2003, 079594)

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)

NMED (New Mexico Environment Department), December 2, 2010. "Approval with Modifications, Technical Area 21 Monitoring Well Network Evaluation and Recommendations," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 111462)

NMED (New Mexico Environment Department), August 26, 2011. "Approval with Modifications, Work Plan for the Technical Area 21 Monitoring Well Network Reconfiguration," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 206269)

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)

Stone, W., D. Vaniman, P. Longmire, D. Broxton, M. Everett, R. Lawrence, and D. Larssen, April 2002. "Characterization Well R-7 Completion Report," Los Alamos National Laboratory report LA-13932-MS, Los Alamos, New Mexico. (Stone et al. 2002, 072717)

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.

Structures: As published; County of Los Alamos GIS data server, feature server feature class; https://gis.losalamosnm.us/securegis/rest/services/basemaps/basemap/FeatureServer; October 2019.

Drainage: As published; Q:\16-Projects\16-0033\project_data.gdb\line\drainage_features; October 2019.

Terrain Contour, 100-ft interval; As published; N3B GIS projecr folder; Q:\15-Projects\15-0017\project_data.gdb\polyline\clip_westbay_contour_100; October 2019.

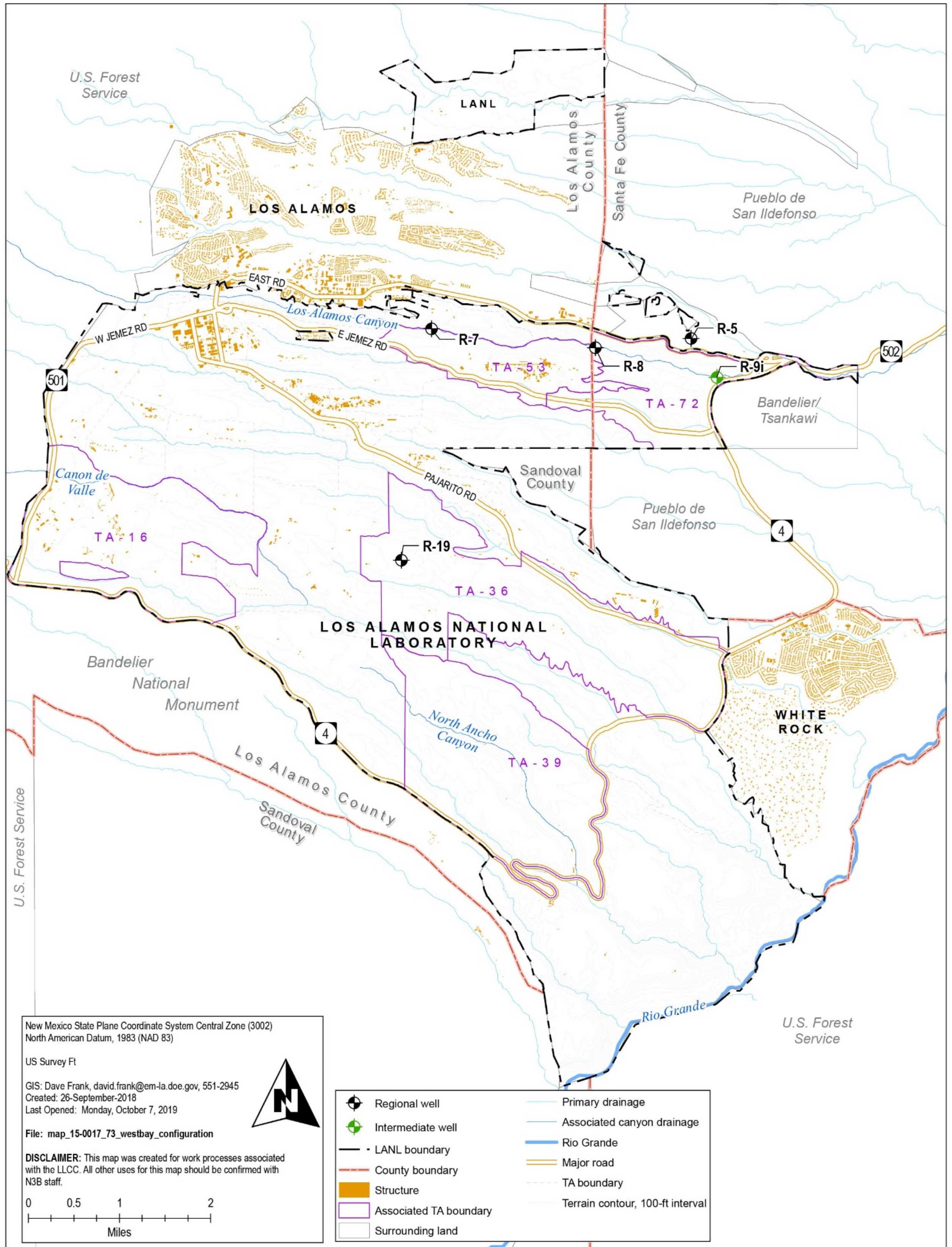


Figure 1.0-1 Locations of reconfigured wells

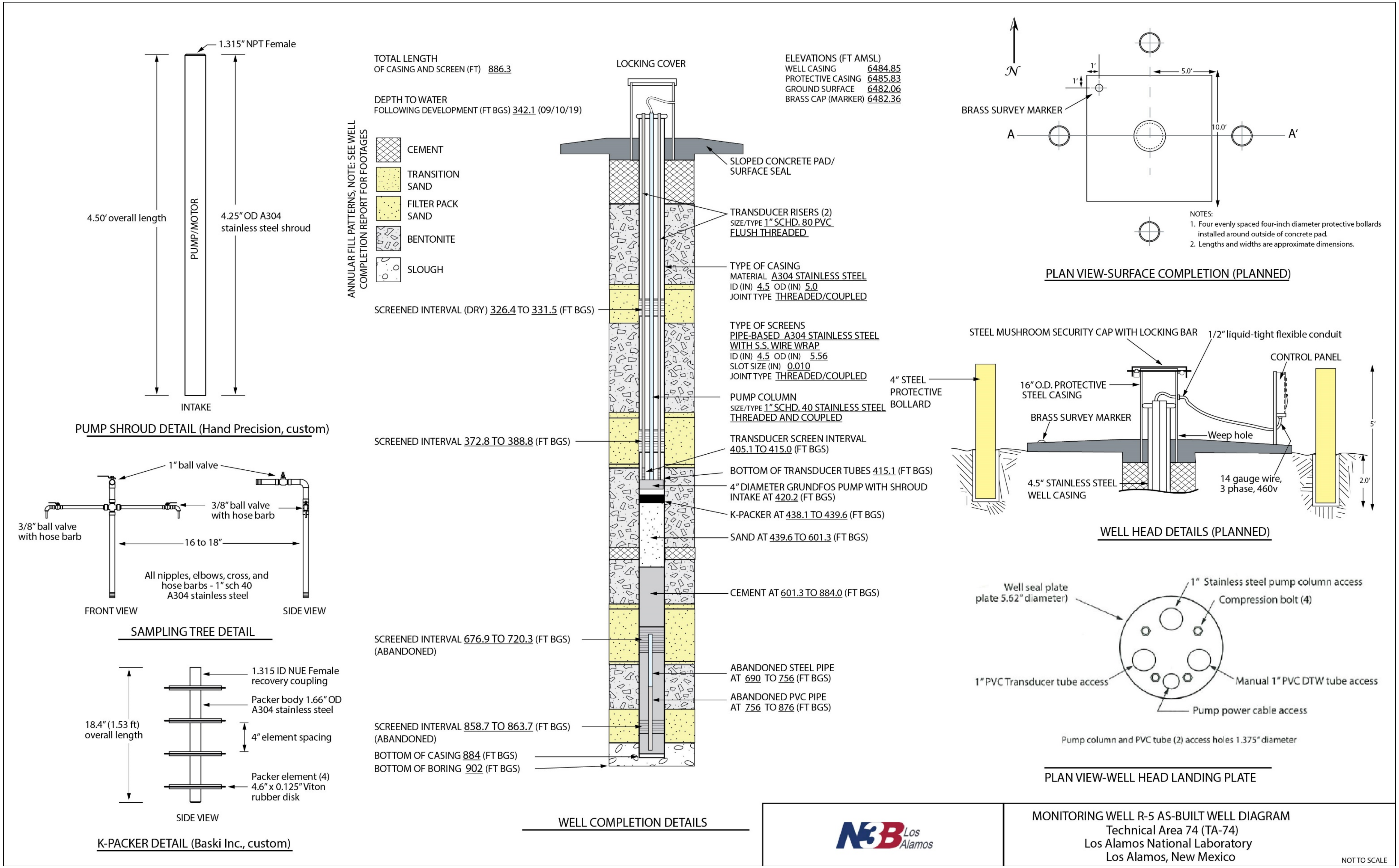


Figure 2.1-1 Monitoring well R-5 as-built construction diagram post-Westbay conversion

R-5 SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES:

SURVEY INFORMATION
Brass Marker
Northing: 1773097.23
Easting: 1646690.50
Elevation: 6482.36 AMSL

Well Casing (top of stainless steel)
Northing: 1773093.62
Easting: 1646693.05
Elevation: 6484.85 AMSL

SAMPLING SYSTEM MATERIALS AND PRODUCT LIST

Pump: Grundfos, 5E10-21
Environmental retrofit

Pump motor: Franklin Electric, 1HP, 3-phase, 460V

Motor cable: 14g, 3 lead with ground, double jacket

Discharge column: 1-in., threaded and coupled, schedule 40, pickled and passivated A316 stainless steel

Check valve: Flomatic, 1-in. female X female, 316 stainless steel, mod. 4201LSS2, 400psi

Couplings: A304 stainless steel deep well couplings

Gauge tubes: 1-in., flush-threaded, schedule 80 PVC, with 10-ft (long) 0.020-in. slot screen, female bottom cap

Banding: ¾-in. 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)

AQUIFER TESTING
24h Constant Rate Pumping Test (Screen #2)
Average Flow Rate: 2.6 gpm
Specific Capacity: 0.061 gpm/ft
Performed on: 9/10/19 - 9/11/19

DEDICATED SAMPLING SYSTEM
Pump (Shrouded)
Make: Grundfos
Mo del: 5E10-21
S/N: P11935
Base of shroud at 420.2 ft bgs
Environmental retrofit

Motor
Make: Franklin Electric
Model: 2202523
1 hp, 3-phase

Pump Shroud
A304 stainless steel, Hand Precision, custom

Pump Column
1-in. threaded/coupled schd. 40, pickled and passivated ,
A316 stainless steel tubing

Transducer Tubes
2x1 in. flush threaded schedule 80 PVC tubing, each with 10-ft (long), 0.020-in. slot screens located above the pump shroud

Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 676313

N3B Los Alamos

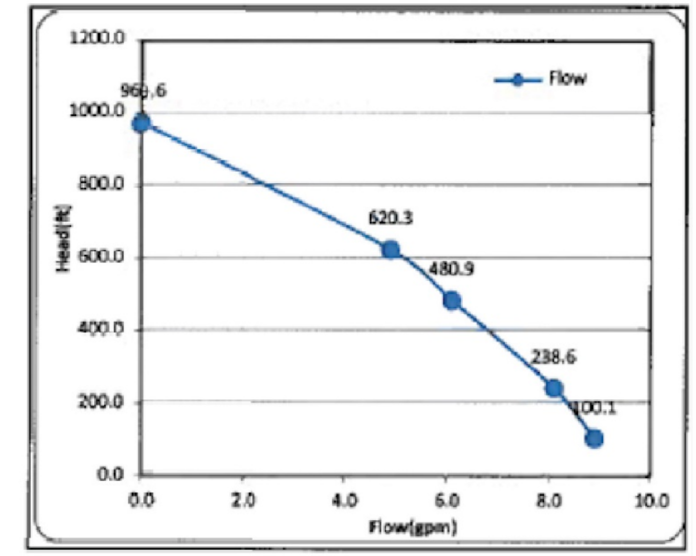
R-5 SAMPLING SYSTEM
DESIGN PACKAGE TECHNICAL NOTES
Technical Area 74 (TA-74) Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.1-2 As-built technical notes for monitoring well R-5 post-Westbay conversion

R-5 PUMP CURVE

DATE: 04/30/2019
CUST: Albuquerque Pipe & Pump
WO #: 82120-4
TEST#: Well R-5



PUMP
MFR: GRUNDFOS
MN: 5520-665
SN: P11206 017

MOTOR

MFR:	FRANKLIN	HP:	2	HZ:	60
MN:	2202523	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						

N3B Los Alamos

R-5 DEDICATED PUMP PERFORMANCE CURVE
Technical Area 74 (TA-74)
Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.1-3 R-5 dedicated pump performance curve

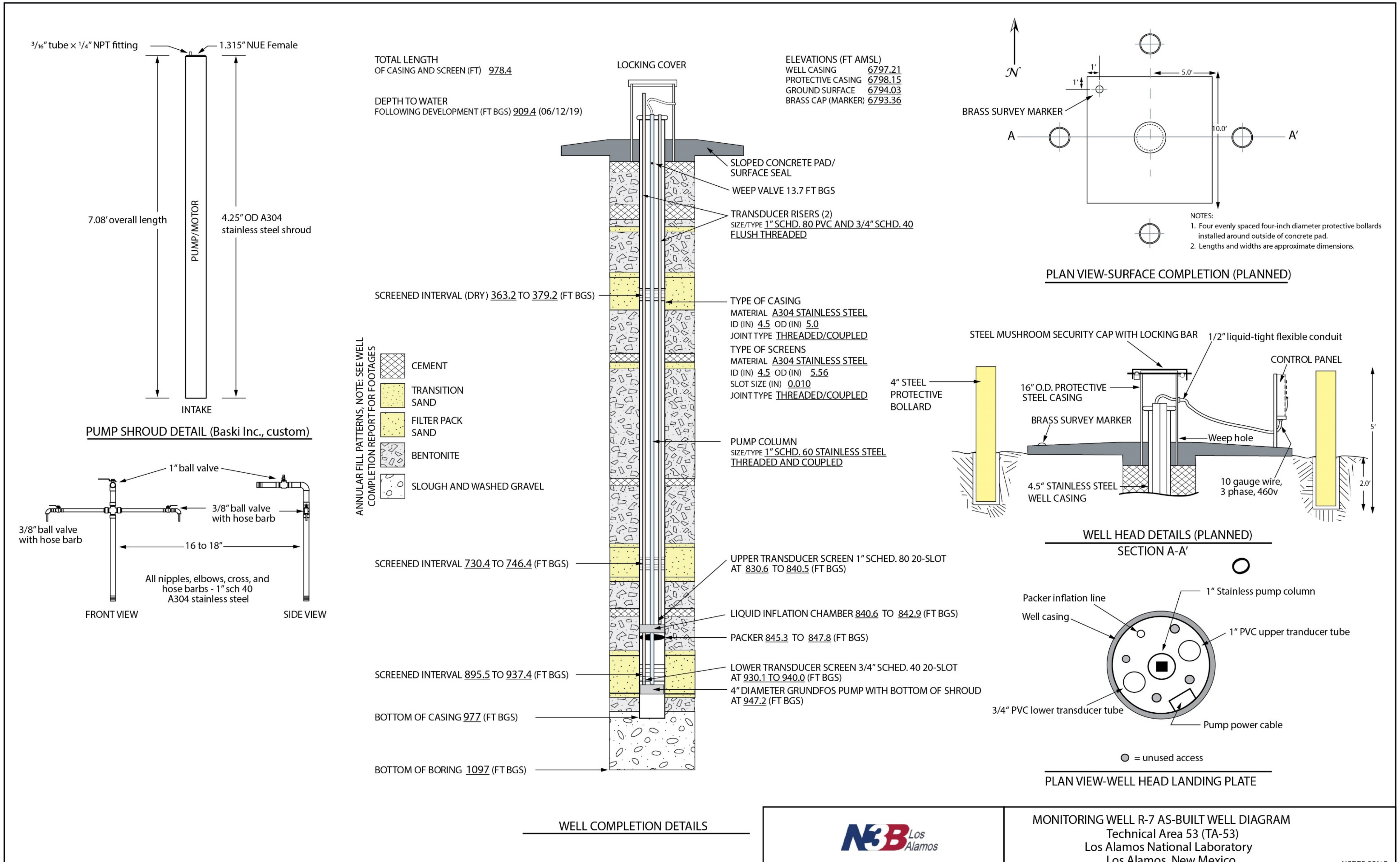


Figure 2.2-1 Monitoring well R-7 as-built construction diagram post-Westbay conversion

R-7 SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES:

SURVEY INFORMATION

Brass Marker
Northing: 1773650.85
Easting: 1631671.69
Elevation: 6793.36 AMSL

Well Casing (top of stainless steel)
Northing: 1773647.96
Easting: 1631672.81
Elevation: 6797.21 AMSL

SAMPLING SYSTEM MATERIALS AND PRODUCT LIST

Pump: Grundfos, 5S30-892CBM, Environmental retrofit

Pump motor: Franklin Electric, 3 HP, 3-phase, 460V

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

Discharge column: 1-in., threaded and coupled, schedule 60, nonannealed A304 stainless steel

Check valve: Swagelok, 1-in. male X male, 316 stainless steel, mod. SS-CHM16-1, 5000psi

Couplings: Nitronic 60 NUE couplings

Upper gauge tube: 1-in., flush-threaded, schedule 80 PVC, with 10-ft (long) 0.020-inch slot screen, female bottom cap

Lower gauge tube: ¾-in., flush-threaded, schedule 40 PVC, with 10-ft (long) 0.020-inch slot screen, female bottom cap

Banding: ¾-in. 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)

AQUIFER TESTING

24h Constant Rate Pumping Test (Screen #3 only)
Average Flow Rate: 7.2 gpm
Specific Capacity: 1.08 gpm/ft
Performed on: 06/22-23/2019

DEDICATED SAMPLING SYSTEM

Pump (Shrouded)
Make: Grundfos
Model: 5S30-892CBM
S/N: P119191006
Base of shroud at 947.2 ft bgs
Environmental retrofit

Motor
Make: Franklin Electric
Model: 2343268602
3 hp, 3-phase

Pump Shroud
A304 stainless steel, 4.25-in. x 0.0120-in. wall tube, Baski Inc. custom

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

Upper Transducer Tube
1 X 1-in. flush threaded schd. 80 PVC tubing
Upper 0.020-in. slot screen at 830.6-840.5 ft bgs

Lower Transducer Tube
1 X ¾-in. flush threaded schd. 40 PVC tubing
Lower 0.020-in. slot screen at 930.1-940.0 ft bgs

Upper Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 675959

Lower Transducer
Make: Geokon
Model: 4500-B
3 MPa
S/N: 1918595

N3B Los Alamos

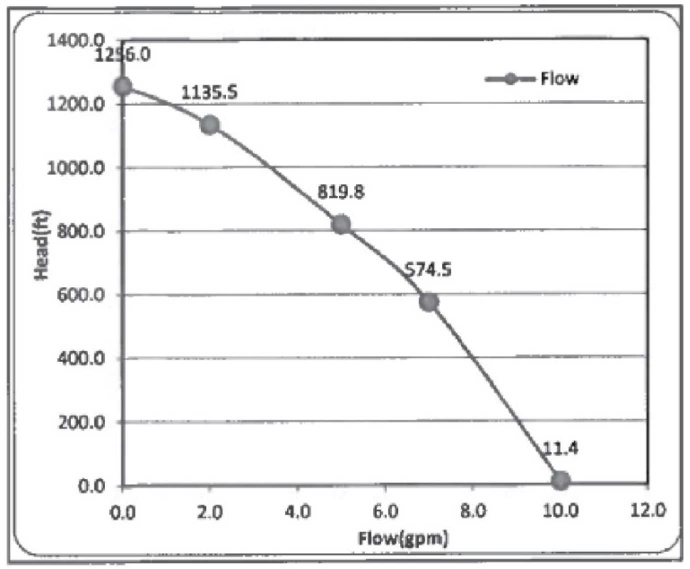
R-7 SAMPLING SYSTEM
DESIGN PACKAGE TECHNICAL NOTES
Technical Area 53 (TA-53) Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.2-2 As-built technical notes for monitoring well R-7 post-Westbay conversion

R-7 PUMP CURVE

DATE: 05/21/2019
CUST: Albuquerque Pipe & Pump
WO #: 82120
TEST#: Well R-7



PUMP

MFR: GRUNDFOS
MN: 5S30-892
SN: P119191006

MOTOR

MFR: FRANKLIN
MN: n/a
SN: n/a

HP: 3
VOLTS: 230
AMPS: 9.5

HZ: 60
PHASE: 3
SFA: 10.9

TEST POINT	FLOW GPM	HEAD FT	HEAD PSI	AMPS L1	AMPS L2	AMPS L3
1	10.0	11.4	4.9	10.1	10.9	10.4
2	7.0	574.5	248.7	9.9	10.9	10.2
3	5.0	819.8	354.9	9.6	10.7	9.9
4	2.0	1135.5	491.5	8.6	9.6	8.8
5	0.0	1256.0	543.7	7.6	8.5	7.9
6						
7						
8						
9						
10						

Tested By: jh

N3B Los Alamos

R-7 DEDICATED PUMP PERFORMANCE CURVE
Technical Area 53 (TA-53)
Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.2-3 R-7 dedicated pump performance curve

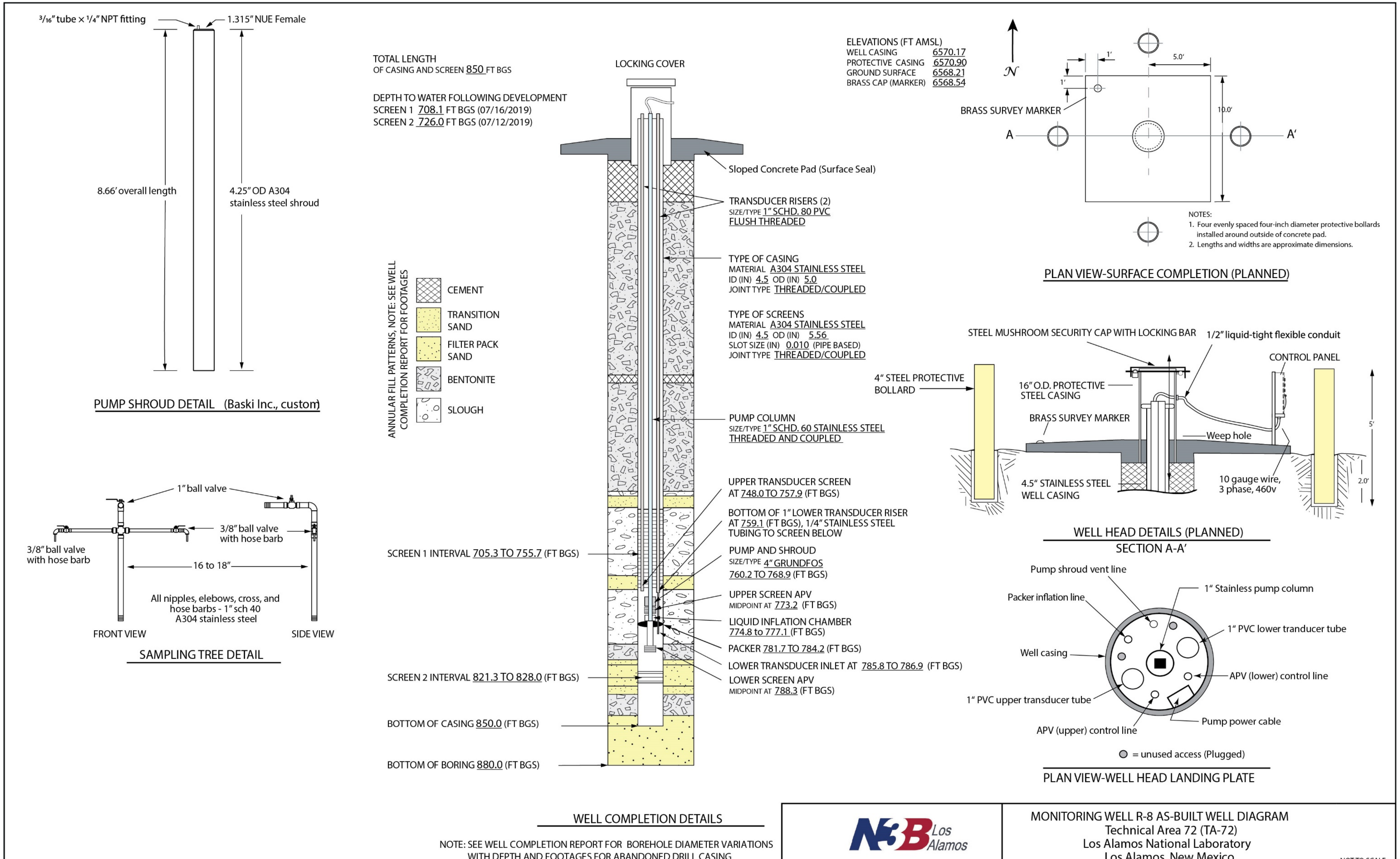


Figure 2.3-1 Monitoring well R-8 as-built construction diagram post-Westbay conversion

R-8 SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES:

SURVEY INFORMATION

Brass Marker
Northing: 1772557.16
Easting: 1641133.61
Elevation: 6568.54 AMSL

Well Casing (top of stainless steel)
Northing: 1772553.58
Easting: 1641135.75
Elevation: 6570.17 AMSL

SAMPLING SYSTEM MATERIALS AND PRODUCT LIST
Pump: Grundfos, 5S20-665, Environmental retrofit

Pump motor: Franklin Electric, 2HP, 3-phase, 460V

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

Discharge column: 1-inch, threaded and coupled, schedule 60, non annealed A304 stainless steel

Check valve: Swagelok, 1-inch male x male, 3/16 stainless steel , mod. SS-chm16-1, 5000 psi.
Couplings: Nitronic 60NUE Couplings

Upper gauge tube: 1-inch, flush-threaded, schedule 80 PVC, with 10-ft (long)
Stainless steel screen below packer, female bottom cap
Banding: 3/4-inch stainless steel with 201 stainless steel buckles
Thread Compound: Jet Lube , V-2

Lower gauge tube: 3/4-inch, flush-threaded, sched. 40 PVC, with 10-ft (long)
0.020-inch slot screen, female bottom cap

Thread Compound: Jet Lube, V-2

Sampling tree: A304 sched. 40 stainless steel 1-inch nipples, elbows, cross, bushings, and hose barbs

AQUIFER TESTING

24h Constant Rate Pumping Test (Screen #1)
Average Flow Rate: 2.1 gpm
Specific Capacity: 0.172 gpm/ft
Performed on: 07/16-17/2019

24h Constant Rate Pumping Test (Screen #2)
Average Flow Rate: 7.5 gpm
Specific Capacity: 1.07 gpm/ft
Performed on: 07/12-13/2019

DEDICATED SAMPLING SYSTEM

Pump (shroud)
Make: Grundfos
Model: 5S20-665
S/N: P119191002
Environmental retrofit

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

Pump Shroud
A304 stainless steel, 4.25-inch x 0.0120-inch wall tube, Baski Inc. custom

Pump Column
1-inch threaded/coupled schd 60.
non annealed A304 stainless steel tubing

Upper Transducer Tube
1x1-inch flush-threaded sched. 80 PVC tubing
Upper 0.020-inch slot screen at 748-757.9 ft bgs

Lower Transducer Tube
1x1-inch flush-threaded sched. 80 PVC tubing
Lower stainless steel screen inlet at 785.8-786.9 ft bgs

Upper Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 675955

Lower Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 676290

N3B Los Alamos

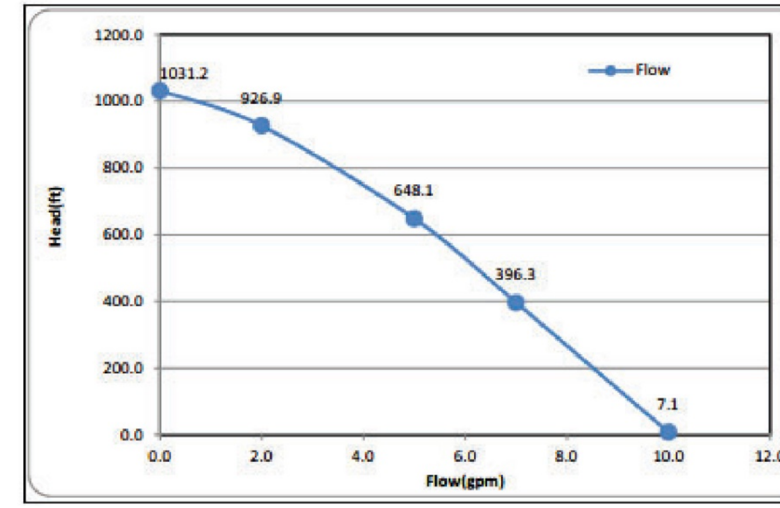
R-8 SAMPLING SYSTEM
DESIGN PACKAGE TECHNICAL NOTES
Technical Area 72 (TA-72) Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.3-2 As-built technical notes for monitoring well R-8 post-Westbay conversion

R-8 PUMP CURVE

DATE: 5/21/2019
CUST: Albuquerque Pipe & Pump
WO #: 82120
TEST#: Well R-8



PUMP
MFR: GRUNDFOS
MN: 5S20-665
SN: P11919 1002

MOTOR
MFR: FRANKLIN
MN: 2343258600
SN: 16L14-14-0100C

HP: 2
VOLTS: 460
AMPS: 3.4

HZ: 60
PHASE: 3
SFA: 4.1

TEST POINT	FLOW GPM	HEAD FT	HEAD PSI	AMPS L1	AMPS L2	AMPS L3
1	10.0	7.1	3.1	3.3	4.1	3.8
2	7.0	396.3	171.6	3.3	4.0	3.8
3	5.0	648.1	280.6	3.2	4.0	3.7
4	2.0	926.9	401.2	2.7	3.6	3.3
5	0.0	1031.2	446.4	2.2	3.2	2.8
6						
7						
8						
9						
10						

Tested By: jh

N3B Los Alamos

R-8 SAMPLING SYSTEM
DEDICATED PUMP PERFORMANCE CURVE
Technical Area 72 (TA-72) Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.3-3 R-8 dedicated pump performance curve

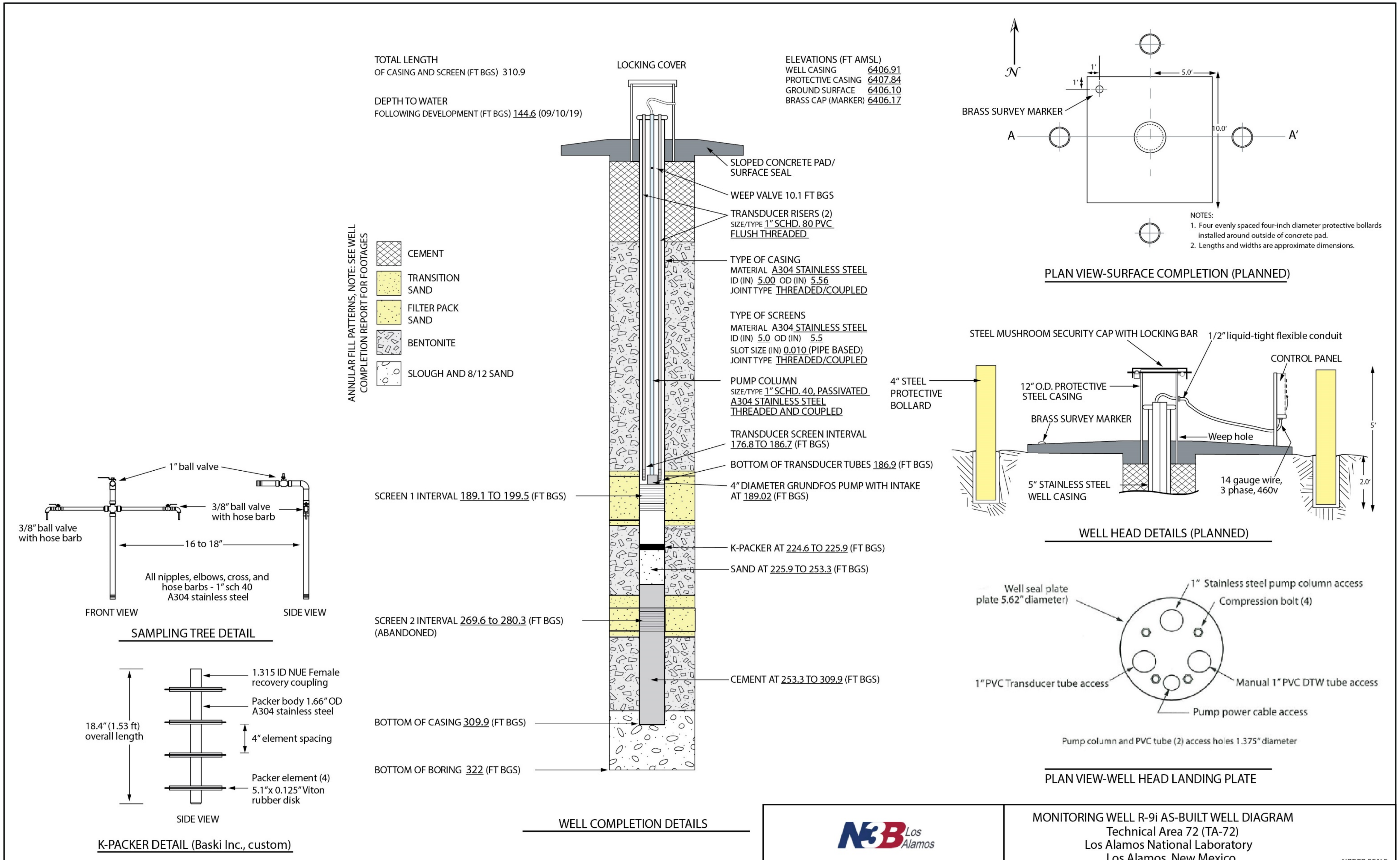


Figure 2.4-1 Monitoring well R-9i as-built construction diagram post-Westbay conversion

R-9i SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES:

SURVEY INFORMATION

Brass Marker

Northing:	1770839.75
Easting:	1648205.61
Elevation:	6406.17 AMSL

Well Casing (top of stainless steel)

Northing:	1770836.98
Easting:	1648208.67
Elevation:	6406.91 AMSL

SAMPLING SYSTEM MATERIALS AND PRODUCT LIST

Pump: Grundfos, 5S05-13
Model A 8010013

Pump motor: Franklin Electric, 1/2 HP, 3-phase, 460V

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

Discharge column: 1-inch, flush-threaded, A304 stainless steel, sch. 40, pickled and passivated

Check Valve: 1" a316 stainless steel Viton Trim

Couplings: A304 stainless steel deep well couplings

Gauge tube: 1-inch, flush-threaded, schedule 80 PVC, with 10-ft (long) 0.020-inch slotted screen, female bottom cap

Banding: 3/4-inch stainless steel

Thread Compound: Jet Lube, V2

Sampling Tree: A304 schd. 40 stainless steel 1-in nipples, elbows, cross, bushings, hose barb, and 1-in and 3/4-inch stainless steel ball valves.

AQUIFER TESTING

24h Constant Rate Pumping Test (Screen #1)

Average Flow Rate:	14.7
Specific Capacity:	4.55 gpm/ft
Performed on:	6/25/19 - 6/26/19

DEDICATED SAMPLING SYSTEM

Make: Grundfos
Model: Type 5s05-13 Model A 8010013
S/N: 1000615P11822
Base of Shroud: 189.02 ft bgs
Environmental Retrofit

Motor
Make: Franklin Electric
Model: 2345219404G
1/2 HP, 3 Phase, sched.40, pickled and passivated

Pump Shroud
Not Recorded

Pump Column
1-in. flush-threaded,
A304 stainless steel sch. 40, pickled and passivated

Transducer Tube
1-inch, flush-threaded, schedule 80 PVC, with 10-ft (long) 0.020-inch slotted screen, female bottom cap

Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 675902

N3B Los Alamos

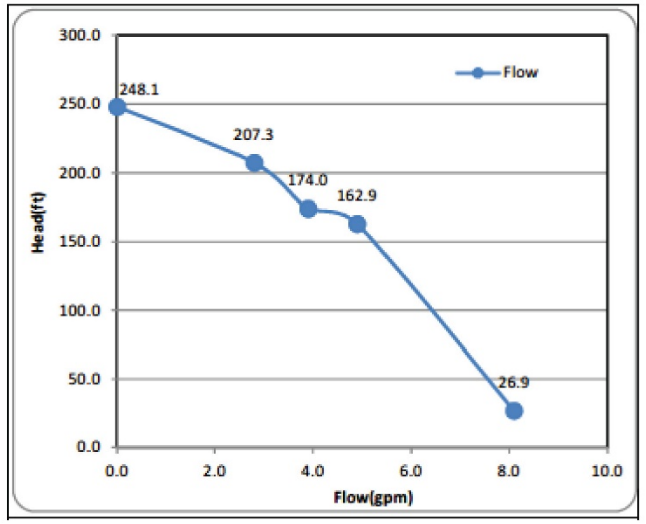
R-9i SAMPLING SYSTEM
SAMPLING SYSTEM TECHNICAL NOTES
Technical Area 72 (TA-72) Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.4-2 As-built technical notes for monitoring well R-9i post-Westbay conversion

R-9i PUMP CURVE

DATE: 04/30/2019
CUST: Albuquerque Pipe & Pump
WO #: 82120
TEST#: Well R-9i



PUMP
MFR: **GRUNDFOS**
MN: 5505-13
SN: 10000615P11822

MOTOR
MFR: FRANKLIN | HP: .5 | HZ: 60
MN: 2345219404G | VOLTS: 460 | PHASE: 3
SN: 18M14-20-01354C | AMPS: 1.2 | SFA: 1.5

TEST POINT	FLOW GPM	HEAD FT	HEAD PSI	AMPS L1	AMPS L2	AMPS L3
1	8.1	26.9	11.6	1.5	2.1	1.4
2	4.9	162.9	70.5	1.5	2.0	1.4
3	3.9	174.0	74.0	1.5	2.0	1.3
4	2.8	207.3	89.7	1.5	2.0	1.4
5	0.0	248.1	107.4	1.5	1.9	1.3
6						
7						
8						
9						
10						

Tested By: jw

N3B Los Alamos

R-9i SAMPLING SYSTM
DEDICATED PUMP PERFORMANCE CURVE
Technical Area 72 (TA-72) Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.4-3 R-9i dedicated pump performance curve

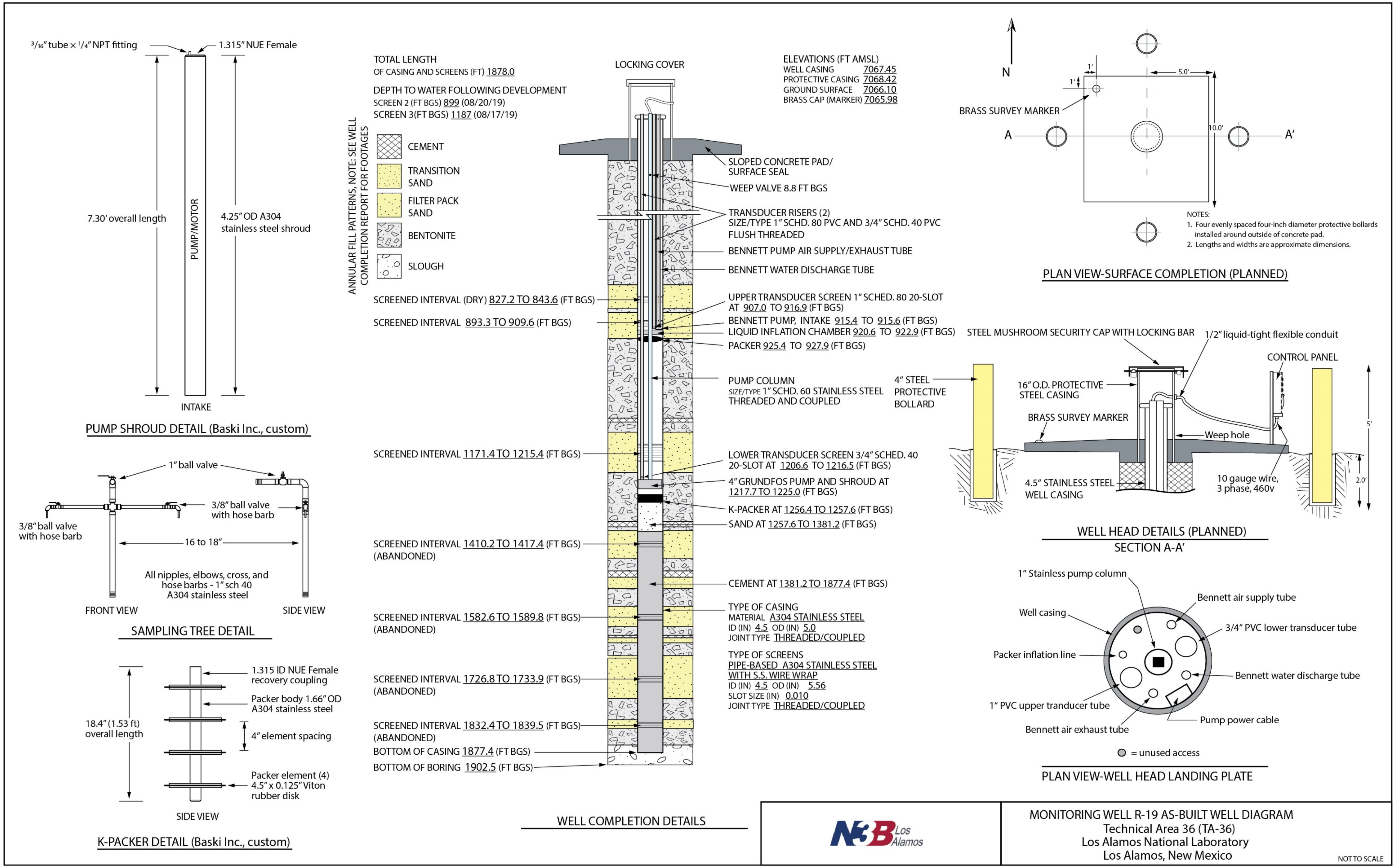


Figure 2.5-1 Monitoring well R-19 as-built construction diagram post-Westbay conversion

R-19 SAMPLING SYSTEM DESIGN PACKAGE TECHNICAL NOTES:

SURVEY INFORMATION*

Brass Marker
Northing: 1760253.38
Easting: 1629918.07
Elevation: 7065.98

Well Casing (top of stainless steel)
Northing: 1760249.29
Easting: 1629920.67
Elevation: 7067.45

AQUIFER TESTING

12h Constant Rate Pumping Test (Screen #2)
Average Flow Rate: Cycled pump at 0.5 gpm
Specific Capacity: 0.05 gpm/ft
Performed on: 08/20/2019

12h Constant Rate Pumping Test (Screen #3)
Average Flow Rate: 6.5 gpm
Specific Capacity: 4.4 gpm/ft
Performed on: 08/17/2019

DEDICATED SAMPLING SYSTEM

Screen 2

Pump
Bennett Sample Pump 1800-6
S/N: 1806B-986
Intake at 915.4-915.6 ft bgs

Pump column
DP3 Bennett tube bundle

Transducer Tube
1 X 1-in. flush-threaded, schedule 80 PVC tubing
Upper 0.020-in. slot screen at 907.0-916.9 ft bgs

Upper Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 675907

DEDICATED SAMPLING SYSTEM

Screen 3

Pump (Shrouded)
Make: Grundfos
Model: 10S50-930CBM
S/N: P1154660002
Base of shroud at 1225.0 ft bgs
Environmental retrofit

Motor
Make: Franklin Electric
Model: 2343278602
5 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

Transducer Tube
1 X ¾-inch flush threaded schd. 40 PVC tubing
Lower 0.020-in. slot screen at 1206.6-1216.5 ft bgs

Lower Transducer
Make: Geokon
Model: 4500-B
3 MPa
S/N: 1918596

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)

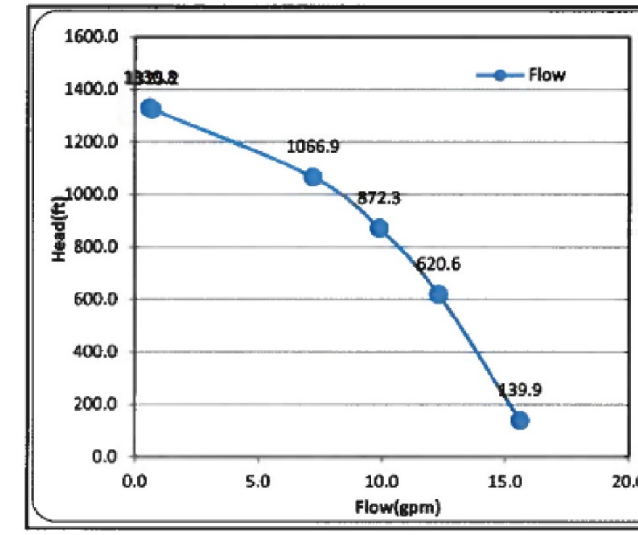
N3B Los Alamos

R-19 SAMPLING SYSTEM
DESIGN PACKAGE TECHNICAL NOTES
Technical Area 36 (TA-36) Los Alamos National Laboratory
Los Alamos, New Mexico
NOT TO SCALE

Figure 2.5-2 As-built technical notes for monitoring well R-19 post-Westbay conversion

R-19 PUMP CURVE

DATE: 04/30/2019
CUST: Albuquerque Pipe & Pump
WO #: 82120-3
TEST#: Well R-19



PUMP

MFR: GRUNDFOS
MN: 10550-930CBM
SN: P11546 0002

MOTOR

MFR: FRANKLIN
MN: 2343278602
SN: Test motor

HP: 5
VOLTS: 460
AMPS: 7.1

HZ: 60
PHASE: 3
SFA: 8.2

TEST POINT	FLOW GPM	HEAD FT	HEAD PSI	AMPS L1	AMPS L2	AMPS L3
1	15.6	139.9	60.6	6.0	7.2	6.8
2	12.3	620.6	268.7	6.3	7.6	7.0
3	9.9	872.3	377.6	6.2	7.6	7.0
4	7.2	1066.9	461.9	5.9	7.2	6.7
5	0.7	1325.2	573.7	4.7	6.1	5.5
6	0.6	1330.8	576.1	4.4	5.7	5.2
7						
8						
9						
10						

Tested By: jw

N3B Los Alamos

R-19 DEDICATED PUMP PERFORMANCE CURVE
Technical Area 36 (TA-36)
Los Alamos National Laboratory
Los Alamos, New Mexico

NOT TO SCALE

Figure 2.5-3 R-19 dedicated pump performance curve

Table 2.1-1
Water Quantities Produced During R-5, R-7, R-8, R-9i, and R-19 Reconfiguration

Date	Depth Interval (ft bgs)	Water Produced (gal.)	Cumulative Water Produced (gal.)
R-5			
6/28/2019	853.7–863.7	150 (bailed)	150
6/29/2019	853.7–863.7	50 (bailed)	195
6/30/2019	853.7–863.7	53.4 (pumped)	248.4
6/30/2019	676.9–720.3	84 (pumped)	332.4
7/1/2019	372.8–388.8	68.8 (pumped)	401.2
7/1/2019	853.7–863.7	75.2 (pumped)	476.4
7/2/2019	853.7–863.7	356 (purged)	832.4
9/5/2019	697–601.9	200 (pumped)	1032.4
9/6/2019	697–601.9	240 (pumped)	1272.4
9/7/2019	441.4	72.8 (pumped)	1345.2
9/8/2019	441.4	271.4 (pumped)	1616.6
9/10/2019	441.4	2526.3 (pumped)	4142.9
9/11/2019	441.4	1244.3 (pumped)	5392.2
R-7			
6/13/2019	Not measured	50 (bailed)	50
6/15/2019	895.5–937.4	441.2 (pumped)	491.2
6/19/2019	895.5–937.4	50 (bailed)	541.2
6/20/2019	895.5–937.4	582.2 (pumped)	1123.4
6/22/2019	895.5–937.4	6912 (pumped)	8035.4
6/23/2019	895.5–937.4	3456 (pumped)	11,491.40
R-8			
6/29/2019	727.7	50 (bailed)	50
7/4/2019	821.3–828.0	603.9 (pumped)	653.9
7/10/2019	821.3–828.0	675 (pumped)	1328.9
7/12/2019	821.3–828.0	7200 (pumped)	8528.9
7/13/2019	821.3–828.0	3600 (pumped)	12,128.90
7/15/2019	764.7–783.3	602.2 (pumped)	12,731.10
7/16/2019	764.7–783.3	2521.2 (pumped)	15,252.30
7/17/2019	764.7–783.3	812.7 (pumped)	16,065

Table 2.1-1 (continued)

Date	Depth Interval (ft bgs)	Water Produced (gal.)	Cumulative Water Produced (gal.)
R-9i			
6/14/2019	309	(bailed)	Amount not recorded
6/15/2019	189.1–199.5	354 (pumped)	354
6/15/2019	189.1–199.5	16.5 (pumped)	370.5
6/16/2019	Not available	45 (pumped)	415.5
6/23/2019	189.1–199.5	1393.7 (pumped)	1719.2
6/25/2019	189.1–199.5	14,112 (pumped)	15,831.20
6/26/2019	189.1–199.5	7056 (pumped)	22,977.20
R-19			
7/24/2019	1840	90 (bailed)	130
7/24/2019	1410	20 (bailed)	150
7/24/2019	1172	10 (bailed)	160
7/27/2019	1410 and 1502	172.8 (pumped)	232.8
7/29/2019	1410	112.7 (pumped)	345.5
8/10/2019	1502	250 (pumped)	595.5
8/17/2019 to 8/19/2019	1172	4680 (pumped)	5335.5

Table 2.1-2
Water Levels Recorded During Westbay Reconfiguration

Well	Date	Time	Level (ft bgs)
R-5	7/5/2019	07:30	662.03 ft bgs
R-5	7/8/2019	13:29	626.3 ft bgs
R-5	9/4/2019	11:20	351.6 ft bgs
R-5	9/7/2019	12:30	342.1 ft bgs
R-7	5/24/2019	11:50	909.5 ft bgs
R-7	6/12/2019	14:00	909.35 ft bgs
R-8	6/29/2019	07:30	727.71 ft bgs
R-9i	6/19/2019	12:30	144.6 ft bgs
R-19	7/24/2019	11:55	912–915 ft bgs
R-19	8/5/2019	09:15	1189.0 ft bgs
R-19	8/6/2019	12:00	1189.1 ft bgs
R-19	8/8/2019	08:35	1189.4 ft bgs

Table 2.1-3
Geodetic Survey Data

Identification	Northing	Easting	Elevation
R-5			
R-5 brass cap embedded in pad	1773097.23	1646690.50	6482.36
R-5 ground surface near pad	1773096.97	1646688.47	6482.06
R-5 top of 16-in. protective casing	1773094.08	1646693.50	6485.83
R-5 top of stainless-steel well casing	1773093.62	1646693.05	6484.85
R-7			
R-7 brass cap embedded in pad	1773650.85	1631671.69	6793.36
R-7 ground surface near pad	1773651.48	1631668.85	6794.03
R-7 top of 16-in. protective casing	1773648.55	1631672.94	6798.15
R-7 top of stainless-steel well casing	1773647.96	1631672.81	6797.21
R-8			
R-8 brass cap embedded in pad	1772557.16	1641133.61	6568.54
R-8 ground surface near pad	1772557.86	1641130.82	6568.21
R-8 top of 16-in. protective casing	1772553.79	1641135.44	6570.90
R-8 top of stainless-steel well casing	1772553.58	1641135.75	6570.17
R-9i			
R-9i brass cap embedded in pad	1770839.75	1648205.61	6406.17
R-9i ground surface near pad	1770839.87	1648202.75	6406.10
R-9i top of 16-in. protective casing	1770837.35	1648208.26	6407.84
R-9i top of stainless-steel well casing	1770836.98	1648208.67	6406.91
R-19			
R-19 brass cap embedded in pad	1760253.38	1629918.07	7065.98
R-19 ground surface near pad	1760254.44	1629913.10	7066.10
R-19 top of 16-in. protective casing	1760249.87	1629920.84	7068.42
R-19 top of stainless steel well casing	1760249.29	1629920.67	7067.45

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

Table 5.0-1
Comparison of Recent Groundwater Analytical Results and Historical Results

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-5 S[a]2	Intermediate	Acetone	9/11/2019	µg/L	FD[b]	UF[c]	5.41	Y[d]	1.62 to 1.62	1/13	2/25/2004	8/23/2016
R-5 S2	Intermediate	Acidity or Alkalinity of a solution	9/11/2019	SU[e]	REG[f]	F[g]	8.06	Y	4.14 to 8.17	13/13	5/2/2005	8/23/2016
R-5 S2	Intermediate	Alkalinity-CO_3	9/11/2019	mg/L	REG	F	1.45	N[h]	0.855 to 1.02	3/14	4/28/2004	8/23/2016
R-5 S2	Intermediate	Alkalinity-CO+HCO_3	9/11/2019	mg/L	REG	F	100	Y	72.9 to 120	13/15	4/28/2004	8/23/2016
R-5 S2	Intermediate	Aluminum	9/11/2019	µg/L	REG	F	68	N	20.5 to 26.7	2/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Ammonia as Nitrogen	9/11/2019	mg/L	REG	F	0.0295	Y	0.051 to 0.0713	2/18	2/23/2004	8/23/2016
R-5 S2	Intermediate	Arsenic	9/11/2019	µg/L	REG	F	3.6	Y	1.5 to 5.34	8/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Barium	9/11/2019	µg/L	REG	F	203	Y	169 to 204	21/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Boron	9/11/2019	µg/L	REG	F	28.3	Y	21.2 to 28.5	17/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Bromide	9/11/2019	mg/L	REG	F	0.149	Y	0.088 to 0.152	13/16	2/23/2004	8/23/2016
R-5 S2	Intermediate	Cadmium	9/11/2019	µg/L	REG	F	0.3	N	0.065 to 0.276	2/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Calcium	9/11/2019	mg/L	REG	F	33.3	Y	27.9 to 32.2	21/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Chloride	9/11/2019	mg/L	REG	F	10.1	Y	6.72 to 8.38	16/16	2/23/2004	8/23/2016
R-5 S2	Intermediate	Chromium	9/11/2019	µg/L	FD	F	3.98	Y	3.7 to 8.59	19/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Cobalt	9/11/2019	µg/L	REG	F	1	N	4.2 to 4.2	1/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Cyanide (Total)	9/11/2019	mg/L	REG	UF	0.00167	N	0.00253 to 0.00253	1/12	2/23/2004	8/23/2016
R-5 S2	Intermediate	Diethylphthalate	9/11/2019	µg/L	REG	UF	0.3	N	6.2 to 6.2	1/9	2/25/2004	8/23/2016
R-5 S2	Intermediate	Fluoride	9/11/2019	mg/L	REG	F	1.24	Y	0.992 to 1.13	16/16	2/23/2004	8/23/2016
R-5 S2	Intermediate	Gross alpha	9/11/2019	pCi/L	REG	UF	4.38	Y	1.72 to 3.22	3/10	5/2/2005	9/10/2015
R-5 S2	Intermediate	Gross beta	9/11/2019	pCi/L	REG	UF	5.34	Y	2.68 to 26.1	10/10	5/2/2005	9/10/2015
R-5 S2	Intermediate	Hardness	9/11/2019	mg/L	REG	F	96.7	Y	80.7 to 92.6	15/15	5/2/2005	8/23/2016
R-5 S2	Intermediate	Iron	9/11/2019	µg/L	REG	F	146	Y	—[i]	0/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Iron	9/11/2019	µg/L	FD	F	30	N	—	—	—	—
R-5 S2	Intermediate	Magnesium	9/11/2019	mg/L	REG	F	3.28	Y	2.67 to 3.21	21/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Manganese	9/11/2019	µg/L	REG	F	2	N	1.4 to 6.7	5/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Molybdenum	9/11/2019	µg/L	REG	F	2.03	Y	2 to 3.2	19/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Nickel	9/11/2019	µg/L	REG	F	3	N	0.58 to 4.2	13/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Nitrate-Nitrite as Nitrogen	9/11/2019	mg/L	REG	F	2.79	Y	2.26 to 3.31	19/19	2/23/2004	8/23/2016
R-5 S2	Intermediate	Perchlorate	9/11/2019	µg/L	REG	F	2.65	Y	0.995 to 4.01	16/23	2/23/2004	8/23/2016
R-5 S2	Intermediate	Potassium	9/11/2019	mg/L	REG	F	4.27	Y	3.86 to 4.45	21/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Selenium	9/11/2019	µg/L	REG	F	2	N	1.74 to 1.74	1/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Silicon Dioxide	9/11/2019	mg/L	REG	F	53.2	Y	26.1 to 56.5	19/19	2/23/2004	8/23/2016
R-5 S2	Intermediate	Sodium	9/11/2019	mg/L	REG	F	15.1	Y	13.6 to 15.9	21/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Specific Conductance	9/11/2019	µS/cm	REG	F	257	Y	219 to 336	13/13	5/2/2005	8/23/2016

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-5 S2	Intermediate	Strontium	9/11/2019	µg/L	REG	F	332	Y	289 to 329	21/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Sulfate	9/11/2019	mg/L	REG	F	10.5	Y	7.97 to 9.67	16/16	2/23/2004	8/23/2016
R-5 S2	Intermediate	Thallium	9/11/2019	µg/L	REG	F	0.6	N	0.14 to 0.64	4/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Toluene	9/11/2019	µg/L	REG	UF	6.69	Y	—	0/13	2/25/2004	8/23/2016
R-5 S2	Intermediate	Toluene	9/11/2019	µg/L	FD	UF	6.59	Y	—	—	—	—
R-5 S2	Intermediate	Total Dissolved Solids	9/11/2019	mg/L	REG	F	184	Y	171 to 316	13/13	5/2/2005	8/23/2016
R-5 S2	Intermediate	Total Kjeldahl Nitrogen	9/11/2019	mg/L	REG	UF	0.655	Y	0.041 to 0.45	7/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Total Organic Carbon	9/11/2019	mg/L	REG	UF	0.378	Y	0.255 to 0.761	10/16	2/23/2004	8/23/2016
R-5 S2	Intermediate	Total Phosphate as Phosphorus	9/11/2019	mg/L	REG	F	0.0754	N	0.016 to 0.049	3/22	2/23/2004	8/23/2016
R-5 S2	Intermediate	Tritium	9/11/2019	pCi/L	REG	UF	4.526	N	-0.2576 to -0.2576	1/16	2/23/2004	9/10/2015
R-5 S2	Intermediate	Tritium	9/11/2019	pCi/L	FD	UF	5.060	N	—	—	—	—
R-5 S2	Intermediate	Uranium	9/11/2019	µg/L	REG	F	3.11	Y	2.58 to 2.9	20/20	2/23/2004	8/23/2016
R-5 S2	Intermediate	Vanadium	9/11/2019	µg/L	REG	F	7.52	Y	7.5 to 9.4	19/21	2/23/2004	8/23/2016
R-5 S2	Intermediate	Zinc	9/11/2019	µg/L	REG	F	11.9	N	2.9 to 10.9	10/21	2/23/2004	8/23/2016
R-5 S4	Regional Deep	Acidity or Alkalinity of a solution	7/2/2019	SU	REG	F	7.97	Y	6.6 to 8.07	7/7	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Alkalinity-CO_3+HCO_3	7/2/2019	mg/L	REG	F	103	Y	103 to 153	9/9	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Aluminum	7/2/2019	µg/L	REG	F	68	N	16 to 167	2/9	11/15/2001	3/9/2011
R-5 S4	Regional Deep	Ammonia as Nitrogen	7/2/2019	mg/L	REG	F	0.0434	N	0.019 to 0.0205	2/9	2/19/2004	8/19/2013
R-5 S4	Regional Deep	Arsenic	7/2/2019	µg/L	REG	F	6.58	Y	5.2 to 5.2	1/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Barium	7/2/2019	µg/L	REG	F	215	Y	100 to 545	8/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Benzene	7/2/2019	µg/L	REG	UF	0.3	N	0.3 to 0.3	1/11	11/15/2001	3/9/2011
R-5 S4	Regional Deep	Bis(2-ethylhexyl)phthalate	7/2/2019	µg/L	REG	UF	2.96	Y	1.4 to 1.4	1/6	11/15/2001	9/30/2004
R-5 S4	Regional Deep	Boron	7/2/2019	µg/L	REG	F	31.5	Y	35.6 to 53.7	8/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Bromide	7/2/2019	mg/L	REG	F	0.121	Y	0.0744 to 0.161	3/10	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Calcium	7/2/2019	mg/L	REG	F	34.7	Y	25 to 45.8	8/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Chloride	7/2/2019	mg/L	REG	F	8.68	Y	4.77 to 8.91	10/10	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Chromium	7/2/2019	µg/L	REG	F	4.37	Y	1.02 to 6.58	4/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Cobalt	7/2/2019	µg/L	REG	F	1	N	0.772 to 0.772	1/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Copper	7/2/2019	µg/L	REG	F	8.25	Y	—	0/4	12/16/2000	5/21/2007
R-5 S4	Regional Deep	Fluoride	7/2/2019	mg/L	REG	F	1.15	Y	0.21 to 0.501	10/10	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Gross alpha	7/2/2019	pCi/L	REG	UF	1.91	N	2.03 to 2.03	1/5	5/4/2005	8/19/2013
R-5 S4	Regional Deep	Gross beta	7/2/2019	pCi/L	REG	UF	7.34	Y	3.32 to 7.53	5/6	11/15/2001	8/19/2013
R-5 S4	Regional Deep	Hardness	7/2/2019	mg/L	REG	F	101	Y	83.4 to 88.2	4/4	8/26/2008	3/9/2011
R-5 S4	Regional Deep	Iron	7/2/2019	µg/L	REG	F	30	N	55.2 to 4490	5/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Lead	7/2/2019	µg/L	REG	F	0.5	N	0.1 to 0.1	1/9	11/15/2001	3/9/2011
R-5 S4	Regional Deep	Magnesium	7/2/2019	mg/L	REG	F	3.36	Y	4.12 to 5.27	8/8	11/14/2001	3/9/2011

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-5 S4	Regional Deep	Methylphenol[4-]	7/2/2019	µg/L	REG	UF	0.3	N	1.2 to 1.2	1/6	11/15/2001	9/30/2004
R-5 S4	Regional Deep	Molybdenum	7/2/2019	µg/L	REG	F	2.2	Y	1.69 to 5	7/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Nickel	7/2/2019	µg/L	REG	F	1.87	Y	1.4 to 18.1	8/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Nitrate-Nitrite as Nitrogen	7/2/2019	mg/L	REG	F	2.67	Y	0.01 to 0.356	8/11	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Perchlorate	7/2/2019	µg/L	REG	F	1.46	Y	0.246 to 0.373	9/14	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Potassium	7/2/2019	mg/L	REG	F	4.43	Y	3.4 to 5.53	8/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Silicon Dioxide	7/2/2019	mg/L	REG	F	55.9	Y	15.7 to 70.8	10/10	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Sodium	7/2/2019	mg/L	REG	F	16.5	Y	16.8 to 19.1	8/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Specific Conductance	7/2/2019	µS/cm	REG	F	282	Y	251 to 256	6/6	8/26/2008	8/19/2013
R-5 S4	Regional Deep	Strontium	7/2/2019	µg/L	REG	F	336	Y	189 to 467	8/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Sulfate	7/2/2019	mg/L	REG	F	9.44	Y	1.59 to 5.26	10/10	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Thallium	7/2/2019	µg/L	REG	F	0.6	N	0.379 to 0.379	1/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Tin	7/2/2019	µg/L	REG	F	2.55	Y	—	0/3	8/19/2005	5/21/2007
R-5 S4	Regional Deep	Toluene	7/2/2019	µg/L	REG	UF	13.9	Y	—	0/4	12/16/2000	5/21/2007
R-5 S4	Regional Deep	Total Dissolved Solids	7/2/2019	mg/L	REG	F	211	Y	126 to 209	7/7	5/4/2005	8/19/2013
R-5 S4	Regional Deep	Total Kjeldahl Nitrogen	7/2/2019	mg/L	REG	UF	0.056	N	0.038 to 1.71	6/11	11/15/2001	8/19/2013
R-5 S4	Regional Deep	Total Organic Carbon	7/2/2019	mg/L	REG	UF	0.452	Y	0.369 to 3.69	11/13	11/15/2001	8/19/2013
R-5 S4	Regional Deep	Total Phosphate as Phosphorus	7/2/2019	mg/L	REG	F	0.0339	N	0.023 to 0.067	2/14	11/14/2001	8/19/2013
R-5 S4	Regional Deep	Tritium	7/2/2019	pCi/L	REG	UF	2.507	N	0.7084 to 3.5742	4/16	11/15/2001	8/19/2013
R-5 S4	Regional Deep	Uranium	7/2/2019	µg/L	REG	F	3.5	Y	1.05 to 2	7/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Vanadium	7/2/2019	µg/L	REG	F	8.08	Y	4.5 to 8.4	4/8	11/14/2001	3/9/2011
R-5 S4	Regional Deep	Zinc	7/2/2019	µg/L	REG	F	34.9	Y	3.5 to 13.2	8/8	11/14/2001	3/9/2011
R-7 S3	Regional Top	Acetone	6/23/2019	µg/L	REG	UF	1.5	N	5.6 to 51	3/11	5/30/2001	3/24/2011
R-7 S3	Regional Top	Acidity or Alkalinity of a solution	6/23/2019	SU	REG	F	7.76	Y	5.8 to 6.2	2/2	5/30/2001	11/20/2001
R-7 S3	Regional Top	Alkalinity-CO_3+HCO_3	6/23/2019	mg/L	REG	F	64.4	Y	54.2 to 120	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Aluminum	6/23/2019	µg/L	REG	F	68	N	53 to 53	1/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Ammonia as Nitrogen	6/23/2019	mg/L	REG	F	0.0768	N	0.11 to 0.11	1/2	8/6/2002	12/18/2003
R-7 S3	Regional Top	Antimony	6/23/2019	µg/L	REG	F	1	N	0.213 to 0.213	1/10	5/30/2001	4/26/2005
R-7 S3	Regional Top	Arsenic	6/23/2019	µg/L	REG	F	2.89	N	5.79 to 5.79	1/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Barium	6/23/2019	µg/L	REG	F	27.8	Y	172 to 240	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Benzoic Acid	6/23/2019	µg/L	REG	UF	6	N	13 to 13	1/6	5/30/2001	12/18/2003
R-7 S3	Regional Top	Beryllium	6/23/2019	µg/L	REG	F	1	N	0.022 to 0.05	3/6	5/30/2001	2/21/2002
R-7 S3	Regional Top	Boron	6/23/2019	µg/L	REG	F	15.9	Y	4.51 to 82	3/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Cadmium	6/23/2019	µg/L	REG	F	0.3	N	0.143 to 0.143	1/6	5/30/2001	2/21/2002
R-7 S3	Regional Top	Calcium	6/23/2019	mg/L	REG	F	10.1	Y	15.2 to 25	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Chloride	6/23/2019	mg/L	REG	F	1.58	Y	1.38 to 3.42	5/5	5/30/2001	2/21/2002

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-7 S3	Regional Top	Chromium	6/23/2019	µg/L	REG	F	3	N	1.1 to 5.8	2/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Cobalt	6/23/2019	µg/L	REG	F	1	N	3.28 to 14	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Copper	6/23/2019	µg/L	REG	F	6.45	N	1.1 to 1.1	1/8	5/30/2001	4/26/2005
R-7 S3	Regional Top	Fluoride	6/23/2019	mg/L	REG	F	0.513	Y	0.33 to 0.4	4/5	5/30/2001	2/21/2002
R-7 S3	Regional Top	Gross alpha	6/23/2019	pCi/L	REG	UF	1.02	N	2 to 13.5	3/6	5/30/2001	4/26/2005
R-7 S3	Regional Top	Gross beta	6/23/2019	pCi/L	REG	UF	2.13	N	2.53 to 6.79	6/8	5/30/2001	4/26/2005
R-7 S3	Regional Top	Hardness	6/23/2019	mg/L	REG	F	42.4	Y	30.8 to 35.4	4/4	8/6/2002	4/26/2005
R-7 S3	Regional Top	Iron	6/23/2019	µg/L	REG	F	30	N	8750 to 17000	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Isopropylbenzene	6/23/2019	µg/L	REG	UF	0.3	N	0.41 to 0.94	3/11	5/30/2001	3/24/2011
R-7 S3	Regional Top	Lead	6/23/2019	µg/L	REG	F	0.5	N	0.124 to 0.98	6/10	5/30/2001	4/26/2005
R-7 S3	Regional Top	Magnesium	6/23/2019	mg/L	REG	F	4.18	Y	4.31 to 5.4	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Manganese	6/23/2019	µg/L	REG	F	30.4	Y	2320 to 3400	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Methylphenol[4-]	6/23/2019	µg/L	REG	UF	3.7	N	1.8 to 58	2/6	5/30/2001	12/18/2003
R-7 S3	Regional Top	Molybdenum	6/23/2019	µg/L	REG	F	0.839	Y	11.6 to 31	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Nickel	6/23/2019	µg/L	REG	F	1.11	Y	27.7 to 210	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Nitrate-Nitrite as Nitrogen	6/23/2019	mg/L	REG	F	0.127	Y	0.05 to 0.05	1/5	5/30/2001	4/26/2005
R-7 S3	Regional Top	Perchlorate	6/23/2019	µg/L	REG	F	0.298	Y	—	0/8	5/30/2001	3/24/2011
R-7 S3	Regional Top	Phenol	6/23/2019	µg/L	REG	UF	3	N	11 to 11	1/6	5/30/2001	12/18/2003
R-7 S3	Regional Top	Potassium	6/23/2019	mg/L	REG	F	1.29	Y	1.14 to 3.4	8/8	5/30/2001	4/26/2005
R-7 S3	Regional Top	Selenium	6/23/2019	µg/L	REG	F	2	N	2.1 to 3.65	2/8	5/30/2001	4/26/2005
R-7 S3	Regional Top	Silicon Dioxide	6/23/2019	mg/L	REG	F	68.2	Y	22.5 to 24.9	2/2	11/20/2001	2/21/2002
R-7 S3	Regional Top	Silver	6/23/2019	µg/L	REG	F	0.3	N	0.69 to 0.69	1/8	5/30/2001	4/26/2005
R-7 S3	Regional Top	Sodium	6/23/2019	mg/L	REG	F	9.45	Y	9.4 to 12.2	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Specific Conductance	6/23/2019	µS/cm	REG	F	131	Y	193 to 193	1/1	5/30/2001	5/30/2001
R-7 S3	Regional Top	Strontium	6/23/2019	µg/L	REG	F	47	Y	91.6 to 160	4/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Sulfate	6/23/2019	mg/L	REG	F	1.63	Y	0.409 to 0.409	1/5	5/30/2001	2/21/2002
R-7 S3	Regional Top	Thallium	6/23/2019	µg/L	REG	F	0.6	N	0.204 to 0.54	2/6	5/30/2001	2/21/2002
R-7 S3	Regional Top	Tin	6/23/2019	µg/L	REG	F	28.9	Y	—	0/4	8/06/2002	4/26/2005
R-7 S3	Regional Top	Total Dissolved Solids	6/23/2019	mg/L	REG	F	117	Y	109 to 128	4/4	8/6/2002	4/26/2005
R-7 S3	Regional Top	Total Kjeldahl Nitrogen	6/23/2019	mg/L	REG	UF	0.103	Y	0.215 to 1.7	6/7	5/30/2001	1/13/2009
R-7 S3	Regional Top	Total Organic Carbon	6/23/2019	mg/L	REG	UF	0.381	Y	1.23 to 13	7/7	5/30/2001	4/26/2005
R-7 S3	Regional Top	Tritium	6/23/2019	pCi/L	REG	UF	0.89	N	0.9338 to 2.5438	5/20	5/30/2001	3/24/2011
R-7 S3	Regional Top	Uranium	6/23/2019	µg/L	REG	F	0.977	Y	0.051 to 0.084	2/4	5/30/2001	2/21/2002
R-7 S3	Regional Top	Vanadium	6/23/2019	µg/L	REG	F	5.31	Y	0.5 to 1.73	3/8	5/30/2001	4/26/2005
R-7 S3	Regional Top	Zinc	6/23/2019	µg/L	REG	F	12.1	Y	11.6 to 320	4/4	5/30/2001	2/21/2002
R-8 S1	Regional Top	Acidity or Alkalinity of a solution	7/17/2019	SU	REG	F	8.39	Y	8.14 to 8.44	12/12	8/1/2006	8/31/2016

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-8 S1	Regional Top	Alkalinity-CO_3	7/17/2019	mg/L	REG	F	1.45	N	0.973 to 2.09	4/14	4/26/2004	8/31/2016
R-8 S1	Regional Top	Alkalinity-CO_3+HCO_3	7/17/2019	mg/L	REG	F	77.9	Y	65.8 to 75.6	14/14	4/26/2004	8/31/2016
R-8 S1	Regional Top	Aluminum	7/17/2019	µg/L	REG	UF	68	N	17.2 to 17.2	1/12	2/25/2004	3/16/2011
R-8 S1	Regional Top	Ammonia as Nitrogen	7/17/2019	mg/L	REG	F	0.0403	Y	0.017 to 0.117	2/16	2/25/2004	8/31/2016
R-8 S1	Regional Top	Arsenic	7/17/2019	µg/L	REG	F	5.68	N	2 to 4.2	6/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Barium	7/17/2019	µg/L	REG	F	36.2	Y	21.5 to 25.3	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Boron	7/17/2019	µg/L	REG	F	15	N	15.5 to 20.6	11/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Calcium	7/17/2019	mg/L	REG	F	16.9	Y	15.3 to 17.7	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Chloride	7/17/2019	mg/L	REG	F	1.59	Y	1.33 to 1.65	14/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Chromium	7/17/2019	µg/L	REG	F	3.44	Y	2.7 to 8.75	11/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Cobalt	7/17/2019	µg/L	REG	F	1	N	3.2 to 3.2	1/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Copper	7/17/2019	µg/L	REG	F	3	N	4.8 to 4.8	1/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Fluoride	7/17/2019	mg/L	REG	F	0.549	Y	0.414 to 0.597	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Gross beta	7/17/2019	pCi/L	REG	UF	3.44	Y	1.8 to 4.35	5/8	4/27/2005	9/24/2015
R-8 S1	Regional Top	Hardness	7/17/2019	mg/L	REG	F	51.5	Y	48.2 to 55.9	11/11	8/1/2006	8/31/2016
R-8 S1	Regional Top	Iron	7/17/2019	µg/L	REG	F	30	N	14.6 to 136	5/12	2/25/2004	3/16/2011
R-8 S1	Regional Top	Lead	7/17/2019	µg/L	REG	F	0.5	N	0.058 to 10.3	2/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Magnesium	7/17/2019	mg/L	REG	F	2.3	Y	2.43 to 2.85	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Manganese	7/17/2019	µg/L	REG	F	2	N	3.1 to 8.2	2/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Molybdenum	7/17/2019	µg/L	REG	F	1.55	Y	1.47 to 1.8	11/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Nickel	7/17/2019	µg/L	REG	F	0.6	N	0.531 to 0.784	5/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Nitrate-Nitrite as Nitrogen	7/17/2019	mg/L	REG	F	0.537	Y	0.0925 to 0.587	15/16	2/25/2004	8/31/2016
R-8 S1	Regional Top	Perchlorate	7/17/2019	µg/L	REG	F	0.3	Y	0.284 to 0.344	11/16	2/25/2004	8/31/2016
R-8 S1	Regional Top	Potassium	7/17/2019	mg/L	REG	F	2.27	Y	1.84 to 2.22	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Silicon Dioxide	7/17/2019	mg/L	REG	F	43.4	Y	26.4 to 61.1	16/16	2/25/2004	8/31/2016
R-8 S1	Regional Top	Sodium	7/17/2019	mg/L	REG	F	14	Y	8.82 to 10.1	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Specific Conductance	7/17/2019	µS/cm	REG	F	163	Y	139 to 12300	12/12	8/1/2006	8/31/2016
R-8 S1	Regional Top	Strontium	7/17/2019	µg/L	REG	F	108	Y	82.8 to 99.4	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Sulfate	7/17/2019	mg/L	REG	F	2.86	Y	1.94 to 2.52	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Thallium	7/17/2019	µg/L	REG	F	0.6	N	1 to 1	1/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Toluene	7/17/2019	µg/L	REG	UF	10.9	Y	—	0/14	2/25/2004	8/31/2016
R-8 S1	Regional Top	Total Dissolved Solids	7/17/2019	mg/L	REG	F	95.7	Y	110 to 140	14/14	4/27/2005	8/31/2016
R-8 S1	Regional Top	Total Kjeldahl Nitrogen	7/17/2019	mg/L	REG	UF	0.033	N	0.049 to 0.27	5/17	2/25/2004	8/31/2016
R-8 S1	Regional Top	Total Organic Carbon	7/17/2019	mg/L	REG	UF	0.33	N	0.084 to 0.821	10/17	2/25/2004	8/31/2016
R-8 S1	Regional Top	Total Phosphate as Phosphorus	7/17/2019	mg/L	REG	F	0.0756	Y	0.046 to 0.0527	3/19	2/25/2004	8/31/2016
R-8 S1	Regional Top	Tritium	7/17/2019	pCi/L	REG	UF	0.584	N	1.2558 to 1.2558	1/17	2/25/2004	9/24/2015

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-8 S1	Regional Top	Uranium	7/17/2019	µg/L	REG	F	0.46	Y	0.251 to 0.409	12/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Vanadium	7/17/2019	µg/L	REG	F	16.9	Y	12 to 14.4	15/15	2/25/2004	8/31/2016
R-8 S1	Regional Top	Zinc	7/17/2019	µg/L	REG	F	7.51	N	2 to 7.3	9/15	2/25/2004	8/31/2016
R-8 S2	Regional Deep	Acidity or Alkalinity of a solution	7/13/2019	SU	REG	F	8.22	Y	8.57 to 9.03	8/8	1/15/2008	9/1/2016
R-8 S2	Regional Deep	Alkalinity-CO_3	7/13/2019	mg/L	REG	F	1.45	N	5.21 to 16.8	11/11	4/27/2004	9/1/2016
R-8 S2	Regional Deep	Alkalinity-CO_3+HCO_3	7/13/2019	mg/L	REG	F	77.3	Y	76.6 to 116	11/11	4/27/2004	9/1/2016
R-8 S2	Regional Deep	Aluminum	7/13/2019	µg/L	REG	F	68	N	69.3 to 95.6	2/9	2/20/2004	3/16/2011
R-8 S2	Regional Deep	Ammonia as Nitrogen	7/13/2019	mg/L	REG	F	0.0516	Y	0.041 to 0.066	2/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Antimony	7/13/2019	µg/L	REG	F	1	N	0.297 to 0.33	2/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Arsenic	7/13/2019	µg/L	REG	F	4.11	Y	1.73 to 4.51	7/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Barium	7/13/2019	µg/L	REG	F	52.3	Y	119 to 198	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Boron	7/13/2019	µg/L	REG	F	24.8	Y	30.7 to 40	7/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Bromide	7/13/2019	mg/L	REG	F	0.067	N	0.0693 to 0.0693	1/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Calcium	7/13/2019	mg/L	REG	F	16.7	Y	7.93 to 21.6	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Carbon Disulfide	7/13/2019	µg/L	REG	UF	1.5	N	3.8 to 3.8	1/11	2/23/2004	9/1/2016
R-8 S2	Regional Deep	Chloride	7/13/2019	mg/L	REG	F	1.61	Y	2.88 to 4.23	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Chromium	7/13/2019	µg/L	REG	F	3	N	0.8 to 6.79	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Cobalt	7/13/2019	µg/L	REG	F	1	N	1.8 to 3.5	2/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Fluoride	7/13/2019	mg/L	REG	F	0.53	Y	0.282 to 0.547	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Gross beta	7/13/2019	pCi/L	REG	UF	4.22	Y	2.8 to 6.13	4/6	4/28/2005	9/25/2015
R-8 S2	Regional Deep	Hardness	7/13/2019	mg/L	REG	F	51.7	Y	50.2 to 74.3	8/8	1/15/2008	9/1/2016
R-8 S2	Regional Deep	Iron	7/13/2019	µg/L	REG	F	30	N	17.8 to 23.4	2/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Lead	7/13/2019	µg/L	REG	F	0.5	N	0.07 to 0.07	1/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Magnesium	7/13/2019	mg/L	REG	F	2.41	Y	2.55 to 6.67	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Manganese	7/13/2019	µg/L	REG	F	2	N	3.9 to 55.7	3/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Molybdenum	7/13/2019	µg/L	REG	F	1.48	Y	1.1 to 2.16	11/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Nickel	7/13/2019	µg/L	REG	F	0.6	N	0.59 to 1.39	4/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Nitrate-Nitrite as Nitrogen	7/13/2019	mg/L	REG	F	0.559	Y	0.102 to 0.565	13/13	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Perchlorate	7/13/2019	µg/L	REG	F	0.347	Y	0.39 to 0.443	8/9	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Potassium	7/13/2019	mg/L	REG	F	2.26	Y	3.06 to 5.25	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Selenium	7/13/2019	µg/L	REG	F	2	N	5.4 to 5.4	2/9	2/20/2004	3/16/2011
R-8 S2	Regional Deep	Silicon Dioxide	7/13/2019	mg/L	REG	F	50.7	Y	18.3 to 76.8	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Sodium	7/13/2019	mg/L	REG	F	13.8	Y	15.9 to 27.1	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Specific Conductance	7/13/2019	µS/cm	REG	F	168	Y	168 to 214	8/8	1/15/2008	9/1/2016
R-8 S2	Regional Deep	Strontium	7/13/2019	µg/L	REG	F	104	Y	138 to 213	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Sulfate	7/13/2019	mg/L	REG	F	2.91	Y	3.3 to 4.35	12/12	2/20/2004	9/1/2016

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-8 S2	Regional Deep	Thallium	7/13/2019	µg/L	REG	F	0.6	N	0.23 to 0.23	1/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Toluene	7/13/2019	µg/L	REG	UF	3.54	Y	—	0/11	2/23/2004	9/01/2016
R-8 S2	Regional Deep	Total Dissolved Solids	7/13/2019	mg/L	REG	F	97.1	Y	107 to 191	9/9	4/28/2005	9/1/2016
R-8 S2	Regional Deep	Total Kjeldahl Nitrogen	7/13/2019	mg/L	REG	UF	0.0892	N	0.0675 to 0.42	4/13	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Total Organic Carbon	7/13/2019	mg/L	REG	UF	0.33	N	0.33 to 1.19	8/13	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Total Phosphate as Phosphorus	7/13/2019	mg/L	REG	F	0.06	Y	0.031 to 0.0756	3/17	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Tritium	7/13/2019	pCi/L	REG	UF	-0.253	N	1.6744 to 1.6744	1/17	2/20/2004	9/25/2015
R-8 S2	Regional Deep	Uranium	7/13/2019	µg/L	REG	F	0.376	Y	0.458 to 1.5	12/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Vanadium	7/13/2019	µg/L	REG	F	17.6	Y	7.2 to 12.6	11/12	2/20/2004	9/1/2016
R-8 S2	Regional Deep	Zinc	7/13/2019	µg/L	REG	F	11.7	N	1.17 to 6.96	7/12	2/20/2004	9/1/2016
R-9i S1	Intermediate Perched	Acidity or Alkalinity of a solution	6/26/2019	SU	REG	F	7.53	Y	6.4 to 8.01	13/13	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Acidity or Alkalinity of a solution	6/26/2019	SU	FD	F	7.72	Y	—	—	—	—
R-9i S1	Intermediate Perched	Alkalinity-CO_3+HCO_3	6/26/2019	mg/L	REG	F	63.4	Y	58.8 to 82	13/13	2/20/2001	9/7/2016
R-9i S1	Intermediate Perched	Alkalinity-CO_3+HCO_3	6/26/2019	mg/L	FD	F	65	Y	—	—	—	—
R-9i S1	Intermediate Perched	Aluminum	6/26/2019	µg/L	REG	Y	68	N	71.2 to 140	2/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Ammonia as Nitrogen	6/26/2019	mg/L	REG	Y	0.0519	N	0.025 to 0.0666	2/10	8/29/2008	9/7/2016
R-9i S1	Intermediate Perched	Antimony	6/26/2019	µg/L	REG	Y	1	N	0.257 to 0.257	1/15	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Arsenic	6/26/2019	µg/L	REG	F	2.61	Y	2.03 to 2.03	1/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Arsenic	6/26/2019	µg/L	FD	F	2.55	Y	—	—	—	—
R-9i S1	Intermediate Perched	Barium	6/26/2019	µg/L	REG	F	37.4	Y	41.4 to 72.6	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Barium	6/26/2019	µg/L	FD	F	38.8	Y	—	—	—	—
R-9i S1	Intermediate Perched	Beryllium	6/26/2019	µg/L	REG	Y	1	N	0.011 to 0.015	3/15	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Boron	6/26/2019	µg/L	REG	F	20.5	Y	18.4 to 24.2	9/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Boron	6/26/2019	µg/L	FD	F	22.4	Y	—	—	—	—
R-9i S1	Intermediate Perched	Bromide	6/26/2019	mg/L	REG	F	0.152	Y	0.122 to 0.181	9/15	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Bromide	6/26/2019	mg/L	FD	F	0.146	Y	—	—	—	—
R-9i S1	Intermediate Perched	Cadmium	6/26/2019	µg/L	REG	F	0.3	N	0.15 to 0.15	1/13	9/14/2000	3/17/2011
R-9i S1	Intermediate Perched	Calcium	6/26/2019	mg/L	REG	F	17.7	Y	17 to 24.2	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Calcium	6/26/2019	mg/L	FD	F	17.9	Y	—	—	—	—
R-9i S1	Intermediate Perched	Chloride	6/26/2019	mg/L	REG	F	53.4	Y	24 to 42.2	14/15	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Chloride	6/26/2019	mg/L	FD	F	54.2	Y	—	—	—	—
R-9i S1	Intermediate Perched	Chromium	6/26/2019	µg/L	REG	Y	3	N	1.4 to 3.4	3/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Cobalt	6/26/2019	µg/L	REG	Y	1	N	1.39 to 5.2	8/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Copper	6/26/2019	µg/L	REG	Y	3	N	1.38 to 8.73	8/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Cyanide (Total)	6/26/2019	mg/L	REG	N	0.00167	N	0.00202 to 0.00454	2/14	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Fluoride	6/26/2019	mg/L	REG	F	0.329	Y	0.325 to 0.64	14/14	9/14/2000	9/7/2016

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-9i S1	Intermediate Perched	Fluoride	6/26/2019	mg/L	FD	F	0.327	Y	—	—	—	—
R-9i S1	Intermediate Perched	Gross alpha	6/26/2019	pCi/L	REG	N	0.978	N	4.94 to 4.94	1/13	9/14/2000	9/21/2015
R-9i S1	Intermediate Perched	Gross beta	6/26/2019	pCi/L	REG	UF	13.5	Y	2.8 to 5.99	12/13	9/14/2000	9/21/2015
R-9i S1	Intermediate Perched	Gross beta	6/26/2019	pCi/L	FD	UF	6.83	Y	—	—	—	—
R-9i S1	Intermediate Perched	Hardness	6/26/2019	mg/L	REG	F	71.5	Y	74.5 to 96.9	8/8	8/29/2008	9/7/2016
R-9i S1	Intermediate Perched	Hardness	6/26/2019	mg/L	FD	F	72.6	Y	—	—	—	—
R-9i S1	Intermediate Perched	Iron	6/26/2019	µg/L	REG	Y	30	N	36 to 2300	10/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Lead	6/26/2019	µg/L	REG	Y	0.5	N	0.121 to 0.137	2/13	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Magnesium	6/26/2019	mg/L	REG	F	6.63	Y	5.6 to 8.84	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Magnesium	6/26/2019	mg/L	FD	F	6.78	Y	—	—	—	—
R-9i S1	Intermediate Perched	Manganese	6/26/2019	µg/L	REG	Y	2	N	9.49 to 1000	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Molybdenum	6/26/2019	µg/L	REG	F	8.29	Y	7.45 to 21	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Molybdenum	6/26/2019	µg/L	FD	F	8.61	Y	—	—	—	—
R-9i S1	Intermediate Perched	Nickel	6/26/2019	µg/L	REG	Y	0.6	N	37.2 to 179	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Nitrate-Nitrite as Nitrogen	6/26/2019	mg/L	REG	F	0.297	Y	0.0207 to 0.218	6/15	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Nitrate-Nitrite as Nitrogen	6/26/2019	mg/L	FD	F	0.297	Y	—	—	—	—
R-9i S1	Intermediate Perched	Perchlorate	6/26/2019	µg/L	REG	F	0.366	Y	0.204 to 2.12	4/14	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Perchlorate	6/26/2019	µg/L	FD	F	0.368	Y	—	—	—	—
R-9i S1	Intermediate Perched	Potassium	6/26/2019	mg/L	REG	F	4.41	Y	3.9 to 4.9	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Potassium	6/26/2019	mg/L	FD	F	4.63	Y	—	—	—	—
R-9i S1	Intermediate Perched	Selenium	6/26/2019	µg/L	REG	Y	2	N	3.72 to 3.72	1/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Silicon Dioxide	6/26/2019	mg/L	REG	F	35.5	Y	29.8 to 34.9	10/10	8/29/2008	9/7/2016
R-9i S1	Intermediate Perched	Silicon Dioxide	6/26/2019	mg/L	FD	F	37.1	Y	—	—	—	—
R-9i S1	Intermediate Perched	Sodium	6/26/2019	mg/L	REG	F	28.3	Y	17 to 24.8	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Sodium	6/26/2019	mg/L	FD	F	28.5	Y	—	—	—	—
R-9i S1	Intermediate Perched	Specific Conductance	6/26/2019	µS/cm	REG	F	333	Y	274 to 310	10/10	8/29/2008	9/7/2016
R-9i S1	Intermediate Perched	Specific Conductance	6/26/2019	µS/cm	FD	F	334	Y	—	—	—	—
R-9i S1	Intermediate Perched	Strontium	6/26/2019	µg/L	REG	F	116	Y	110 to 141	12/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Strontium	6/26/2019	µg/L	FD	F	117	Y	—	—	—	—
R-9i S1	Intermediate Perched	Sulfate	6/26/2019	mg/L	REG	F	13.4	Y	9.6 to 16.4	14/14	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Sulfate	6/26/2019	mg/L	FD	F	13.4	Y	—	—	—	—
R-9i S1	Intermediate Perched	Thallium	6/26/2019	µg/L	REG	Y	0.6	N	0.109 to 0.109	1/15	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Tin	6/26/2019	µg/L	REG	F	26.7	Y	3.41 to 3.41	1/8	8/29/2008	9/7/2016
R-9i S1	Intermediate Perched	Tin	6/26/2019	µg/L	FD	F	29.3	Y	—	—	—	—
R-9i S1	Intermediate Perched	Toluene	6/26/2019	µg/L	REG	UF	1.12	Y	—	0/11	9/14/2000	9/07/2016
R-9i S1	Intermediate Perched	Toluene	6/26/2019	µg/L	FD	UF	1.19	Y	—	—	—	—

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-9i S1	Intermediate Perched	Total Dissolved Solids	6/26/2019	mg/L	REG	F	147	Y	159 to 200	14/14	7/26/2002	9/7/2016
R-9i S1	Intermediate Perched	Total Dissolved Solids	6/26/2019	mg/L	FD	F	160	Y	—	—	—	—
R-9i S1	Intermediate Perched	Total Kjeldahl Nitrogen	6/26/2019	mg/L	REG	UF	0.0914	Y	0.06 to 0.31	7/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Total Kjeldahl Nitrogen	6/26/2019	mg/L	FD	UF	0.0953	Y	—	—	—	—
R-9i S1	Intermediate Perched	Total Organic Carbon	6/26/2019	mg/L	REG	UF	2.43	Y	2.06 to 4.6	17/17	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Total Organic Carbon	6/26/2019	mg/L	FD	UF	2.44	Y	—	—	—	—
R-9i S1	Intermediate Perched	Total Phosphate as Phosphorus	6/26/2019	mg/L	REG	Y	0.0475	N	0.0404 to 0.09	4/11	4/29/2005	9/7/2016
R-9i S1	Intermediate Perched	Tritium	6/26/2019	pCi/L	REG	UF	37.588	Y	97.6626 to 348	18/21	9/14/2000	3/17/2011
R-9i S1	Intermediate Perched	Tritium	6/26/2019	pCi/L	FD	UF	36.161	Y	—	—	—	—
R-9i S1	Intermediate Perched	Uranium	6/26/2019	µg/L	REG	F	0.382	Y	0.086 to 1.37	14/14	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Uranium	6/26/2019	µg/L	FD	F	0.393	Y	—	—	—	—
R-9i S1	Intermediate Perched	Vanadium	6/26/2019	µg/L	REG	F	1.42	Y	0.39 to 0.52	3/12	9/14/2000	9/7/2016
R-9i S1	Intermediate Perched	Vanadium	6/26/2019	µg/L	FD	F	1.57	Y	—	—	—	—
R-9i S1	Intermediate Perched	Zinc	6/26/2019	µg/L	REG	Y	9.28	N	3.32 to 15.2	7/12	9/14/2000	9/7/2016
R-9i S2	Intermediate Perched	Acetone	6/16/2019	µg/L	REG	UF	5.71	Y	—	—	—	—
R-9i S2	Intermediate Perched	Acidity or Alkalinity of a solution	6/16/2019	SU	REG	F	7.8	Y	6.1 to 9.07	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Alkalinity-CO_3	6/16/2019	mg/L	REG	F	1.45	N	3.22 to 13.7	8/8	9/2/2008	8/8/2013
R-9i S2	Intermediate Perched	Alkalinity-CO_3+HCO_3	6/16/2019	mg/L	REG	F	66.8	Y	55.6 to 75	11/11	2/21/2001	8/8/2013
R-9i S2	Intermediate Perched	Aluminum	6/16/2019	µg/L	REG	F	68	N	299 to 299	1/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Ammonia as Nitrogen	6/16/2019	mg/L	REG	F	0.0727	N	0.016 to 0.0566	4/8	9/2/2008	8/8/2013
R-9i S2	Intermediate Perched	Antimony	6/16/2019	µg/L	REG	F	1.23	Y	—	0/14	9/15/2000	8/08/2013
R-9i S2	Intermediate Perched	Arsenic	6/16/2019	µg/L	REG	F	2.15	Y	1.6 to 1.6	1/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Barium	6/16/2019	µg/L	REG	F	35.7	Y	18.9 to 49.2	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Beryllium	6/16/2019	µg/L	REG	F	1	N	0.01 to 0.01	1/14	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Bis(2-ethylhexyl)phthalate	6/16/2019	µg/L	REG	UF	3.64	Y	—	0/3	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Boron	6/16/2019	µg/L	REG	F	25.5	Y	15.4 to 22	3/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Bromide	6/16/2019	mg/L	REG	F	0.162	Y	0.0719 to 0.0719	1/14	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Butanone[2-]	6/16/2019	µg/L	REG	UF	6.93	Y	—	0/7	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Cadmium	6/16/2019	µg/L	REG	F	0.3	N	0.04 to 0.04	1/14	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Calcium	6/16/2019	mg/L	REG	F	20.5	Y	13 to 21.7	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Chloride	6/16/2019	mg/L	REG	F	53.4	Y	12.3 to 22	14/15	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Chromium	6/16/2019	µg/L	REG	F	3	N	1.1 to 1.1	1/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Cobalt	6/16/2019	µg/L	REG	F	1	N	1.3 to 2.5	2/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Copper	6/16/2019	µg/L	REG	F	3	N	3.12 to 3.12	1/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Dinitrotoluene[2,4-]	6/16/2019	µg/L	REG	UF	3.09	N	0.5 to 0.5	1/6	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Di-n-butylphthalate	6/16/2019	µg/L	REG	UF	0.34	Y	—	0/3	9/15/2000	3/18/2011

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-9i S2	Intermediate Perched	Fluoride	6/16/2019	mg/L	REG	F	0.32	Y	0.177 to 0.42	14/14	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Gross alpha	6/16/2019	pCi/L	REG	UF	7.9	Y	0.664 to 0.664	1/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Gross beta	6/16/2019	pCi/L	REG	UF	8.61	Y	2.08 to 4.32	9/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Hardness	6/16/2019	mg/L	REG	F	78.8	Y	69.2 to 77.1	6/6	9/2/2008	8/8/2013
R-9i S2	Intermediate Perched	Iron	6/16/2019	µg/L	REG	F	30	N	703 to 1700	5/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Lead	6/16/2019	µg/L	REG	F	0.5	N	0.211 to 0.211	1/14	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Magnesium	6/16/2019	mg/L	REG	F	6.73	Y	4.4 to 5.9	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Manganese	6/16/2019	µg/L	REG	F	32.6	Y	4.53 to 580	9/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Mercury	6/16/2019	µg/L	REG	UF	0.067	N	0.066 to 0.066	1/10	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Mercury	6/16/2019	µg/L	REG	F	0.067	N	0.11 to 0.11	1/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Methylphenol[2-]	6/16/2019	µg/L	REG	UF	5.64	Y	—	0/3	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Methylphenol[3-,4-]	6/16/2019	µg/L	REG	UF	4.76	Y	—	0/3	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Molybdenum	6/16/2019	µg/L	REG	F	8.44	Y	2.8 to 20	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Nickel	6/16/2019	µg/L	REG	F	15.6	Y	1.94 to 110	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Nitrate-Nitrite as Nitrogen	6/16/2019	mg/L	REG	F	0.202	Y	0.02 to 0.895	9/12	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Perchlorate	6/16/2019	µg/L	REG	F	0.316	Y	2.01 to 2.38	8/11	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Phenol	6/16/2019	µg/L	REG	UF	6.7	Y	—	0/3	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Potassium	6/16/2019	mg/L	REG	F	4.74	Y	3.5 to 4.31	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Silicon Dioxide	6/16/2019	mg/L	REG	F	34.6	Y	31.4 to 39.7	8/8	9/2/2008	8/8/2013
R-9i S2	Intermediate Perched	Sodium	6/16/2019	mg/L	REG	F	29.1	Y	9.94 to 18	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Specific Conductance	6/16/2019	µS/cm	REG	F	340	Y	176 to 207	8/8	9/2/2008	8/8/2013
R-9i S2	Intermediate Perched	Strontium	6/16/2019	µg/L	REG	F	116	Y	86.6 to 106	10/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Sulfate	6/16/2019	mg/L	REG	F	14	Y	6.25 to 14.8	14/14	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Thallium	6/16/2019	µg/L	REG	F	0.6	N	0.103 to 0.513	2/14	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Toluene	6/16/2019	µg/L	REG	UF	529	Y	—	0/7	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Total Dissolved Solids	6/16/2019	mg/L	REG	F	213	Y	123 to 149	10/10	7/29/2002	8/8/2013
R-9i S2	Intermediate Perched	Total Kjeldahl Nitrogen	6/16/2019	mg/L	REG	UF	0.218	Y	0.034 to 0.077	3/9	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Total Organic Carbon	6/16/2019	mg/L	REG	UF	32.9	Y	0.494 to 4.2	13/14	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Total Phosphate as Phosphorus	6/16/2019	mg/L	REG	F	0.158	Y	0.03 to 0.188	5/9	9/6/2001	8/8/2013
R-9i S2	Intermediate Perched	Tritium	6/16/2019	pCi/L	REG	UF	38.577	Y	100.464 to 223.468	14/16	9/15/2000	3/18/2011
R-9i S2	Intermediate Perched	Uranium	6/16/2019	µg/L	REG	F	0.613	Y	0.02 to 1.72	10/11	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Vanadium	6/16/2019	µg/L	REG	F	1.29	Y	0.39 to 1.82	6/10	9/15/2000	8/8/2013
R-9i S2	Intermediate Perched	Xylene[1,3-]+Xylene[1,4-]	6/16/2019	µg/L	REG	UF	0.54	Y	n/a	0/5	9/02/2008	3/18/2011
R-9i S2	Intermediate Perched	Zinc	6/16/2019	µg/L	REG	F	444	Y	3.37 to 42.2	4/10	9/15/2000	8/8/2013
R-19 S2	Intermediate Perched	Acenaphthene	8/21/2019	µg/L	REG	UF	0.315	N	0.18 to 0.18	1/9	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Acenaphthylene		µg/L	REG	UF	0.315	N	0.16 to 0.16	1/9	9/22/2000	4/13/2015

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-19 S2	Intermediate Perched	Acetone	8/21/2019	µg/L	REG	UF	2.31	N	3.1 to 3.1	1/17	9/22/2000	5/12/2011
R-19 S2	Intermediate Perched	Acidity or Alkalinity of a solution	8/21/2019	SU	REG	F	7.75	Y	7.73 to 8.79	14/14	7/21/2005	4/13/2015
R-19 S2	Intermediate Perched	Acidity or Alkalinity of a solution	8/21/2019	SU	FD	F	7.71	Y	—	—	—	—
R-19 S2	Intermediate Perched	Alkalinity-CO_3	8/21/2019	mg/L	REG	F	1.45	N	1.07 to 5.23	6/14	7/21/2005	4/13/2015
R-19 S2	Intermediate Perched	Alkalinity-CO_3+HCO_3	8/21/2019	mg/L	REG	F	71.9	Y	69.9 to 89	17/17	4/10/2001	4/13/2015
R-19 S2	Intermediate Perched	Alkalinity-CO_3+HCO_3	8/21/2019	mg/L	FD	F	71.7	Y	—	—	—	—
R-19 S2	Intermediate Perched	Aluminum	8/21/2019	µg/L	REG	F	68	N	217 to 409	2/17	4/10/2001	5/12/2011
R-19 S2	Intermediate Perched	Ammonia as Nitrogen	8/21/2019	mg/L	REG	F	0.0537	Y	0.0317 to 0.058	4/14	7/21/2005	4/13/2015
R-19 S2	Intermediate Perched	Ammonia as Nitrogen	8/21/2019	mg/L	FD	F	0.0578	Y	—	—	—	—
R-19 S2	Intermediate Perched	Anthracene	8/21/2019	µg/L	REG	UF	0.315	N	0.2 to 0.2	1/9	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Arsenic	8/21/2019	µg/L	REG	F	2	N	2.14 to 2.14	1/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Barium	8/21/2019	µg/L	REG	F	23.9	Y	22.4 to 33	20/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Barium	8/21/2019	µg/L	FD	F	23.5	Y	—	—	—	—
R-19 S2	Intermediate Perched	Bis(2-ethylhexyl)phthalate	8/21/2019	µg/L	REG	UF	0.61	Y	0.17 to 0.17	1/7	9/22/2000	9/10/2009
R-19 S2	Intermediate Perched	Bis(2-ethylhexyl)phthalate	8/21/2019	µg/L	FD	UF	0.923	Y	—	—	—	—
R-19 S2	Intermediate Perched	Boron	8/21/2019	µg/L	REG	F	15.3	Y	12.7 to 21	6/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Cadmium	8/21/2019	µg/L	REG	F	0.3	N	0.156 to 0.156	1/23	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Calcium	8/21/2019	mg/L	REG	F	14.6	Y	14.9 to 21.1	20/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Calcium	8/21/2019	mg/L	FD	F	14.7	Y	—	—	—	—
R-19 S2	Intermediate Perched	Chloride	8/21/2019	mg/L	REG	F	2.94	Y	2.18 to 3.12	19/19	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Chloride	8/21/2019	mg/L	FD	F	2.96	Y	—	—	—	—
R-19 S2	Intermediate Perched	Chloromethane	8/21/2019	µg/L	REG	UF	0.3	N	0.317 to 0.317	1/17	9/22/2000	5/12/2011
R-19 S2	Intermediate Perched	Chromium	8/21/2019	µg/L	REG	F	3	N	0.54 to 4.45	12/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Cobalt	8/21/2019	µg/L	REG	F	1	N	0.41 to 1.04	4/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Copper	8/21/2019	µg/L	REG	F	3	N	0.56 to 14	4/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Cyanide (Total)	8/21/2019	µg/L	REG	UF	0.00167	N	0.00202 to 0.00202	1/14	4/10/2001	4/13/2015
R-19 S2	Intermediate Perched	Dichlorobenzene[1,2-]	8/21/2019	µg/L	REG	UF	0.3	N	0.47 to 0.47	1/24	9/22/2000	5/12/2011
R-19 S2	Intermediate Perched	Fluoranthene	8/21/2019	µg/L	REG	UF	0.315	N	0.19 to 0.19	1/9	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Fluoride	8/21/2019	mg/L	REG	F	0.601	Y	0.409 to 0.849	19/19	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Fluoride	8/21/2019	mg/L	FD	F	0.605	Y	—	—	—	—
R-19 S2	Intermediate Perched	Gross alpha	8/21/2019	pCi/L	REG	UF	3.73	Y	8.59 to 9.7	2/16	4/10/2001	4/13/2015
R-19 S2	Intermediate Perched	Gross beta	8/21/2019	pCi/L	REG	UF	3.53	Y	1.79 to 3.26	2/16	4/10/2001	4/13/2015
R-19 S2	Intermediate Perched	Gross beta	8/21/2019	pCi/L	FD	UF	4.61	Y	132 to 132	1/14	4/10/2001	10/15/2010
R-19 S2	Intermediate Perched	Hardness	8/21/2019	mg/L	REG	F	47.6	Y	47.6 to 56.8	15/15	7/21/2005	4/13/2015
R-19 S2	Intermediate Perched	Hardness	8/21/2019	mg/L	FD	F	47.6	Y	—	—	—	—
R-19 S2	Intermediate Perched	Iron	8/21/2019	µg/L	REG	F	30	N	25 to 480	5/20	9/22/2000	4/13/2015

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-19 S2	Intermediate Perched	Lead	8/21/2019	µg/L	REG	F	0.5	N	0.448 to 1.73	2/23	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Magnesium	8/21/2019	mg/L	REG	F	2.68	Y	2.51 to 3.47	20/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Magnesium	8/21/2019	mg/L	FD	F	2.67	Y	—	—	—	—
R-19 S2	Intermediate Perched	Manganese	8/21/2019	µg/L	REG	F	3.45	Y	2.25 to 160	7/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Manganese	8/21/2019	µg/L	FD	F	2.14	Y	—	—	—	—
R-19 S2	Intermediate Perched	Molybdenum	8/21/2019	µg/L	REG	F	0.151	N	1.12 to 2.1	16/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Nickel	8/21/2019	µg/L	REG	F	1.24	Y	0.51 to 12	10/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Nickel	8/21/2019	µg/L	FD	F	1.01	Y	—	—	—	—
R-19 S2	Intermediate Perched	Nitrate-Nitrite as Nitrogen	8/21/2019	mg/L	REG	F	0.341	Y	0.128 to 0.69	18/18	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Nitrate-Nitrite as Nitrogen	8/21/2019	mg/L	FD	F	0.326	Y	—	—	—	—
R-19 S2	Intermediate Perched	Perchlorate	8/21/2019	µg/L	REG	F	0.333	Y	0.317 to 0.381	14/19	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Perchlorate	8/21/2019	µg/L	FD	F	0.505	Y	—	—	—	—
R-19 S2	Intermediate Perched	Phenanthrene	8/21/2019	µg/L	REG	UF	0.315	N	0.24 to 0.24	1/9	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Potassium	8/21/2019	mg/L	REG	F	1	Y	0.897 to 1.4	18/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Potassium	8/21/2019	mg/L	FD	F	0.967	Y	—	—	—	—
R-19 S2	Intermediate Perched	Pyrene	8/21/2019	µg/L	REG	UF	0.315	N	0.19 to 0.19	1/9	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	RDX[j]	8/21/2019	µg/L	REG	UF	0.0846	N	0.098 to 0.098	1/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Selenium	8/21/2019	µg/L	REG	UF	2	N	2.8 to 2.8	1/17	4/10/2001	5/12/2011
R-19 S2	Intermediate Perched	Silicon Dioxide	8/21/2019	mg/L	REG	F	74.7	Y	64.8 to 73.8	14/14	7/21/2005	4/13/2015
R-19 S2	Intermediate Perched	Silicon Dioxide	8/21/2019	mg/L	FD	F	74.6	Y	—	—	—	—
R-19 S2	Intermediate Perched	Sodium	8/21/2019	mg/L	REG	F	14.2	Y	13 to 15.3	20/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Sodium	8/21/2019	mg/L	FD	F	14.2	Y	—	—	—	—
R-19 S2	Intermediate Perched	Specific Conductance	8/21/2019	µS/cm	REG	F	132	Y	116 to 172	14/14	7/21/2005	4/13/2015
R-19 S2	Intermediate Perched	Specific Conductance	8/21/2019	µS/cm	FD	F	132	Y	—	—	—	—
R-19 S2	Intermediate Perched	Strontium	8/21/2019	µg/L	REG	F	56.6	Y	64.9 to 85.5	19/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Strontium	8/21/2019	µg/L	FD	F	56.6	Y	—	—	—	—
R-19 S2	Intermediate Perched	Sulfate	8/21/2019	mg/L	REG	F	3.25	Y	2.56 to 3.56	18/19	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Sulfate	8/21/2019	mg/L	FD	F	3.25	Y	—	—	—	—
R-19 S2	Intermediate Perched	Thallium	8/21/2019	µg/L	REG	F	0.6	N	0.52 to 0.86	2/25	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Toluene	8/21/2019	µg/L	REG	UF	0.3	N	0.54 to 0.54	1/17	9/22/2000	5/12/2011
R-19 S2	Intermediate Perched	Total Dissolved Solids	8/21/2019	mg/L	REG	F	151	Y	145 to 164	17/17	8/20/2002	4/13/2015
R-19 S2	Intermediate Perched	Total Dissolved Solids	8/21/2019	mg/L	FD	F	156	Y	—	—	—	—
R-19 S2	Intermediate Perched	Total Kjeldahl Nitrogen	8/21/2019	mg/L	REG	UF	0.033	N	—	—	—	—
R-19 S2	Intermediate Perched	Total Organic Carbon	8/21/2019	mg/L	REG	UF	0.3	N	0.238 to 3.3	15/19	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Total Phosphate as Phosphorus	8/21/2019	mg/L	REG	F	0.114	Y	0.05 to 0.139	8/15	9/13/2001	4/13/2015
R-19 S2	Intermediate Perched	Total Phosphate as Phosphorus	8/21/2019	mg/L	FD	F	0.117	Y	—	—	—	—

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-19 S2	Intermediate Perched	Tritium	8/21/2019	pCi/L	REG	UF	2.184	N	—	—	—	—
R-19 S2	Intermediate Perched	Tritium	8/21/2019	pCi/L	FD	UF	1.988	N	—	—	—	—
R-19 S2	Intermediate Perched	Uranium	8/21/2019	µg/L	REG	F	0.228	Y	0.174 to 0.39	21/21	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Uranium	8/21/2019	µg/L	FD	F	0.231	Y	—	—	—	—
R-19 S2	Intermediate Perched	Vanadium	8/21/2019	µg/L	REG	F	1.54	Y	0.56 to 2.84	19/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Vanadium	8/21/2019	µg/L	FD	F	1.31	Y	—	—	—	—
R-19 S2	Intermediate Perched	Zinc	8/21/2019	µg/L	REG	F	44.4	Y	3 to 87	14/20	9/22/2000	4/13/2015
R-19 S2	Intermediate Perched	Zinc	8/21/2019	µg/L	FD	F	40.1	Y	—	—	—	—
R-19 S3	Regional Top	Acenaphthylene	8/19/2019	µg/L	REG	UF	0.3	N	0.2 to 0.2	1/10	9/26/2000	4/14/2015
R-19 S3	Regional Top	Acetone	8/19/2019	µg/L	REG	UF	1.5	N	2.1 to 2.1	1/22	9/26/2000	7/20/2011
R-19 S3	Regional Top	Acidity or Alkalinity of a solution	8/19/2019	SU	REG	F	8.31	Y	7.57 to 9.13	14/14	7/21/2005	4/14/2015
R-19 S3	Regional Top	Acidity or Alkalinity of a solution	8/19/2019	SU	FD	F	8.31	Y	—	—	—	—
R-19 S3	Regional Top	Alkalinity-CO_3	8/19/2019	mg/L	REG	F	1.5	N	4.21 to 4.21	1/14	7/21/2005	4/14/2015
R-19 S3	Regional Top	Alkalinity-CO_3+HCO_3	8/19/2019	mg/L	REG	F	65.6	Y	52.1 to 75.4	18/18	4/9/2001	4/14/2015
R-19 S3	Regional Top	Alkalinity-CO_3+HCO_3	8/19/2019	mg/L	FD	F	64.4	Y	—	—	—	—
R-19 S3	Regional Top	Aluminum	8/19/2019	µg/L	REG	F	68	N	17.6 to 17.6	1/22	9/26/2000	7/20/2011
R-19 S3	Regional Top	Ammonia as Nitrogen	8/19/2019	mg/L	REG	F	0.047	N	0.02 to 0.0593	3/14	7/21/2005	4/14/2015
R-19 S3	Regional Top	Anthracene	8/19/2019	µg/L	REG	UF	0.3	N	0.25 to 0.25	1/10	9/26/2000	4/14/2015
R-19 S3	Regional Top	Antimony	8/19/2019	µg/L	REG	F	1	N	5.67 to 5.67	1/27	9/26/2000	4/14/2015
R-19 S3	Regional Top	Arsenic	8/19/2019	µg/L	REG	F	2.35	Y	1.6 to 1.7	2/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Arsenic	8/19/2019	µg/L	FD	F	2.58	Y	—	—	—	—
R-19 S3	Regional Top	Barium	8/19/2019	µg/L	REG	F	20.3	Y	16.8 to 37.4	23/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Barium	8/19/2019	µg/L	FD	F	20.2	Y	—	—	—	—
R-19 S3	Regional Top	Benzo(b)fluoranthene	8/19/2019	µg/L	REG	UF	0.3	N	0.17 to 0.17	1/10	9/26/2000	4/14/2015
R-19 S3	Regional Top	Boron	8/19/2019	µg/L	REG	F	15	N	8.4 to 20.2	6/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Calcium	8/19/2019	mg/L	REG	F	13.5	Y	9.21 to 13.4	23/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Calcium	8/19/2019	mg/L	FD	F	13.6	Y	—	—	—	—
R-19 S3	Regional Top	Chloride	8/19/2019	mg/L	REG	F	1.77	Y	1.48 to 2.6	20/20	9/26/2000	4/14/2015
R-19 S3	Regional Top	Chloride	8/19/2019	mg/L	FD	F	1.79	Y	—	—	—	—
R-19 S3	Regional Top	Chromium	8/19/2019	µg/L	REG	F	3	N	1.4 to 4.46	15/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Cobalt	8/19/2019	µg/L	REG	F	1	N	0.51 to 0.51	1/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Copper	8/19/2019	µg/L	REG	F	3	N	0.44 to 1.43	2/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Fluoranthene	8/19/2019	µg/L	REG	UF	0.3	N	0.22 to 0.22	1/10	9/26/2000	4/14/2015
R-19 S3	Regional Top	Fluoride	8/19/2019	mg/L	REG	F	0.372	Y	0.188 to 0.53	20/20	9/26/2000	4/14/2015
R-19 S3	Regional Top	Fluoride	8/19/2019	mg/L	FD	F	0.368	Y	—	—	—	—
R-19 S3	Regional Top	Gross alpha	8/19/2019	pCi/L	REG	UF	0.0737	N	16.5 to 16.5	1/13	9/26/2000	4/14/2015

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-19 S3	Regional Top	Gross beta	8/19/2019	pCi/L	REG	UF	1.17	N	1.72 to 3.49	3/13	9/26/2000	4/14/2015
R-19 S3	Regional Top	Hardness	8/19/2019	mg/L	REG	F	46.2	Y	34.5 to 47.5	18/18	7/21/2005	4/14/2015
R-19 S3	Regional Top	Hardness	8/19/2019	mg/L	FD	F	46.6	Y	—	—	—	—
R-19 S3	Regional Top	Iron	8/19/2019	µg/L	REG	F	30	N	62 to 1100	2/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Magnesium	8/19/2019	mg/L	REG	F	3.03	Y	2.79 to 3.42	23/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Magnesium	8/19/2019	mg/L	FD	F	3.07	Y	—	—	—	—
R-19 S3	Regional Top	Manganese	8/19/2019	µg/L	REG	F	9.85	Y	1.69 to 32	20/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Manganese	8/19/2019	µg/L	FD	F	9.81	Y	—	—	—	—
R-19 S3	Regional Top	Molybdenum	8/19/2019	µg/L	REG	F	1.49	Y	0.878 to 1.32	16/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Molybdenum	8/19/2019	µg/L	FD	F	1.42	Y	—	—	—	—
R-19 S3	Regional Top	Nickel	8/19/2019	µg/L	REG	F	0.6	N	0.512 to 1.5	11/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Nitrate-Nitrite as Nitrogen	8/19/2019	mg/L	REG	F	0.268	Y	0.116 to 0.705	18/19	9/26/2000	4/14/2015
R-19 S3	Regional Top	Nitrate-Nitrite as Nitrogen	8/19/2019	mg/L	FD	F	0.267	Y	—	—	—	—
R-19 S3	Regional Top	Perchlorate	8/19/2019	µg/L	REG	F	0.225	Y	0.208 to 0.255	14/20	9/26/2000	4/14/2015
R-19 S3	Regional Top	Perchlorate	8/19/2019	µg/L	FD	F	0.229	Y	—	—	—	—
R-19 S3	Regional Top	Phenanthrene	8/19/2019	µg/L	REG	UF	0.3	N	0.28 to 0.28	1/10	9/26/2000	4/14/2015
R-19 S3	Regional Top	Potassium	8/19/2019	mg/L	REG	F	1.24	Y	1.07 to 1.57	22/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Potassium	8/19/2019	mg/L	FD	F	1.31	Y	—	—	—	—
R-19 S3	Regional Top	Pyrene	8/19/2019	µg/L	REG	UF	0.3	N	3.67068	0.23 to 0.23	4/14/2015	—
R-19 S3	Regional Top	Selenium	8/19/2019	µg/L	REG	F	2	N	4.075652	1 to 1.06	4/14/2015	—
R-19 S3	Regional Top	Silicon Dioxide	8/19/2019	mg/L	REG	F	72.6	Y	64.8 to 76.1	13/14	7/21/2005	4/14/2015
R-19 S3	Regional Top	Silicon Dioxide	8/19/2019	mg/L	FD	F	72.8	Y	—	—	—	—
R-19 S3	Regional Top	Sodium	8/19/2019	mg/L	REG	F	11.1	Y	9 to 11.4	23/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Sodium	8/19/2019	mg/L	FD	F	11.3	Y	—	—	—	—
R-19 S3	Regional Top	Specific Conductance	8/19/2019	µS/cm	REG	F	135	Y	111 to 134	14/14	7/21/2005	4/14/2015
R-19 S3	Regional Top	Specific Conductance	8/19/2019	µS/cm	FD	F	136	Y	—	—	—	—
R-19 S3	Regional Top	Strontium	8/19/2019	µg/L	REG	F	54.3	Y	44.8 to 56.3	23/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Strontium	8/19/2019	µg/L	FD	F	54.9	Y	—	—	—	—
R-19 S3	Regional Top	Sulfate	8/19/2019	mg/L	REG	F	1.88	Y	1.57 to 2.03	18/20	9/26/2000	4/14/2015
R-19 S3	Regional Top	Sulfate	8/19/2019	mg/L	FD	F	1.88	Y	—	—	—	—
R-19 S3	Regional Top	Thallium	8/19/2019	µg/L	REG	F	0.6	N	0.073 to 0.539	2/26	9/26/2000	7/20/2011
R-19 S3	Regional Top	Toluene	8/19/2019	µg/L	REG	UF	4.25	Y	—[h]	0/22	9/26/2000	7/20/2011
R-19 S3	Regional Top	Toluene	8/19/2019	µg/L	FD	UF	4.1	Y	—	—	—	—
R-19 S3	Regional Top	Total Dissolved Solids	8/19/2019	mg/L	REG	F	117	Y	84.3 to 151	17/17	8/22/2002	4/14/2015
R-19 S3	Regional Top	Total Dissolved Solids	8/19/2019	mg/L	FD	F	141	Y	—	—	—	—
R-19 S3	Regional Top	Total Kjeldahl Nitrogen	8/19/2019	mg/L	REG	UF	0.0654	Y	0.047 to 0.47	3/14	9/26/2000	4/14/2015

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-19 S3	Regional Top	Total Kjeldahl Nitrogen	8/19/2019	mg/L	FD	UF	0.0621	Y	—	—	—	—
R-19 S3	Regional Top	Total Organic Carbon	8/19/2019	mg/L	REG	UF	0.33	N	0.47 to 0.5	2/2	9/18/2001	9/19/2001
R-19 S3	Regional Top	Total Phosphate as Phosphorus	8/19/2019	mg/L	REG	F	0.1	N	0.042 to 1.38	6/19	9/18/2001	4/14/2015
R-19 S3	Regional Top	Tritium	8/19/2019	pCi/L	REG	UF	1.034	N	-0.1288 to 0.644	3/21	9/26/2000	7/29/2010
R-19 S3	Regional Top	Tritium	8/19/2019	pCi/L	FD	UF	1.366	N	—	—	—	—
R-19 S3	Regional Top	Uranium	8/19/2019	µg/L	REG	F	0.395	Y	0.197 to 0.39	22/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Uranium	8/19/2019	µg/L	FD	F	0.383	Y	—	—	—	—
R-19 S3	Regional Top	Vanadium	8/19/2019	µg/L	REG	F	3.99	Y	3.4 to 5.71	22/23	9/26/2000	4/14/2015
R-19 S3	Regional Top	Vanadium	8/19/2019	µg/L	FD	F	4.27	Y	—	—	—	—
R-19 S4	Regional Deep	Acetone	7/29/2019	µg/L	REG	UF	1.5	N	1.69 to 1.69	1/26	4/6/2001	7/20/2011
R-19 S4	Regional Deep	Acidity or Alkalinity of a solution	7/29/2019	SU	REG	F	7.9	Y	6.81 to 8.48	22/22	7/28/2005	4/15/2015
R-19 S4	Regional Deep	Alkalinity-CO_3+HCO_3	7/29/2019	mg/L	REG	F	64.2	Y	15.9 to 62	24/24	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Aluminum	7/29/2019	µg/L	REG	F	68	N	81.5 to 81.5	1/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Ammonia as Nitrogen	7/29/2019	mg/L	REG	F	0.0414	Y	0.021 to 0.0897	5/22	7/28/2005	4/15/2015
R-19 S4	Regional Deep	Arsenic	7/29/2019	µg/L	REG	F	2	N	2.6 to 2.6	1/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Barium	7/29/2019	µg/L	REG	F	20.6	Y	24.6 to 35	28/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Beryllium	7/29/2019	µg/L	REG	F	1	N	0.026 to 0.026	1/30	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Bis(2-ethylhexyl)phthalate	7/29/2019	µg/L	REG	UF	0.319	N	2.56 to 2.9	2/13	4/6/2001	9/16/2009
R-19 S4	Regional Deep	Boron	7/29/2019	µg/L	REG	F	15	N	10.2 to 31	14/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Bromide	7/29/2019	mg/L	REG	F	0.067	N	0.169 to 0.169	1/25	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Bromoform	7/29/2019	µg/L	REG	UF	0.3	N	1.7 to 1.7	1/26	4/6/2001	7/20/2011
R-19 S4	Regional Deep	Calcium	7/29/2019	mg/L	REG	F	12.2	Y	8.22 to 13.4	28/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Chloride	7/29/2019	mg/L	REG	F	2.14	Y	1.45 to 7.66	24/25	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Chromium	7/29/2019	µg/L	REG	F	3.32	Y	1.4 to 5.05	22/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Cobalt	7/29/2019	µg/L	REG	F	1	N	0.49 to 6	5/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Copper	7/29/2019	µg/L	REG	F	3	N	0.39 to 0.39	1/27	4/6/2001	7/20/2011
R-19 S4	Regional Deep	Diethyl Ether	7/29/2019	µg/L	REG	UF	0.3	N	0.32 to 0.32	1/18	8/16/2006	7/20/2011
R-19 S4	Regional Deep	Fluoride	7/29/2019	mg/L	REG	F	0.622	Y	0.153 to 0.477	25/25	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Gross alpha	7/29/2019	pCi/L	REG	UF	0.764	N	1.38 to 1.43	2/15	4/6/2001	4/15/2015
R-19 S4	Regional Deep	Gross beta	7/29/2019	pCi/L	REG	UF	1.65	N	1.65 to 4.16	8/15	4/6/2001	4/15/2015
R-19 S4	Regional Deep	Hardness	7/29/2019	mg/L	REG	F	41.4	Y	30.6 to 50.4	26/26	7/28/2005	4/15/2015
R-19 S4	Regional Deep	Iron	7/29/2019	µg/L	REG	F	30	N	32.3 to 55.2	5/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Lead	7/29/2019	µg/L	REG	F	0.5	N	0.091 to 0.097	2/27	4/6/2001	7/20/2011
R-19 S4	Regional Deep	Magnesium	7/29/2019	mg/L	REG	F	2.66	Y	2.44 to 4.15	28/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Manganese	7/29/2019	µg/L	REG	F	8.05	Y	2.08 to 23	13/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Mercury	7/29/2019	µg/L	REG	F	0.072	Y	—	0/28	4/6/2001	4/15/2015

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-19 S4	Regional Deep	Mercury	7/29/2019	µg/L	REG	UF	0.071	Y	—	0/29	4/6/2001	4/15/2015
R-19 S4	Regional Deep	Methylene Chloride	7/29/2019	µg/L	REG	UF	1	N	2.7 to 2.7	1/26	4/6/2001	7/20/2011
R-19 S4	Regional Deep	Molybdenum	7/29/2019	µg/L	REG	F	1.4	Y	0.868 to 1.33	17/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Nickel	7/29/2019	µg/L	REG	F	1.38	Y	0.51 to 1.5	10/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Nitrate-Nitrite as Nitrogen	7/29/2019	mg/L	REG	F	0.28	Y	0.233 to 793	24/24	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Perchlorate	7/29/2019	µg/L	REG	F	0.265	Y	0.207 to 0.305	22/29	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Potassium	7/29/2019	mg/L	REG	F	1.1	Y	1.39 to 1.66	27/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Silicon Dioxide	7/29/2019	mg/L	REG	F	69.7	Y	61.7 to 77.8	20/22	7/28/2005	4/15/2015
R-19 S4	Regional Deep	Sodium	7/29/2019	mg/L	REG	F	10.9	Y	8.78 to 11	28/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Specific Conductance	7/29/2019	µS/cm	REG	F	143	Y	94.2 to 117	22/22	7/28/2005	4/15/2015
R-19 S4	Regional Deep	Strontium	7/29/2019	µg/L	REG	F	51.5	Y	40.2 to 56.5	28/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Sulfate	7/29/2019	mg/L	REG	F	2.16	Y	1.13 to 1.67	22/24	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Thallium	7/29/2019	µg/L	REG	F	0.6	N	0.36 to 0.639	4/30	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Tin	7/29/2019	µg/L	REG	F	2.5	N	2.83 to 2.83	1/26	7/28/2005	4/15/2015
R-19 S4	Regional Deep	Total Dissolved Solids	7/29/2019	mg/L	REG	F	137	Y	100 to 147	27/27	8/26/2002	4/15/2015
R-19 S4	Regional Deep	Total Kjeldahl Nitrogen	7/29/2019	mg/L	REG	F	0.033	ND	0.053 to 0.0882	3/21	8/16/2006	4/15/2015
R-19 S4	Regional Deep	Total Organic Carbon	7/29/2019	mg/L	REG	UF	0.498	Y	0.178 to 1.79	15/25	4/6/2001	4/15/2015
R-19 S4	Regional Deep	Total Phosphate as Phosphorus	7/29/2019	mg/L	REG	F	0.131	Y	0.029 to 1.24	5/22	7/28/2005	4/15/2015
R-19 S4	Regional Deep	Tritium	7/29/2019	pCi/L	REG	UF	1.725	N	0 to 0.5152	3/16	4/6/2001	7/30/2010
R-19 S4	Regional Deep	Uranium	7/29/2019	µg/L	REG	F	0.266	Y	0.231 to 0.393	25/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Vanadium	7/29/2019	µg/L	REG	F	3.67	Y	3.2 to 5.7	26/28	4/9/2001	4/15/2015
R-19 S4	Regional Deep	Zinc	7/29/2019	µg/L	REG	F	48.9	Y	2.5 to 37.9	20/28	4/9/2001	4/15/2015

[a] S = Screen.
[b] FD = Field duplicate.
[c] UF = Unfiltered.
[d] Y = Yes.
[e] SU = Standard unit.
[f] REG = Regular sample.
[g] F = Filtered.
[h] N = No.
[i] — = Not applicable.
[j] RDX = Royal Demolition Explosive.

Appendix A

Initial Pumping Test and Jetting Analysis

A-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of the initial pumping tests conducted from June to August 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. The wells and screens aquifer tested included R-5 screens 2 and 3, R-7 screen 3, R-8 screens 1 and 2, R-9i screen 1, and R-19 screens 2 and 3. Initial test pumping followed swabbing and bailing activities.

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 for certain perched zones and wells that were screened across the water table.

A-2.0 R-5 INITIAL PUMPING TEST OF SCREENS 2, 3, AND 4

Following swabbing and bailing activities, initial test pumping was performed on R-5 screens 2, 3, and 4. 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 rates for final aquifer testing.
- Provide baseline production performance to support evaluation of the efficacy of the jetting procedures planned for screens 2 and 3.
- Understand the effects of dewatering screen 3 during pumping because of the static water level falling within the well screen.

The screen 2 interval in R-5 extends from 372.8 to 388.8 ft below ground surface (bgs) within Puye sediments. The static water level measured on July 5, 2019, was 354.1 ft bgs although the water level was continuing to rise slowly, implying a slightly shallower actual water level.

With little yield information available from the screen 2 zone, a step-drawdown test was selected for initial evaluation of the pumping response. Screen 2 was tested at multiple discharge rates for 125 min from 9:45 a.m. to 11:50 a.m. on July 1, 2019. Figure A-2.0-1 shows the observed drawdown response. The initial discharge rate was 12.7 gallons per minute (gpm), which was maintained until the screen and filter pack were drained. Once the screen and filter pack storage volume was removed, the rate quickly declined to 4.8 gpm. At that time, the discharge valve was partially closed in steps to increase the backpressure incrementally and reduce the pumping rate as indicated on Figure A-2.0-1. Finally, the valve was opened in steps to successively increase the discharge rate.

As shown on Figure A-2.0-1, screen 2 produced 2.39 gpm with a drawdown of 30.19 ft well into the screen. This drawdown consisted of 18.7 ft (the distance from the static water level to the top of the well screen) plus 11.49 ft (the amount of dewatering of the screen).

The dewatered distance within the well screen can be converted to a theoretical equivalent drawdown that would have been observed had no dewatering occurred. The formula for computing the corrected drawdown is as follows:

$$s_c = s - \frac{s^2}{2b}$$ **Equation A-1**

Where, s_c = corrected (theoretical) drawdown

s = observed drawdown

b = saturated thickness or saturated screen length

Applying this formula to the 11.49 ft of dewatering yielded a theoretical equivalent drawdown of 7.36 ft, making the combined theoretical drawdown 18.7 + 7.36 = 26.06 ft. Thus, the theoretical specific capacity of screen 2 when no dewatering occurs is 2.3 gpm ÷ 26.06 ft, or 0.088 gpm/ft.

The expected discharge rate with the pumping water level at the top of the screen is 0.088 gpm/ft × 18.7 ft = 1.65 gpm.

When R-5 is open, the pumping water level drops beneath the bottom of screen 2. When this occurs, the drawdown consists of 18.7 ft (the distance from the static water level to the top of the well screen) plus 16 ft (the amount of dewatering of the screen). Using the above equation to correct the latter component for dewatering yields half the screen length, or 8 ft. Thus, the total theoretical drawdown is 18.7 + 8 = 26.7 ft. This makes the expected downward flow from screen 2, when the well is open, equal to 0.088 gpm/ft × 26.7 ft = 2.35 gpm.

R-5 screen 3 extends from 676.9 to 720.3 ft bgs and lies within Santa Fe Group sediments. The pumping test of screen 3 produced inexplicable data. The static water level measured using the downhole pressure transducer was 672.6 ft bgs before pumping, a few feet above the top of the well screen; however, it is likely that the actual water table falls within the screen, as evidenced by the Westbay water-level data recorded in April showing an approximate static water level of 709 ft bgs.

Even more perplexing, after test pumping screen 3 and shutting down the pump, the apparent water level rose to a height of 638 ft bgs—seemingly impossible. During this period, adequate packer pressures were maintained, discounting the possibility of leakage of screen 2 water past the packer. Furthermore, the very low yield obtained from screen 3 during pumping supported the idea that there was no flow contribution from screen 2.

There was no apparent explanation for the unusual water level responses observed during the screen 3 testing. The unusual and inconsistent water level responses made it impossible to assess the screen 3 properties for the purposes of supporting cross-flow calculations for R-5.

Figure A-2.0-2 shows the plot of the water levels measured while pumping screen 3. Pumping began at 3:40 p.m. on June 30, 2019, and continued for 80 min until 5:00 p.m. After rapidly dewatering the screen and filter pack at pumping rates ranging from 9.0 to 8.3 gpm, the pump began cavitating. At that time, the discharge valve was partially closed to reduce the rate to 3.9 gpm. Pump cavitation continued, however, and the discharge rate continued to decline to a level of 1.5 gpm after 1 hr of pumping.

To eliminate cavitation, the pumping rate was reduced to 0.87 gpm. At this rate, water levels recovered slightly. The combination of the discharge of 0.87 gpm plus the casing/screen refill rate (estimated to be 0.46 gpm) totaled 0.87 + 0.46 = 1.33 gpm. This was judged to be the maximum sustainable pumping rate from screen 3.

Both cavitation and valving back the discharge rate severely to eliminate cavitation have the effect of severely stressing the pump. Therefore, the pumping test was terminated after just 80 min of pumping to minimize damage to the pump.

R-5 screen 4 extends from 858.7 to 863.7 ft bgs and lies within Santa Fe Group basalt. Testing of screen 4 began on June 30, 2019, at 12:00 p.m. and continued until 1:00 p.m. Figure A-2.0-3 shows the draw-down observed during the pumping test.

The screen and filter pack were depressurized quickly at a discharge rate of 5.3 gpm, with immediate pump cavitation occurring. The pumping rate was cut back to less than 4 gpm and continued to decline, ultimately reaching 3.5 gpm. Because cavitation continued to occur, the test was terminated after 1 hr to avoid damage to the pump. The data showed that the maximum discharge rate obtainable from screen 4 while keeping the well screen saturated is just under 3.5 gpm.

The times that R-5 stood open were tracked during testing activities. Table A-2.0-1 shows the times that packers were deflated and inflated between Westbay equipment removal and purging, and sampling of screen 4 on July 2, 2019.The total time that the well was open was 12,322 min. The downward flux from screen 2 was estimated at 2.35 gpm. Thus, the total volume of downward flow was approximately 12,322 × 2.35 = 29,000 gal. This volume of water would have entered screens 3 and 4; however, the unusual water level data obtained during screen 3 testing made it impossible to make a determination of how this volume would have been split between screens 3 and 4.

A-2.1 R-5 Jetting of Screens 2 and 3

Following swabbing and bailing and the initial testing of R-5 screens 2, 3, and 4, the well was developed further by simultaneous high-velocity jetting and pumping. Original plans called for abandoning screen 4 before jet development; however, the very low yields obtained from screens 2 and 3 dictated using flow from screen 4 and screens 2 and 3 to help remove sediment loosened by the jetting tool. Jetting, therefore, was performed first, and cement abandonment of screen 4 was deferred until after the jetting.

Jet development was accomplished by running a 10-horsepower (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 length of the screen, one section at a time, 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 a powerful and effective method of jet development that has been used several times at LANL with good success.

The pump used for jetting had an estimated capacity of 21 to 27 gpm at the prevailing discharge pressures, which ranged from approximately 400 to 600 pounds per square inch (psi). During operation, an inline valve at the top of the drop pipe was adjusted as needed to keep the discharge to the surface at 7 gpm or less. This was done to avoid cavitation that could have occurred by over-pumping the well.

Development at R-5 screen 2 was performed from 9:10 a.m. to 10:40 a.m. on July 3, 2019. Initially, a jetting pressure of approximately 500 psi was needed to limit the surface discharge to 7 gpm. Later, the jetting pressure had to be maintained near 600 psi to control the surface discharge rate adequately. These pressures were achieved by partially closing the inline valve. It was surmised that one of the nozzles clogged early on, necessitating that backpressure be applied, and that a second nozzle clogged later, necessitating a further increase in applied backpressure.

R-5 screen 3 was jetted from 4:05 p.m. to 6:20 p.m. on July 3, 2019. An estimated jetting pressure of 400 psi was maintained throughout the process.

Subsequent cementing operations resulted in the tremie pipe used for cement placement being cemented into the well casing. At the time of preparation of this report, the screens in R-5 were inaccessible. Therefore, it was not possible to complete the test pumping work needed to measure the effectiveness of the jetting operation on screens 2 and 3.

A-3.0 R-7 INITIAL PUMPING TEST OF SCREEN 3

Following swabbing and bailing activities, initial test pumping was performed on R-7 screen 3. Little was known about the yield potential of screen 3, so brief testing was required to achieve several objectives.

- Support jetting tool design for subsequent jet development.
- Guide selection of discharge rates for final aquifer testing.
- Provide baseline production performance to support evaluation of the efficacy of the jetting procedures planned for screen 3.
- Understand the effects of dewatering screen 3 during pumping because of the static water level falling within the well screen.
- Support selection of the permanent sampling pump for R-7.

The screen 3 interval in R-7 extends from 895.5 to 937.4 ft bgs and straddles the water table at 909.0 ft within pumiceous Puye sediments. Original plans called for housing the test pump inside a shroud and running the shroud into the sump beneath screen 3. This would have kept the pump motor cooled even while pulling the water level to the bottom of the screen during pumping; however, the short riser casing above ground surface had been welded on crooked when the well was originally constructed. When trying to place the 4.25-in. outside diameter shroud inside the 4.5-in. inside diameter well casing, it was not possible to push the shroud through the crooked casing section. Thus, the pump had to be run without a shroud. This meant that the pump had to be kept well up inside the well screen, above the bottom, in hopes of having enough water contribution from the screen beneath the pump to keep the motor cool during pump operation. In practice, the pump was installed with the bottom of the motor approximately 8 ft above the bottom of the well screen.

A step-drawdown test was selected for assessing the performance of R-7 screen 3 so that the magnitude of screen dewatering could be observed at a variety of discharge rates. This information was useful for the objectives listed above.

R-7 screen 3 was pumped at successively decreasing discharge rates for 1 h from 3:00 p.m. to 4:00 p.m. on June 15, 2019. Pumping time was kept to a minimum to avoid overheating the motor in the event that little water was produced from beneath the pump. Figure A-3.0-1 shows the drawdown response observed for four different pumping rates ranging from 4.77 to 10.2 gpm. The results showed that screen 3 could readily produce in excess of 10 gpm without dewatering most of the well screen.

Table A-3.0-1 lists the pumping rates and observed drawdown values from the step-drawdown test along with the computed specific capacity (gpm per ft of drawdown) at each pumping rate. Also shown are theoretical corrected drawdown and specific capacity values.

In general, when an aquifer is dewatered during pumping, the drawdown increases disproportionately with the increased discharge rate because of progressive thinning of the saturated zone and loss of transmissivity. The result is a steadily declining specific capacity at successively greater pumping rates.

It is possible to correct the observed drawdown to a theoretical value that would have been observed had no dewatering occurred. It is expected that the corresponding specific capacities computed using the theoretical drawdown values would remain constant at all pumping rates. The formula for computing the corrected drawdown is as follows:

$$s_c = s - \frac{s^2}{2b}$$ **Equation A-2**

Where, s_c = corrected (theoretical) drawdown

s = observed drawdown

b = saturated thickness, or saturated well screen length

Figure A-3.0-2 shows a plot of specific capacity versus discharge rate for the values listed in Table A-3.0-1. Surprisingly, the actual specific capacity did not decline as the pumping rate increased, as would normally be expected, but remained nearly constant instead. This indicated that dewatering the upper 10 ft of well screen had little or no effect on the transmissivity near the well and suggested that most of the production in screen 3 likely came from the bottom 18 ft of screen length.

In theory, the corrected specific capacities on Figure A-3.0-2 would be expected to remain constant at all discharge rates; however, they showed a steady increase instead, consistent with the idea that little transmissivity was lost when the upper 10 ft of saturation was dewatered. This resulted in the dewatering correction actually being an overcorrection.

This result bodes well for future sampling of R-7 screen 3. For the next several years, as the water table gradually declines, there should be little loss of capacity and pumping performance when sampling R-7.

Based on the pumping performance of R-7 screen 3, the permanent sampling pump selected for the well was the Grundfos model 5S30-48DS (or CBM equivalent), a pump capable of producing near 4 gpm after retrofitting. The pump should be placed in a shroud and run into the sump beneath the well screen.

A-3.1 R-7 Jetting of Screen 3

Following swabbing and bailing and the initial testing of R-7 screen 3, the well was developed further by simultaneous high-velocity jetting and pumping. This was accomplished by running a 10 hp submersible pump through the screen with a jetting tool above the pump. While the pump was running, the assembly was raised and lowered through the length of the screen, one section at a time, 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 a powerful and effective method of development that has been used several times at LANL with good success.

The pump used for jetting had an estimated capacity of just under 27 gpm at the prevailing discharge pressure of slightly greater than 400 psi. The nozzles in the jetting tool above the pump were sized to allow a combined flow of a slightly more than 18 gpm at that pressure. Thus, during operation it was expected that about 8 or 9 gpm would be discharged at the surface.

Development began on June 18, 2019, at about 10:20 a.m. and continued until 4:00 p.m. When jetting and pumping began, the discharge rate at the surface averaged approximately 9 gpm. As jetting continued, the surface discharge rate gradually increased, as one of the downhole jet nozzles clogged, reducing the jet output somewhat. Toward the end of the procedure, the discharge from the well was approximately 14 gpm, implying that approximately 13 gpm continued to exit the jet nozzles downhole.

As part of the subsequent aquifer testing performed on screen 3, a step-drawdown test was conducted so a comparison of the yields before and after jetting could be made. On June 20, 2019, R-7 screen 3 was pumped at several discharge rates for 75 min from 8:00 a.m. to 9:15 a.m. Figure A-3.1-1 shows the drawdown response observed for four different pumping rates ranging from 4.95 to 10.0 gpm during the first 60 min of pumping. (During the last 15 min, not shown, the discharge rate was preset to the planned rate for the subsequent 24-hr pumping test.).

Table A-3.1-1 lists the pumping rates and observed drawdown values from the step-drawdown test along with the computed specific capacity at each pumping rate.

Figure A-3.1.-2 shows a comparison of the specific capacity values measured before jet development and those observed after jetting. The data show an approximate 10% increase in well performance from that achieved by the previous swabbing and bailing.

The 10% yield increase is somewhat less than that seen in other applications of jetting at LANL. Note that the well screens installed in R-7 were pipe base screens with 10-slot-size (0.010-in.) openings. The very fine slot opening size is restrictive and makes removal of sediment challenging. Also, the presence of the base pipe deflects the water jets most of the time, except when the jets are aimed at the perforations in the base pipe. Despite these restrictions, the jetting/pumping operation provided a useful increase in well performance.

A-4.0 R-8 INITIAL PUMPING TEST OF SCREENS 1 AND 2

Following swabbing and bailing activities, initial test pumping was performed on R-8 screens 1 and 2. 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 rates for final aquifer testing.
- Provide baseline production performance to support evaluation of the efficacy of the jetting procedures planned for screens 1 and 2.
- Understand the effects of dewatering screen 1 during pumping because of the static water level falling within the well screen.
- Support selection of the permanent sampling system design (one pump versus two pumps).
- Support selection of the size of the permanent pump.

The screen 1 interval in R-8 extends from 705.3 to 755.7 ft bgs and straddles the water table within the Puye sediments. The static water level measured on July 5, 2019, was 708.1 ft bgs, making the saturated screen length 755.7 – 708.1 = 47.6 ft. When the water level was measured, however, it was continuing to rise slowly, implying an actual static water level slightly higher than 708.1 ft.

With little yield information available from the screen 1 zone, a step-drawdown test was selected for initial evaluation of pumping response. Screen 1 was tested at multiple discharge rates for 100 min from 7:20 a.m. to 9:00 a.m. on July 5, 2019. Figure A-4.0-1 shows the drawdown response observed for four different pumping rates ranging from 2.4 to 8.3 gpm. The initial discharge rate was 8.3 gpm, which was maintained until the screen and filter pack were drained. Once the screen and filter pack storage volume was removed, the rate quickly dropped to 5.5 gpm.

Table A-4.0-1 lists the pumping rates and observed drawdown values from the step-drawdown test along with the computed specific capacity (gpm per ft of drawdown) at each pumping rate. Also shown are theoretical corrected drawdown and specific capacity values.

In general, when an aquifer is dewatered during pumping, the drawdown increases disproportionately with increased discharge rate because of progressive thinning of the saturated zone and loss of transmissivity. The result is a steadily declining specific capacity at successively greater pumping rates.

It is possible to correct the observed drawdown to a theoretical value that would have been observed had no dewatering occurred. It is expected then that the corresponding specific capacities computed using the theoretical drawdown values would remain constant at all pumping rates. The formula for computing the corrected drawdown is as follows:

$$s_c = s - \frac{s^2}{2b}$$ **Equation A-3**

Where, s_c = corrected (theoretical) drawdown

s = observed drawdown

b = saturated thickness or saturated screen length

Figure A-4.0-2 shows a plot of specific capacity versus discharge rate. Surprisingly, the actual specific capacity did not decline as the pumping rate increased, as would normally be expected, but remained nearly constant instead.

Because of the sluggish response of screen 1, equilibration of the pumping water levels did not occur during any of the pumping steps. It is clear from Figure A-4.0-1 that the pumping level was continuing to decrease rapidly during the first two pumping steps and was continuing to rise during the last two steps. Had pumping occurred longer for each step, the specific capacities at the higher rates would have decreased and those at the lower rates would have increased. This would have resulted in the expected decline in specific capacity with increased pumping rate. The apparent similarity of the specific capacity values was merely an artifact of the brief pumping steps and lack of equilibration during each step.

The pumping rate and drawdown data showed a very low specific capacity for screen 1; however, the pumping capacity was judged sufficient to support sampling the zone using a conventional submersible pump. The low yield of screen 1 dictated designing the sampling system using the Grundfos pump model 5S20-39DS (or 5S30-820 CBM equivalent), a pump capable of producing approximately 3 gpm in retrofit configuration.

This pump can be incorporated into the design of a dual access port valve sampling system for R-8. In this system, the shrouded pump should be placed in the blank casing just beneath screen 1.

R-8 screen 2 extends from 821.3 to 828.0 ft bgs in the Puye formation. The static water level estimated from the transducer data from July 4, 2019, was 726.0 ft bgs, approximately 18 ft below the screen 1 static water level.

Screen 2 was tested at multiple discharge rates for 120 min from 2:00 p.m. to 4:00 p.m. on July 4, 2019. Figure A-4.0-3 shows the drawdown response observed for three different pumping rates ranging from 4.5 to 7.5 gpm.

Table A-4.0-2 lists the pumping rates and observed draw-down values from the step-drawdown test and the computed specific capacity at each pumping rate. The specific capacity data from Table A-4.0-2 are plotted on Figure A-4.0-4. As indicated, the specific capacity remained essentially constant at all pumping rates, consistent with laminar flow conditions. The data from the screen 2 step-drawdown test showed that screen 2 can readily sustain large pumping rates.

Throughout the testing of R-8, including the initial testing, well development, and subsequent 24-hr testing, the times during which cross-flow occurred were documented so that a total cross-flow volume could be calculated. The cross-flow rate between two screen zones can be computed from the following equation:

$$Q = h\frac{c_1 c_2}{c_1 + c_2}$$ **Equation A-4**

Where, for Well R-8,

Q = cross-flow rate, in gpm

c_1 = specific capacity of screen 1, in gpm/ft (0.12 gpm/ft)

c_2 = specific capacity of screen 2, in gpm/ft (1.13 gpm/ft)

h = head difference between screens 1 and 2, in ft (726.0 – 708.1 = 17.9 ft)

The resulting computed cross-flow rate estimate was 1.94 gpm.

Table A-4.0-3 shows the packer deflation and inflation times that occurred during the work on well R-8 and the times that the well was open to flow. The total cumulative cross-flow time was 21,112 min. Thus, the total cross-flow volume was estimated to be approximately 21,112 min × 1.94 gpm = 40,960 gal.

A-4.1 R-8 Jetting of Screens 1 and 2

Following swabbing and bailing and the initial testing of R-8 screens 1 and 2, the well was developed further by simultaneous high-velocity jetting and pumping. 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 length of the screen, one section at a time, 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 a powerful and effective method of development that has been used several times at LANL with good success.

The pump used for jetting had an estimated capacity of 28 gpm at the prevailing discharge pressure of approximately 320 psi. The nozzles in the jetting tool above the pump were sized to allow a combined flow of approximately 17 gpm at that pressure. Thus, during operation it was expected that about 11 gpm would be discharged at the surface.

Development began at screen 1 on the afternoon of July 6, 2019, and continued for a little more than 1 hr before a lightning stand-down ended the day's activities. Jetting at screen 1 continued on the morning of July 7, 2019, and continued for approximately 3 hr until the entire screen surface had been developed. Throughout the procedure, the discharge from the well was approximately 14 gpm, implying that approximately 14 gpm exited the jet nozzles downhole. This combination of jetting rate and surface discharge rate suggested that one of the four jet nozzles may have been partially clogged.

Following the completion of the screen 1 jetting/pumping procedures, the pump and jet assembly was tripped out of the well and reconfigured to accommodate jetting screen 2. The revisit to the well was completed on the morning of July 8, 2019. Jetting and simultaneous pumping were applied to screen 2 for about 1 hr. During the screen 2 jetting procedures, the measured discharge at the surface was initially 16 gpm, increasing gradually to more than 19 gpm. This suggested the possibility that two of the four jet nozzles had partially or completely clogged with sediment during the jetting procedures.

As part of the subsequent aquifer testing performed at R-8, a step-drawdown test was conducted on screen 1 so that a comparison of the yields before and after jetting could be made. On July 15, 2019, R-8 screen 1 was pumped at several discharge rates for 120 min from 7:30 a.m. to 9:30 a.m. Figure 4.1-1 shows the drawdown response observed for four different pumping rates ranging from 2.35 to 8.6 gpm during the first 100 min of pumping. (During the last 20 min, not shown, the discharge rate was preset to the planned rate for the subsequent 24-hr pumping test on screen 1.)

Table A-4.1-1 lists the pumping rates and observed drawdown values from the step-drawdown test and the computed specific capacity at each pumping rate.

Figure A-4.1-2 shows a comparison of the specific capacity values measured before jet development and those observed after jetting. The data showed an approximate 45% improvement in screen 1 performance over and above that achieved by the previous swabbing and bailing.

Pumping performance before and after jetting was evaluated at screen 2 by comparing drawdown measured at identical discharge rates. Following swabbing and bailing, screen 2 was pumped at 7.5 gpm on July 4, 2019, to establish a baseline for comparison. Before pumping, the water level was stable so no correction of the drawdown data was needed. After jetting screen 2, it was pumped again at 7.5 gpm on July 10, 2019. At the time of the test, the water level was declining at a rate of 0.00069 ft/min in response to PM-3 operation. The measured data were corrected for this trend.

Figure A-4.1-3 shows a comparison of the drawdown responses from these tests, before and after jetting. As indicated, there was some improvement in performance, but the screen 2 drawdown observed after jetting was only slightly less than that measured before jetting.

A-5.0 R-9i INITIAL PUMPING TEST OF SCREENS 1 AND 2

Following swabbing and bailing activities, initial test pumping was performed on R-9i screens 1 and 2. Little was known about the yield potential of screens 1 and 2, so brief testing was required to achieve several objectives:

- Guide selection of discharge rates for final aquifer testing.
- Determine the cross-flow from screen 1 to screen 2 during Westbay system removal.
- Support selection of the permanent sampling pump for R-9i screen 1.

R-9i screen 1 extends from 189.1 to 199.5 ft bgs in a perched interval within the Cerros del Rio basalt. The static water level measured on June 19, 2019, was 144.6 ft bgs. With little yield information available on the screen 1 zone, a step-drawdown test was selected for initial evaluation of pumping response.

Screen 1 was tested at multiple discharge rates for 120 min from 12:00 p.m. to 2:00 p.m. on June 15, 2019. Figure A-5.0-1 shows the drawdown response observed for four different pumping rates ranged from 5.7 to 14.6 gpm. The results showed that screen 1 could readily support large production rates.

Table A-5.0-1 lists the pumping rates and observed drawdown values from the step-drawdown test along with the computed specific capacity (gpm per ft of drawdown) at each pumping rate.

Figure A-5.0-2 shows a plot of specific capacity versus discharge rate for the values listed in Table A-5.0-1. The data showed that the specific capacity declined steadily at increasing pumping rates, indicating an increase in the turbulent flow component of drawdown at greater discharge rates. Generally, flow in porous media is strictly laminar at moderate discharge rates such as these; however, because screen 1 is located in basalt rather than sediments, it is likely that the flow regime includes some fracture or “pipeline” flow, which accounts for the presence of some turbulent flow.

Based on the pumping performance of R-9i screen 1, the permanent sampling pump selected for the well was the Grundfos model 5S30-13 (or CBM equivalent), a pump capable of producing approximately 5 to 6 gpm after retrofitting.

R-9i screen 2 extends from 269.6 to 280.3 ft bgs in a perched zone at the base of the Cerros del Rio basalt. The static water level estimated from the transducer data from June 15, 2019, was 242.5 ft bgs; however, the observed head was continuing to decline when this measurement was made, indicating that static equilibrium had not been reached. Thus, the actual static water level of the screen 2 zone is somewhat deeper than 242.5 ft bgs.

Testing of screen 2 began at 5:00 p.m. on June 15, 2019. The pump began surging (cavitating) immediately after starting because the screen 2 zone could not produce enough flow to satisfy the pump capacity. The average discharge rate was just 0.55 gpm. The test was terminated after 30 min at 5:30 p.m. to minimize damage to the pump caused by operating in cavitation mode.

Figure A-5.0-3 shows the drawdown response observed in screen 2 during pumping. The locations of the top and bottom of screen 2 are shown on the figure for reference. The pumping water level was pulled below the bottom of the screen. During the first few minutes of operation, the pump pulled a strong vacuum on the screen zone. Later, the magnitude of the vacuum dissipated somewhat, perhaps with some air reaching the pumped zone, although there may have still been some residual vacuum remaining within the screen.

The pumping information obtained from screens 1 and 2 supported a determination of the cross-flow from screen 1 to screen 2 that occurred during the Westbay reconfiguration. Data required for this include the specific capacities of the two screen zones and the head difference between them.

Because the cross-flow rate was expected to be low, the specific capacity of screen 1 was computed based on the lowest test rate to be most representative of cross-flow conditions. Screen 1 produced 5.7 gpm with 1.19 ft of drawdown for a specific capacity of 4.79 gpm/ft.

Screen 2 produced 0.55 gpm with the pumping water level below the bottom of the well screen. The drawdown was taken as the sum of (1) the drawdown from the static water level (approximately 242.5 ft) to the top of the well screen (269.6 ft) plus (2) the effective drawdown associated with complete dewatering of the screen length. It was necessary to correct the drawdown through the screen length for dewatering using the following formula:

$$s_c = s - \frac{s^2}{2L}$$ **Equation A-5**

Where, s_c = corrected (theoretical) drawdown

s = observed drawdown through the well screen (10.7 ft)

L = well screen length (10.7 ft)

Using this estimate, the effective incremental drawdown associated with pulling the water level to the bottom of the screen is equal to half the well screen length, or 5.35 ft. Thus, the total effective drawdown was taken as 5.35 ft + 27.1 ft (269.6 ft – 242.5 ft), or 32.45 ft. The resulting expected specific capacity of screen 2 for fully saturated conditions was estimated to be 0.55/32.45 = 0.0169 gpm/ft.

The cross-flow rate between two screen zones can be computed from the following equation:

$$Q = h\frac{c_1 c_2}{c_1 + c_2}$$ **Equation A-6**

Where, for well R-9i,

Q = cross-flow rate, in gpm

c_1 = specific capacity of screen 1, in gpm/ft (4.79 gpm/ft)

c_2 = specific capacity of screen 2, in gpm/ft (0.0169 gpm/ft)

h = head difference between screens 1 and 2, in ft (242.5 – 144.6 = 97.9 ft)

The resulting computed cross-flow rate estimate was 1.65 gpm.

Table A-5.0-2 shows the packer deflation and inflation times that occurred during the work on Well R-9i along with the times that the well was open to flow. The total cumulative cross-flow time was 8602 min. Thus, the total cross-flow volume was estimated to be approximately 8602 min × 1.65 gpm = 14,200 gal.

A-5.1 R-9i Jetting of Screens 1 and 2

Screens 1 and 2 in well R-9i were not jetted because they were in fractured basalt instead of sandy alluvial beds as were the other screen intervals in the other wells.

A-6.0 R-19 INITIAL PUMPING TEST OF SCREENS 2, 3, AND 4

Following swabbing and bailing activities, initial test pumping was performed on R-19 screens 2, 3, and 4. 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 rates for final aquifer testing.

- Provide baseline production performance to support evaluation of the efficacy of the jetting procedures planned for screens 2 and 3.
- Understand the effects of dewatering screens 2 and 3 during pumping because of the static water level falling within the well screens.
- Support selection of the size of the permanent pump.

The screen 2 interval in R-19 extends from 893.3 to 909.6 ft bgs and straddles the water table within a perched zone in the upper fanglomerate facies of the Puye sediments. The static water level measured on July 28, 2019, was 899.2 ft bgs. 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. These procedures showed a short-term yield of approximately 0.2 gpm at maximum drawdown.

The screen 3 interval in R-19 extends from 1171.4 to 1215.4 ft bgs and straddles the regional water table within the lower fanglomerate facies of the Puye Formation. The static water level measured on July 27, 2019, was 1188.8 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 73 min from 12:20 p.m. to 1:33 p.m. on July 27, 2019, and, after a brief lightning shutdown, for 30 min from 2:20 p.m. to 2:50 p.m. Figure A-6.0-1 shows the drawdown response observed for four different pumping rates ranging from 2.52 to 6.22 gpm.

The measured screen 3 specific capacities were quite high, actually higher than the R-19 open hole specific capacity obtained via brief pumping before testing the screens individually. Subsequent examination of the data showed that when the pumping string was moved to screen 3, it was inadvertently set one pipe length too high, resulting in the bottom packer being set within the screen. This would have allowed leakage past the packer, resulting in hydraulic communication between screen 3 and all the deeper screens. Thus, the screen 3 tests actually measured the response of screens 3 through 7. Therefore, individual data from screen 3, sought to establish a baseline yield before jet development for comparison purposes, were not obtained.

Table A-6.0-1 lists the pumping rates and observed drawdown values from the R-19 screen 3 step-drawdown test along with the computed specific capacity (gpm per ft of drawdown) at each pumping rate.

Figure A-6.0-2 shows a plot of specific capacity versus discharge rate for the values listed in Table A-6.0-1. The specific capacity appeared to remain constant at all pumping rates, suggesting predominantly laminar flow conditions.

All of the initial data obtained from the screen 3 tests likely represent open hole conditions. Although screen 2 was isolated, it would have provided negligible contribution to the yield.

R-19 screen 4 extends from 1410.2 to 1417.4 ft bgs in the lower fanglomerate facies of the Puye Formation. The static water level estimated from the transducer data on July 26, 2019, was 1194.2 ft bgs.

Screen 4 was tested at multiple discharge rates for 90 min from 7:50 p.m. to 9:20 p.m. on July 27, 2019. Figure A-6.0-3 shows the drawdown response observed for three different pumping rates ranging from 2.92 to 5.74 gpm.

Table A-6.0-2 lists the pumping rates and observed drawdown values from the step-drawdown test along with the computed specific capacity at each pumping rate. The specific capacity data from the table are plotted on Figure A-6.0-4. As indicated, the specific capacity increased at greater discharge rates. Testing was from larger rate to smaller rate, so greater pumping time was associated with the lower rates, contributing to reduced specific capacity.

In summary, the specific capacity measured at the highest pumping rate during the screen 3 test was 6.7 gpm/ft, actually reflecting the combined capacity of screens 3 through 7. The specific capacity measured at the highest pumping rate during the screen 4 test was 2.29 gpm/ft. The difference of 6.7 – 2.29 = 4.41 gpm/ft was likely representative of the combined specific capacity of screens 3, 5, 6, and 7. Thus, the baseline specific capacity of screen 3 was likely well below 4.41 gpm/ft.

Throughout the testing of R-19, including the initial testing and well development, the times during which cross-flow occurred were documented so that a total cross-flow volume could be calculated. Table A-6.0-3 shows the packer deflation and inflation times that occurred during the work on Well R-19 along with the times that the well was open to flow. The total cumulative cross-flow time was 15,075 min. Because no head or specific capacity data were measured for screens 5, 6, and 7, it was not possible to compute the cross-flow into screen 4 when the well was open.

A-6.1 R-19 Jetting of Screens 2 and 3

Following swabbing and bailing and the initial testing of R-19 screens 2, 3, and 4, the well was developed further by simultaneous high-velocity jetting and pumping of screens 2 and 3. 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 a powerful and effective method of development that has been used several times at LANL with good success.

The pump used for jetting had an estimated capacity of 21 gpm at the planned discharge pressure of approximately 530 psi. The nozzles in the jetting tool above the pump were sized to allow a combined flow of approximately 10 gpm at that pressure. Thus, during operation it was expected that about 11 gpm would be discharged at the surface.

Development began at screen 2 on the morning of July 31, 2019, and continued for more than 1 hr from 10:53 a.m. to 12:15 p.m. Throughout the procedure, the discharge from the well ranged from approximately 8 to 12 gpm, implying that approximately 9 to 13 gpm exited the jet nozzles downhole.

Following the completion of the screen 2 jetting/pumping procedures, development continued at screen 3 on the morning of August 1, 2019. During the screen 3 jetting procedures, the measured discharge at the surface ranged from approximately 13.5 to 15 gpm, suggesting the possibility that one of the four jet nozzles had clogged with sediment during the jetting procedures.

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. Nevertheless, two sets of pump-down and refill response showed a continuous achievable yield of 0.49 gpm. This was substantially greater than the baseline (pre-jetting) capacity of 0.2 gpm, reflecting a yield increase of 145 % and demonstrating the effectiveness of the simultaneous jetting and pumping method.

As part of the subsequent aquifer testing performed at R-19, a step-drawdown test was conducted on screen 3 to compare the yields before and after jetting. On August 19, R-19 screen 3 was pumped at several discharge rates for 150 min from 8:40 a.m. to 11:10 a.m. Figure A-6.1-1 shows the drawdown response observed for four different pumping rates ranged from 2.85 to 6.46 gpm.

Table A-6.1-1 lists the pumping rates and observed drawdown values from the step-drawdown test along with the computed specific capacity at each pumping rate. Figure A-6.1-2 shows the specific capacities obtained from screen 3.

Before jet development, the combined specific capacity of screens 3, 5, 6, and 7 was 4.41 gpm/ft, making the capacity of screen 3 alone less than that. Following simultaneous jetting and pumping, the specific capacity of screen 3 pumping alone was 4.9 gpm//ft. This represented an 11% increase over the combined specific capacities of screens 3, 5, 6, and 7 and, therefore, an even greater increase in the yield of screen 3 alone. For example, if the starting specific capacity of 4.41 gpm/ft was distributed equally among screens 3, 5, 6, and 7 (1.1 gpm/ft per screen), the final screen 3 specific capacity of 4.9 gpm/ft would represent a yield increase of 345%. Although the initial screen 3 specific capacity was not known, it appeared that the jet development procedures were reasonably effective.

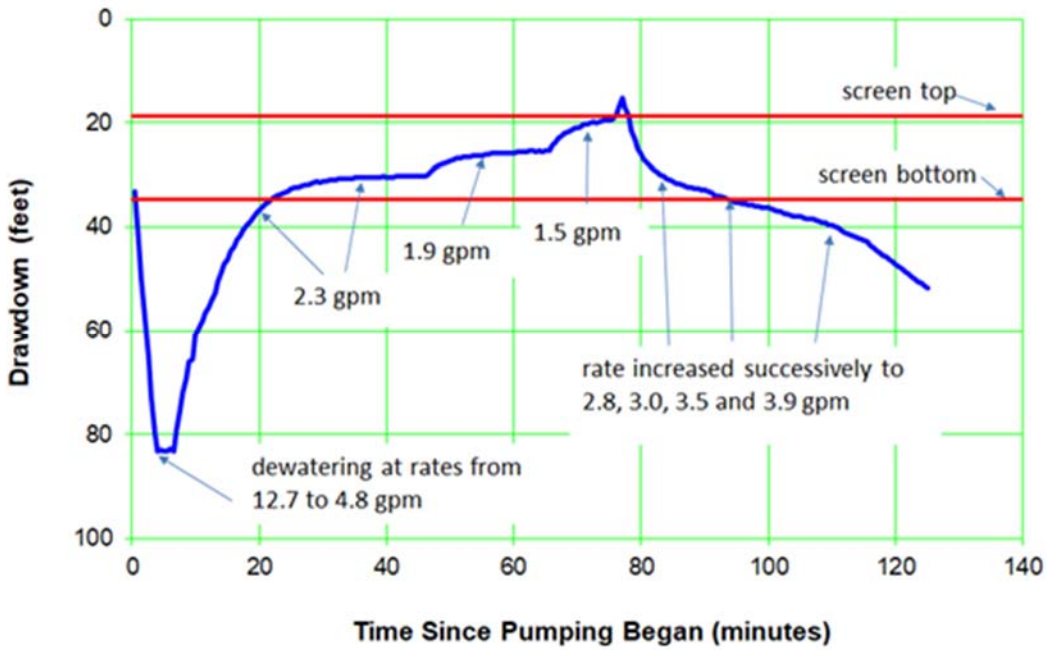


Figure A-2.0-1 Well R-5 screen 2 initial pumping test response

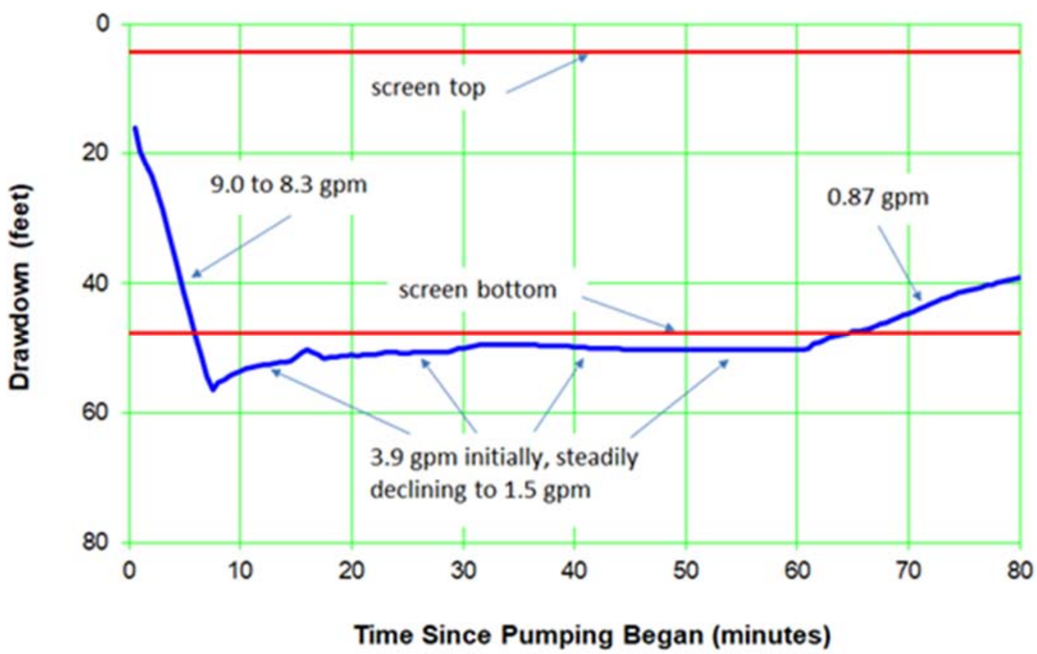


Figure A-2.0-2 Well R-5 screen 3 initial pumping test response

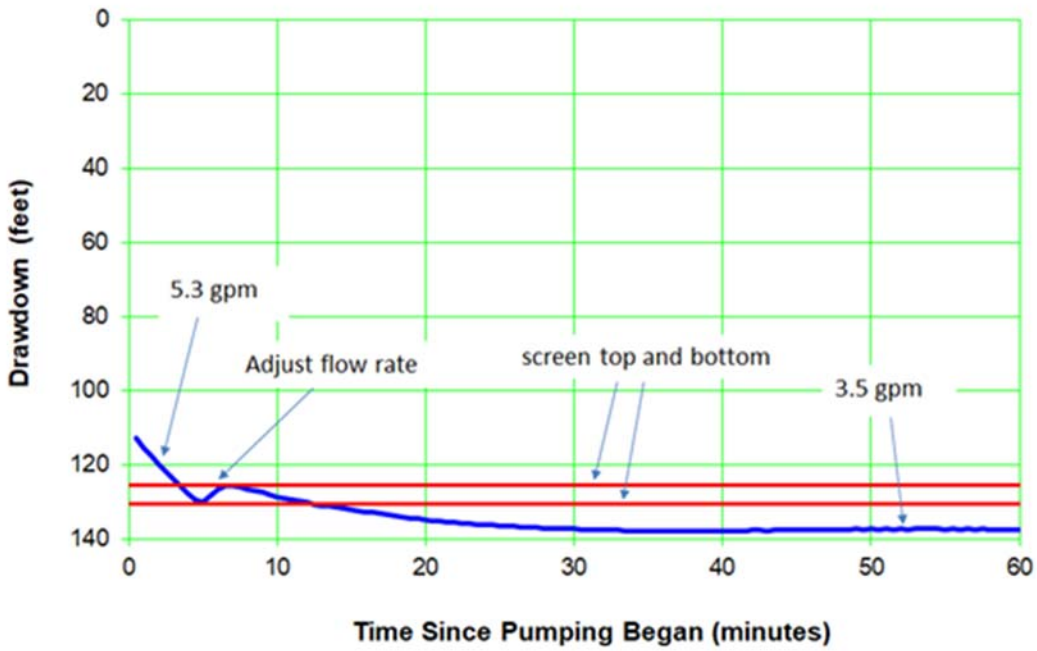


Figure A-2.0-3 Well R-5 screen 4 initial pumping test response

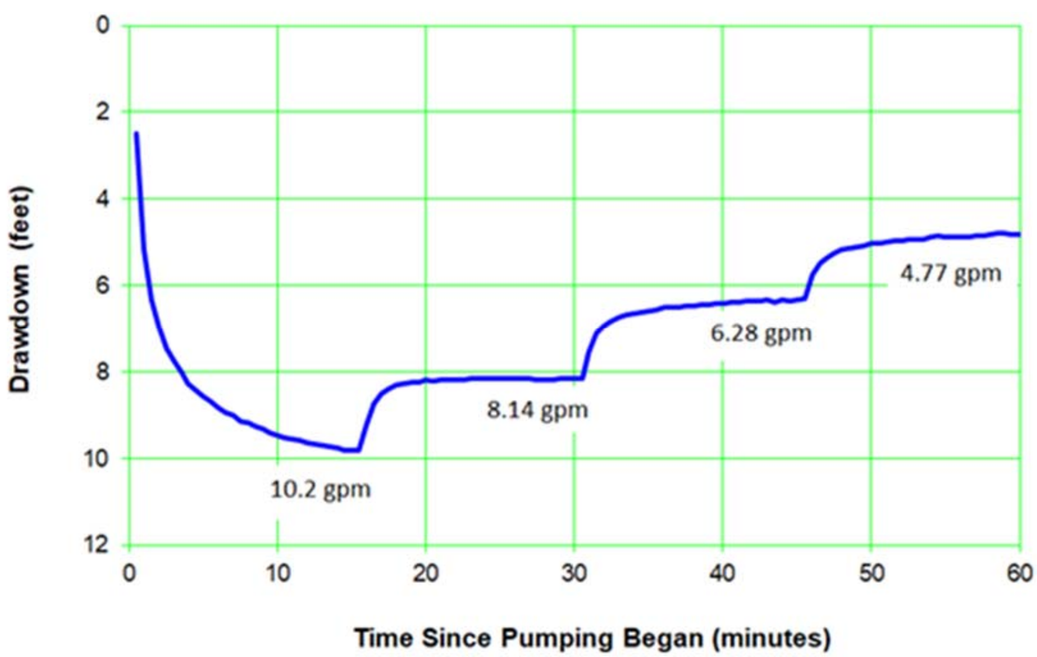


Figure A-3.0-1 Well R-7 screen 3 initial step-drawdown test response

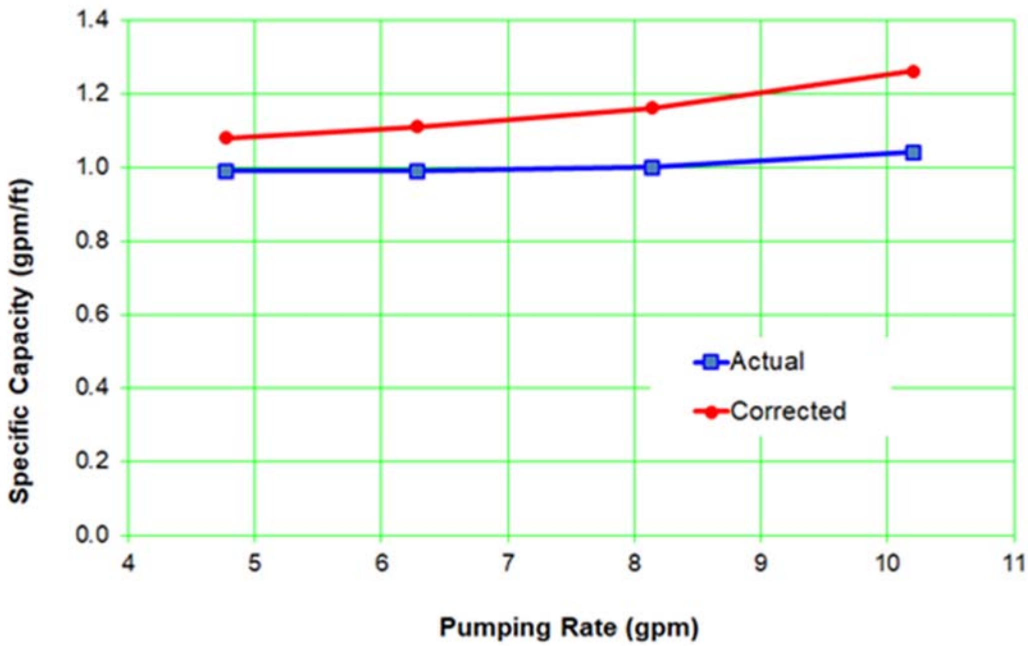


Figure A-3.0-2 Well R-7 screen 3 actual and corrected specific capacities

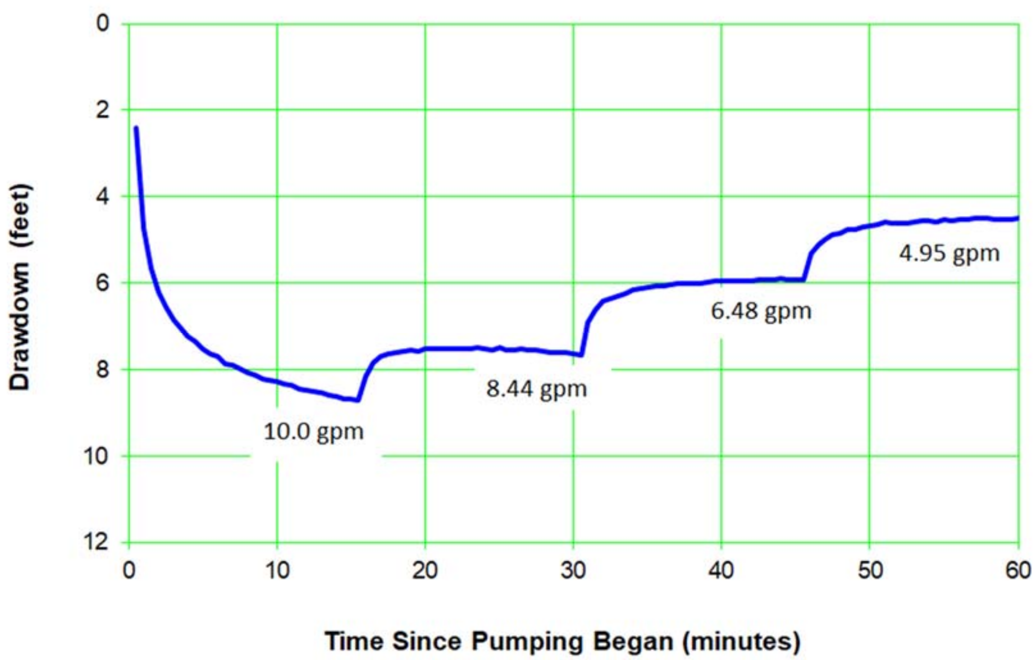


Figure A-3.1-1 Well R-7 screen 3 step-drawdown test response after jetting

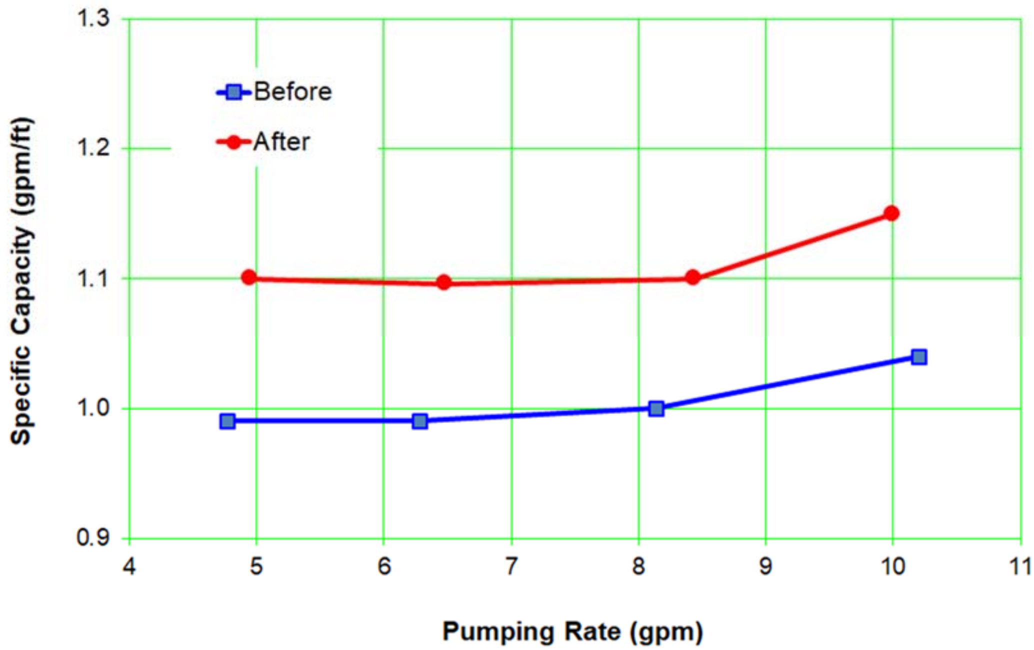


Figure A-3.1-2 Well R-7 screen 3 specific capacities before and after jetting

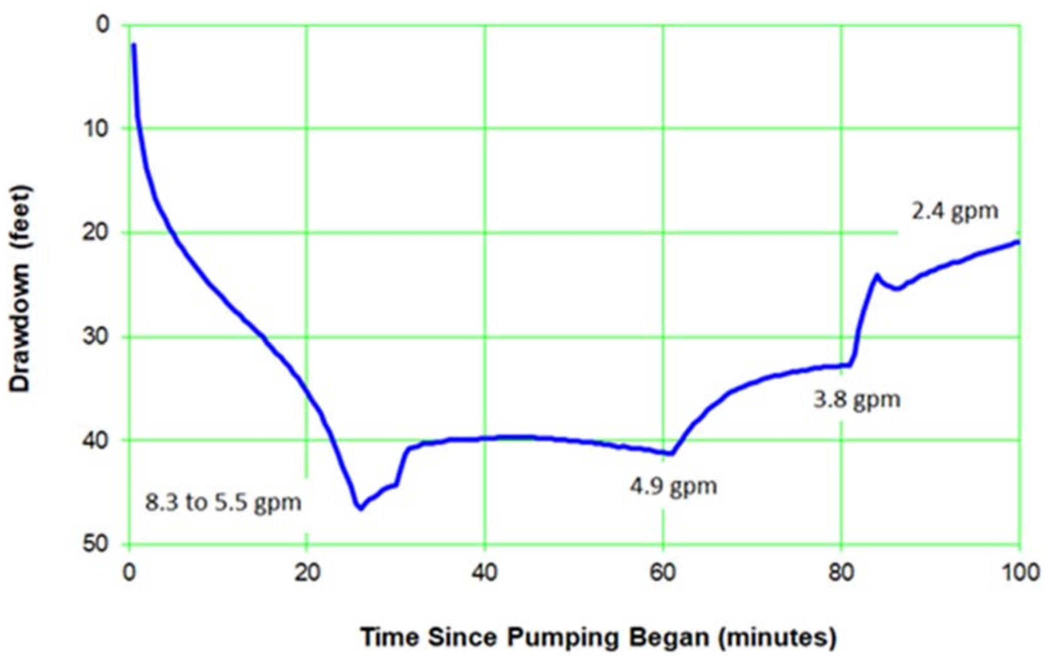


Figure A-4.0-1 Well R-8 screen 1 initial step-drawdown test response

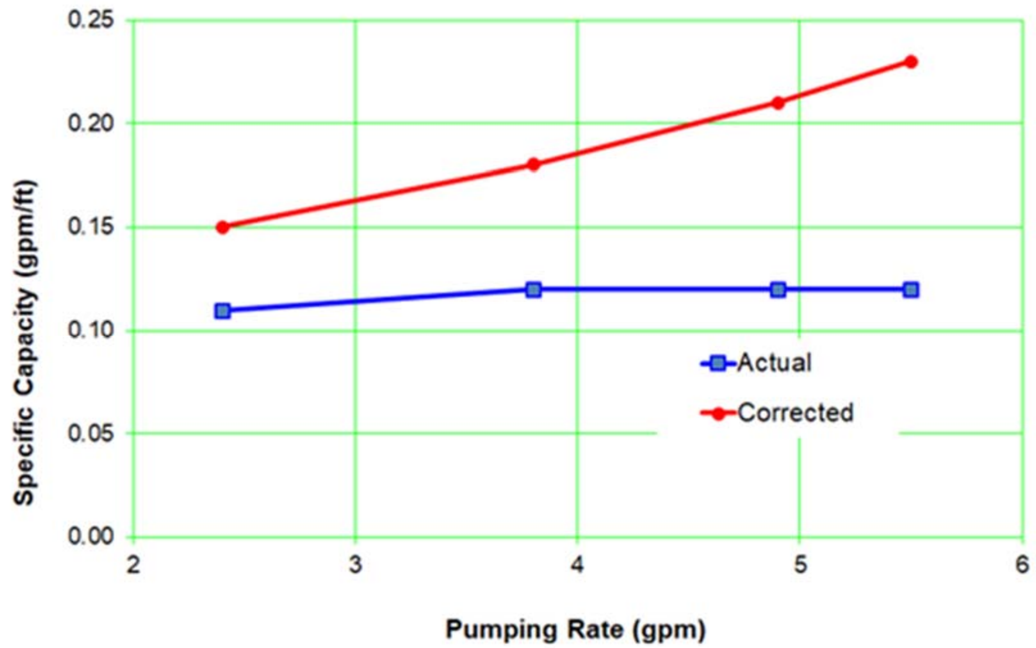


Figure A-4.0-2 Well R-8 screen 1 actual and corrected specific capacities

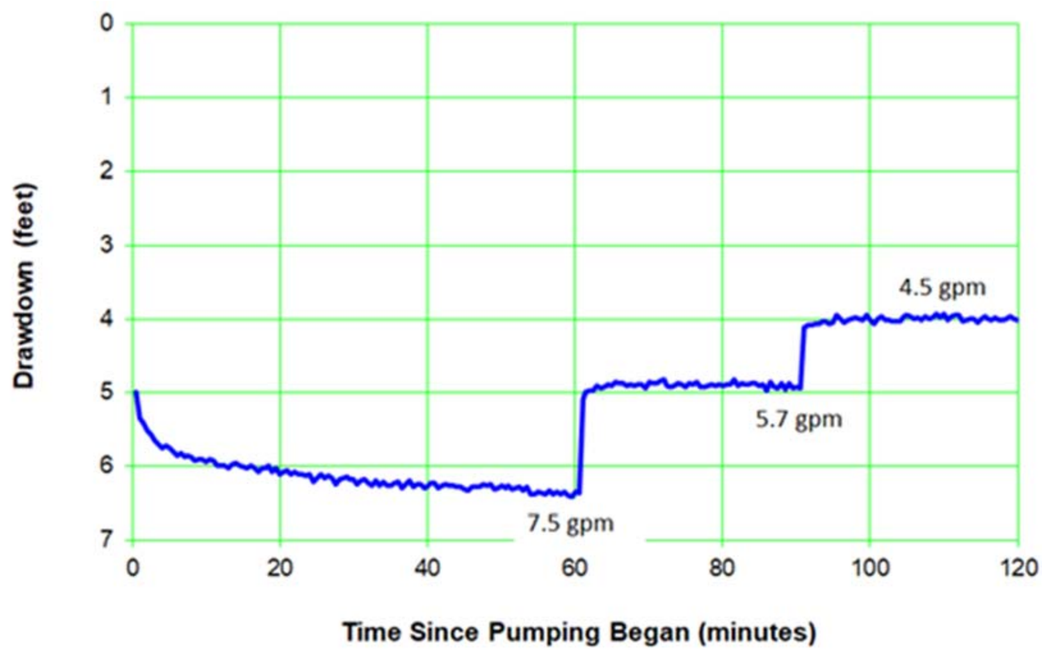


Figure A-4.0-3 Well R-8 screen 2 initial step-drawdown test response

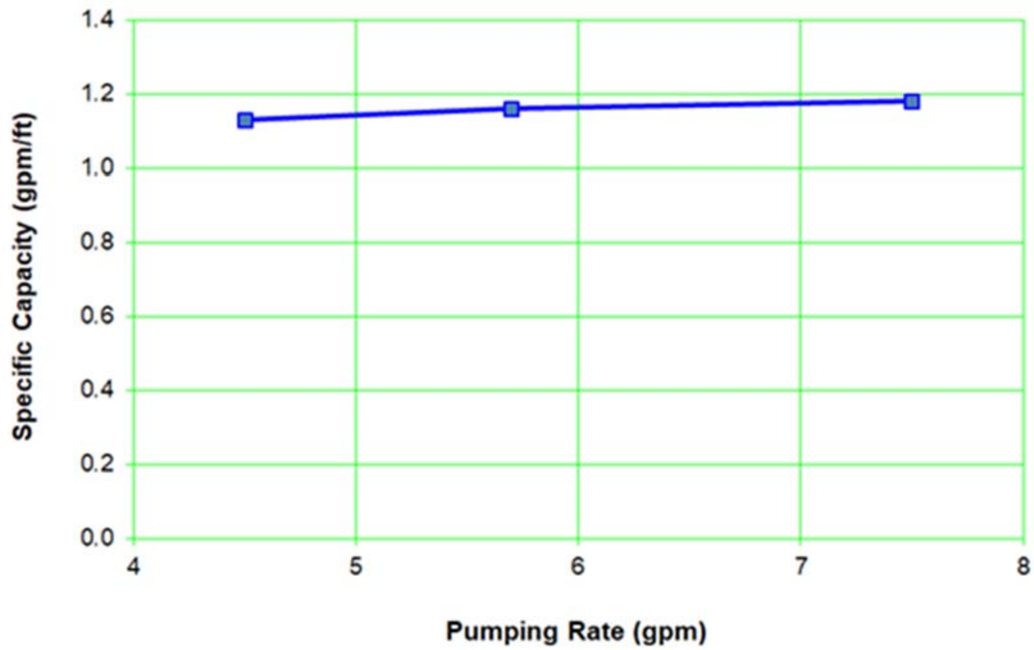


Figure A-4.0-4 Well R-8 screen 2 specific capacities

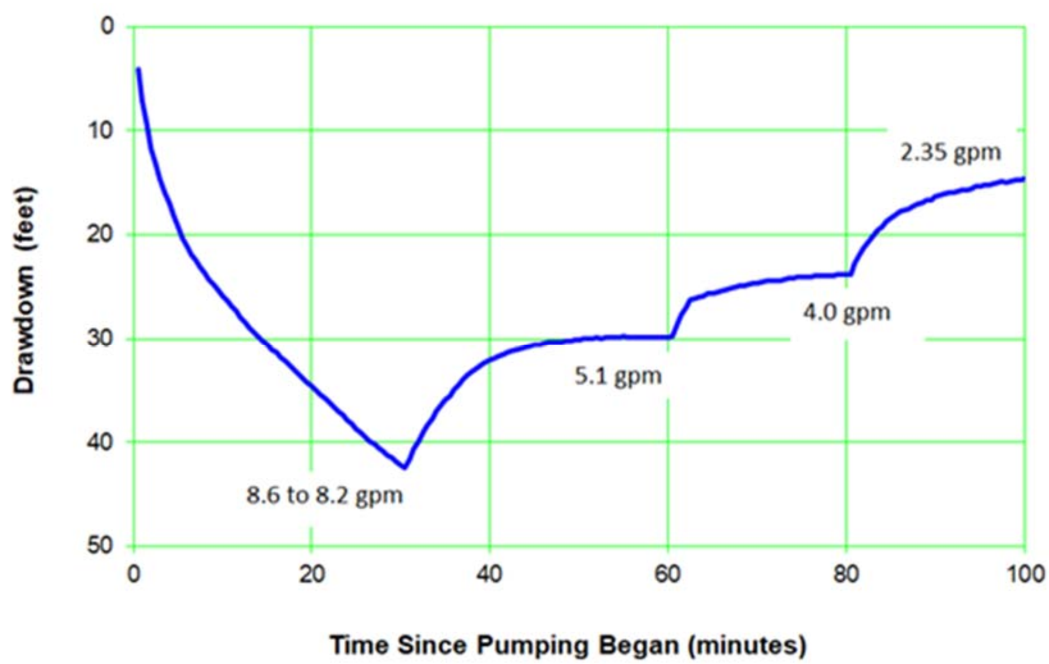


Figure A-4.1-1 Well R-8 screen 1 step-drawdown test response after jetting

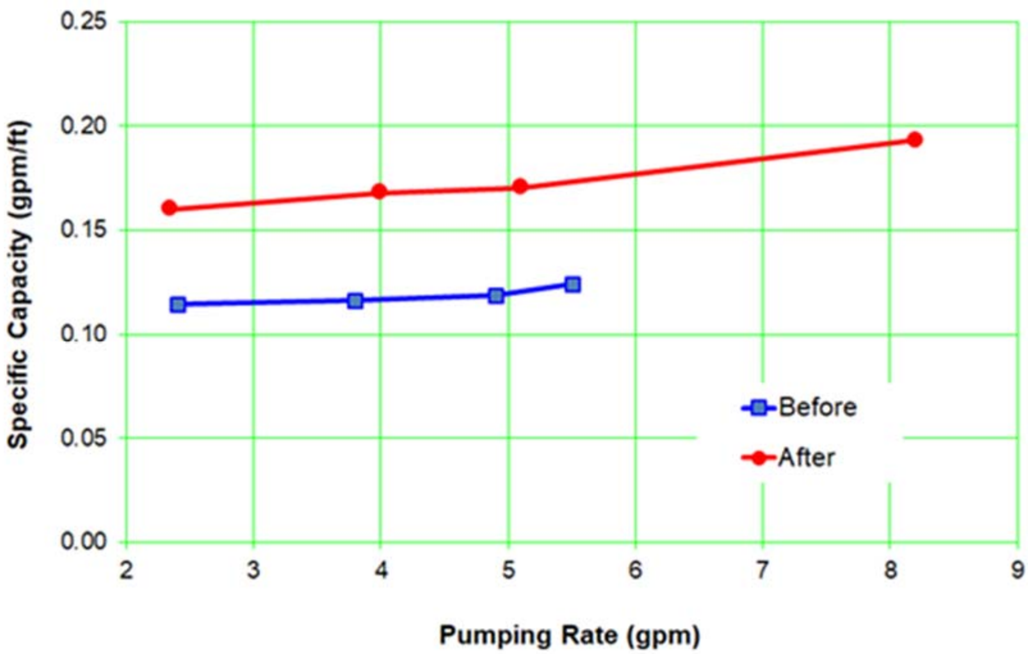


Figure A-4.1-2 Well R-8 screen 1 specific capacities before and after jetting

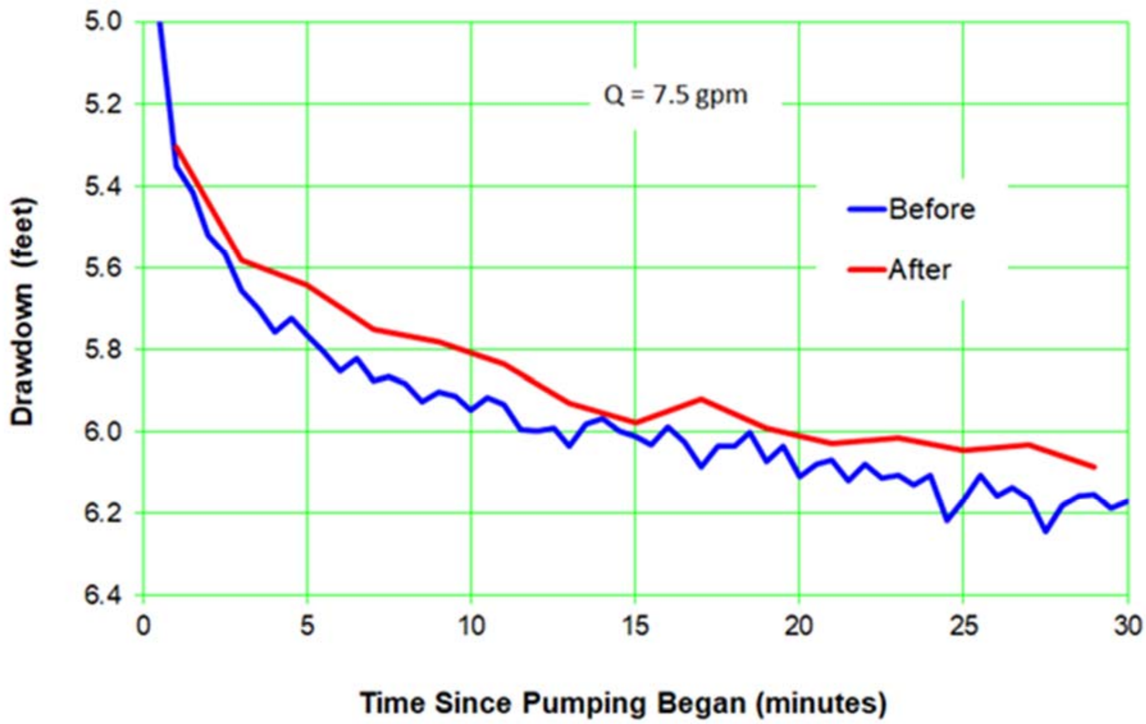


Figure A-4.1-3 Well R-8 screen 2 drawdown before and after jetting

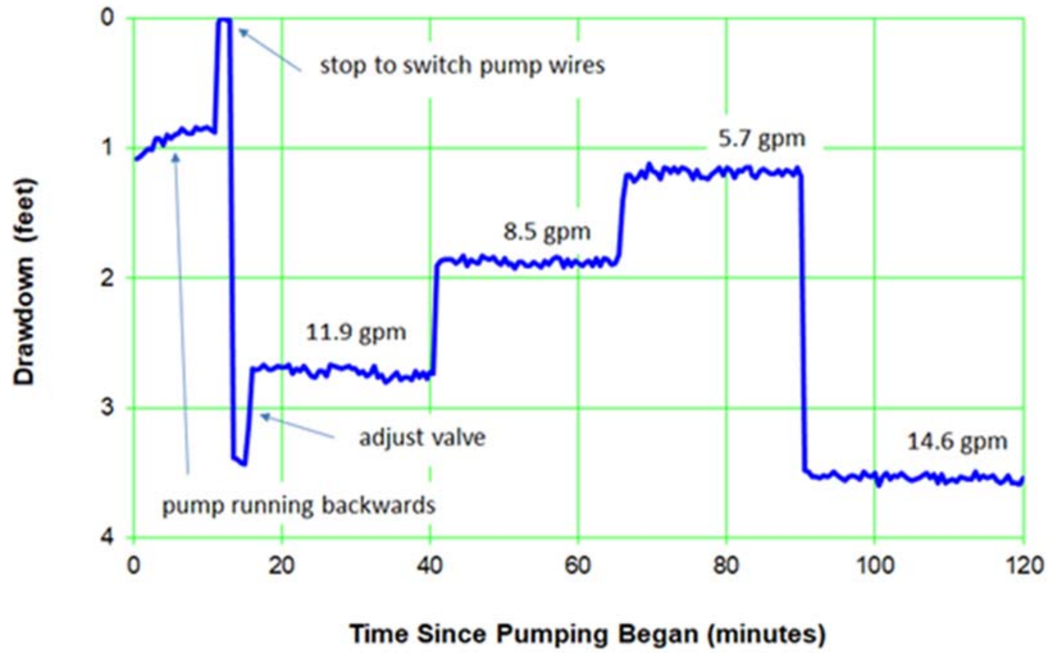


Figure A-5.0-1 Well R-9i screen 1 step-drawdown test response

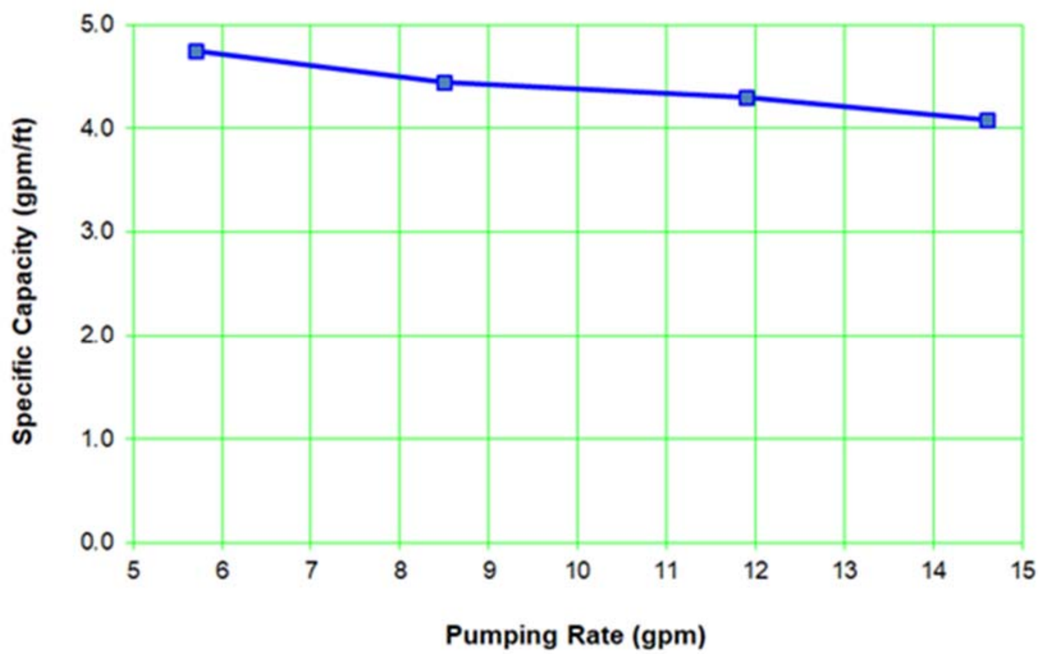


Figure A-5.0-2 Well R-9i screen 1 specific capacities

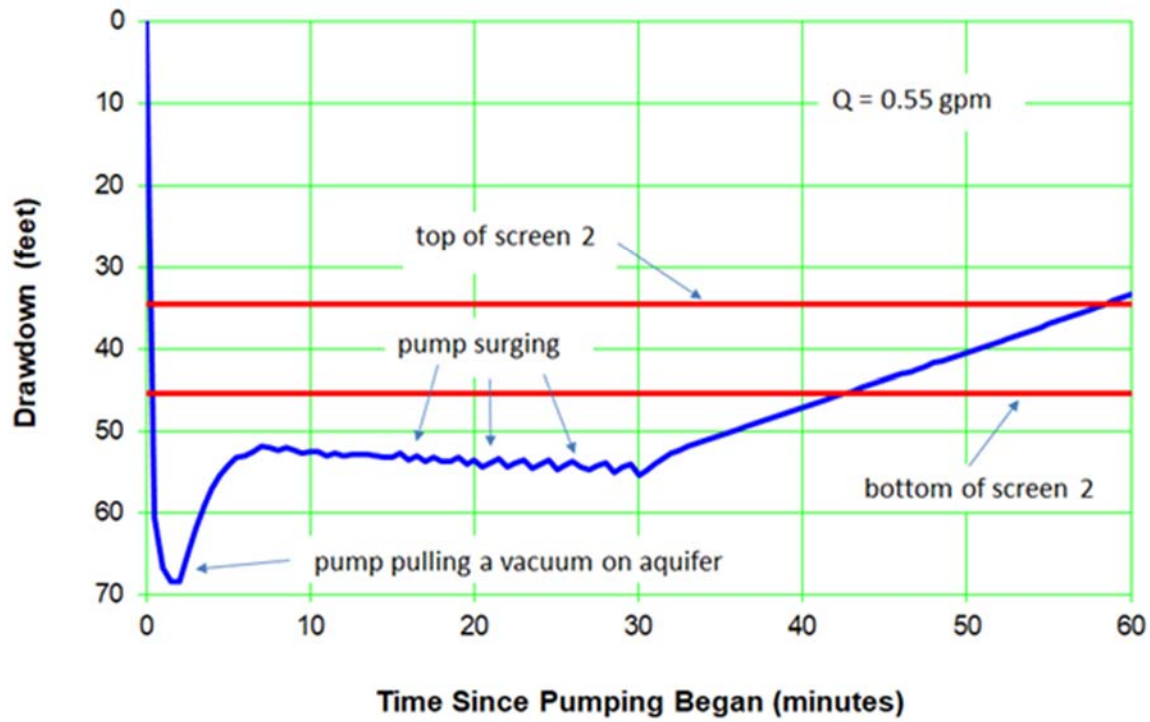


Figure A-5.0-3 Well R-9i screen 2 initial pumping test response

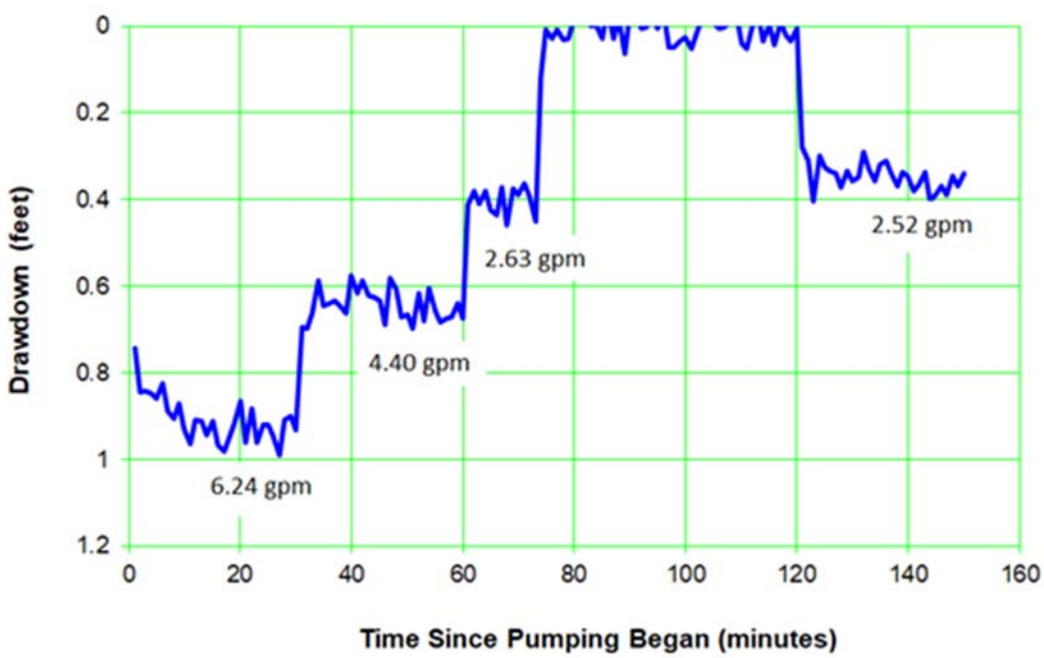


Figure A-6.0-1 Well R-19 screen 3 initial step-drawdown test response (screens 3 through 7 open)

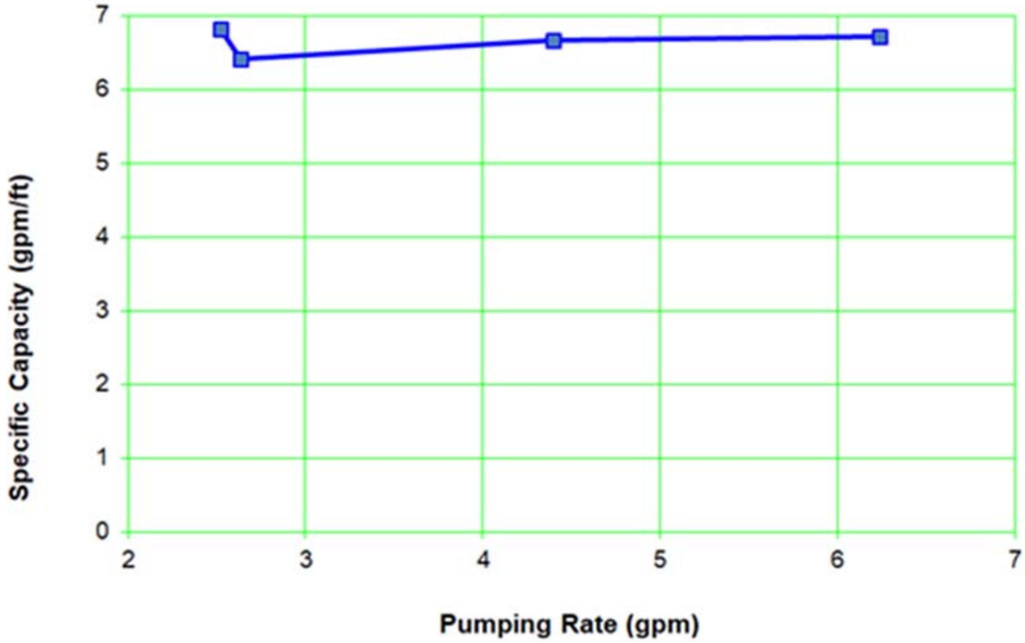


Figure A-6.0-2 Well R-19 screen 3 specific capacities (screens 3 through 7 open)

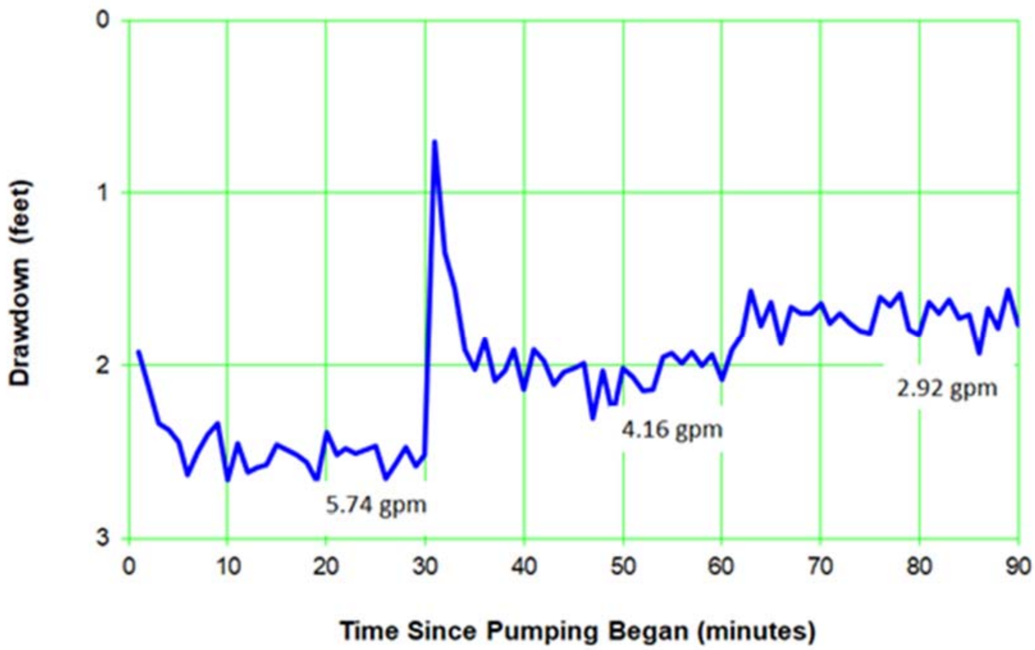


Figure A-6.0-3 Well R-19 screen 4 initial step-drawdown test response

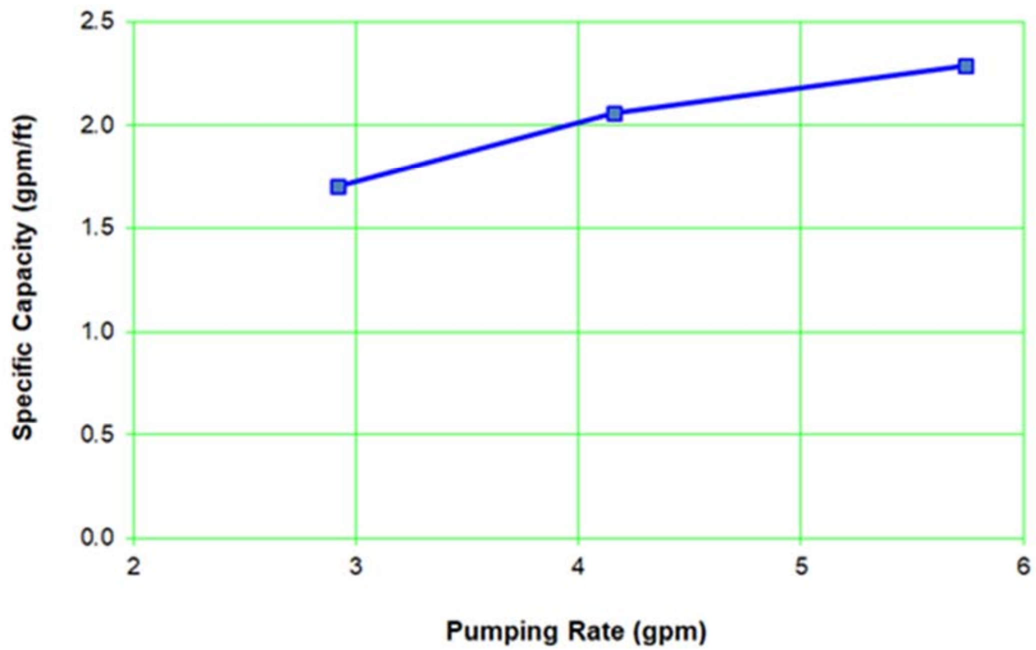


Figure A-6.0-4 Well R-19 screen 4 specific capacities

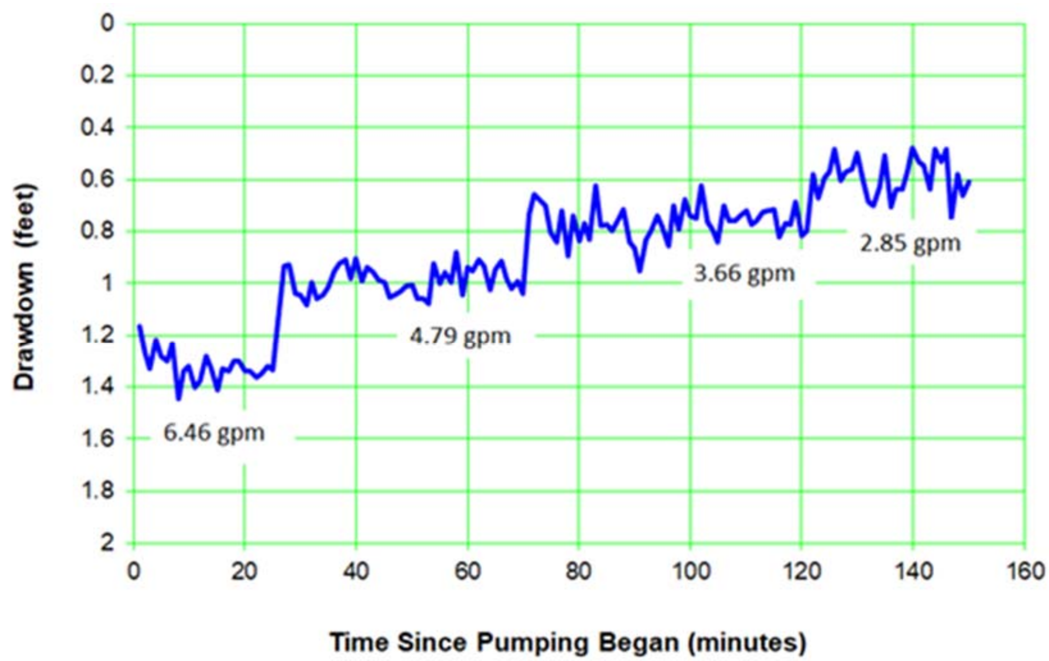


Figure A-6.1-1 Well R-19 screen 3 step drawdown test response after jetting

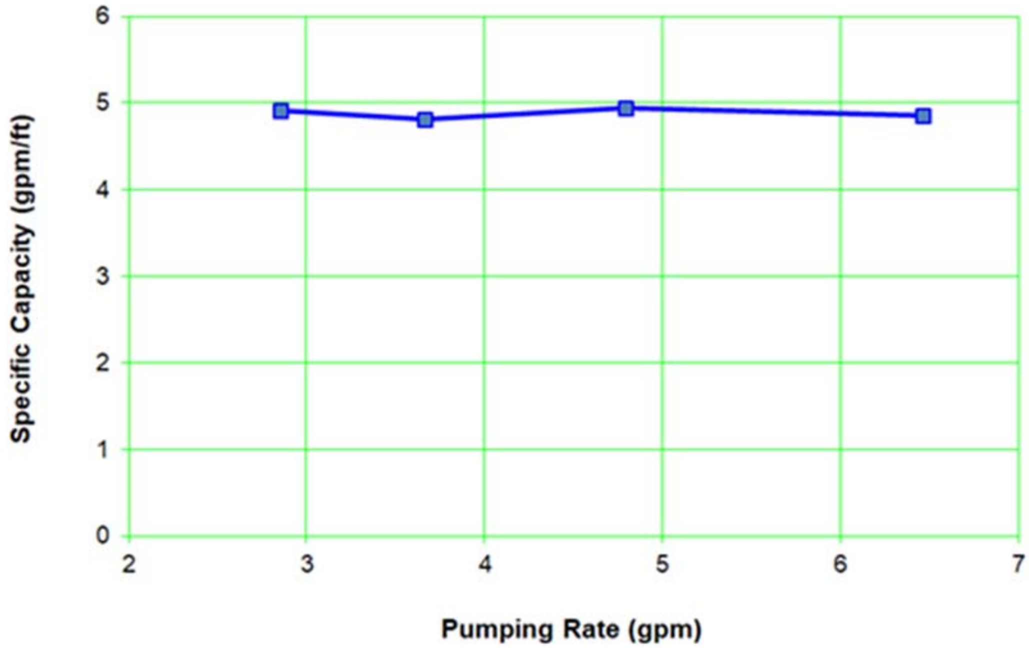


Figure A-6.1-2 Well R-19 screen 3 specific capacities after jetting

Table A-2.0-1
Well R-5 Screen 4 Cross-Flow Times

Date and Time of Deflate Packer	Date and Time of Inflate Packer	Time (min)
5/17/2019 10:55	5/22/19 11:30	7235
6/26/2019 17:00	6/26/19 17:30	30
6/27/2019 6:55	6/30/19 11:07	4572
6/30/2019 13:30	6/30/19 14:40	70
7/1/2019 7:02	7/1/19 8:48	106
7/1/2019 13:11	7/1/19 18:20	309

Table A-3.0-1
Well R-7 Screen 3 Actual and Corrected Specific Capacities

Q (gpm)	s (ft)	Q/s (gpm/ft)	s_c (ft)	Q/s_c (gpm/ft)
10.2	9.82	1.04	8.12	1.26
8.14	8.17	1.00	6.99	1.16
6.28	6.35	0.99	5.64	1.11
4.77	4.82	0.99	4.41	1.08

Table A-3.1-1
Well R-7 Screen 3 Post-Jetting Specific Capacities

Q (gpm)	S (ft)	Q/s (gpm/ft)
10	8.70	1.15
8.44	7.66	1.10
6.48	5.91	1.10
4.95	4.50	1.10

Table A-4.0-1
Well R-8 Screen 1 Actual and Corrected Specific Capacities

Q (gpm)	S (ft)	Q/s (gpm/ft)	s_c (ft)	Q/s_c (gpm/ft)
5.5	44.3	0.12	23.7	0.23
4.9	41.3	0.12	23.4	0.21
3.8	32.7	0.12	21.5	0.18
2.4	20.9	0.11	16.3	0.15

Table A-4.0-2
Well R-8 Screen 2 Specific Capacities

Q (gpm)	S (ft)	Q/s (gpm/ft)
7.5	6.35	1.18
5.7	4.92	1.16
4.5	3.99	1.13

Table A-4.0-3
Well R-8 Screen 2 Cross-Flow Times

Date and Time of Deflate Packer	Date and Time of Inflate Packer	Time (min)
5/21/2019 18:30	5/25/19 15:40	5590
6/11/2019 13:45	6/11/19 16:20	155
6/27/2019 15:40	7/3/19 18:55	8835
7/4/2019 7:02	7/4/19 13:00	358
7/4/2019 16:30	7/4/19 17:30	60
7/5/2019 9:30	7/8/19 18:45	4875
7/14/2019 7:00	7/14/19 17:04	604
7/18/2019 7:00	7/18/19 17:35	635

Table A-4.1-1
Well R-8 Screen 1 Post-Jetting Specific Capacities

Q (gpm)	S (ft)	Q/s (gpm/ft)
8.2	42.5	0.19
5.1	29.9	0.17
4.0	23.8	0.17
2.35	14.7	0.16

Table A-5.0-1
Well R-9i Screen 1 Specific Capacities

Q (gpm)	S (ft)	Q/s (gpm/ft)
11.9	2.77	4.30
8.5	1.91	4.45
5.7	1.20	4.75
14.6	3.58	4.08

Table A-5.0-2
Well R-9i Screen 2 Cross-Flow Times

Date and Time of Deflate Packer	Date and Time of Inflate Packer	Time (min)
5/23/2019 14:15	5/26/19 12:30	4215
6/12/2019 10:30	6/15/19 10:37	4327
6/15/2019 15:00	6/15/19 16:00	60

Table A-6.0-1
Well R-19 Screen 3 Specific Capacities (Screens 3 Through 7 Open)

Q (gpm)	S (ft)	Q/s (gpm/ft)
6.24	0.93	6.71
4.40	0.66	6.67
2.63	0.41	6.41
2.52	0.37	6.81

Table A-6.0-2
Well R-19 Screen 4 Specific Capacities

Q (gpm)	S (ft)	Q/s (gpm/ft)
5.74	2.51	2.29
4.16	2.02	2.06
2.92	1.72	1.70

Table A-6.0-3
Well R-19 Cross-Flow Times

Date and Time of Deflate Packer	Date and Time of Inflate Packer	Time (min)
6/5/2019 10:45	6/8/19 13:40	4495
6/20/2019 10:30	6/20/19 15:00	270
7/20/2019 8:30	7/26/19 16:10	9100
7/27/2019 10:20	7/27/19 11:21	61
7/27/2019 15:00	7/28/19 10:09	1149

Table A-6.1-1
Well R-19 Screen 3 Post-Jetting Specific Capacities

Q (gpm)	S (ft)	Q/s (gpm/ft)
6.46	1.33	4.9
4.79	0.97	4.9
3.66	0.76	4.8
2.85	0.58	4.9

Appendix B

Groundwater Field Parameters and Analytical Results

B-1.0 INTRODUCTION

This appendix presents the field parameter and laboratory analytical results for samples collected during the final purge and sample event before abandonment of screens and at the end of aquifer testing at retained screens in monitoring wells R-5, R-7, R-8, R-9i, and R-19.

B-1.1 Field Parameter Measurements

Groundwater field parameter measurements were collected during each constant-rate pumping test for all retained screens and during the purge and sample event at the abandoned screens. Before sample collection, field parameters were collected until they had stabilized at which point sample collection began. Field parameters included temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), specific conductance, and turbidity. The time of sample collection and discharge rate were also recorded for each sample.

Table B-1.1-1 lists the field parameters recorded for the purge and sample events. Tables B-1.1-2 through B-1.1-8 list the field parameters measured during the constant-rate pumping tests.

B-1.2 Sample Collection

A groundwater sample was collected from monitoring well R-5 screen 2 at the end of the 24-hr pumping test. The sample was analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), anions and metals, alkalinity, total cyanide, gross alpha, gross beta, tritium, perchlorate, sulfate, total dissolved solids (TDS), total organic carbon (TOC), tritium, and total phosphate (TP). .

Table B-1.2-1 lists the analytical results for this sample.

A groundwater sample was collected from monitoring well R-5 screen 4 following purging and before plugging and abandonment. The sample was analyzed for tritium, anions and metals, alkalinity, total cyanide, gross alpha, gross beta, tritium, perchlorate, sulfate, VOCs, SVOCs, TDS, TOC, and TP.

Table B-1.2-2 lists the analytical results for this sample.

A groundwater sample was collected from monitoring well R-7 screen 3 at the end of the 24-hr pumping test. The sample was analyzed for tritium, anions and metals, alkalinity, total cyanide, gross alpha, gross beta, tritium, perchlorate, sulfate, VOCs, SVOCs, TDS, TOC, and TP.

Table B-1.2-3 lists the analytical results for these two samples.

One groundwater sample was collected from monitoring well R-8 screen 1 and one from screen 2 at the end of the screens' respective 24-hr pumping tests. Both samples were analyzed for anions and metals, alkalinity, total cyanide, gross alpha, gross beta, tritium, perchlorate, sulfate, VOCs, SVOCs, TDS, TOC, and TP.

Table B-1.2-4 lists the analytical results for these two samples.

One groundwater sample was collected from monitoring well R-9i screen 1 after the 24-hr pumping test and one from screen 2 following the purge of the drop pipe. Both samples were analyzed for anions and metals, alkalinity, total cyanide, gross alpha, gross beta, tritium, perchlorate, sulfate, VOCs, SVOCs, TDS, TOC, TP, and tritium.

Table B-1.2-5 lists the analytical results for these three samples.

One groundwater sample was collected from R-19 screen 2 following multiple pumping cycles conducted the day before. One groundwater sample was collected from monitoring well R-19 screen 3 at the end of the screens' 12-hr pumping test. One groundwater sample was collected from screen 4 after purging until field parameters were stable All three samples were analyzed for anions and metals, alkalinity, total cyanide, gross alpha, gross beta, tritium, HE, perchlorate, sulfate, VOCs, SVOCs, TDS, TOC, and TP.

Table B-1.2-6 lists the analytical results for these three samples.

B-2.0 FIELD PARAMETER AND LABORATORY ANALYTICAL RESULTS

This section presents field parameters that were measured before sample collection, as well as the concentrations for all analytes that were reported at or above their detection limits. These analytes include general chemistry, VOCs and SVOCs; anions and metals; perchlorate; and radionuclides (gross alpha, gross beta, and tritium).

B-2.1 Field Parameter Measurement Results

Field parameter measurements for monitoring well R-5 screen 2 were 19.1°C for temperature, 7.98 for pH, 238.5 mV for ORP, 275.7 µC/cm for specific conductance, 7.22 mg/L for DO, and 0.85 nephelometric turbidity units (NTU) for turbidity. Table B-1.1-2 lists the real-time field parameter measurements recorded during the aquifer test of R-5 screen 2. Field parameter measurements for R-5 screen 4 were 19.9°C for temperature, 7.97 for pH, 181.7 mV for ORP, 274.0 µC/cm for specific conductance, 5.80 mg/L for DO, and 2.47 NTU for turbidity.

Field parameter measurements for monitoring well R-7 screen 3 were 16.53°C for temperature, 7.71 for pH, 291.1 mV for ORP, 140.0 µC/cm for specific conductance, 7.33 mg/L for DO, and 163.6 NTU for turbidity. Table B-1.1-3 lists the real-time field parameter measurements recorded during the aquifer test of R-7 screen 3.

Field parameter measurements for monitoring well R-8 screen 1 were 22.7°C for temperature, 8.3 for pH, 237.2 mV for ORP, 162.1 µC/cm for specific conductance, 7.92 mg/L for DO, and 341.25 NTU for turbidity. Field parameter measurements for R-8 screen 2 were 21.3°C for temperature, 8.37 for pH, 230.1 mV for ORP, 163.3 µC/cm for specific conductance, 7.19 mg/L for DO, and 54.96 NTU for turbidity. Table B-1.1-4 lists the real-time field parameter measurements recorded during the aquifer test of R-8 screen 1, and Table B-1.1-5 lists the real-time field parameter measurements recorded during the aquifer test of R-8 screen 2.

Field parameter measurements for monitoring well R-9i screen 1 were 11.95°C for temperature, 7.76 for pH, 293.2 mV for ORP, 365.3 µC/cm for specific conductance, 7.76 mg/L for DO, and 38.39 NTU for turbidity. Field parameter measurements for R-9i screen 2 were 21.49°C for temperature, 7.58 for pH, 254.2 mV for ORP, 342.7 µC/cm for specific conductance, 6.46 mg/L for DO, and 62.42 NTU for turbidity. Table B-1.1-6 lists the real-time field parameter measurements recorded during the aquifer test of R-9i screen 1.

Field parameter measurements for monitoring well R-19 screen 2 were 15.8°C for temperature, 7.42 for pH, 124.9 mV for ORP, 148.4 µC/cm for specific conductance, 7.71 mg/L for DO, and 5.2 NTU for turbidity. Field parameter measurements for R-19 screen 3 were 21.3°C for temperature, 8.33 for pH, 146.4 mV for ORP, 128.2 µC/cm for specific conductance, 5.94 mg/L for DO, and 90.0 NTU for turbidity. Field parameter measurements for R-19 screen 4 were 14.6°C for temperature, 7.63 for pH, 197.4 mV for ORP, 128.6 µC/cm for specific conductance, 8.41 mg/L for DO, and 1.37 NTU for turbidity. Table B-1.1-7 lists the real-time field parameter measurements recorded during the aquifer test of R-19 screen 2, and

Table B-1.1-8 lists the real-time field parameter measurements recorded during the aquifer test of R-19 screen 3.

B-2.2 General Chemistry and Anion Analytical Results

General chemistry results for monitoring well R-5 screen 2 included the following detections: 0.378 mg/L for TOC, 184.0 mg/L for TDS, 8.06 standard units (SU) for acidity/alkalinity, 100 mg/L for alkalinity as CO_3–HCO_3, 2.79 mg/L for nitrate-nitrite as nitrogen, and 10.5 mg/L for sulfate. Results for field duplicates collected alongside the regular samples are available in Intellus, New Mexico.

General chemistry results for monitoring well R-5 screen 4 included the following detections: 0.452 mg/L for TOC, 211.0 mg/L for TDS, 7.97 SU for acidity/alkalinity, 103.0 mg/L for alkalinity as CO_3–HCO_3, 2.67 mg/L for nitrate-nitrite as nitrogen, and 9.44 mg/L for sulfate.

General chemistry results for monitoring well R-7 screen 3 included the following detections: 0.381 mg/L for TOC, 117.0 mg/L for TDS, 7.76 SU for acidity/alkalinity, 64.4 mg/L for alkalinity as CO_3–HCO_3, 0.127 mg/L for nitrate-nitrite as nitrogen, 1.63 mg/L for sulfate, and 0.103 mg/L for total Kjeldahl nitrogen (TKN).

General chemistry results from screens 1 and 2 in monitoring well R-8 included the following detections: 95.7 to 97.1 mg/L for TDS, 8.39 SU for acidity/alkalinity, 77.3 to 77.9 mg/L for alkalinity as CO_3–HCO_3, 0.537 mg/L for nitrate-nitrite as nitrogen, 2.86 to 2.91 mg/L for sulfate, and 0.0756 to 0.06 mg/L for TP.

General chemistry results from screens 1 and 2 in monitoring well R-9i included the following detections: 2.34 to 32.9 mg/L for TOC, 2.43 to 32.9 mg/L for TDS, 7.53 to 7.8 SU for acidity/alkalinity, 63.4 to 66.8 mg/L for alkalinity as CO_3–HCO_3, 0.297 to 0.202 mg/L for nitrate-nitrite as nitrogen, 13.4 to 14.0 mg/L for sulfate, and 0.0218 to 0.0914 mg/L for TP.

General chemistry results from screens 2, 3, and 4 in monitoring well R-19 included the following detections: 0.498 mg/L for TOC, 117.0 to 213.0 mg/L for TDS, 7.75 to 8.31 SU for acidity/alkalinity, 64.2 to 71.9 mg/L for alkalinity as CO_3–HCO_3, 0.268 to 2.16 mg/L for nitrate-nitrite as nitrogen, 1.88 to 14.0 mg/L for sulfate, 0.0654 to 0.131 mg/L for TKN, and 0.114 to 0.158 mg/L for TP.

B-2.3 VOC and SVOC Analytical Results

VOC and SVOC results for samples from monitoring well R-5 screen 2 included the following detections: 5.41 for acetone and 6.59 to 6.69 µg/L for toluene.

VOC and SVOC results for samples from monitoring well R-5 screen 4 included the following detections: 13.9 µg/L for toluene and 2.96 µg/L for bis(2-ethylhexyl)phthalate.

There were no VOC or SVOC detections from monitoring well R-7 screen 3.

VOC results for samples from monitoring well R-8 screens 1 and 2 included the following detections: 3.54 to 10.9 µg/L for toluene. There were no SVOC detections from R-8 screens 1 and 3.

VOC and SVOC results for samples from monitoring well R-9i screens 1 and 2 included the following detections: 6.93 µg/L for 2-butanone; 1.12 to 529.0 µg/L for toluene; 0.54 µg/L for 1,3-xylene + 1,4-xylene; 3.64.0 µg/L for bis(2-ethylhexyl)phthalate; 0.34 µg/L for di-n-butylphthalate; 5.64 µg/L for 2-methylphenol; 4.76 µg/L for 3-,4-methylphenol; and 6.7 µg/L for phenol.

VOC and SVOC results for samples from monitoring well R-19 screens 2, 3, and 4 included the following detections: 2.31 µg/L for acetone, 1.38 µg/L for methylene chloride, 4.25 µg/L for toluene, and 0.61 µg/L for bis(2-ethylhexyl)phthalate.

B-2.4 Cation Analytical Results

Cation results for samples from monitoring well R-5 screen 2 included the following detections: 3.6 to 3.8 µg/L for arsenic, 203 to 209 µg/L for barium, 28.2 to 28.3 µg/L for boron, 33.3 to 34.3 mg/L for calcium, 3.98 µg/L for chromium, 3.42 µg/L for copper, 3.28 to 3.68 mg/L for magnesium, 1.97 to 2.03 µg/L for molybdenum, 4.27 to 4.54 mg/L for potassium, 53.2 to 54.9 mg/L for silicon dioxide (dissolved silica), 15.1 to 15.5 mg/L for sodium, 332 to 342 µg/L for strontium, 3.11 to 3.14 µg/L for uranium, and 7.52 to 7.69 µg/L for vanadium.

Cation results for samples from monitoring well R-5 screen 4 included the following detections: 6.58 µg/L for arsenic, 215.0 µg/L for barium, 31.5 µg/L for boron, 34.7 mg/L for calcium, 4.37 µg/L for chromium, 8.25 µg/L for copper, 3.36 mg/L for magnesium, 2.2 µg/L for molybdenum, 1.87 µg/L for nickel, 4.43 mg/L for potassium, 55.9 mg/L for silicon dioxide (dissolved silica), 16.5 mg/L for sodium, 336.0 µg/L for strontium, 2.55 µg/L for tin, 3.5 µg/L for uranium, 8.08 µg/L for vanadium, and 34.9 µg/L for zinc.

Cation results for samples from monitoring well R-7 screen 3 included the following detections: 27.8 µg/L for barium, 15.9 µg/L for boron, 10.7 mg/L for calcium, 4.18 mg/L for magnesium, 30.4 µg/L for manganese, 0.839 µg/L for molybdenum, 1.11 µg/L for nickel, 1.29 mg/L for potassium, 68.2 mg/L for silicon dioxide (dissolved silica), 9.45 mg/L for sodium, 47.0 µg/L for strontium, 28.9 µg/L for tin, 0.977 µg/L for uranium, 5.31 µg/L for vanadium, and 12.1 µg/L for zinc.

Cation results for samples from monitoring well R-8 screens 1 and 2 included the following detections: 4.11 µg/L for arsenic, 52.3 µg/L for barium, 24.8 µg/L for boron, 16.7 to 16.9 mg/L for calcium, 3.44 µg/L for chromium, 2.3 to 2.41 mg/L for magnesium, 1.48 to 1.55 µg/L for molybdenum, 2.26 to 2.27 mg/L for potassium, 43.4 to 50.7 mg/L for silicon dioxide (dissolved silica), 13.8 to 14.0 mg/L for sodium, 104.0 to 108.0 µg/L for strontium, 0.376 to 0.46 µg/L for uranium, and 16.9 to 17.6 µg/L for vanadium.

Cation results for samples from monitoring well R-9i screens 1 and 2 included the following detections: 2.15 to 2.61 µg/L for arsenic, 35.7 to 37.4 µg/L for barium, 20.5 to 25.5 µg/L for boron, 17.7 to 20.5 mg/L for calcium, 6.63 to 6.73 mg/L for magnesium, 32.6 µg/L for manganese, 8.29 to 8.44 µg/L for molybdenum, 4.41 to 4.74 mg/L for potassium, 34.6 to 35.5 mg/L for silicon dioxide (dissolved silica), 28.3 to 29.1 mg/L for sodium, 116.0 µg/L for strontium, 26.7 µg/L for tin, 0.384 to 0.613 µg/L for uranium, 1.29 to 1.42 µg/L for vanadium, and 444.0 µg/L for zinc.

Cation results for samples from monitoring well R-19 screens 2, 3, and 4 included the following detections: 20.3 to 23.9 µg/L for barium, 15.3 µg/L for boron, 12.2 to 14.6 mg/L for calcium, 3.32 µg/L for chromium, 2.66 to 3.03 mg/L for magnesium, 3.45 to 9.85 µg/L for manganese, 1.40 to 1.49 µg/L for molybdenum, 1.0 to 1.24 mg/L for potassium, 69.7 to 74.7 mg/L for silicon dioxide (dissolved silica), 10.9 to 14.2 mg/L for sodium, 51.5 to 56.6 µg/L for strontium, 0.228 to 0.395 µg/L for uranium, 1.54 to 3.99 µg/L for vanadium, and 44.4 to 48.9 µg/L for zinc.

B-2.5 Perchlorate Analytical Results

Perchlorate was detected in the sample from monitoring well R-5 screen 2 in both the sample and the field duplicate at concentrations of 2.6 and 2.65 µg/L, respectively.

Perchlorate was detected in the sample from monitoring well R-5 screen 4 at a concentration of 1.46 µg/L.

Perchlorate was detected in the sample from monitoring well R-7 screen 3 at a concentration of 0.298 µg/L.

Perchlorate was detected in the sample from monitoring well R-8 screens 1 and 2 at concentrations of 0.3 and 0.347 µg/L, respectively.

Perchlorate was detected in the sample from monitoring well R-9i screens 1 and 2 at concentrations of 0.366 and 0.316 µg/L, respectively.

Perchlorate was detected in the sample from monitoring well R-19 screens 2, 3, and 4 at concentrations of 0.333, 0.225, and 0.265 µg/L, respectively

B-2.6 Radionuclide Analytical Results

Radionuclide results for samples from monitoring well R-5 screen 2 included a detection of 4.38 pCi/L for gross alpha and gross beta detections of 5.19 and 5.34 pCi/L. No tritium was detected in screen 2.

Radionuclide results for samples from monitoring well R-5 screen 4 included a detection of 7.34 pCi/L for gross beta. No tritium was detected in screen 4.

There were no radionuclide results above detection limits from samples collected from monitoring well R-7. No tritium was detected in screen 3.

Radionuclide results for samples from monitoring well R-8 screens 1 and 2 included the following detections: 3.44 and 4.22 pCi/L for gross beta, respectively. No tritium was detected in screens 1 and 2.

Radionuclide results for samples from monitoring well R-9i screen 1 were 13.5 pCi/L for gross beta and 37.588 pCi/L for tritium; for screen 2 they were 7.9 pCi/L for gross alpha, 8.61 pCi/L for gross beta, and 38.577 pCi/L for tritium.

Radionuclide results for samples from monitoring well R-19 screen 2 included the following detections: 3.73 pCi/L for gross alpha and 3.53 pCi/L for gross beta. No tritium was detected in screens 2, 3, and 4.

Table B-1.1-1
Field Parameter Measurements During Purge and Sample Events

Location	Date	Time	Temp. (°C)	pH	ORP (mV)	DO (mg/L)	Spec. Cond. (µS/cm)	Turbidity (NTU)	Discharge Rate (gpm)[a]
R-5, S[b]4	7/2/2019	0810	19.8	7.76	201.2	6.68	270.7	38.2	3.2
R-5, S4	7/2/2019	0815	19.7	7.94	196.3	6.68	271.9	11.29	3.2
R-5, S4	7/2/2019	0820	19.7	7.97	191.9	6.67	271.8	6.26	3.2
R-5, S4	7/2/2019	0825	19.9	7.97	187.8	6.28	272.8	4.48	3.2
R-5, S4	7/2/2019	0830	20.0	7.95	182.2	5.77	272.9	5.21	3.2
R-5, S4	7/2/2019	0835	20.0	7.95	182.8	5.77	273.6	7.33	3.2
R-5, S4	7/2/2019	0840	19.9	7.97	181.7	5.80	274.0	2.47	3.2
R-9i, S2	6/16/2019	1128	21.49	7.58	254.2	6.46	342.7	62.42	0.26
R-19, S4	7/29/2019	0938	25.9	7.10	174.4	4.66	129.5	3.51	5.0
R-19, S4	7/29/2019	0943	14.5	7.65	195.5	7.81	125.4	0.71	5.5
R-19, S4	7/29/2019	0948	13.2	7.50	208.9	8.23	124.0	0.73	5.3
R-19, S4	7/29/2019	0953	14.6	7.65	199.1	8.18	124.9	0.49	5.1
R-19, S4	7/29/2019	0958	14.6	7.63	197.4	8.41	128.6	1.37	4.4

[a] gpm = Gallons per minute.

[b] S = Screen.

Table B-1.1-2
R-5 Screen 2 Aquifer Test Field Parameter Data

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	Discharge Rate (gpm)	HACH (turbidimeter reading, NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
9/10/2019	8:00	Pump on	—[a]	—	—	—	—	—	—	0	0
	8:30	ND[b]	ND	ND	ND	ND	ND	2.66	1.02	79.8	80
	9:00	8.02	19.60	254.50	6.55	98.10	159.9	2.63	1.21	78.9	159
	9:30	8.01	20.30	259.40	6.87	6.60	171.4	2.63	0.96	78.9	238
	10:00	8.00	20.60	260.60	6.81	5.90	177.5	2.62	1.15	78.6	316
	10:30	8.00	20.80	260.80	6.85	30.10	182.6	2.61	0.97	78.3	395
	11:00	8.00	21.20	260.70	7.16	22.50	188.8	2.61	1.13	78.3	473
	11:30	8.00	20.80	260.60	6.97	NA[c]	195.0	2.61	1.42	78.3	551
	12:00	8.00	20.70	261.10	6.99	40.60	197.1	2.61	1.33	78.3	629
	12:30	8.00	20.70	262.10	6.90	42.40	199.4	2.61	1.16	78.3	708
	13:00	7.99	21.60	262.60	6.75	91.80	201.3	2.61	1.49	78.3	786
	13:30	8.00	21.30	263.70	6.96	56.40	199.6	2.61	1.28	78.3	864
	14:00	8.00	21.50	266.20	6.84	67.30	199.6	2.61	1.33	78.3	943
	14:30	7.99	21.50	265.10	6.54	113.50	203.5	2.61	1.28	78.3	1021
	15:00	7.99	21.10	265.00	6.91	106.20	205.3	2.61	1.12	78.3	1099
	15:30	7.99	20.90	265.80	6.92	69.40	205.1	2.61	1.39	78.3	1178
	16:00	7.99	20.80	266.60	7.03	13.30	208.7	2.61	1.28	78.3	1256
	16:30	7.99	20.90	266.60	6.99	62.20	209.5	2.61	2.78	78.3	1334
	17:00	7.99	21.10	267.40	6.93	NA	208.1	2.61	NA	78.3	1412
	17:30	7.99	20.70	267.50	7.00	NA	207.7	2.61	1.19	78.3	1491
	18:00	7.99	20.50	268.40	7.10	108.00	206.0	2.61	1.01	78.3	1569
	18:30	8.00	20.30	269.20	7.17	NA	204.4	2.68	1.05	80.4	1649
	19:00	7.99	20.20	269.80	7.18	NA	203.2	2.55	0.97	76.5	1726
	19:30	7.99	20.00	270.00	7.25	NA	200.3	2.60	0.82	78.0	1804
	20:00	7.99	20.20	274.00	7.24	NA	206.0	2.58	1.10	77.4	1881

Table B-1.1-2 (continued)

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	Discharge Rate (gpm)	HACH (turbidimeter reading, NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
9/10/2019	20:30	7.99	20.10	271.00	7.25	NA	201.1	2.62	1.03	78.6	1960
	21:00	7.99	19.90	271.40	7.22	NA	200.1	2.60	1.21	78.0	2038
	21:30	7.99	19.80	271.60	7.24	NA	203.4	2.60	1.21	78.0	2116
	22:00	7.99	19.70	271.60	7.25	28.60	205.2	2.61	1.47	78.3	2194
	22:30	7.99	19.70	271.90	7.27	48.28	207.1	2.60	2.42	78.0	2272
	23:00	7.99	19.60	272.60	7.24	79.01	203.5	2.61	1.37	78.3	2351
	23:30	7.99	19.50	272.50	7.31	37.60	206.2	2.61	2.01	78.3	2429
9/11/2019	0:00	7.99	19.60	272.80	7.26	121.81	210.2	2.61	1.73	78.3	2507
	0:30	7.99	19.50	273.40	7.24	NA	213.9	2.60	2.00	78.0	2585
	1:00	7.99	19.50	273.40	7.24	66.89	216.8	2.61	1.79	78.3	2663
	1:30	7.99	19.40	273.80	7.25	114.91	217.6	2.60	1.72	78.0	2741
	2:00	7.99	19.40	273.80	7.32	48.66	218.2	2.63	1.34	78.9	2820
	2:30	7.99	19.40	274.20	7.27	82.61	218.6	2.63	1.58	78.9	2899
	3:00	7.99	19.30	274.50	7.27	118.20	222.2	2.58	1.54	77.4	2977
	3:30	7.99	19.30	274.90	7.27	1520.00	227.1	2.71	1.48	81.3	3058
	4:00	7.98	19.20	274.30	7.33	62.57	228.4	2.54	1.20	76.2	3134
	4:30	7.98	19.30	274.80	7.24	102.10	233.3	2.58	1.54	77.4	3212
	5:00	7.98	19.30	275.00	7.24	NA	237.6	2.68	1.31	80.4	3292
	5:30	7.98	19.30	275.00	7.26	NA	245.7	2.65	0.86	79.5	3371
	6:00	7.98	19.40	275.40	7.15	NA	242.0	2.64	1.19	79.2	3451
	6:30	7.98	19.10	275.70	7.22	NA	238.5	2.65	0.85	79.5	3530
	8:00	Pump off	—	—	—	—	—	2.65	—	238.5	3769

[a] — = Data not logged because the pump was turned off.

[b] ND = Not detected because of startup of YSI instrument logging inaccurate readings.

[c] NA = Not analyzed.

Table B-1.1-3
R-7 Screen 3 Aquifer Test Field Parameter Data

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
6/22/2019	8:00	Pump on	—[a]	—	—	—	—	—	—	0	0.0
	8:02	ND[b]	ND	ND	ND	ND	ND	No	7.10	14.2	14
	8:32	7.34	16.59	147.3	2.80	4.4	184.4	No	7.15	214.5	229
	9:02	7.45	18.09	142.3	6.00	4.6	206.6	No	7.17	215.1	444
	9:32	7.53	18.03	141.0	6.53	19.3	225.1	No	7.18	215.4	659
	10:02	7.55	18.12	140.2	6.73	26.0	236.5	No	7.18	215.4	875
	10:32	7.58	18.63	140.4	6.80	48.5	242.7	No	7.19	215.7	1090
	11:02	7.58	18.62	140.3	6.80	58.4	238.0	No	7.18	215.4	1306
	11:32	7.60	18.56	140.4	6.91	56.5	244.3	No	7.18	215.4	1521
	12:02	7.61	18.97	140.3	6.91	65.8	244.3	No	7.19	215.7	1737
	12:32	7.61	18.61	140.3	6.92	82.8	252.5	No	7.19	215.7	1953
	13:02	7.62	19.01	140.3	6.89	140.9	246.4	No	7.19	215.7	2168
	13:32	7.64	19.27	140.5	6.77	14.4	259.4	No	7.19	215.7	2384
	14:02	7.63	19.34	140.4	6.85	17.8	264.0	No	7.20	216.0	2600
	14:32	7.63	19.23	141.1	7.00	19.4	255.6	No	7.17	215.1	2815
	15:02	7.66	18.95	140.7	6.87	27.3	261.3	No	7.19	215.7	3031
	15:32	7.66	19.06	141.4	7.13	82.2	270.3	No	7.19	215.7	3246
	16:02	7.64	19.57	141.6	6.97	1.7	273.1	No	7.19	215.7	3462
	16:32	7.66	19.72	141.0	7.05	25.1	274.8	No	7.18	215.4	3678
	17:02	7.67	19.58	141.1	7.07	7.9	273.7	No	7.18	215.4	3893
	17:32	7.67	18.88	140.5	7.00	19.5	281.2	No	7.19	215.7	4109
	18:02	7.67	18.69	140.7	7.10	36.3	283.0	No	7.33	219.9	4329
	18:32	7.68	18.51	140.8	7.12	39.0	288.7	No	7.11	213.3	4542
	19:02	7.67	18.35	141.2	7.06	44.2	285.0	No	7.17	215.1	4757

Table B-1.1-3 (continued)

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
6/22/2019	19:32	7.67	18.23	140.6	7.11	63.6	280.8	No	7.13	213.9	4971
	20:02	7.68	18.15	140.2	7.07	79.5	285.0	No	7.20	216.0	5187
	20:32	7.68	18.05	140.6	7.09	50.1	287.6	No	7.19	215.7	5403
	21:02	7.68	17.94	140.6	7.11	61.9	291.0	No	7.19	215.7	5618
	21:32	7.69	17.45	140.3	7.21	65.2	291.4	No	7.26	217.8	5836
	22:02	7.69	17.58	140.5	7.08	89.9	292.3	No	7.21	216.3	6052
	22:32	7.69	17.58	140.4	7.17	106.4	292.3	No	7.25	217.5	6270
	23:02	7.69	17.49	140.4	7.21	36.4	292.9	No	7.00	210.0	6480
	23:32	7.69	17.40	140.4	7.13	11.4	292.3	No	7.20	216.0	6696
	0:02	7.69	17.29	140.2	7.14	13.8	293.5	No	7.14	214.2	6910
6/23/2019	0:32	7.69	17.16	140.1	7.21	18.3	293.8	No	7.19	215.7	7126
	1:02	7.69	17.11	140.6	7.32	22.6	295.9	No	7.13	213.9	7340
	1:32	7.69	17.07	140.2	7.17	14.0	295.2	No	7.24	217.2	7557
	2:02	7.69	17.05	140.1	7.18	43.2	297.7	No	7.16	214.8	7772
	2:32	7.70	17.01	140.5	7.21	49.0	295.5	No	7.27	218.1	7990
	3:02	7.70	17.06	140.3	7.14	60.5	295.2	No	7.10	213.0	8203
	3:32	7.70	17.01	140.3	7.20	67.3	296.7	No	7.16	214.8	8418
	4:02	7.70	16.87	140.0	7.22	5.9	297.7	No	7.18	215.4	8633
	4:32	7.70	16.71	139.8	7.25	18.9	298.1	No	7.19	215.7	8849
	5:02	7.71	16.73	140.4	7.18	38.5	280.5	No	7.16	214.8	9063
	5:32	7.70	16.62	140.1	7.22	76.2	288.2	No	7.21	216.3	9280
	6:02	7.71	16.48	140.0	7.20	98.7	290.4	No	7.18	215.4	9495
	6:32	7.71	16.53	139.7	7.25	133.6	292.5	No	7.18	215.4	9711
	7:02	7.71	16.53	140.0	7.33	163.6	291.1	No	7.17	215.1	9926
	8:00	Pump off	—	—	—	—	—	—	7.18	430.8	10,356

[a] — = Data not logged because the pump was turned off.

[b] ND = Not detected because of startup of YSI instrument logging inaccurate readings.

Table B-1.1-4
R-8 Screen 1 Aquifer Test Field Parameter Data

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
7/16/2019	8:00	Pump on	—[a]	—	—	—	—	—	—	0	0
	8:05	ND	ND[b]	ND	ND	ND	ND	No	3.2	16.0	16
	8:35	8.27	18.7	159.20	8.21	26.05	110.7	No	3.28	98.4	114
	9:05	8.33	21.9	158.70	8.00	48.58	138.5	No	3.32	99.6	214
	9:35	8.31	22.4	159.80	8.11	40.69	156.4	No	3.28	98.4	312
	10:05	8.31	22.7	160.10	8.14	71.05	164.9	No	3.27	98.1	411
	10:35	8.32	23.1	161.10	8.01	39.50	169.8	No	3.26	97.8	508
	11:05	8.31	23.4	162.40	8.05	47.78	175.8	No	3.26	97.8	606
	11:35	8.31	23.5	161.80	7.90	43.29	179.6	No	3.26	97.8	704
	12:05	8.31	23.6	161.60	8.02	46.61	183.7	No	3.25	97.5	801
	12:35	8.31	23.6	161.40	7.94	53.93	186.8	No	3.23	96.9	898
	13:04	8.31	23.8	161.60	7.98	61.04	190.8	No	3.24	97.2	996
	13:34	8.31	23.7	163.60	8.10	8.71	193.1	No	3.24	97.2	1093
	14:04	8.31	23.9	162.10	7.94	42.37	195.9	No	3.24	97.2	1190
	14:34	8.31	23.8	163.70	7.94	57.15	198.0	No	3.24	97.2	1287
	15:04	8.31	24.0	162.10	7.94	49.97	200.1	No	3.23	96.9	1384
	15:34	8.31	23.9	162.00	7.85	56.89	201.9	No	3.23	96.9	1481
	16:04	8.31	24.3	162.60	7.81	60.06	203.3	No	3.22	96.6	1578
	16:34	8.32	23.9	163.80	7.63	39.38	203.3	No	2.12	63.6	1641
	17:04	8.31	23.6	164.20	7.85	17.60	204.6	No	2.07	62.1	1703
	17:34	8.31	23.8	163.90	7.55	16.42	205.3	No	2.14	64.2	1767
	18:04	8.32	23.6	163.40	7.57	5.63	206.5	No	2.13	63.9	1831
	18:34	8.32	23.4	163.20	7.65	69.51	208.1	No	2.14	64.2	1896
	19:04	8.32	23.2	163.20	7.79	64.07	210.3	No	2.14	64.2	1960
	19:34	8.32	23.1	161.10	7.89	158.22	212.3	No	2.12	63.6	2023

Table B-1.1-4 (continued)

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
7/16/2019	20:04	8.32	23.0	163.20	7.88	123.31	214.1	No	2.12	63.6	2087
	20:34	8.31	22.9	163.00	7.97	60.10	216.0	No	2.11	63.3	2150
	21:04	8.32	22.9	161.30	8.01	6.59	217.0	No	2.10	63.0	2213
	21:34	8.32	22.9	163.30	7.94	231.23	218.4	No	2.13	63.9	2277
	22:04	8.32	22.8	162.20	7.96	125.85	220.0	No	1.73	51.9	2329
	22:34	8.32	22.8	163.10	7.96	111.41	221.3	No	2.41	72.3	2401
	23:04	8.32	22.7	163.10	7.96	76.50	222.1	No	2.13	63.9	2465
	23:34	8.32	22.8	163.10	7.98	167.14	222.9	No	2.08	62.4	2528
	0:04	8.32	22.7	163.00	7.89	107.14	224.1	No	2.10	63.0	2591
7/17/2019	0:34	8.32	22.7	162.60	8.01	107.62	225.5	No	2.10	63.0	2654
	1:04	8.32	22.7	163.00	7.94	161.76	226.4	No	2.09	62.7	2716
	1:34	8.32	22.7	163.00	8.00	107.59	227.3	No	2.10	63.0	2779
	2:04	8.32	22.6	162.40	8.02	7.87	228.2	No	2.39	71.7	2851
	2:34	8.32	22.7	162.80	7.95	111.74	229.3	No	1.93	57.9	2909
	3:04	8.32	22.6	162.30	7.99	138.96	230.3	No	1.87	56.1	2965
	3:34	8.31	22.6	163.20	7.94	42.78	231.4	No	2.06	61.8	3027
	4:04	8.32	22.5	163.10	7.91	66.69	231.9	No	2.09	62.7	3090
	4:34	8.31	22.5	163.10	8.01	122.23	233.2	No	2.43	72.9	3162
	5:04	8.31	22.5	162.30	8.00	212.81	233.7	No	1.75	52.5	3215
	5:34	8.31	22.5	163.10	7.99	174.73	234.6	No	2.08	62.4	3277
	6:04	8.31	22.4	162.10	8.22	107.46	235.6	No	2.06	61.8	3339
	6:34	8.32	22.4	163.20	8.18	39.66	236.0	No	2.07	62.1	3401
	7:04	8.31	22.5	162.60	7.98	188.35	236.7	No	2.10	63.0	3464
	7:34	8.30	22.7	162.10	7.92	341.25	237.2	No	2.12	63.6	3528
	8:00	Pump off	—	—	—	—	—	—	2.13	63.9	3592

[a] — = Data not logged because the pump was turned off.

[b] ND = Not detected because of startup of YSI instrument logging inaccurate readings.

Table B-1.1-5
R-8 Screen 2 Aquifer Test Field Parameter Data

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
7/12/2019	8:00	Pump on	—[a]	—	—	—	—	—	—	0	0
	8:10	ND[b]	ND	ND	ND	ND	ND	No	7.45	74.5	75
	8:40	8.32	22.0	162.20	7.30	40.12	150.2	No	7.44	223.2	298
	9:10	8.33	22.6	161.50	7.73	24.96	158.3	No	7.49	224.7	522
	9:40	8.34	21.8	162.10	7.36	5.15	163.5	No	7.50	225.0	747
	10:10	8.34	22.5	162.90	7.29	26.00	166.2	No	7.50	225.0	972
	10:40	8.34	22.7	163.10	7.30	23.92	169.7	No	7.50	225.0	1197
	11:10	8.34	23.1	161.80	7.37	32.65	173.3	No	7.50	225.0	1422
	11:40	8.35	23.3	162.30	7.11	24.29	175.4	No	7.50	225.0	1647
	12:10	8.35	23.3	163.20	7.26	20.30	177.5	No	7.51	225.3	1873
	12:40	8.34	23.4	160.90	7.13	44.10	179.6	No	7.53	225.9	2099
	13:10	8.35	23.5	161.90	7.22	40.54	181.4	No	7.51	225.3	2324
	13:40	8.35	23.6	162.90	7.16	25.11	183.4	No	7.57	227.1	2551
	14:10	8.35	23.6	162.50	7.14	29.47	184.6	No	7.53	225.9	2777
	14:40	8.35	23.6	162.20	7.13	18.70	185.9	No	7.51	225.3	3002
	15:10	8.35	23.7	164.10	7.02	39.84	187.0	No	7.51	225.3	3228
	15:40	8.35	23.8	163.50	7.09	8.27	188.4	No	7.50	225.0	3453
	16:10	8.35	23.7	161.10	7.08	22.63	190.3	No	7.50	225.0	3678
	16:40	8.35	23.7	163.00	7.00	22.00	192.2	No	7.50	225.0	3903
	17:10	8.35	23.6	163.30	7.02	27.94	192.8	No	7.51	225.3	4128
	17:40	8.35	23.7	163.40	7.06	37.97	193.3	No	7.51	225.3	4353
	18:10	8.35	23.8	162.10	7.03	23.82	195.0	No	7.53	225.9	4579
	18:40	8.35	23.8	162.00	6.98	17.44	196.0	No	7.44	223.2	4802
	19:10	8.35	23.6	162.10	6.99	16.68	196.6	No	7.58	227.4	5030

Table B-1.1-5 (continued)

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
7/12/2019	19:40	8.35	23.4	161.50	7.03	14.78	197.6	No	7.85	235.5	5265
	20:10	8.35	23.2	162.50	6.94	36.15	199.3	No	7.38	221.4	5487
	20:40	8.35	23.1	161.90	7.06	15.40	201.2	No	7.33	219.9	5706
	21:10	8.35	23.0	162.00	7.06	48.92	202.7	No	7.55	226.5	5933
	21:40	8.35	22.9	161.50	7.07	46.68	204.4	No	7.47	224.1	6157
	22:10	8.36	22.9	162.50	7.06	33.32	206.0	No	7.43	222.9	6380
	22:40	8.35	22.8	162.60	7.10	20.12	207.9	No	7.59	227.7	6608
	23:10	8.36	22.8	160.90	7.01	21.56	208.8	No	7.52	225.6	6833
	23:40	8.36	22.8	162.60	7.10	21.95	210.3	No	7.55	226.5	7060
7/13/2019	0:10	8.34	22.7	161.40	7.08	33.54	212.6	No	7.52	225.6	7285
	0:40	8.36	22.6	160.90	7.07	18.92	213.3	No	7.49	224.7	7510
	1:10	8.36	22.6	160.50	7.14	27.69	214.5	No	7.50	225.0	7735
	1:40	8.36	22.5	160.90	7.07	29.78	215.7	No	7.56	226.8	7962
	2:10	8.36	22.4	160.20	7.11	19.77	217.0	No	7.49	224.7	8187
	2:40	8.36	22.4	162.90	7.11	13.29	218.3	No	7.53	225.9	8412
	3:10	8.36	22.3	161.60	7.07	41.80	219.4	No	7.50	225.0	8637
	3:40	8.36	22.3	162.50	7.09	20.35	220.3	No	7.54	226.2	8864
	4:10	8.36	22.2	161.70	7.17	25.86	221.8	No	7.50	225.0	9089
	4:40	8.37	22.1	162.40	7.10	26.71	222.5	No	7.55	226.5	9315
	5:10	8.37	22.0	161.70	7.15	33.71	223.4	No	7.52	225.6	9541
	5:40	8.37	22.1	158.90	7.16	19.98	224.4	No	7.53	225.9	9767
	6:10	8.36	22.1	162.00	7.13	34.98	225.3	No	7.52	225.6	9992
	6:40	8.37	22.0	162.70	7.19	27.55	226.3	No	7.53	225.9	10,218
	7:10	8.37	21.3	163.30	7.19	54.96	230.1	No	7.53	225.9	10,444
	8:00	Pump off	—	—	—	—	—	—	7.54	226.2	10,670

[a] — = Data not logged because the pump was turned off.

[b] ND= Not detected because of startup of YSI instrument logging inaccurate readings.

Table B-1.1-6
R-9i Screen 1 Aquifer Test Field Parameter Data

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
6/25/2019	8:00	7.45	17.60	385	2.79	30.21	59.8	No	—*	0	0
	8:30	7.39	12.66	373.1	7.76	0.33	229.0	No	14.59	438	438
	9:00	7.39	12.91	371.0	7.76	0.31	238.4	No	14.62	439	877
	9:30	7.38	13.06	370.6	7.76	0.32	239.5	No	14.63	439	1316
	10:00	7.39	13.38	370.2	7.73	0.32	235.6	No	14.63	439	1754
	10:30	7.38	13.74	370.0	7.63	0.34	229.6	No	14.64	439	2194
	11:00	7.38	14.02	369.9	7.59	0.34	230.7	No	14.63	439	2633
	11:30	7.38	14.22	369.8	7.56	0.36	234.5	No	14.62	439	3071
	12:00	7.38	14.03	369.6	7.62	0.47	233.5	No	14.64	439	3510
	12:30	7.37	14.21	369.1	7.61	0.57	233.4	No	14.61	438	3949
	13:00	7.38	14.35	368.8	7.55	1.12	237.2	No	14.58	437	4386
	13:30	7.28	14.63	367.9	7.56	1.70	246.0	No	14.59	438	4824
	14:00	7.25	14.58	368.6	7.55	3.50	252.0	No	14.60	438	5262
	14:30	7.24	14.60	368.4	7.61	5.66	254.2	No	14.60	438	5700
	15:00	7.24	14.63	368.3	7.51	7.37	259.4	No	14.63	439	6139
	15:30	7.25	14.67	367.4	7.58	11.69	263.3	No	14.64	439	6578
	16:00	7.26	14.37	367.9	7.59	14.70	262.3	No	14.64	439	7017
	16:30	7.25	14.53	367.2	7.61	17.00	264.1	No	14.64	439	7456
	17:00	7.26	14.44	366.7	7.55	22.21	267.5	No	14.64	439	7895
	17:30	7.27	14.26	366.0	7.61	12.77	273.3	No	14.64	439	8335
	18:00	7.27	14.02	366.4	7.60	18.34	272.3	No	14.61	438	8773
	18:30	7.28	13.73	366.1	7.63	14.08	270.2	No	14.65	440	9212
	19:00	7.29	13.53	366.1	7.66	26.12	269.3	No	14.69	441	9653
	19:30	7.29	13.13	365.6	7.71	29.51	272.6	No	14.61	438	10,091

Table B-1.1-6 (continued)

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
6/25/2019	20:00	7.28	12.78	366.3	7.72	25.97	285.3	No	14.66	440	10,531
	20:30	7.30	12.88	365.7	7.70	35.66	290.6	No	14.66	440	10,971
	21:00	7.31	12.72	365.7	7.71	42.79	294.3	No	14.66	440	11,411
	21:30	7.31	12.64	365.6	7.69	30.54	296.2	No	14.65	440	11,850
	22:00	7.32	12.52	365.4	7.73	42.05	298.0	No	14.67	440	12,290
	22:30	7.34	12.51	365.4	7.73	41.76	298.6	No	14.66	440	12,730
	23:00	7.36	12.36	365.2	7.72	45.08	298.0	No	14.66	440	13,170
	23:30	7.36	12.26	365.3	7.74	45.93	298.4	No	14.66	440	13,610
	0:00	7.36	12.18	365.2	7.73	48.50	297.8	No	14.69	441	14,051
6/26/2019	0:30	7.74	12.11	365.2	7.74	52.24	299.2	No	14.68	440	14,491
	1:00	7.73	12.02	365.1	7.73	55.50	300.0	No	14.68	440	14,931
	1:30	7.75	11.98	365.0	7.75	58.23	300.6	No	14.69	441	15,372
	2:00	7.76	11.91	365.1	7.76	61.31	302.0	No	14.68	440	15,812
	2:30	7.74	11.87	364.8	7.74	65.63	302.8	No	14.70	441	16,253
	3:00	7.75	11.91	364.8	7.75	64.82	302.9	No	14.69	441	16,694
	3:30	7.76	11.91	364.8	7.76	64.02	303.0	No	14.68	440	17,135
	4:00	7.73	11.95	364.6	7.73	66.81	303.7	No	14.68	440	17,575
	4:30	7.75	11.80	364.7	7.75	67.10	304.4	No	14.71	441	18,016
	5:00	7.76	11.73	364.7	7.76	67.37	304.4	No	14.67	440	18,456
	5:30	7.75	11.63	364.5	7.75	66.79	301.5	No	14.72	442	18,898
	6:00	7.77	11.53	364.5	7.77	66.85	302.6	No	14.71	441	19,339
	6:30	7.77	11.62	364.4	7.77	67.49	303.1	No	14.69	441	19,780
	7:00	7.76	11.95	365.3	7.76	38.39	293.2	No	14.71	441	20,221
	8:00	Pump off	—	—	—	—	—	—	14.71	882.6	21,104

*— = Data not logged because the pump was turned off.

Table B-1.1-7
R-19 Screen 2 Aquifer Test Field Parameter Data

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
8/21/2019	9:00	ND*	ND	ND	ND	ND	ND	No	1.7	0.0	0.0
	9:03	7.31	28.60	163.5	3.50	3.9	116.7	Yes	1.6	5.1	5.1
	9:06	7.41	19.10	150.7	6.12	4.6	117.9	Yes	1.6	4.8	9.9
	9:09	7.42	16.90	148.9	7.03	4.5	120.5	Yes	1.6	4.8	14.7
	9:12	7.42	16.40	149.0	7.47	5.0	122.0	Yes	1.6	4.8	19.5
	9:15	7.42	16.00	148.6	7.63	5.3	123.3	Yes	1.6	4.8	24.3
	9:18	7.42	15.80	148.4	7.71	5.2	124.9	Yes	1.6	4.8	29.1

Notes: Table is from purge before stability and sampling that occurred the following day after aquifer test. No aquifer test field parameter data were collected.
*ND= Not detected because of startup of YSI instrument logging inaccurate readings.

Table B-1.1-8
R-19 Screen 3 Aquifer Pump Test Field Parameter Data

Date	Time	pH	Temp (°C)	Spec. Cond. (µS/cm)	DO (mg/L)	Turbidity (NTU)	ORP (mV)	HACH Turbidimeter Used? (Yes or No)	Discharge Rate (gpm)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
8/17/2019	8:00	Pump on									
	8:02	8.37	14.1	164.2	7.02	54.9	123.3	No	6.50	13	13
	8:32	8.65	18.3	169.6	5.93	26.9	120.5	No	6.43	193	206
	9:02	8.60	19.8	165.7	5.43	12.5	125.5	No	6.44	193	399
	9:32	8.59	20.2	160.4	5.84	2.6	132.0	No	6.41	192	591
	10:02	8.56	20.5	154.2	5.93	25.1	136.5	No	6.44	193	785
	10:32	8.53	20.7	151.3	5.98	18.1	140.0	No	6.44	193	978
	11:02	8.50	20.7	150.4	5.83	35.0	141.4	No	6.46	194	1172
	11:32	8.47	20.9	152.4	6.01	6.7	142.9	No	6.50	195	1367
	12:02	8.47	20.9	147.6	5.86	37.0	143.4	No	6.54	196	1563
	12:32	8.45	21.1	143.1	5.81	46.1	143.5	No	6.47	194	1757
	13:02	8.44	20.9	139.6	5.90	51.9	144.6	No	6.47	194	1951
	13:32	8.42	21.7	138.8	5.71	66.5	145.5	No	6.47	194	2145
	14:02	8.41	22.0	136.5	5.79	23.0	146.1	No	6.48	194	2340
	14:32	8.39	21.7	135.4	5.83	33.1	147.8	No	6.48	194	2534
	15:02	8.38	22.2	137.2	5.98	6.2	148.6	No	6.49	195	2729
	15:32	8.36	21.1	133.7	5.93	19.0	149.7	No	6.49	195	2923
	16:02	8.35	21.2	130.9	5.99	55.7	146.5	No	6.50	195	3118
	16:32	8.33	21.3	128.2	5.94	90.0	146.4	No	6.52	196	3314

Table B-1.2.1
Analytical Results for Well R-5, Screen 2

Sample ID	Sample Date	Parameter Name	Report Result[a]	Lab Qualifier	Sample Purpose
N3B-2019-3279	9/11/2019	Acidity or Alkalinity of a solution	8.06 SU	H[b]	REG[c]
N3B-2019-3279	9/11/2019	Alkalinity-CO_3+HCO_3	100 mg/L	NQ[d]	REG
N3B-2019-3279	9/11/2019	Ammonia as Nitrogen	0.0295 mg/L	J[e]	REG
N3B-2019-3279	9/11/2019	Arsenic	3.6 µg/L	J	REG
N3B-2019-3279	9/11/2019	Barium	203 µg/L	NQ	REG
N3B-2019-3279	9/11/2019	Boron	28.3 µg/L	J	REG
N3B-2019-3279	9/11/2019	Bromide	0.149 mg/L	J	REG
N3B-2019-3279	9/11/2019	Calcium	33.3 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Chloride	10.1 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Copper	3.42 µg/L	J	REG
N3B-2019-3279	9/11/2019	Fluoride	1.24 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Gross alpha	4.38 pCi/L	NQ	REG
N3B-2019-3279	9/11/2019	Gross beta	5.34 pCi/L	NQ	REG
N3B-2019-3279	9/11/2019	Hardness	96.7 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Iron	146 µg/L	NQ	REG
N3B-2019-3279	9/11/2019	Magnesium	3.28 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Molybdenum	2.03 µg/L	NQ	REG
N3B-2019-3279	9/11/2019	Nitrate-Nitrite as Nitrogen	2.79 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Perchlorate	2.65 µg/L	NQ	REG
N3B-2019-3279	9/11/2019	Potassium	4.27 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Silicon Dioxide	53.2 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Sodium	15.1 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Specific Conductance	257 µS/cm	NQ	REG
N3B-2019-3279	9/11/2019	Strontium	332 µg/L	NQ	REG
N3B-2019-3279	9/11/2019	Sulfate	10.5 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Toluene	6.69 µg/L	NQ	REG
N3B-2019-3279	9/11/2019	Total Dissolved Solids	184 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Total Kjeldahl Nitrogen	0.655 mg/L	NQ	REG
N3B-2019-3279	9/11/2019	Total Organic Carbon	0.378 mg/L	J	REG
N3B-2019-3279	9/11/2019	Uranium	3.11 µg/L	NQ	REG
N3B-2019-3279	9/11/2019	Vanadium	7.52 µg/L	NQ	REG

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

[b] H = The required extraction or analysis holding time for this result was exceeded.

[c] REG = Regular sample.

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

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

Table B-1.2-2
Analytical Results for Well R-5, Screen 4

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-2382	7/2/2019	Gross beta	7.34 pCi/L	J[b]
N3B-2019-2382	7/2/2019	TOC	0.452 mg/L	J
N3B-2019-2382	7/2/2019	TDS	211.0 mg/L	NQ[c]
N3B-2019-2382	7/2/2019	Acidity/alkalinity	7.97 SU	NQ
N3B-2019-2382	7/2/2019	Alkalinity–CO_3+HCO_3	103.0 mg/L	NQ
N3B-2019-2382	7/2/2019	Nitrate-nitrite as nitrogen	2.67 µg/L	NQ
N3B-2019-2382	7/2/2019	Sulfate	9.44 mg/L	NQ
N3B-2019-2382	7/2/2019	Arsenic	6.58 µg/L	NQ
N3B-2019-2382	7/2/2019	Barium	215 µg/L	NQ
N3B-2019-2382	7/2/2019	Boron	31.5 µg/L	J
N3B-2019-2382	7/2/2019	Bromide	0.121 mg/L	J
N3B-2019-2382	7/2/2019	Calcium	34.7 mg/L	NQ
N3B-2019-2382	7/2/2019	Chloride	8.68 mg/L	J+[d]
N3B-2019-2382	7/2/2019	Chromium	4.37 µg/L	J
N3B-2019-2382	7/2/2019	Copper	8.25 µg/L	J
N3B-2019-2382	7/2/2019	Fluoride	1.15 mg/L	NQ
N3B-2019-2382	7/2/2019	Magnesium	3.36 mg/L	NQ
N3B-2019-2382	7/2/2019	Molybdenum	2.2 µg/L	NQ
N3B-2019-2382	7/2/2019	Nickel	1.87 µg/L	J
N3B-2019-2382	7/2/2019	Perchlorate	1.46 µg/L	NQ
N3B-2019-2382	7/2/2019	Potassium	4.43 mg/L	NQ
N3B-2019-2382	7/2/2019	Silicon dioxide	55.9 mg/L	NQ
N3B-2019-2382	7/2/2019	Sodium	16.5 mg/L	NQ
N3B-2019-2382	7/2/2019	Strontium	336,0 µg/L	NQ
N3B-2019-2382	7/2/2019	Tin	2.55 µg/L	J
N3B-2019-2382	7/2/2019	Uranium	3.5 µg/L	NQ
N3B-2019-2382	7/2/2019	Vanadium	8.08 µg/L	NQ
N3B-2019-2382	7/2/2019	Zinc	34.9 µg/L	J+

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

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

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

[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-1.2-3
Analytical Results for Well R-7, Screen 3

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-2280	6/23/2019	TOC	0.381 mg/L	J[b]
N3B-2019-2280	6/23/2019	TDS	117 mg/L	NQ[c]
N3B-2019-2280	6/23/2019	Acidity/alkalinity	7.76 SU	NQ
N3B-2019-2280	6/23/2019	Alkalinity–CO_3+HCO_3	64.4 mg/L	NQ
N3B-2019-2280	6/23/2019	Nitrate-nitrite as nitrogen	0.127 mg/L	NQ
N3B-2019-2280	6/23/2019	Sulfate	1.63 mg/L	NQ
N3B-2019-2280	6/23/2019	TKN	0.103 mg/L	NQ
N3B-2019-2280	6/23/2019	Barium	27.8 µg/L	NQ
N3B-2019-2280	6/23/2019	Boron	15.9 µg/L	J
N3B-2019-2280	6/23/2019	Calcium	10.1 mg/L	NQ
N3B-2019-2280	6/23/2019	Chloride	1.58 mg/L	NQ
N3B-2019-2280	6/23/2019	Fluoride	0.513 mg/L	NQ
N3B-2019-2280	6/23/2019	Magnesium	4.18 mg/L	NQ
N3B-2019-2280	6/23/2019	Manganese	30.4 µg/L	NQ
N3B-2019-2280	6/23/2019	Molybdenum	0.839 µg/L	J
N3B-2019-2280	6/23/2019	Nickel	1.11 µg/L	J
N3B-2019-2280	6/23/2019	Perchlorate	0.298 µg/L	NQ
N3B-2019-2280	6/23/2019	Potassium	1.29 mg/L	NQ
N3B-2019-2280	6/23/2019	Silicon dioxide	68.2 mg/L	NQ
N3B-2019-2280	6/23/2019	Sodium	9.45 mg/L	NQ
N3B-2019-2280	6/23/2019	Strontium	47.0 µg/L	NQ
N3B-2019-2280	6/23/2019	Tin	28.9 µg/L	J+[d]
N3B-2019-2280	6/23/2019	Uranium	0.977 µg/L	NQ
N3B-2019-2280	6/23/2019	Vanadium	5.31 µg/L	NQ
N3B-2019-2280	6/23/2019	Zinc	12.1 µg/L	J

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

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

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

[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-1.2-4
Analytical Results for Well R-8, Screens 1 and 2

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
Screen 1				
N3B-2019-2576	7/17/2019	Gross beta	3.44 pCi/L	NQ[b]
N3B-2019-2576	7/17/2019	Toluene	10.9 µg/L	NQ
N3B-2019-2576	7/17/2019	TDS	95.7 mg/L	NQ
N3B-2019-2576	7/17/2019	Acidity/alkalinity	8.39 SU	NQ
N3B-2019-2576	7/17/2019	Alkalinity–CO_3+HCO_3	77.9 mg/L	NQ
N3B-2019-2576	7/17/2019	Nitrate-nitrite as nitrogen	0.537 mg/L	NQ
N3B-2019-2576	7/17/2019	Sulfate	2.86 mg/L	NQ
N3B-2019-2576	7/17/2019	TP	0.0756 mg/L	NQ
N3B-2019-2576	7/17/2019	Barium	36.2 µg/L	NQ
N3B-2019-2576	7/17/2019	Calcium	16.9 mg/L	NQ
N3B-2019-2576	7/17/2019	Chloride	1.59 mg/L	NQ
N3B-2019-2576	7/17/2019	Chromium	3.44 µg/L	J[c]
N3B-2019-2576	7/17/2019	Fluoride	0.549 mg/L	NQ
N3B-2019-2576	7/17/2019	Magnesium	2.3 mg/L	NQ
N3B-2019-2576	7/17/2019	Molybdenum	1.55 µg/L	NQ
N3B-2019-2576	7/17/2019	Perchlorate	0.3 µg/L	NQ
N3B-2019-2576	7/17/2019	Potassium	2.27 mg/L	NQ
N3B-2019-2576	7/17/2019	Silicon dioxide	43.4 mg/L	NQ
N3B-2019-2576	7/17/2019	Sodium	14.0 mg/L	NQ
N3B-2019-2576	7/17/2019	Strontium	108.0 µg/L	NQ
N3B-2019-2576	7/17/2019	Uranium	0.46 µg/L	NQ
N3B-2019-2576	7/17/2019	Vanadium	16.9 µg/L	NQ
Screen 2				
N3B-2019-2509	7/13/2019	Gross beta	4.22 µCi/L	NQ
N3B-2019-2509	7/13/2019	Toluene	3.54 µg/L	NQ
N3B-2019-2509	7/13/2019	TDS	97.1 mg/L	NQ
N3B-2019-2509	7/13/2019	Acidity/alkalinity	8.39 SU	NQ
N3B-2019-2509	7/13/2019	Alkalinity–CO_3+HCO_3	77.3 mg/L	NQ
N3B-2019-2509	7/13/2019	Nitrate-nitrite as nitrogen	0.537 mg/L	NQ
N3B-2019-2509	7/13/2019	Sulfate	2.91 mg/L	NQ
N3B-2019-2509	7/13/2019	TP	0.06 mg/L	NQ
N3B-2019-2509	7/13/2019	Arsenic	4.11 µg/L	J
N3B-2019-2509	7/13/2019	Barium	52.3 µg/L	NQ
N3B-2019-2509	7/13/2019	Boron	24.8 µg/L	J
N3B-2019-2509	7/13/2019	Calcium	16.7 mg/L	NQ
N3B-2019-2509	7/13/2019	Chloride	1.61 mg/L	NQ

Table B-1.2-4 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-2509	7/13/2019	Fluoride	0.53 mg/L	NQ
N3B-2019-2509	7/13/2019	Magnesium	2.41 mg/L	NQ
N3B-2019-2509	7/13/2019	Molybdenum	1.48 µg/L	NQ
N3B-2019-2509	7/13/2019	Perchlorate	0.347 µg/L	NQ
N3B-2019-2509	7/13/2019	Potassium	2.26 mg/L	NQ
N3B-2019-2509	7/13/2019	Silicon dioxide	50.7 mg/L	NQ
N3B-2019-2509	7/13/2019	Sodium	13.8 mg/L	NQ
N3B-2019-2509	7/13/2019	Strontium	104.0 µg/L	NQ
N3B-2019-2509	7/13/2019	Uranium	0.376 µg/L	NQ
N3B-2019-2509	7/13/2019	Vanadium	17.6 µg/L	NQ

[a] Only detected results are reported; analytes below the 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-1.2-5
Analytical Results for Well R-9i, Screens 1 and 2

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
Screen 1				
N3B-2019-2289	6/26/2019	Gross beta	13.5 pCi/L	NQ[b]
N3B-2019-2289	6/26/2019	Toluene	1.12 µg/L	NQ
N3B-2019-2289	6/26/2019	TOC	2.43 mg/L	NQ
N3B-2019-2289	6/26/2019	TDS	147.0 mg/L	NQ
N3B-2019-2289	6/26/2019	Acidity/alkalinity	7.53 SU	NQ
N3B-2019-2289	6/26/2019	Alkalinity–CO_3+HCO_3	63.4 mg/L	NQ
N3B-2019-2289	6/26/2019	Nitrate-nitrite as nitrogen	0.297 mg/L	NQ
N3B-2019-2289	6/26/2019	Sulfate	13.4 mg/L	NQ
N3B-2019-2289	6/26/2019	TKN	0.0914 mg/L	J[c]
N3B-2019-2289	6/26/2019	Arsenic	2.61 µg/L	J
N3B-2019-2289	6/26/2019	Barium	37.4 µg/L	NQ
N3B-2019-2289	6/26/2019	Boron	20.5 µg/L	J
N3B-2019-2289	6/26/2019	Bromide	0.152 mg/L	J
N3B-2019-2289	6/26/2019	Calcium	17.7 mg/L	NQ
N3B-2019-2289	6/26/2019	Chloride	53.4 mg/L	NQ
N3B-2019-2289	6/26/2019	Fluoride	0.329 mg/L	NQ
N3B-2019-2289	6/26/2019	Magnesium	6.63 mg/L	NQ
N3B-2019-2289	6/26/2019	Molybdenum	8.29 µg/L	NQ
N3B-2019-2289	6/26/2019	Perchlorate	0.366 µg/L	NQ

Table B-1.2-5 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-2289	6/26/2019	Potassium	4.41 mg/L	NQ
N3B-2019-2289	6/26/2019	Silicon dioxide	35.5 mg/L	NQ
N3B-2019-2289	6/26/2019	Sodium	28.3 mg/L	NQ
N3B-2019-2289	6/26/2019	Strontium	116.0 µg/L	NQ
N3B-2019-2289	6/26/2019	Tin	26.7 µg/L	NQ
N3B-2019-2289	6/26/2019	Uranium	0.382 µg/L	NQ
N3B-2019-2289	6/26/2019	Vanadium	1.42 µg/L	J
N3B-2019-2295	6/26/2019	Tritium	37.588 pCi/L	NQ
Screen 2				
N3B-2019-2205	6/16/2019	Bis(2-ethylhexyl)phthalate	3.64 µg/L	NQ
N3B-2019-2205	6/16/2019	Butanone[-2]	6.93 µg/L	J
N3B-2019-2205	6/16/2019	Di-n-butylphthalate	0.34 µg/L	J
N3B-2019-2205	6/16/2019	Gross alpha	7.9 pCi/L	NQ
N3B-2019-2205	6/16/2019	Gross beta	8.61 pCi/L	NQ
N3B-2019-2205	6/16/2019	Methylphenol[-2]	5.64 µg/L	J
N3B-2019-2205	6/16/2019	Methylphenol[-3,4]	4.76 µg/L	J
N3B-2019-2205	6/16/2019	Phenol	6.7 µg/L	J
N3B-2019-2205	6/16/2019	Toluene	529.0 µg/L	J
N3B-2019-2205	6/16/2019	Xylene[-1,3] + xylene[-1,4]	0.54 µg/L	J
N3B-2019-2205	6/16/2019	TOC	32.9 mg/L	NQ
N3B-2019-2205	6/16/2019	TDS	213.0 mg/L	J+[d]
N3B-2019-2205	6/16/2019	Acidity/alkalinity	7.8 SU	NQ
N3B-2019-2205	6/16/2019	Alkalinity–CO_3+HCO_3	66.8 mg/L	NQ
N3B-2019-2205	6/16/2019	Nitrate-nitrite as nitrogen	0.202 mg/L	NQ
N3B-2019-2205	6/16/2019	Sulfate	14 mg/L	NQ
N3B-2019-2205	6/16/2019	TKN	0.218 mg/L	NQ
N3B-2019-2205	6/16/2019	Antimony	1.23 µg/L	J
N3B-2019-2205	6/16/2019	Arsenic	2.15 µg/L	J
N3B-2019-2205	6/16/2019	Barium	35.7 µg/L	NQ
N3B-2019-2205	6/16/2019	Boron	25.5 µg/L	J
N3B-2019-2205	6/16/2019	Bromide	0.162 mg/L	J
N3B-2019-2205	6/16/2019	Calcium	20.5 mg/L	NQ
N3B-2019-2205	6/16/2019	Chloride	53.4 mg/L	NQ
N3B-2019-2205	6/16/2019	Fluoride	0.32 mg/L	NQ
N3B-2019-2205	6/16/2019	Magnesium	6.73 mg/L	NQ
N3B-2019-2205	6/16/2019	Molybdenum	8.44 µg/L	NQ
N3B-2019-2205	6/16/2019	Nickel	15.6 µg/L	NQ
N3B-2019-2205	6/16/2019	Perchlorate	0.316 µg/L	NQ
N3B-2019-2205	6/16/2019	Potassium	4.74 mg/L	NQ

Table B-1.2-5 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-2205	6/16/2019	Silicon dioxide	34.6 mg/L	NQ
N3B-2019-2205	6/16/2019	Sodium	29.1 mg/L	NQ
N3B-2019-2205	6/16/2019	Strontium	116.0 µg/L	NQ
N3B-2019-2205	6/16/2019	TP	0.158 mg/L	NQ
N3B-2019-2205	6/16/2019	Uranium	0.613 µg/L	NQ
N3B-2019-2205	6/16/2019	Vanadium	1.29 µg/L	J
N3B-2019-2205	6/16/2019	Zinc	444.0 µg/L	NQ
N3B-2019-2248	6/16/2019	Tritium	38.577 pCi/L	NQ

[a] Only detected results are reported; analytes below the 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 positive bias.

Table B-1.2-6
Analytical Results for Well R-19, Screens 2, 3, and 4

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
Screen 2				
N3B-2019-3088	8/21/2019	Acetone	2.31 µg/L	J[b]
N3B-2019-2205	6/16/2019	Bis(2-ethylhexyl)phthalate	3.64 µg/L	NQ[c]
N3B-2019-3088	8/21/2019	Bis(2-ethylhexyl)phthalate	0.61 µg/L	J
N3B-2019-2205	6/16/2019	Butanone[-2]	6.93 µg/L	J
N3B-2019-2205	6/16/2019	Di-n-butylphthalate	0.34 µg/L	J
N3B-2019-2205	6/16/2019	Gross alpha	7.9 pCi/L	NQ
N3B-2019-2205	6/16/2019	Gross beta	8.61 pCi/L	NQ
N3B-2019-2205	6/16/2019	Methylphenol[-2]	5. 64 µg/L	J
N3B-2019-2205	6/16/2019	Methylphenol[-3,4]	4.76 µg/L	J
N3B-2019-2205	6/16/2019	Phenol	6.7 µg/L	J
N3B-2019-2205	6/16/2019	Toluene	529.0 µg/L	J
N3B-2019-2205	6/16/2019	TOC	32.9 mg/L	NQ
N3B-2019-2205	6/16/2019	Xylene[1,3] + xylene[1,4]	0.54 µg/L	J
N3B-2019-2205	6/16/2019	TDS	213.0 mg/L	J+[d]
N3B-2019-3088	8/21/2019	TDS	151.0 mg/L	J+
N3B-2019-3088	8/21/2019	Acidity/alkalinity	7.75 SU	NQ
N3B-2019-2205	6/16/2019	Alkalinity–CO_3+HCO_3	66.8 mg/L	NQ
N3B-2019-3088	8/21/2019	Alkalinity–CO_3+HCO_3	71.9 mg/L	NQ
N3B-2019-3088	8/21/2019	Nitrate-nitrite as nitrogen	0.341 mg/L	NQ
N3B-2019-2205	6/16/2019	Sulfate	14.0 mg/L	NQ

Table B-1.2-6 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-3088	8/21/2019	Sulfate	3.25 mg/L	NQ
N3B-2019-2205	6/16/2019	TP	0.158 mg/L	NQ
N3B-2019-3088	8/21/2019	TP	0.114 mg/L	NQ
N3B-2019-2205	6/16/2019	Antimony	1.23 µg/L	J
N3B-2019-2205	6/16/2019	Arsenic	2.15 µg/L	J
N3B-2019-2205	6/16/2019	Barium	35.7 µg/L	NQ
N3B-2019-3088	8/21/2019	Barium	23.9 µg/L	NQ
N3B-2019-2205	6/16/2019	Boron	25.5 µg/L	J
N3B-2019-3088	8/21/2019	Boron	15.3 µg/L	J
N3B-2019-2205	6/16/2019	Bromide	0.162 mg/L	J
N3B-2019-2205	6/16/2019	Calcium	20.5 mg/L	NQ
N3B-2019-3088	8/21/2019	Calcium	2.94 mg/L	NQ
N3B-2019-2205	6/16/2019	Chloride	53.4 mg/L	NQ
N3B-2019-3088	8/21/2019	Chloride	2.94 mg/L	NQ
N3B-2019-2205	6/16/2019	Fluoride	0.32 mg/L	NQ
N3B-2019-3088	8/21/2019	Fluoride	0.601 µg/L	NQ
N3B-2019-2205	6/16/2019	Magnesium	6.73 mg/L	NQ
N3B-2019-3088	8/21/2019	Magnesium	2.68 mg/L	NQ
N3B-2019-2205	6/16/2019	Manganese	32.6 µg/L	NQ
N3B-2019-3088	8/21/2019	Manganese	3.45 µg/L	J
N3B-2019-2205	6/16/2019	Molybdenum	8.44 µg/L	NQ
N3B-2019-3088	8/21/2019	Methylene chloride	1.38 µg/L	NQ
N3B-2019-2205	6/16/2019	Nickel	15.6 µg/L	NQ
N3B-2019-3088	8/21/2019	Nickel	1.24 µg/L	NQ
N3B-2019-2205	6/16/2019	Perchlorate	0.316 µg/L	NQ
N3B-2019-3088	8/21/2019	Perchlorate	0.333 µg/L	NQ
N3B-2019-2205	6/16/2019	Potassium	4.74 mg/L	NQ
N3B-2019-3088	8/21/2019	Potassium	1.0 mg/L	J+
N3B-2019-2205	6/16/2019	Silicon dioxide	34.6 mg/L	NQ
N3B-2019-3088	8/21/2019	Silicon dioxide	74.7 mg/L	NQ
N3B-2019-2205	6/16/2019	Sodium	29.1 mg/L	NQ
N3B-2019-3088	8/21/2019	Sodium	14.2 mg/L	J+
N3B-2019-2205	6/16/2019	Strontium	116.0 µg/L	NQ
N3B-2019-3088	8/21/2019	Strontium	56.6 µg/L	NQ
N3B-2019-2205	6/16/2019	Uranium	0.613 µg/L	NQ
N3B-2019-3088	8/21/2019	Uranium	0.288 µg/L	NQ
N3B-2019-2205	6/16/2019	Vanadium	1.29 µg/L	J
N3B-2019-3088	8/21/2019	Vanadium	1.54 µg/L	J
N3B-2019-2205	6/16/2019	Zinc	444.0 µg/L	NQ

Table B-1.2-6 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-3088	8/21/2019	Zinc	44.4 µg/L	J+
Screen 3				
N3B-2019-3037	8/19/2019	Toluene	4.25 µg/L	NQ
N3B-2019-3037	8/19/2019	TDS	117.0 mg/L	NQ
N3B-2019-3037	8/19/2019	Acidity/alkalinity	8.31 SU	NQ
N3B-2019-3037	8/19/2019	Alkalinity–CO_3+HCO_3	65.6 mg/L	NQ
N3B-2019-3037	8/19/2019	Nitrate-nitrite as nitrogen	0.268 mg/L	NQ
N3B-2019-3037	8/19/2019	Sulfate	1.88 mg/L	NQ
N3B-2019-3037	8/19/2019	TKN	0.0654 mg/L	J
N3B-2019-3037	8/19/2019	Arsenic	2.35 µg/L	J
N3B-2019-3037	8/19/2019	Barium	20.3 µg/L	NQ
N3B-2019-3037	8/19/2019	Calcium	13.5 mg/L	NQ
N3B-2019-3037	8/19/2019	Chloride	1.77 mg/L	NQ
N3B-2019-3037	8/19/2019	Fluoride	0.372 mg/L	NQ
N3B-2019-3037	8/19/2019	Magnesium	3.03 mg/L	NQ
N3B-2019-3037	8/19/2019	Manganese	9.85 µg/L	J
N3B-2019-3037	8/19/2019	Molybdenum	1.49 µg/L	NQ
N3B-2019-3037	8/19/2019	Perchlorate	0.225 µg/L	NQ
N3B-2019-3037	8/19/2019	Potassium	1.24 mg/L	NQ
N3B-2019-3037	8/19/2019	Silicon dioxide	72.6 mg/L	NQ
N3B-2019-3037	8/19/2019	Sodium	11.1 mg/L	NQ
N3B-2019-3037	8/19/2019	Strontium	54.3 µg/L	NQ
N3B-2019-3037	8/19/2019	Uranium	0.395 µg/L	NQ
N3B-2019-3037	8/19/2019	Vanadium	3.99 µg/L	J
Screen 4				
N3B-2019-2689	7/29/2019	TOC	0.498 mg/L	J
N3B-2019-2689	7/29/2019	TDS	137 mg/L	NQ
N3B-2019-2689	7/29/2019	Acidity/alkalinity	7.9 SU	NQ
N3B-2019-2689	7/29/2019	Alkalinity–CO3+HCO3	64.2 mg/L	NQ
N3B-2019-2689	7/29/2019	Nitrate-nitrite as nitrogen	0.28 mg/L	NQ
N3B-2019-2689	7/29/2019	Sulfate	2.16 mg/L	NQ
N3B-2019-2689	7/29/2019	TP	0.131 mg/L	NQ
N3B-2019-2689	7/29/2019	Barium	20.6 µg/L	NQ
N3B-2019-2689	7/29/2019	Calcium	12.2 mg/L	NQ
N3B-2019-2689	7/29/2019	Chloride	2.14 mg/L	NQ
N3B-2019-2689	7/29/2019	Chromium	3.32 µg/L	J
N3B-2019-2689	7/29/2019	Fluoride	0.622 µg/L	NQ
N3B-2019-2689	7/29/2019	Magnesium	2.66 mg/L	NQ
N3B-2019-2689	7/29/2019	Manganese	8.05 µg/L	J

Table B-1.2-6 (continued)

Sample ID	Sample Date	Analyte	Report Result[a]	Lab Qualifier
N3B-2019-2689	7/29/2019	Mercury	0.072 µg/L	J
N3B-2019-2689	7/29/2019	Molybdenum	1.4 µg/L	NQ
N3B-2019-2689	7/29/2019	Nickel	1.38 µg/L	J
N3B-2019-2689	7/29/2019	Perchlorate	0.265 µg/L	NQ
N3B-2019-2689	7/29/2019	Potassium	1.1 mg/L	NQ
N3B-2019-2689	7/29/2019	Silicon dioxide	69.7 mg/L	NQ
N3B-2019-2689	7/29/2019	Sodium	10.9 mg/L	NQ
N3B-2019-2689	7/29/2019	Strontium	51.5 µg/L	NQ
N3B-2019-2689	7/29/2019	Uranium	0.266 µg/L	NQ
N3B-2019-2689	7/29/2019	Vanadium	3.67 µg/L	J
N3B-2019-2689	7/29/2019	Zinc	48.9 µg/L	J+

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

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

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

[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.

Appendix C

Aquifer Testing Report for
Westbay Wells Reconfiguration Project

C-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of pumping tests conducted from June to August 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. The wells and screens tested included R-5 screens 2 and 3, R-7 screen 3, R-8 screens 1 and 2, R-9i screen 1, and R-19 screens 2 and 3. Testing consisted of brief trial pumping, background water-level data collection, and a 12-hr or 24-hr constant rate pumping and recovery test on each of the relevant screen zones.

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 for certain perched zones and wells that were screened across the water table.

C-2.0 BACKGROUND DATA

The background water-level data collected in conjunction with running the pumping tests allow observation of 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 percentage of 100 minus the barometric efficiency, and in the same direction as the barometric pressure change, rather than in the opposite direction.

Barometric pressure data were obtained from the Technical Area 54 (TA-54) tower site from LANL’s Environmental Protection and Compliance Programs (formerly the Waste and Environmental Services Division–Environmental Data and Analysis). The TA-54 measurement location is at an elevation of 6548 ft above mean sea level (amsl), whereas the wellheads and static water levels were at different elevations than this. Therefore, the measured barometric pressure data from TA-54 had to be adjusted to reflect the pressure at the elevation of the water table within each tested well.

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

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

Where, P_{WT} = barometric pressure at the water table inside tested well

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

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, in feet

E_{WT} = elevation of the water level in tested well, in feet

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

T_{WELL} = air column temperature inside tested well, 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 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

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:

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

Equation C-4

Where,

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

Equation C-5

and

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

and where, s = drawdown, in feet

Q = discharge rate, in gallons per minute

T = transmissivity, in gallons per day per foot

S = storage coefficient (dimensionless)

t = pumping time, in days

r = distance from center of pumpage, in feet

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

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

Where, T = transmissivity, in gallons per day per foot

S = storage coefficient

Q = discharge rate, in gallons per minute

$W(u)$ = match-point value

s = match-point value, in feet

u = match-point value

t = match-point value, in minutes

An alternative solution method applicable to time-drawdown data is the Cooper-Jacob method (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:

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

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

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

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

Equation C-10

Where, T = transmissivity, in gallons per day per foot

Q = discharge rate, in gallons per minute

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

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

Equation C-11

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

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

b = aquifer thickness

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

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

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

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

K_z = vertical hydraulic conductivity

K_r = horizontal hydraulic conductivity

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

$$\beta = \sqrt{\frac{K_z}{K_r}}\frac{n\pi r}{b}.$$

Equation C-12

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

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).

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:

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

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

To apply this procedure, a storage coefficient value must be assigned. 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-5 SCREEN 2 PUMPING TESTS

C-7.1 Introduction

This section presents analysis of data obtained from final test pumping conducted on R-5 screen 2. Final test pumping was performed to evaluate well capacity and assess aquifer parameters.

Previously, field activities included Westbay equipment removal, swabbing and bailing, initial test pumping, purging and sampling of screen 4, and abandonment of screen 4. During the abandonment of screen 4, cement grout was inadvertently placed in the bottom half of screen 3 and the grout pipe was cemented in place. After initial attempts at freeing the tremie pipe failed, the pipe was successfully removed 2 mo later and the rest of screen 3 was cemented and abandoned.

The screen 2 interval in R-5 extends from 372.8 to 388.8 ft below ground surface (bgs) in a perched zone within the Tertiary Chamita Formation (Tcar). The contact between Tertiary Puye Formation (Tpf) and Tcar was re-assigned to 327 ft bgs based on the presence of mixed Precambrian and volcanic lithologies below 327 ft. The static water level measured on September 9 was 342.1 ft bgs.

Aquifer testing of R-5 screen 2 was performed from September 7 to 12, 2019. Testing consisted of (1) brief pumping on September 7 to fill the drop pipe and set the flow rate by adjusting the discharge valve, (2) step-drawdown testing on September 8, (3) background data collection, and (4) a 24-hr pumping and recovery test.

Step-drawdown testing of R-5 screen 2 began at 8:00 a.m. on September 8 and continued for 105 min. Following shutdown, background data were recorded for 2775 min until 8:00 a.m. on September 10.

The 24-hr pumping test began at 8:00 a.m. on September 10 at a discharge rate of 2.6 gallons per minute (gpm) and continued for 1440 min until 8:00 a.m. on September 11. Following pump shutoff, recovery data were monitored for 1465 min until 8:25 a.m. on September 12 when the pump was pulled from the well. This appendix discusses only the 24-hr pumping and recovery test. The step-drawdown test is presented in Appendix A.

Because the screen 2 perched interval was dewatered continually during most of the prior work performed at R-5, frequent draining of the filter pack would have allowed air to be trapped in the filter packed annulus above the screen. Such trapped air expands and contracts when water levels draw down and recover, causing a storage effect, even if an inflatable packer is used to seal the annulus between the drop pipe and the well casing. Because storage effects were inevitable and unavoidable, the pump was run without the use of an inflatable packer.

C-7.2 Background Data Analysis

Background aquifer pressure data collected during the R-5 screen 2 tests 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-5 screen 2 during the test period along with barometric pressure data from TA-54 that have been corrected to equivalent barometric pressure in feet of water at the water table. The R-5 data measurements reflect the sum of the water pressure and barometric pressure that was recorded using a non-vented pressure transducer. The term “adjusted” is used to identify the hydrograph because it includes both the true height of water above the transducer plus the barometric pressure. The times of the pumping periods for the R-5 screen 2 pumping tests are included in the figure for reference.

To provide better definition of the hydrograph, a rolling average plot was prepared, shown on Figure C-7.2-2. It is clear from the hydrograph that there was no discernable correlation with changes in barometric pressure, implying a high barometric efficiency.

The hydrograph data showed that water levels were extremely sluggish in recovering, even after short pumping periods. This suggested the possibility of low transmissivity or lateral limits to the producing zone.

C-7.3 Well R-5 Screen 2 Pumping Test Analysis

Figure C-7.3-1 shows drawdown data from the R-5 screen 2 pumping test. The locations of the top and bottom of the well screen are included in the figure for reference. Several significant observations can be made from this graph.

Because of the low specific capacity of screen 2, the pumping level dropped into the screen within 30 min of pumping, even at the low discharge rate of 2.6 gpm. Toward the end of the test, the pumping level reached the sump beneath the well screen.

Once the pumping level reached the screen, it was necessary to correct the drawdown data for dewatering, as shown by the flatter of the two curves. The portion of the drawdown consisting of the dewatered distance within the well screen can be converted to a theoretical equivalent drawdown component that would have been observed had no dewatering occurred. The formula for computing the corrected drawdown increment is as follows:

$$s_c = s - \frac{s^2}{2b}$$ **Equation C-16**

Where, s_c = corrected (theoretical) drawdown component

s = observed drawdown component

b = saturated screen length

Once the pumping water level reaches the bottom of the well screen, no further correction is applied to the data (i.e., the effective theoretical drawdown remains constant thereafter).

This correction procedure is based on the assumption of uniform flow contribution throughout the entire length of the well screen. However, the original and corrected data from Figure C-7.3-1 suggested the possibility that a disproportionate amount of the flow had come from the bottom portion of the screen. Generally, when the well screen becomes dewatered, the raw measurements show a concave downward curve shape, because the rate of drawdown accelerates as the transmissivity is reduced steadily via dewatering. The actual drawdown curve did not show this effect until the water level reached deep into the screen. Also, the corrected data would be expected to show a fairly straight slope. In this case, however, the corrected data showed a flattening (concave upward curve) that would typically imply increasing transmissivity or a recharge boundary—both of which were belied by the recovery data, discussed below. It appeared that the bulk of the flow contribution to screen 2 came from the lower portion of the well screen, causing the standard correction algorithm to be an overcorrection.

Use of the data was further limited because of the large casing and filter pack storage effect, also attributable to the very low specific capacity. Data from the first several hours of the test were storage affected and unanalyzable (t_c, calculated from Equation C-3, as indicated in Figure C-7.3-1).

Figure C-7.3-2 shows an expanded-scale graph of the late actual and corrected drawdown data. The transmissivity values computed from the actual and corrected data were 100 and 220 gallons per day (gpd)/ft, respectively. It was likely that some data correction was warranted, making the actual data plot too steep to use for determining transmissivity and resulting in an underestimate of transmissivity. The likely overcorrection of the data would have led to too flat a curve, resulting in an overestimate of transmissivity. Thus, the two values shown on the figure probably bracket the true value of transmissivity.

Figure C-7.3-3 shows the recovery data collected following pump shutdown. The bulk of the data was storage affected and, therefore, unanalyzable. The storage times shown on the figure were calculated using Equation C-3 with the magnitude of recovery substituted for the drawdown term in the equation.

Figure C-7.3-4 shows an expanded-scale plot of the late recovery data. The transmissivity calculated from the line of fit shown on the graph was 130 gpd/ft. The late corrected time-drawdown data should, in theory, show the same slope as the late recovery data. However, the corrected drawdown data showed a flatter slope (and greater transmissivity calculation), confirming the idea of overcorrection using the standard approach based on uniform contribution along the screen.

C-7.4 Well R-5 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-5 screen 2 to provide a frame of reference for evaluating the foregoing analysis.

Rather than using the Brons and Marting method (Equation C-14), fully penetrating conditions were assumed and the lower-bound transmissivity was calculated by iterating the Cooper-Jacob equation (Equation C-9). A pumping time of 1440 min was used for the analysis. The pumping rate of 2.6 gpm was used in the calculations. The actual drawdown to the bottom of the well screen was 46.7 ft. This value was corrected for dewatering, yielding 38.7 ft. However, it was likely that the assumption of uniform conditions was incorrect and that the correction algorithm caused an overcorrection. Therefore, the actual and corrected values were averaged (42.7 ft) in an attempt to obtain a perhaps more realistic representation of effective drawdown. This made the effective representative specific capacity 2.6/42.7 = 0.061 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 0.1 and a borehole radius of 0.51 ft (based on the 12.25-in. borehole size). Even though unconfined conditions were assumed, the storage coefficient range was expanded to include leaky-confined values.

Applying the Cooper-Jacob method to these inputs yielded the lower-bound hydraulic transmissivity estimates shown on Figure C-7.4-1. According to the figure, they ranged from approximately 40 to 80 gpd/ft, not inconsistent with the pumping test estimates.

C-7.5 Well R-5 Screen 2 Summary

Pumping tests were conducted on R-5 screen 2 to assess well yield, evaluate jet development, and gain an understanding of the hydraulic characteristics of the aquifer. Several important observations and conclusions from the test pumping include the following:

- A comparison of barometric pressure and R-5 screen 2 water-level data showed a highly barometrically efficient screen zone. Changes in barometric pressure caused little change in the apparent hydrographs from the well, obtained using non-vented transducers.
- Step-drawdown testing (discussed in Appendix A) showed only modest improvement in well yield attributable to simultaneous jetting and pumping development.
- Casing and filter packer effects persisted for several hours, limiting the pumping test data collection protocols and analyses that could be applied to the data.
- The specific capacity of screen 2 was very low. The well produced 2.6 gpm with drawdown into the sump beneath the screen (greater than 46.7 ft of drawdown).
- It appeared that the dewatering correction applied to the drawdown within the well screen resulted in an overcorrection, implying the possibility that flow to the well came disproportionately from the lower portion of the screen.
- It appeared that the transmissivity calculated from the actual data underestimated the transmissivity while calculations from the corrected data overestimated it. The resulting values of 100 and 220 gpd/ft likely bracket the true transmissivity.
- Recovery data, which did not require correction for dewatering, yielded a transmissivity estimate of 130 gpd/ft.
- Specific capacity data implied a lower-bound transmissivity ranging from approximately 40 to 80 for the range of storage coefficients used in the calculations. This result was not inconsistent with the pumping test values.

C-8.0 WELL R-7 SCREEN 3 PUMPING TESTS

C-8.1 Introduction

This section presents analysis of data obtained from final pumping tests conducted on R-7 screen 3. Earlier, field activities included Westbay equipment removal, swabbing and bailing, initial test pumping, and simultaneous high velocity jetting and pumping of screen 3. Final test pumping was performed to measure the results of the jetting procedures, evaluate well capacity, and assess aquifer parameters.

The screen 3 interval in R-7 extends from 895.5 to 937.4 ft bgs and straddles the water table at 909.0 ft within Miocene pumiceous (Tjfp) sediments. Original testing plans called for housing the test pump inside a shroud and running the shroud into the sump beneath screen 3. This would have assured keeping the pump motor cooled even while pulling the water level to the bottom of the screen during pumping.

However, the short riser casing above ground surface had been welded on crooked when the well was originally constructed. When trying to place the 4.25-in. outside diameter (OD) shroud inside the 4.5-in. inside diameter (ID) well casing, it was not possible to push the shroud through the crooked casing section. Thus, the pump had to be run without a shroud.

This meant that the pump had to be kept well up inside the well screen, above the bottom, in hopes of having enough water contribution from the portion of the screen beneath the pump to keep the motor cool during pump operation. In practice the pump was installed with the bottom of the motor approximately 8 ft above the bottom of the well screen.

Testing consisted of a step drawdown test followed by background monitoring and a 24-hr pumping and recovery test. Because the screen straddled the water level, draining and refilling of the screen and filter pack were inevitable and, thus, it was not possible to use an inflatable packer to eliminate storage effects.

Step-drawdown testing began at 8:00 a.m. on June 20 and continued for 75 min until 9:15 a.m. at discharge rates ranging from 4.9 to 10.0 gpm. The step-drawdown results are presented in Appendix A.

Following step-drawdown testing, background data were recorded until 8:00 a.m. on June 22 when the 24-hr constant rate pumping test began. Pumping continued for 1440 min until 8:00 a.m. on June 23. Following shut down, recovery data were recorded for 1440 min until 8:00 a.m. on June 24 when the pump was pulled from the well.

C-8.2 Background Data Analysis

Background aquifer pressure data collected during the R-7 screen 3 tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure C-8.2-1 shows aquifer pressure data from R-7 screen 3 during the test period along with barometric pressure data from TA-54 that have been corrected to equivalent barometric pressure in feet of water at the water table. The R-7 data measurements reflect the sum of the water pressure and barometric pressure that was recorded using a non-vented pressure transducer, which is why they are referred to as “adjusted” as opposed to the true hydrograph. The times of the pumping periods for the R-7 screen 3 pumping tests are included in Figure C-8.2-1 for reference. Figure C-8.2-2 shows a rolling average illustration of the data.

A comparison of the adjusted hydrograph and barometric pressure curve showed little correlation between the two, suggesting a high barometric efficiency, likely close to 100%. Large changes in barometric pressure caused little change in the apparent hydrograph, meaning the changes in water level were nearly equal to and opposite of changes in barometric pressure.

C-8.3 Well R-7 Screen 3 Pumping Test Analysis

When the R-7 borehole was drilled, it was extended through Miocene pumiceous sediments (Tjfp) to a depth of 1097 ft. This makes the current saturated thickness in the well from 909 to 1097 ft bgs. Screen 3 penetrates just the top 28.4 ft of saturation. When screen 3 was pumped, the cone of depression expanded vertically from the screened interval through a steadily increasing thickness of sediments, presumably including multiple hydraulically contiguous zones separated by intervening less hydraulically transmissive beds. At any given time, it was not possible to know the effective thickness of sediments penetrated by the cone of depression at that particular moment. This made it difficult to know how to assign measured transmissivities to corresponding aquifer thicknesses. Notably, because storage effects could not be eliminated, it was not possible to obtain accurate/representative initial response data when the effective height of the cone of depression was known (approximately equal to the saturated portion of the well screen length).

Figure C-8.3-1 shows a semilog plot of the drawdown data obtained during the 24-hr pumping test. The key casing and filter pack storage times are shown on the plot, obtained using Equation C-3. Clearly, the bulk of the drawdown incurred during pumping was not analyzable.

Figure C-8.3-2 shows an analysis of the earliest valid drawdown data yielding a transmissivity value of 1570 gpd/ft. This value represents the transmissivity of a sediment thickness strictly greater than the saturated screened interval of 28.4 ft. The exact corresponding thickness is not known. An upper bound hydraulic conductivity can be obtained by dividing the transmissivity by the saturated screen length, yielding 1570/28.4 = 55.3 gpd/ft^2, or 7.4 ft/day. The true effective thickness of sediments represented by the slope of the line of fit on the graph would yield a hydraulic conductivity strictly less than 7.4 ft/day, applicable to the screened interval plus an unknown thickness of adjacent sediments near the top of the aquifer. [Note: the drawdown values were not corrected for dewatering before analysis as is normally done when dewatering a portion of the aquifer occurs during pumping. Prior step-drawdown testing demonstrated that little to no capacity was lost when the degree of dewatering was increased. This suggested that the dewatered portion of the screen produced little contribution to the flow and that correcting the data for dewatering would have been unnecessary and would have been an overcorrection.]

Figure C-8.3-3 shows an analysis of the late data obtained from the pumping test revealing a computed transmissivity of 15,000 gpd/ft. The corresponding aquifer thickness represented by this transmissivity is not known but could include most of the 188 ft of saturated Miocene pumiceous sediments (Tjfp). If so, the estimated average hydraulic conductivity of the full thickness of the Tjfp Formation at R-7 would be 15,000/188 = 79.8 gpd/ft, or 10.7 ft/day.

Figure C-8.3-4 shows a semilog plot of the recovery data recorded after pump shutdown. The casing and filter pack storage times are shown on the plot. As was the case with the drawdown plot, the bulk of the recovery data was not analyzable.

Figure C-8.3-5 shows an analysis of the earliest valid data from the recovery plot, yielding a transmissivity of 1580 gpd/ft. This indicates an upper-bound hydraulic conductivity for the sediments near the screened interval of 1580/28.4 = 55.6 gpd/ft^2, or 7.4 ft/day.

Figure C-8.3-6 shows a plot of the late recovery data from screen 3. These data were replotted as a rolling average on Figure C-8.3-7 to reduce the amount of data scatter. The analysis depicted on the graph indicates a transmissivity of 16,100 gpd/ft. Assuming that this represents the full saturated thickness of the Tjfp intersecting the wellbore, the computed hydraulic conductivity is 16,100/188 = 85.6 gpd/ft^2, or 11.4 ft/day.

C-8.4 Well R-7 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-7 screen 3 to provide a frame of reference for evaluating the foregoing analysis.

The total saturated thickness of Puye sediments was assigned a value of 188 ft. The well screen length of 28.4 ft was used in the partial penetration calculations. The drawdown observed after 24 hr of pumping was 6.66 ft.

After 24 hr of operation, R-7 screen 3 produced 7.2 gpm with 6.66 ft of drawdown for a specific capacity of 1.08 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient value of 0.10 and a borehole radius of 0.51 ft (based on the 12.25-in. drill bit used in constructing the well).

Applying the Brons and Marting (1961, 098235) method to these inputs yielded a lower-bound hydraulic conductivity estimate for the screened interval of 4.8 ft/day. This result was consistent with the pumping test analysis, which implied an upper-bound hydraulic conductivity of 7.4 ft/day.

C-8.5 Well R-7 Screen 3 Summary

Step-drawdown and 24-hr pumping and recovery tests were conducted on R-7 screen 3 to gain an understanding of the hydraulic characteristics of the aquifer. Several important observations and conclusions from the test pumping include the following:

- A comparison of barometric pressure and R-7 screen 3 water-level data showed a highly barometrically efficient screen zone. Large changes in barometric pressure caused little change in the apparent hydrographs from the well, obtained using non-vented transducers.
- Step-drawdown testing (discussed elsewhere in this report) showed little loss of specific capacity at pumping rates in excess of 10 gpm and drawdowns up to 10 ft. This suggested that most of the yield to screen 3 came from sediments deeper than 10 ft below the water table. This bodes well for continued productivity in future years when the water table declines.
- The Tjfp Formation at R-7 has a saturated thickness of 188 ft. Screen 3 penetrates just the top 28.4 ft of saturation. Not knowing the thickness of individual hydraulically contiguous portions of the aquifer limited the ability to know what thicknesses corresponded to calculated transmissivity values.
- Because screen 3 straddles the water table, it was not possible to use an inflatable packer to eliminate casing and filter pack storage effects. These effects rendered the first 10 to 20 min of pumping and recovery data unanalyzable.
- Test analysis of the earliest valid data showed an upper-bound hydraulic conductivity for the shallow portion of the aquifer of 7.4 ft/day. Based on this analysis, the actual hydraulic conductivity in this area is strictly less than 7.4 ft/day.
- Specific capacity data implied a lower-bound average hydraulic conductivity of 4.8 ft/day for the screened interval and shallow portion of the aquifer. Thus, the hydraulic conductivity of the upper portion of the aquifer is bracketed between 4.8 and 7.4 ft/day.
- Test analysis of late pumping and recovery data suggested average aquifer hydraulic conductivity values of 10.7 and 11.4 ft/day, respectively. Thus, the average conductivity is greater than that at the top of the aquifer.
- Testing showed that simultaneous high velocity jetting and pumping increased the yield of R-7 screen 3 by about 10%.

C-9.0 WELL R-8 SCREENS 1 AND 2 PUMPING TESTS

C-9.1 INTRODUCTION

This section presents analysis of data obtained from final pumping tests conducted on R-8 screens 1 and 2. Previously, field activities included Westbay equipment removal, swabbing and bailing, initial test pumping, and simultaneous high-velocity jetting and pumping of screens 1 and 2. Final test pumping was performed to measure the results of the jetting procedures, evaluate well capacity, and assess aquifer parameters.

The screen 1 interval in R-8 extends from 705.3 to 755.7 ft bgs within the Tcar and straddles the water table within the Puye sediments. The static water level measured on July 5 was 708.1 ft bgs, making the saturated screen length 755.7 – 708.1 = 47.6 ft. However, when the water level was measured, it was continuing to rise slowly, implying an actual static water level slightly higher than 708.1 ft.

R-8 screen 2 extends from 821.3 to 828.0 ft bgs in the Tcar. The static water level estimated from the transducer data from July 4, 2019, was 726.0 ft bgs, approximately 18 ft below the screen 1 static water level. The difference in the static water levels between screens 1 and 2 showed that the two zones are hydraulically isolated from one another.

Step-drawdown testing of screen 1 began at 7:30 a.m. on July 15 and continued for 120 min until 9:30 a.m. at discharge rates ranging from 2.35 to 8.6 gpm. The step-drawdown results are presented in Appendix A.

Following step-drawdown testing, background data were recorded until 8:00 a.m. on July 16. The 24-hr pumping test began at 8:00 a.m. on July 16 at a discharge rate of 3.25 gpm. After 480 min, the discharge rate was reduced to 2.1 gpm to minimize ongoing dewatering of the well screen. This rate was maintained for the balance of the 24-hr test. Following pump shutoff, recovery data were monitored for 1440 min until 8:00 a.m. on July 18 when the pump was pulled from the well.

Days earlier, screen 2 was tested from July 9 through 14, 2019. Testing consisted of brief trial tests followed by a 24-hr pumping and recovery test.

After installing the pump and getting water to the surface on July 9, trial testing was performed on July 10. Trial testing of R-8 screen 2 (trial 1) began at 8:00 a.m. on July 10 at a discharge rate of 7.5 gpm and continued for 30 min. Following 30 min of recovery, a second trial test (trial 2) was performed at 9:00 a.m. for 60 min at a discharge rate of 7.5 gpm. Following shutdown, recovery/background data were recorded for 2760 min until the start of the 24-hr pumping test.

The 24-hr pumping test on screen 2 began at 8:00 a.m. on July 12 at a discharge rate of 7.5 gpm. Pumping continued for 1440 min until 8:00 a.m. on July 13. Following pump shutoff, recovery data were monitored for 1440 min until 8:00 a.m. on July 14 when the pump was pulled from the well.

C-9.2 Background Data Analysis

Background aquifer pressure data collected during the R-8 screens 1 and 2 tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure C-9.2-1 shows aquifer pressure data from R-8 screen 1 during the screen 1 pumping test along with barometric pressure data from TA-54 that have been corrected to equivalent barometric pressure in feet of water at the water table. The R-8 screen 1 data measurements reflect the sum of the water pressure and barometric pressure that was recorded using a non-vented pressure transducer. The times of the pumping periods for the R-8 screen 1 pumping tests are included in Figure C-9.2-1 for reference.

A comparison of the apparent hydrograph and barometric pressure curve showed little correlation between the two, suggesting a high barometric efficiency, likely close to 100%. Large changes in barometric pressure caused little change in the apparent hydrograph, meaning the changes in water level were nearly equal to and opposite of changes in barometric pressure.

Figure C-9.2-2 shows aquifer pressure data from R-8 screen 2 during the screen 1 pumping test. The times of the screen 1 pumping periods as well as the run times for Los Alamos County production well PM-3 are included for reference. There was little correlation between barometric pressure changes and the screen 2 hydrograph, indicating a high barometric efficiency for screen 2. The large changes in water levels at screen 2 are a direct response to PM-3 pumping. Close inspection of the graphs showed that the drawdown response in screen 2 to PM-3 pumping was delayed by a few hours (i.e., after PM-3 kicked on there was a delay of several hours before the water levels in screen 2 began declining). There was no discernable response in screen 2 because of screen 1 pumping.

Figure C-9.2-3 shows aquifer pressure data from R-8 screen 2 during the screen 2 pumping test. The times of the screen 2 pumping periods and the PM-3 run times are included in the plot. There was little correlation between barometric pressure changes and the screen 2 hydrograph, confirming the high barometric efficiency for screen 2.

Figure C-9.2-4 shows aquifer pressure data from R-8 screen 1 during the screen 2 pumping test. The magnitude of the water level scale is double that of the barometric pressure scale to accommodate showing a greater portion of the screen 1 recovery. There was little correlation between barometric pressure changes and the screen 1 hydrograph, confirming the high barometric efficiency for screen 1.

Note that water levels in screen 1 rose steadily throughout the monitoring period, apparently recovering from days of flow from screen 1 to screen 2 that occurred when the well was open. There was no distinct response in screen 1 to pumping screen 2. Also, there was no apparent response to PM-3 operation.

C-9.3 Well R-8 Screen 1 Pumping Test Analysis

Figure C-9.3-1 shows a semilog plot of drawdown data from R-8 screen 1. Along with the actual drawdown are values corrected for dewatering of the well screen that occurred during pumping. This was necessary because the relevant equations applied to analyze the data are based on theoretical drawdown rather than actual drawdown. Equation C-16 was used for computing the corrected drawdown.

Because the screen straddled the water table, it was not possible to eliminate screen and filter pack storage effects. The key storage times are shown on the plot for reference.

At a pumping time of approximately 200 min, the slope of the time-drawdown curve doubled. This response is often an indication that the pumping water level has been drawn just beneath a high-producing portion of the aquifer. The rapidly increasing drawdown was manifested at the surface by subtle transient reductions in gauge pressure. In order to minimize the amount of dewatering of the well screen that might occur over 24 hr, the decision was made to reduce the flow rate. After 480 min, the rate was cut back from 3.25 gpm to 2.1 gpm and maintained there for the balance of the pumping test.

As shown on Figure C-9.3-1, transmissivity values computed from the 3.25 gpm and 2.1 gpm portions of the drawdown graph were 210 and 290 gpd/ft, respectively.

Figure C-9.3-2 shows a semilog plot of the recovery data from R-8 screen 1. The storage times are shown on the plot for reference. The transmissivity computed from the line of fit shown on the graph was 230 gpd/ft. The calculation was made using actual, rather than corrected, data because the magnitude of drawdown was small enough to ignore the correction for dewatering. This is illustrated on Figure C-9.3-3, which compares actual and corrected drawdown. For drawdown values less than about 4 ft, the two sets of values were identical.

Averaging the calculated transmissivities yielded an average value of 240 gpd/ft. Assuming that screen 1 fully penetrates the permeable zone, the corresponding calculated hydraulic conductivity was 240/47.6 = 5.0 gpd/ft, or 0.67 ft/day. If the actual thickness of the hydraulically contiguous zone is greater than the screen length, the actual conductivity would be somewhat less. Thus, 0.67 ft/day can be viewed as an upper bound. The screen 1 interval was known to be underlain by impermeable sediments because of the lack of hydraulic response to pumping screen 2. However, the location of this aquitard was not known.

C-9.4 Well R-8 Screen 1 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-8 screen 1 to provide a frame of reference for evaluating the foregoing analysis.

Full penetration was assumed for this calculation. After 24 hr of operation, R-8 screen 1 produced 2.1 gpm with 14.4 ft of drawdown. This value had to be corrected for dewatering, yielding a theoretical drawdown of 12.2 ft for a theoretical specific capacity of 0.172 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient value of 0.10 and a borehole radius of 0.6 ft (based on the 14.5-in. borehole size).

Applying the Cooper-Jacob equation to these inputs yielded a lower-bound hydraulic conductivity estimate for the screened interval of 2.9 gpd/ft^2, or 0.39 ft/day. This result was consistent with the pumping test analysis, which implied an upper-bound hydraulic conductivity of 0.67 ft/day.

C-9.5 Well R-8 Screen 2 Pumping Test Analysis

Figure C-9.5-1 shows a semilog plot of the drawdown data collected during trial 1 at R-8 screen 2 at a pumping rate of 7.5 gpm. Before starting trial 1, water levels in R-8 screen 2 were declining at a rate of 0.00069 ft/min because of PM-3 operation. Therefore, the drawdown values were corrected for this trend before plotting. The transmissivity computed from the line of fit on Figure C-9.5-1 was 3700 gpd/ft.

Figure C-9.5-2 shows a semilog plot of the screen 2 recovery data collected during trial 1. Again, the data were corrected for the trend associated with PM-3 operation. The transmissivity computed from the line of fit on the plot was 3360 gpd/ft.

Figure C-9.5-3 shows a semilog plot of the corrected drawdown data collected during trial 2 at R-8 screen 2 at a pumping rate of 7.5 gpm. The calculated transmissivity was 4060 gpd/ft. The first couple of data points exhibited storage-affected response. The water pumped from screen 2 contained a large amount of gas/air throughout the testing. If any of the air was trapped beneath the upper packer, it would be expected to cause a storage effect by expanding and contracting in response to pressure changes during pumping and recovery.

Figure C-9.5-4 shows a semilog plot of the corrected recovery data collected during trial 2 at R-8 screen 2. The calculated transmissivity was 3820 gpd/ft. Correction was limited to the first 30 min of recovery, as PM-3 shut down after that. Again, the first couple of data points exhibited storage-affected response, likely attributable to air trapped beneath the upper packer. Note that after PM-3 shut down (indicated on the graph), there was a significant lag before water levels showed discernable recovery, consistent with the time lag identified on the barometric pressure curves.

Figure C-9.5-5 shows an expanded-scale plot of the late recovery data. After PM-3 shut down, there was a lag and a continuing drawdown effect at R-8 screen 2 caused by PM-3 (data points sagging below the line of fit), followed by ongoing sinusoidal response to PM-3 pumping and shutdown cycles.

Figure C-9.5-6 shows drawdown data collected during the 24-hr test on R-8 screen 2. Before pumping, water levels in R-8 screen 2 were declining at a rate of 0.00053 ft/min because of PM-3 operation. Therefore, the data were corrected for this trend. However, the correction was applied to just the first 210 min of data because PM-3 shut down after that. After 210 min, no further correction increment was applied as PM-3 continued to cycle.

The earliest data showed a storage-like effect, probably associated with a tiny volume of air trapped beneath the upper packer. Also, there was exaggerated drawdown during the first few seconds of pumping. It is possible that this reflected inertial effects sometimes seen at startup. A more likely possibility is that air had been trapped at the top of the drop pipe at the end of the previous pumping event (trial 2) 2 days earlier. When trial 2 ended, the 800 ft of drop pipe would have been filled with aerated water. The air bubbles likely would have risen up the drop pipe, collecting at the surface. On startup, the trapped air volume would have been compressed before the full resistance of the discharge valve would have been felt by the pump. During this brief interval, the discharge rate would have been higher temporarily until full backpressure was applied to the pump. The higher transient pumping rate would have caused exaggerated drawdown temporarily. During the first minute of pumping, the volume of water passing through the flow meter was 6.6 gal., rather than the expected 7.5 gal. The volume difference could reflect the volume reduction in trapped air that occurred via compression when pumping began.

The transmissivity computed from the line of fit on the graph was 3680 gpd/ft.

Figure C-9.5-7 shows a semilog plot of the corrected recovery data collected following the 24-hr test. The calculated transmissivity was also 3860 gpd/ft. Because these data were preceded by pumping screen 2, it was not possible to identify the magnitude of the antecedent trend caused by PM-3. Therefore, the data were corrected for an assumed trend of 0.00061 ft/min, the average of the two previously measured trends. Corrections were applied to the first 330 min, at which time PM-3 shut down. No additional correction increment was applied after that.

Again, the first portion of the plot exhibited storage-affected response, likely attributable to air trapped beneath the upper packer. This time, however, the duration of the effect was approximately 1 min, whereas the previous observed effects lasted only a second or so. It was likely that the extended pumping period (24 hr) allowed a greater amount of air to collect beneath the upper packer, thereby increasing the storage time.

The average transmissivity calculated from the six results obtained from trial 1, trial 2, and the 24-hr test was 3750 gpd/ft. The effective saturated thickness corresponding to the transmissivity was not known. Applying just the well screen length of 6.7 ft yielded an upper-bound hydraulic conductivity of 3750/6.7 = 560 gpd/ft^2, or 74.8 ft/day. Assuming a greater thickness of hydraulically contiguous sediments would produce a correspondingly lower conductivity value.

C-9.6 WELL R-8 SCREEN 2 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-8 screen 2 to provide a frame of reference for evaluating the foregoing analysis.

An arbitrary aquifer thickness of 50 ft was assigned in the calculations. After 24 hr of operation, R-8 screen 2 produced 7.5 gpm with 7.28 ft of drawdown. This value had to be corrected for estimated PM-3 effects of 0.25 ft, yielding a representative drawdown of 7.03 ft and a specific capacity of 1.07 gpm/ft. 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 0.6 ft (based on the 14.5-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 111 gpd/ft^2, or 14.8 ft/day, far below the upper-bound estimate from the pumping test analysis. Thus, the hydraulic conductivity was not very well constrained, potentially falling anywhere in the range of 14.8 to 74.8 ft/day.

Dividing the lower-bound conductivity (111 gpd/ft^2) into the transmissivity (3750 gpd/ft) provided an upper-bound estimate of the thickness of hydraulically contiguous sediments in which screen 2 lies, about 34 ft. This implied that the thickness of the tested interval fell between about 6.7 and 34 ft, with aquitards both above and below the tested interval. Without identifiable aquitard locations inferred from the drillers log, geophysics, or formation samples, it was not possible to constrain the tested zone thickness and hydraulic conductivity values any better than this.

C-9.7 Well R-8 Screens 1 and 2 Summary

Step-drawdown testing, short trial tests, and 24-hr pumping and recovery tests were conducted on R-8 screens 1 and 2 to gain an understanding of the hydraulic characteristics of the aquifer. Several important observations and conclusions from the test pumping include the following:

- A comparison of barometric pressure and R-8 screens 1 and 2 water-level data showed highly barometrically efficient screens zone. Large changes in barometric pressure caused little change in the apparent hydrographs from the screen zones, obtained using non-vented transducers.
- Screens 1 and 2 are hydraulically separate from one another. Pumping either zone had no discernable effect on the other.
- Screen 1 is not affected by Los Alamos County production well operation.
- Screen 2 shows a direct response to operation of PM-3, 3360 ft away, with a time lag of several hours.
- Because screen 1 straddles the water table, it was not possible to eliminate casing and filter pack storage effects. These effects rendered the first hour or so of pumping and recovery data unanalyzable.
- No data were available to identify tops and bottoms of hydraulically contiguous zones, making it difficult to correlate transmissivity values with particular aquifer thicknesses. This limited the ability to constrain the hydraulic conductivity values.
- Testing R-8 screen 1 revealed a transmissivity of 240 gpd/ft and an upper-bound conductivity of 0.67 ft/day.
- Screen 1 specific capacity data implied a lower-bound average hydraulic conductivity of 0.39 ft/day for the screened interval. Thus, the hydraulic conductivity of the upper portion of the aquifer was bracketed between 0.39 and 0.67 ft/day.
- Testing R-8 screen 2 revealed a transmissivity of 3750 gpd/ft and an upper-bound conductivity of 74.8 ft/day.

- Screen 2 specific capacity data implied a lower-bound average hydraulic conductivity of 14.8 ft/day for the screened interval. Thus, the hydraulic conductivity of the upper portion of the aquifer was not well constrained, bracketed between 14.8 and 74.8 ft/day.
- The pumping capacity of screen 1 was sufficient to support operation of a submersible pump. Thus, the sampling system for R-8 was based on a single pump, dual access port valve design.
- Testing revealed that simultaneous high velocity jetting and pumping increased the yield of screen 1 by 45%, but showed only minor improvement at screen 2.

C-10.0 WELL R-9I SCREEN 1 PUMPING TESTS

C-10.1 Introduction

This section presents analysis of data obtained from final pumping tests conducted on R-9i screen 1. Previously, field activities included Westbay equipment removal, swabbing and bailing, initial test pumping, and purging and sampling of screen 2. Final test pumping was performed to evaluate well capacity and assess aquifer parameters.

The screen 1 interval in R-9i extends from 189.0 to 199.5 ft bgs in a perched zone within the Cerros del Rio basalt. The static water level measured on June 19 was 144.6 ft bgs. The R-9i completion report indicated that saturation of this perched zone extends down as deep as 236 ft bgs. Although water (fracturing) was first encountered at 186 ft bgs, the observed static water level suggested that saturation might extend as high as 144.56 ft bgs away from the well. The wellbore happened to encounter fractures only at 186 ft bgs and perhaps deeper.

Aquifer testing of R-9i screen 1 was performed from June 23 to 27, 2019. Testing consisted of brief trial testing followed by a 24-hr pumping and recovery test.

Trial testing of R-9i screen 1 (trial 1) began at 10:00 a.m. on June 23 at a discharge rate of 14.6 gpm and continued for 30 min. Following shutdown, recovery data were recorded for 30 min until 11:00 a.m.

Trial 2 began at 11:00 a.m. at a discharge rate of 14.5 gpm and continued for 60 min until 12:00 p.m. Following shutdown, recovery/background data were recorded for 2640 min until the start of the 24-hr pumping test.

The 24-hr pumping test began at 8:00 a.m. on June 25 at a discharge rate of 14.7 gpm and continued for 1440 min until 8:00 a.m. on June 26. Following pump shutoff, recovery data were monitored for 1440 min until 8:00 a.m. on June 27 when the pump was pulled from the well.

C-10.2 Background Data Analysis

Background aquifer pressure data collected during the R-9i screen 1 tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure C-10.2-1 shows aquifer pressure data from R-9i screen 1 during the test period along with barometric pressure data from TA-54 that have been corrected to equivalent barometric pressure in feet of water at the water table. The R-9i data measurements reflect the sum of the water pressure and barometric pressure that was recorded using a non-vented pressure transducer. The times of the pumping periods for the R-9i screen 1 pumping tests are included in Figure C-10.2-1 for reference.

A comparison of the apparent hydrograph and barometric pressure curve showed a similar shape. Although the data scatter obscured the hydrograph somewhat, it appeared that the hydrograph amplitude was less than that of the barometric pressure curve.

To reduce the data scatter, the hydrograph data were replotted as a rolling average on Figure C-10.2-2. In addition, on this figure, the barometric pressure data were modified to reflect an arbitrary barometric efficiency in such a way that the efficiency could be adjusted to obtain a best fit to the hydrograph data. The match depicted was obtained for a barometric efficiency of 45%. This meant that even when using a non-vented pressure transducer, changes in barometric pressure would be expected to cause changes in the measured head, unlike the deep wells at LANL where barometric pressure changes have negligible effect on measured head.

C-10.3 Well R-9i Screen 1 Pumping Test Analysis

The pumping test response at R-9i screen 1 was highly unusual in that essentially full drawdown occurred instantly when pumping began. In some of the tests, data were recorded starting at less than 0.25 s since pumping started or stopped and yet near maximum drawdown/recovery was already achieved.

Subsequently, there was little change in water level over time, suggesting enormous transmissivity. The combination of tiny drawdown changes superimposed on large barometric-related water level fluctuations made precise determination of aquifer parameters based on the available data challenging and subject to inaccuracy. Further, because screen 1 is completed in rock (Cerros del Rio basalt) rather than sediments, application of porous media analytical methods is subject to limitations and the corresponding results may not be definitive.

Figure C-10.3-1 shows a semilog plot of the drawdown data from trial 1 in which screen 1 was pumped at 14.6 gpm. Because of the small changes in drawdown over time, the data were replotted on an expanded scale on Figure C-10.3-2 and converted to a rolling average to reduce data scatter. The transmissivity computed from the line of fit shown on the graph was 82,300 gpd/ft.

Figure C-10.3-3 shows a semilog plot of the recovery data following trial 1. Again, the data were replotted on an expanded scale on Figure C-10.3-4 and as a rolling average on Figure C-10.3-5 to reduce scatter. The transmissivity estimated from the line of fit shown on Figure C-10.3-5 was 77,000 gpd/ft.

Figure C-10.3-6 shows a semilog plot of the drawdown data from trial 2 in which screen 1 was pumped at 14.5 gpm. The data were replotted on an expanded scale on Figure C-10.3-7 and as a rolling average on Figure C-10.3-8 to reduce scatter. The transmissivity estimated from the line of fit shown on the graph was 115,000 gpd/ft.

Figure C-10.3-9 shows a semilog plot of the recovery data following trial 2. The earliest data clearly showed inertial effects. The data were replotted on an expanded scale on Figure C-10.3-10 and as a rolling average on Figure C-10.3-11 to reduce scatter. The transmissivity estimated from the line of fit shown on Figure C-10.3-11 was 94,800 gpd/ft.

Figure C-10.3-12 shows a semilog plot of the drawdown data from the 24-hr test in which screen 1 was pumped at 14.7 gpm. The data were replotted on an expanded scale on Figure C-10.3-13 and as a rolling average on Figure C-10.3-14 to reduce scatter. The transmissivity estimated from the line of fit shown on Figure C-10.3-14 was 66,300 gpd/ft.

Figure C-10.3-15 shows a semilog plot of the recovery data following pump shutdown. The earliest data clearly showed inertial effects. The data were replotted on an expanded scale on Figure C-10.3-16 and as a rolling average on Figure C-10.3-17 to reduce scatter. The transmissivity estimated from the line of fit shown on Figure C-10.3-17 was 60,000 gpd/ft.

Test analysis showed a broad range of computed transmissivity values, from 60,000 to 115,000 gpd/ft, averaging 82,600 gpd/ft. These values were calculated from water level changes on only a few hundredths of a foot in a data set where simple random transducer data scatter exceeded this magnitude and where barometric pressure induced fluctuations were several times greater than relevant water level changes. These conditions contributed to the inconsistency of the computed values and limited the ability to obtain precise aquifer parameters. The tested interval of the Cerros del Rio basalt at R-9i screen 1 is found to be very transmissive.

C-10.4 Well R-9i Screen 1 Specific Capacity

Specific capacity data were used along with well geometry to estimate a lower-bound transmissivity value for the saturated perched zone penetrated by R-9i screen 1 to provide a frame of reference for evaluating the foregoing analysis.

The R-9i completion report indicated that the saturated perched zone in which R9i screen 1 was located reached a depth of 236 ft bgs. The static water level at the time of the current testing was measured at 144.56 ft. It is reasonable to assume that saturated fractures/voids in the perched zone extend from 144.56 to 236 ft, a potential saturated thickness of 91.44 ft. This value was used in the calculation of a lower-bound transmissivity value for comparison to the pumping test values. During drilling, water was not encountered until the borehole reached a depth of 186 ft, after which water rose to the prevailing static level. This could imply that saturated fractures and voids are absent above 186 ft. It is also possible that they do exist but that because of the sparse nature of void/fracture patterns, this particular borehole did not happen to intersect them.

After 24 hr of operation, R-9i screen 1 produced 14.7 gpm with 3.23 ft of drawdown for a specific capacity of 4.55 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient value of 5×10^{-5} and a borehole radius of 0.51 ft (based on the 12.25-in. borehole size).

Applying the Brons and Marting (1961, 098235) method to these inputs yielded a lower-bound transmissivity estimate for the perched interval of 34,600 gpd/ft. In a porous medium (unconsolidated material), this would imply a well efficiency of approximately 34,600/82,600 = 42%, a marginal but adequate value. In fractured media, however, this may not apply. The yield to wells from voids and fractures is largely dependent on the random way that the borehole intersects the sporadically spaced voids. Two wells near each other can have very different yields, depending on which fractures each borehole happens to penetrate/intersect. Nevertheless, it can be said that the calculated lower-bound transmissivity and the pumping test value appeared to be consistent with each other.

C-10.5 Well R-9i Screen 1 Summary

Trial testing and 24-hr pumping and recovery tests were conducted on R-9i screen 1 to gain an understanding of the hydraulic characteristics of the aquifer. Several important observations and conclusions from the test pumping include the following:

- A comparison of barometric pressure and R-9i screen 1 water-level data showed barometric effects on aquifer pressure, with a barometric efficiency of approximately 45%.

- Because of the enormous transmissivity of the Cerros del Rio perched zone at R-9i screen 1, transient water level changes during drawdown and recovery tests were miniscule, typically just a few hundredths of a foot. Random transducer data scatter (output fluctuations) was greater than this, as were barometric pressure induced water level fluctuations. As a result, water level changes sought to support determination of aquifer parameters were obscured, making accurate determination of aquifer coefficients difficult.
- Analysis of R-9i screen 1 pumping test data yielded transmissivity values ranging from 60,000 to 115,000 gpd/ft, averaging 82,600 gpd/ft.
- Screen 1 specific capacity data implied a lower-bound transmissivity of 34,600 gpd/ft—a reasonable value and consistent with the pumping test results, suggesting a moderate well efficiency.
- Any calculations from the test data should be considered approximate, as they involve applying porous media analytical methods to a formation where open channel flow through voids and fractures may predominate.

C-11.0 WELL R-19 SCREENS 2 AND 3 PUMPING TESTS

C-11.1 Introduction

This section presents analysis of data obtained from final pumping tests conducted on R-19 screens 2 and 3. Previously, field activities included Westbay equipment removal; swabbing and bailing; initial test pumping; simultaneous jetting and pumping development of screens 2 and 3; and abandonment of screens 4, 5, 6 and 7. Final test pumping was performed to evaluate screen zone capacity and assess aquifer parameters.

The screen 2 interval in R-19 extends from 893.3 to 909.6 ft bgs and straddles the water table within a perched zone in Puye Formation sediments overlying the Cerros del Rio basalt. The static water level measured on August 20 was 899.0 ft bgs. Previous testing had shown that screen 2 could not support continuous pumping with a conventional submersible pump. Therefore, testing was accomplished by pumping the water level down into the casing well beneath the bottom of the screen and observing the refill rate as the casing refilled. 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.

Testing of screen 2 was performed twice. Initially, on August 16, 2019, when the pump was deployed to test screen 3 and the packers were inflated, the refill rate above the upper packer (flow from screen 2) was monitored. After inflating the packers around screen 3, the water level above the upper packer rose steadily within the casing between the upper transducer and the bottom of screen 2 for 344 min from 3:40 p.m. to 9:24 p.m. on August 16.

Subsequently, on August 20, screen 2 was packed off and several pumping cycles were applied successively to lower the water level into the sump beneath screen 2 so that the refill rate could be monitored. The initial pumping cycle began at 8:00 a.m. on August 20 and additional pumping and recovery cycles were applied. Useful blocks of recovery data were obtained intermittently for 652 min from 8:07 a.m. until 6:59 p.m.

The screen 3 interval in R-19 extends from 1171.4 to 1215.4 ft bgs and straddles the water table at the top of the regional aquifer in the lower fanglomerate facies of the Puye Formation sediments overlying the Cerros del Rio basalt. The static water level measured on August 17 was 1187.0 ft bgs. Screen 3 was tested from August 16 through 19, 2019. Testing consisted of a 12-hr constant rate test followed by background data collection and a final step-drawdown test.

After brief background data collection overnight, the 12-hr test on R-19 screen 3 began at 8:00 a.m. on August 17 at a discharge rate of 6.5 gpm and continued until 8:00 p.m. Following shutdown, recovery/background data were recorded for 2200 min until 8:40 a.m. on August 19.

The final step-drawdown test on screen 3 began at 8:40 a.m. on August 19 and continued for 150 min until 11:10 a.m. The results of this test are summarized in Appendix A.

C-11.2 Background Data Analysis

Background aquifer pressure data collected during the R-19 screens 2 and 3 tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure C-11.2-1 shows aquifer pressure data from R-19 screen 2 along with barometric pressure data from TA-54 that have been corrected to equivalent barometric pressure in feet of water at the water table. The R-19 screen 2 data measurements reflect the sum of the water pressure and barometric pressure that was recorded using a non-vented pressure transducer. The time of the pumping period for the R-19 screen 3 pumping test is included in Figure C-11.2-1 for reference. It appeared that screen 2 showed a tiny, transient, muted response to pumping screen 3, possibly a pressure response to elastic deformation of the sediments caused by pumping, or simple elastic response of the pumping string and packers when stressed by pumping.

The rising trend illustrated in the screen 2 water levels showed continued water level recovery at screen 2 resulting from previous inflation of the packers around screen 3 and filling of the casing above the upper packer. This made it difficult to discern the correlation of water levels to barometric pressure. Nevertheless, portions of the hydrograph seemed to mimic the changes in barometric pressure.

To check this, the hydrograph was modified to correct the data for the simplified assumption of a linear water level rise, and the barometric pressure response was modified to reflect an arbitrarily assigned barometric efficiency. The magnitude of the water level rise rate and the barometric efficiency were adjusted to obtain a best match between the two curves.

Figure C-11.2-2 shows a rolling average of the corrected hydrograph data and the adjusted barometric pressure curve for an assumed water level rise of 0.105 ft/day and barometric efficiency of 55%. The data recorded for about a day and a half following shutdown of the screen 3 pumping test showed a good correlation, suggesting a moderate barometric efficiency for the screen 2 perched zone.

Figure C-11.2-3 shows aquifer pressure data from R-19 screen 3 along with the barometric pressure data. To minimize the data scatter, the water level data were replotted as a rolling average, as shown on Figure C-11.2-4. The plot showed no correlation between the two curves, suggesting a high barometric efficiency for the screen 3 zone.

C-11.3 Well R-19 Screen 2 Pumping Test Analysis

Figure C-11.3-1 shows water level recovery measured in the casing beneath screen 2 on August 16, when packers were inflated around screen 3 in preparation for testing of screen 3. It is apparent that the recovery rate was approximately linear, suggesting a fairly uniform flow rate from screen 2. Throughout the recovery illustrated, the water level remained beneath screen 2, meaning that the drawdown in screen 2 was constant and was the maximum value of 10.6 ft (from the static water level of 899.0 ft to the bottom of screen 2 at 909.6 ft bgs). Because the entire length of screen 2 was dewatered at all times, the observed drawdown was corrected for dewatering. At maximum drawdown, the correction factor is 50%, making the effective, or theoretical, drawdown for analytical calculation purposes 10.6/2 = 5.3 ft.

The rate of inflow from screen 2 was calculated based on the casing volume and the change in observed head from one measurement to another. Head data were collected at 2-min intervals and, thus, the effective discharge rate from screen 2 between consecutive measurements was taken as the volume of refill divided by 2 min. Refill volume was calculated assuming an annular volume of 0.596 gal./ft between the 4.5-in. ID casing and the 2-in. stainless-steel drop pipe. Figure C-11.3-2 shows the resulting flow rate as a function of time.

Figure C-11.3-2 shows a peculiar pattern in that the calculated flow shows a distinct, transient increase every thirteenth or fourteenth measurement (every 26 to 28 min). The true flow rate into the well may have been steady and the observed response did not represent actual inflow but was an artifact of the functioning of the transducer. It appeared as though the transducer tensiometer response did not keep pace with the actual pressure change until a particular threshold was reached; and then there was a sudden “jump” as the transducer caught up with the ongoing pressure increase. This cycle was then repeated at approximately 27-min intervals. To reduce the data scatter and, perhaps, more closely reflect the actual hydraulic response, the data were replotted as a rolling average on Figure C-11.3-3.

Typically, refill rate data such as these are used to compute specific drawdown (ratio of drawdown to pumping rate), which is plotted on a semilog graph versus time since pumping began. Such a graph can then be used to compute transmissivity, analogous to conventional semilog time-drawdown analysis. In this case, however, the well had been open to screen 2 flow for more than 19 days (exactly 27,695 min) before monitoring the refill associated with packer inflation around screen 3. Thus, plotting the 344-min monitoring period on a log scale would have spanned the time from 27,695 to 28,039 min, thereby compressing all of the information into a tiny portion of the graph. Such a plot would be unusable and unanalyzable.

Therefore, for illustration purposes, the specific drawdown data were plotted versus time since monitoring began. The specific drawdown for each data point was obtained by dividing the theoretical drawdown of 5.3 ft by the corresponding refill rate. The resulting plot is shown on Figure C-11.3-4.

As shown on Figure C-11.3-4, the specific drawdown (and refill rate) remained essentially constant for nearly 3 hr. This is the expected outcome because negligible change in the specific capacity of a well would be expected to occur between 27,695 and 28,039 min since pumping began. After a few hours, however, there was a decline in the computed specific drawdown, corresponding to the decline in refill rates evident on Figures C-11.3-2 and C-11.3-3. This suggested that the transducer did not record the water pressure accurately as the casing beneath screen 2 filled. Scrutiny of the data showed that the water level discrepancies that could produce the plot shown on Figure C-11.3-4 were still within the manufacturer’s published accuracy guidelines for the transducer. Apparently, the accuracy of the transducer degraded at higher applied pressure.

After flowing for nearly 3 wk, screen 2 water levels were allowed to recover from the afternoon of August 16 until the morning of August 20, 2019, except for a 51-min period when the pump and packer string was moved from screen 3 to screen 2. This long recovery event provided an opportunity to re-saturate the screen 2 perched zone and monitor a new set of pumping and recovery data to support determination of aquifer properties.

Pumping began at 8:00 a.m. on August 20, 2019. Usable data were obtained from 8:07 a.m. to 6:59 p.m. and are illustrated on Figure C-11.3-5. Pumping was performed at periodic intervals in an attempt to keep the water level in the blank casing beneath the bottom of screen 2. Care was taken to avoid restarting the pump too often in order to avoid overheating the motor. This effort was largely successful except for two long recovery intervals between elapsed times of 200 and 500 min. These corresponded to site shutdowns forced by lightning and explosives detonation in the area.

During each cycle shown on Figure C-11.3-5, the water level was pumped down to the pump intake, about 10 ft above the location of the transducer. Then the pump was shut down to allow water levels to recover. The first 4 ft or so of recovery during each cycle showed a steeper slope than the subsequent curve. This was because that portion of the casing contained the pump and shroud which occupied substantially more volume than the overlying 2-in. stainless-steel drop pipe and, thus, refilled faster (i.e., there was less water volume per foot in that area). In a few cases, toward the end of the cycle, the water level rose into the well screen. At that point, the rate of water level rise diminished because (1) both the screen and the filter pack refilled, thereby increasing the water volume per foot, and (2) the effective drawdown declined, causing a reduction in the rate of inflow.

The head data on Figure C-11.3-5 were used to compute the refill rate. Head data were recorded at 2-min intervals, so the refill rates were calculated for each of the 2-min intervals. To simplify the calculations, the water volume of 0.596 gal./ft, representing the annular volume between the casing and the 2-in. drop pipe, was used for all computations. This had the effect of (1) exaggerating the computed flow rate for early recovery, through the area of the pump and shroud where the true annular volume was less than 0.596 gal./ft and (2) underestimating the flow rate for the late recovery during each cycle, when the water level rose into the well screen, where the combined volume of casing annulus and filter pack voids was greater than 0.596 gal./ft. These exaggerated and underestimated flow rates were then excluded from the subsequent analysis.

Figure C-11.3-6 shows the results of the flow rate calculations. The true flow rate averaged approximately 0.5 gpm. Data points well above this level on the graph represented the exaggerated flow rates corresponding to early recovery in the area of the pump and shroud. Data points below this level represented either (1) the underestimated flow rates corresponding to late recovery when the water level rose into the well screen or (2) periods of pump operation when the computed flow rate value was a negative number.

The plot on Figure C-11.3-6 was edited to remove the exaggerated and underestimated data points. The remaining flow rate data are shown on Figure C-11.3-7. These data showed the same periodic spikes in calculated flow rate that had been observed during the initial monitoring period (Figure C-11.3-2).

To eliminate the erroneous spikes in flow rate and more accurately represent actual conditions, the data from Figure C-11.3-7 were replotted as a rolling average on Figure C-11.3-8.

These data were converted to specific drawdown by dividing the theoretical drawdown of 5.3 ft by the magnitude of the rolling average flow rate. The results were plotted versus time since pumping began on the semilog graph shown on Figure C-11.3-9. Based on the slope of the line of fit shown on the graph, the transmissivity was estimated at 260 gpd/ft. The data corresponding to times greater than about 200 min did not fit the analysis. This was because of the long recovery/re-saturation periods that resulted from the two extended site shutdowns that occurred between 200 and 500 min.

The effective saturated thickness corresponding to the computed transmissivity from screen 2 was not known. It was a minimum of 10.6 ft but could have been greater, depending on the makeup of the sediments and the vertical rate of growth of the cone of depression. Using a saturated perched zone thickness of 10.6 yielded a hydraulic conductivity of 24.5 gpd/ft^2, or 3.3 ft/day. A greater thickness would yield a correspondingly lower conductivity. For example, an effective thickness several times greater than the saturated screen length would imply a conductivity several times lower than 3.3 ft/day. The value of 3.3 ft/day was considered an upper-bound estimate of conductivity for the perched zone.

C-11.4 Well R-19 Screen 2 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-19 screen 2 to provide a frame of reference for evaluating the foregoing analysis.

An arbitrary aquifer thickness of 50 ft was assigned in the calculations. After 652 min of operation, R-19 screen 2 produced 0.49 gpm with a theoretical drawdown of 5.3 ft, yielding a theoretical specific capacity of 0.0924 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient value of 0.05 and a borehole radius of 0.51 ft (based on the 12.25-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 6.0 gpd/ft^2, or 0.80 ft/day, well below the upper-bound estimate from the pumping test analysis. Thus, the hydraulic conductivity was constrained between 0.80 and 3.3 ft/day.

C-11.5 Well R-19 Screen 3 Pumping Test Analysis

R-19 screen 3 was test pumped for 12 hr from 8:00 a.m. to 8:00 p.m. on August 17, 2019, at a discharge rate of 6.5 gpm. Figure C-11.5-1 shows a semilog plot of the observed drawdown data. To reduce the amount of data scatter, the drawdown values were replotted as a rolling average on Figure C-11.5-2. The casing and filter pack storage time estimates are indicated on the graph for reference. The transmissivity calculated from the earliest valid data on the graph was 8700 gpd/ft.

The later data shown on the plot showed flattening, likely a combination of delayed yield and vertical growth of the cone of depression.

Figure C-11.5-3 shows a semilog plot of the screen 3 recovery data. Again, data scatter was reduced by replotting the residual drawdown values as a rolling average as shown on Figure C-11.5-4. The casing and filter pack storage times are indicated for reference.

For clarity of analysis, these data were plotted on the expanded scale shown on Figure C-11.5-5. The transmissivity calculated from the earliest valid data on this graph was 11,200 gpd/ft. Subsequent data showed flattening of the curve, indicating delayed yield and/or vertical expansion of the cone of impression.

Combining the two results yielded an estimated average transmissivity of 9950 gpd/ft. This value could be representative of the saturated well screen thickness of 28.4 ft or a somewhat greater thickness of sediments. Based on the saturated screen length of 28.4 ft, the estimate of the average hydraulic conductivity would equal 9950/28.4 = 350 gpd/ft^2, or 46.8 ft/day. This value was considered an upper bound for the conductivity. Assuming a greater effective cone of depression thickness for the early time data would yield a correspondingly lower conductivity value.

C-11.6 Well R-19 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-19 screen 3 to provide a frame of reference for evaluating the foregoing analysis.

An arbitrary aquifer thickness of 100 ft rather than 50 ft was assigned in the calculations because of the longer screen. After 720 min of operation, R-19 screen 3 produced 6.5 gpm with a drawdown of 1.47 ft, yielding a specific capacity of 4.4 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included an assigned storage coefficient value of 0.05 and a borehole radius of 0.51 ft (based on the 12.25-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 153 gpd/ft^2, or 20.5 ft/day. This result was not inconsistent with the pumping test analysis results and helped constrain the hydraulic conductivity between 20.5 and 46.7 ft/day.

C-11.7 Well R-19 Screens 2 and 3 Summary

Pumping tests were conducted on R-19 screens 2 and 3 to gain an understanding of the flow capacity of each zone and assess the hydraulic characteristics of the perched zone and the top of the regional aquifer. Several important observations and conclusions from the test pumping include the following:

- A comparison of barometric pressure and R-19 screen 2 water-level data showed a moderate barometric efficiency of approximately 55% for the zone. Changes in barometric pressure induced significant change in the aquifer pressure as shown by the apparent hydrograph, obtained using a non-vented transducer.
- Screen 3, on the other hand, showed negligible pressure response to barometric changes, indicating a high barometric efficiency, near 100%.
- Screen 2 posed a testing challenge because its low yield would not support continuous pumping using a submersible pump. Therefore, it was necessary to conduct a constant drawdown test rather than a constant rate test. However, the testing was interrupted by a lightning shutdown and a shutdown for a "shot" (explosives detonation) at TA-15. Nevertheless, an upper-bound estimate of hydraulic conductivity of 3.3 ft/day was obtained from the testing that was performed. The effective thickness of permeable sediments at screen 2 was not known, so the true conductivity of the hydraulically contiguous sediments could not be determined. If the thickness is greater than the saturated screen length of 10.6 ft, then the conductivity would be less than 3.3 ft.
- Constant rate testing of screen 3 showed an upper-bound conductivity of 46.8 ft/day. Again, the total thickness of hydraulically contiguous sediments was not known. If the thickness is greater than the saturated screen length of 28.4 ft, then the conductivity would be less than 46.8 ft.
- Screen 2 produced a specific capacity of 0.0462 gpm/ft, corresponding to a theoretical maximum specific capacity (neglecting dewatering) of 0.0924 gpm/ft. This performance implied a lower-bound hydraulic conductivity of 0.80 ft/day, thus constraining the sediment conductivity between 0.80 and 3.3 ft/day.
- Screen 3 produced a specific capacity of 4.4 gpm/ft. This performance implied a lower-bound hydraulic conductivity of 20.5 ft/day, thus constraining the sediment conductivity between 20.5 and 46.8 ft/day.
- The overall maximum flow rate from screen 2 was 0.49 gpm. This was substantially greater than the post-swabbing yield of 0.2 gpm. Thus, the process of jetting with simultaneous pumping increased the yield by 145%. This will make future sampling of screen 2, using a Bennett pump, more effective and sustainable.

C.12.0 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 Newport News Nuclear BWXT-Los Alamos, LLC (N3B) (IDs 700000 and above). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The New Mexico Environment Department (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)

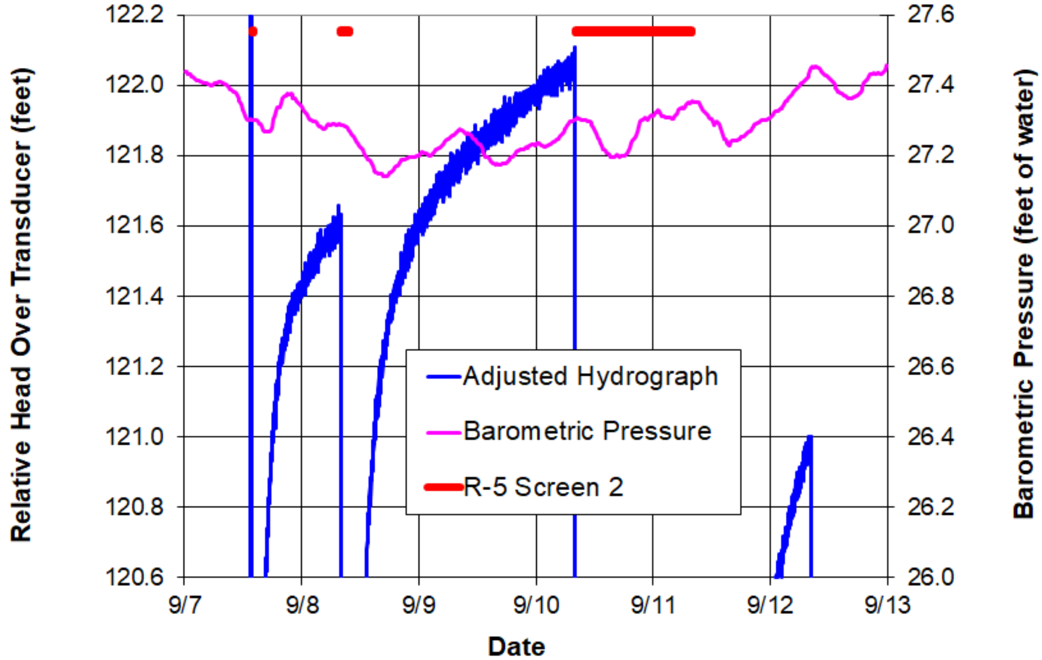


Figure C-7.2-1 Well R-5 screen 2 adjusted hydrograph

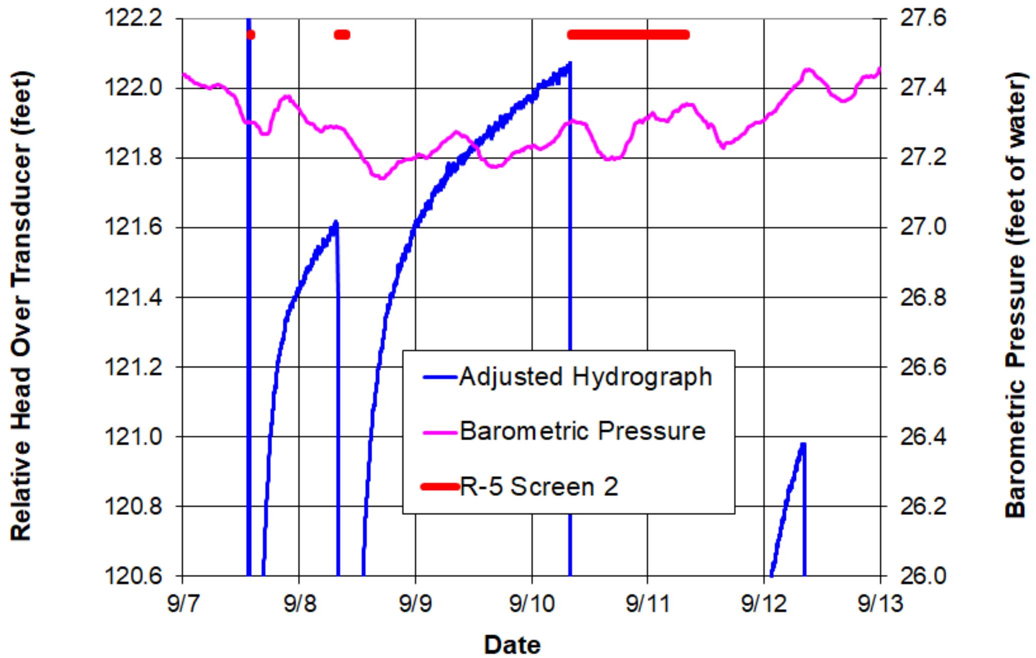


Figure C-7.2-2 Well R-5 screen 2 adjusted hydrograph – rolling average

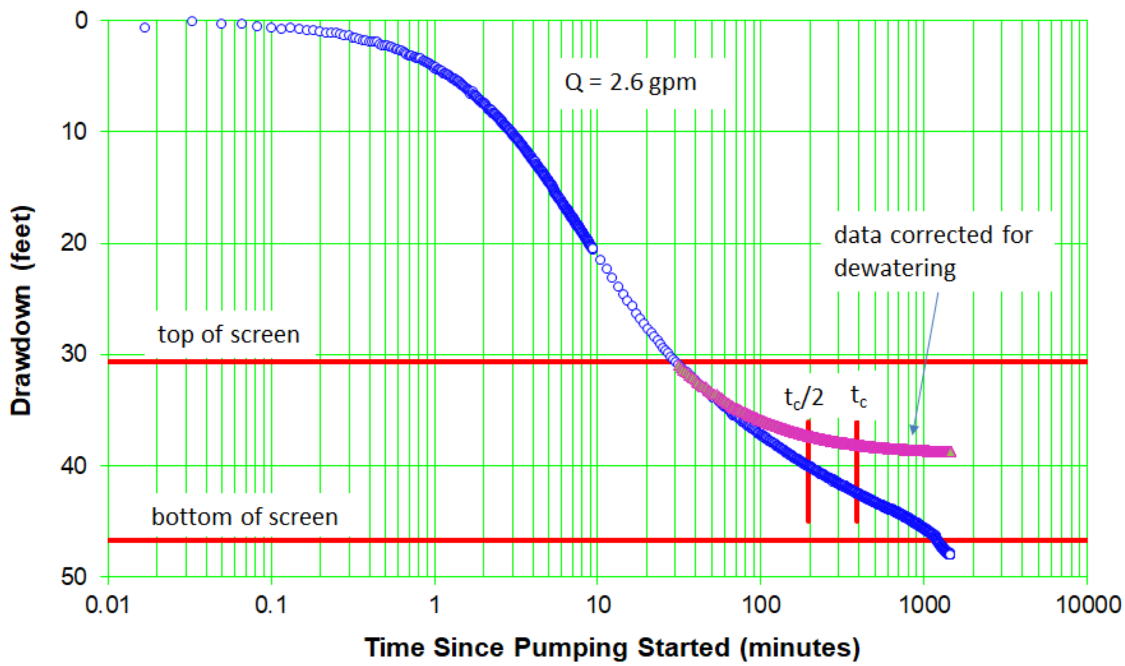


Figure C-7.3-1 Well R-5 screen 2 drawdown

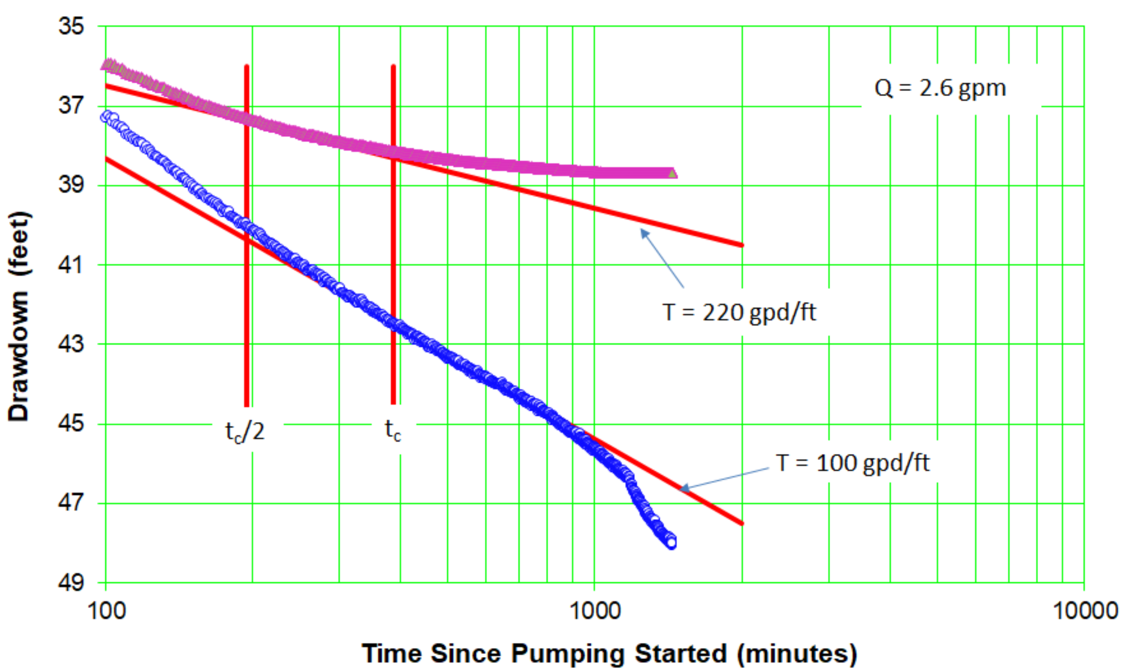


Figure C-7.3-2 Well R-5 screen 2 drawdown – expanded scale

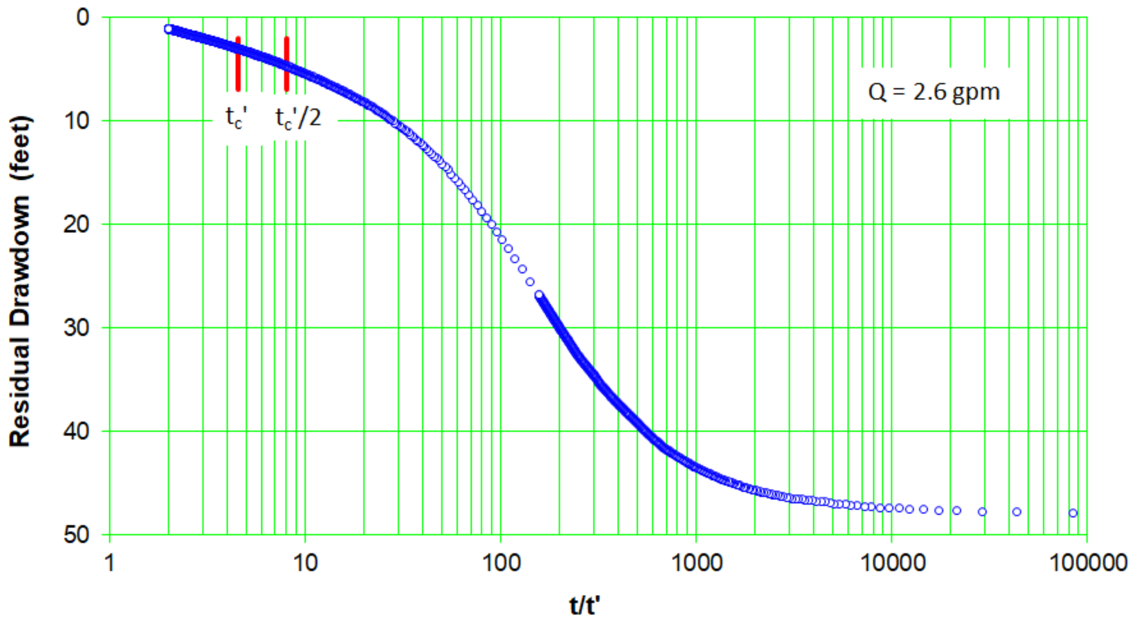


Figure C-7.3-3 Well R-5 screen 2 recovery

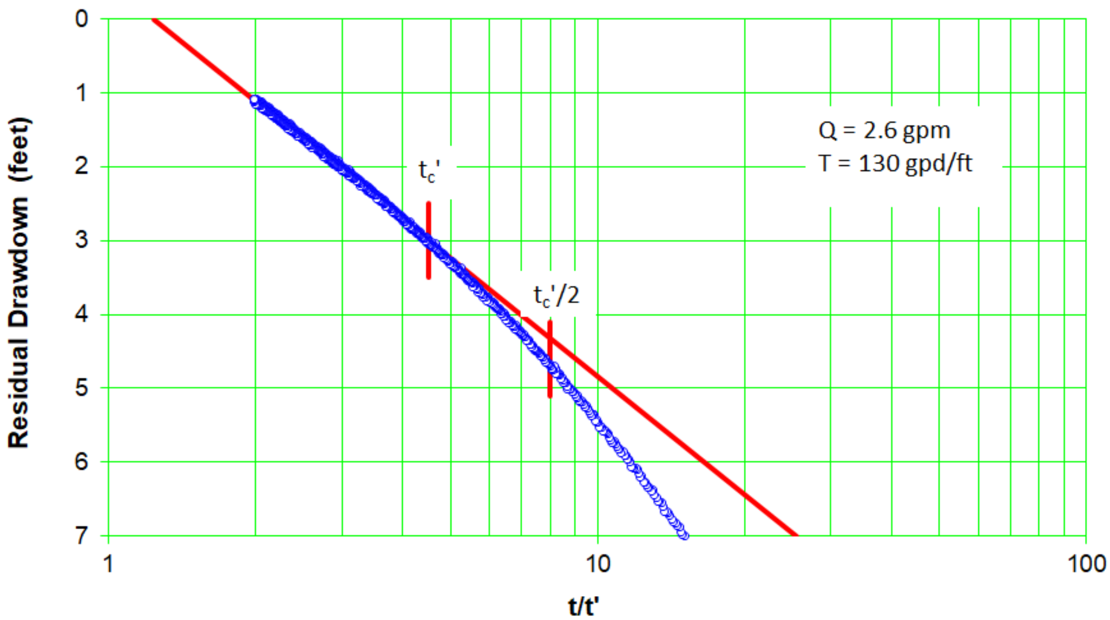


Figure C-7.3-4 Well R-5 screen 2 recovery – expanded scale

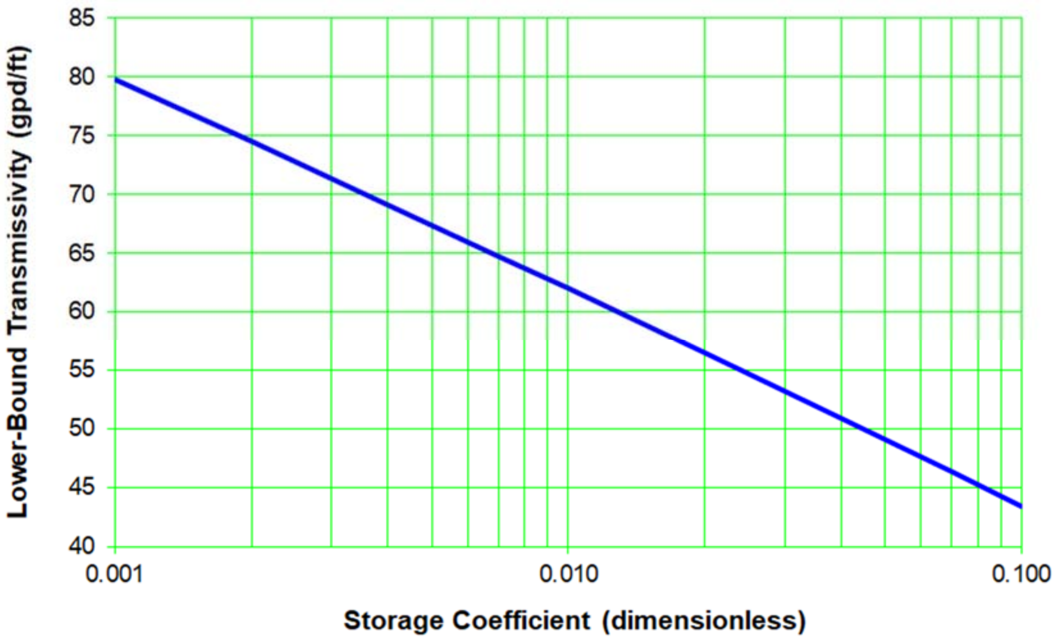


Figure C-7.4-1 Well R-5 screen 2 lower-bound transmissivity

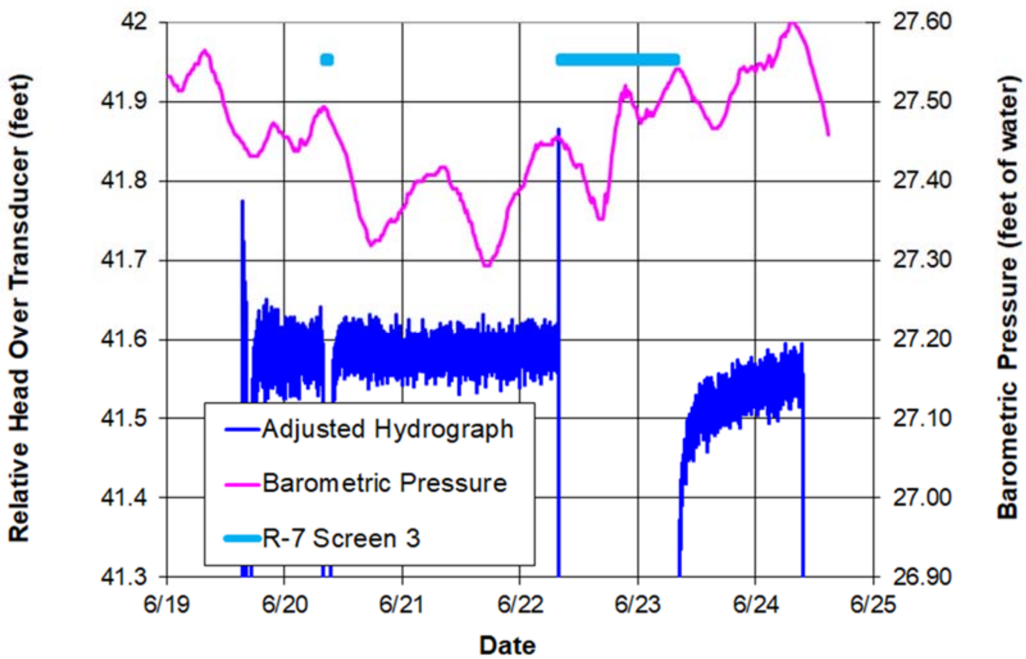


Figure C-8.2-1 Well R-7 screen 3 adjusted hydrograph

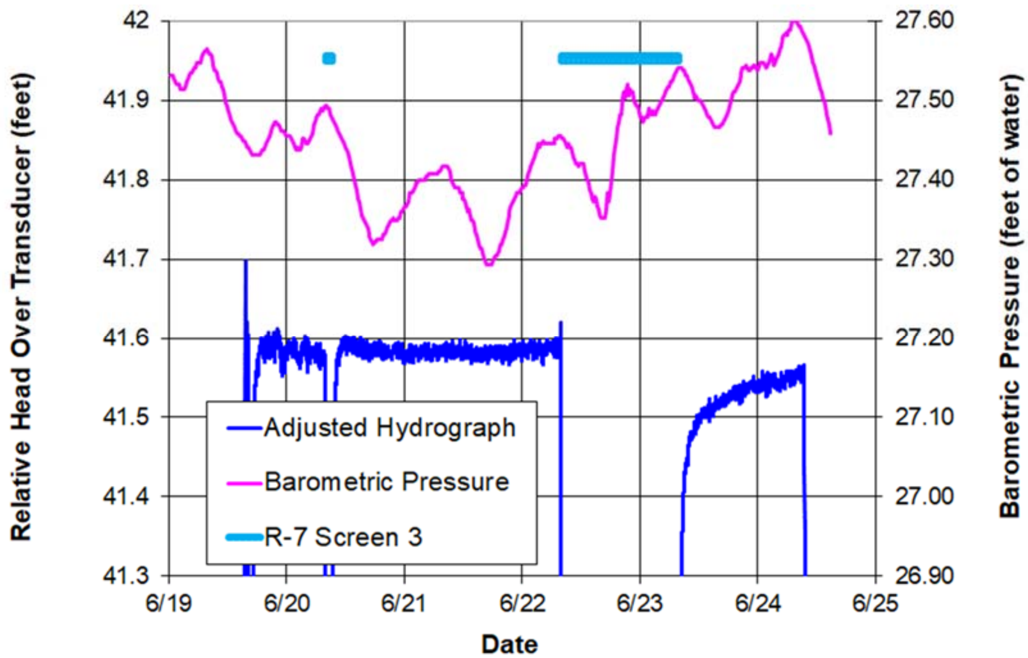


Figure C-8.2-2 Well R-7 screen 3 adjusted hydrograph – rolling average

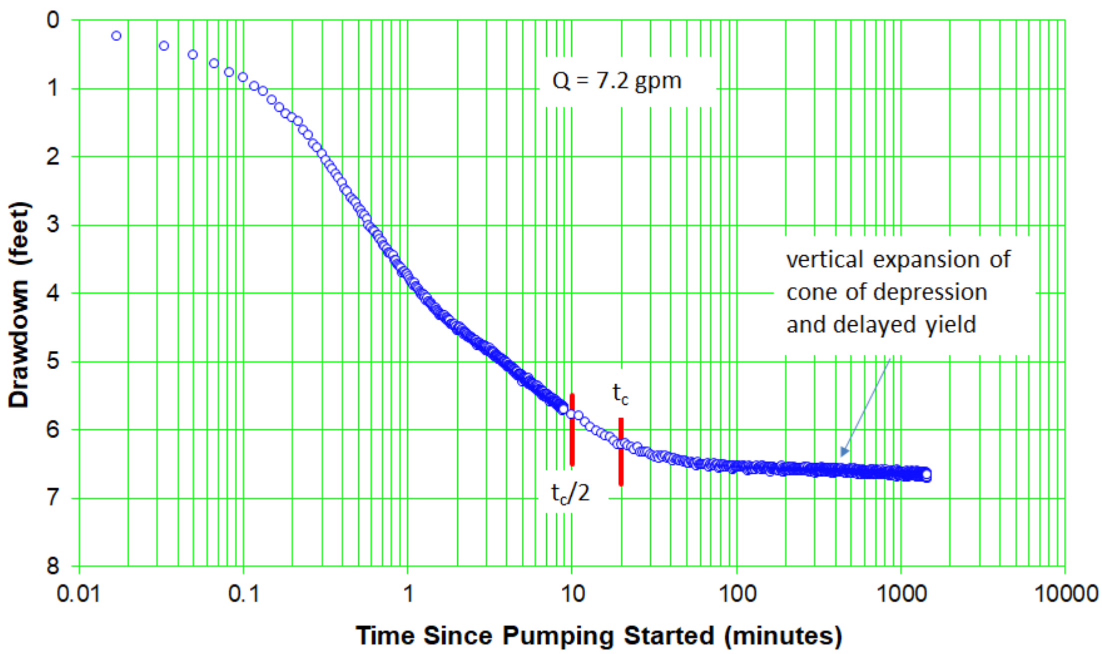


Figure C-8.3-1 Well R-7 screen 3 drawdown

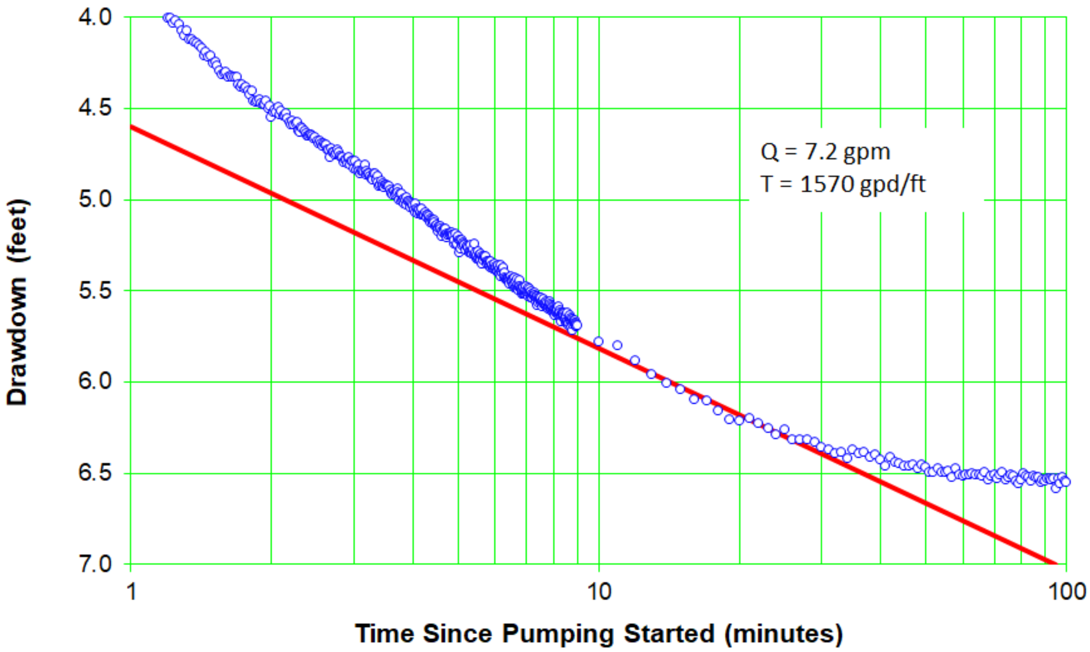


Figure C-8.3-2 Well R-7 screen 3 drawdown – early data

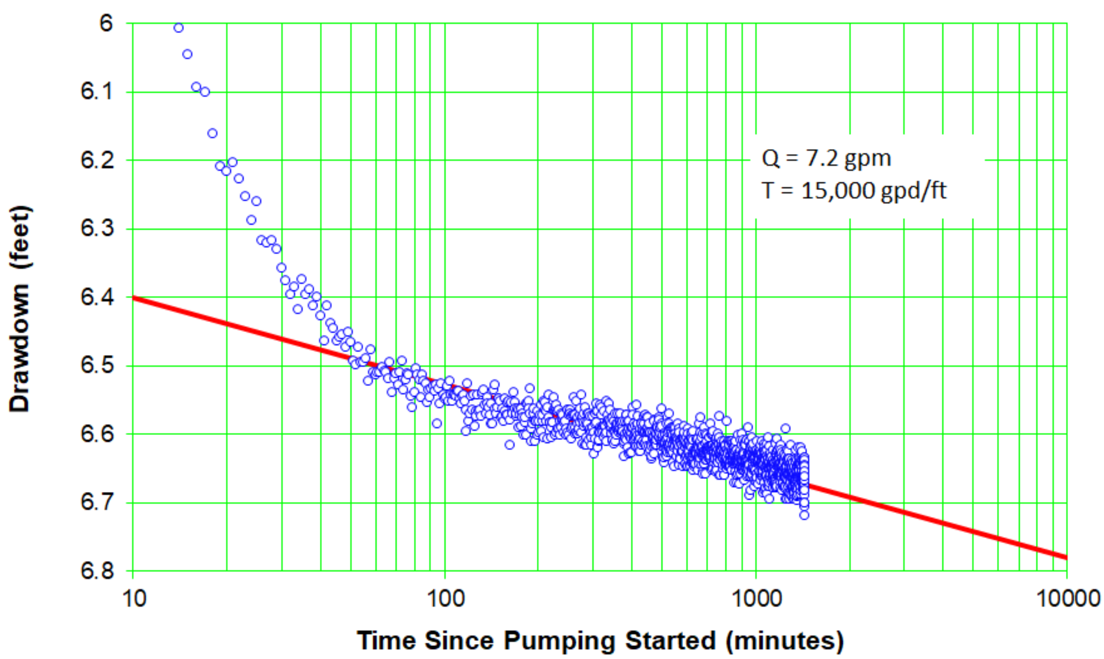
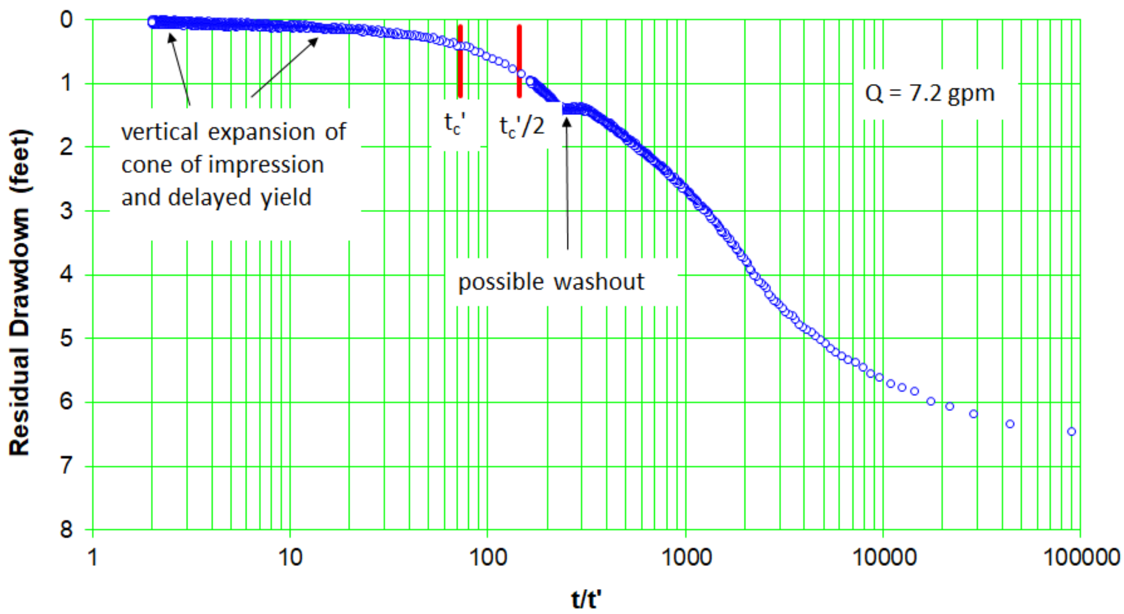


Figure C-8.3-3 Well R-7 screen 3 drawdown – late data



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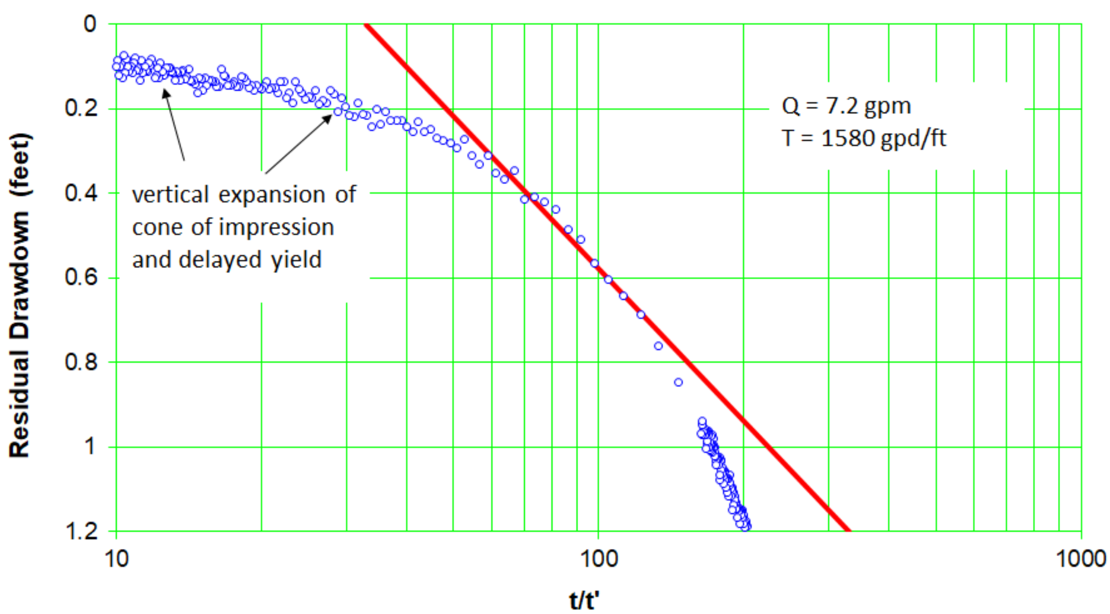


Figure C-8.3-5 Well R-7 screen 3 recovery – early data

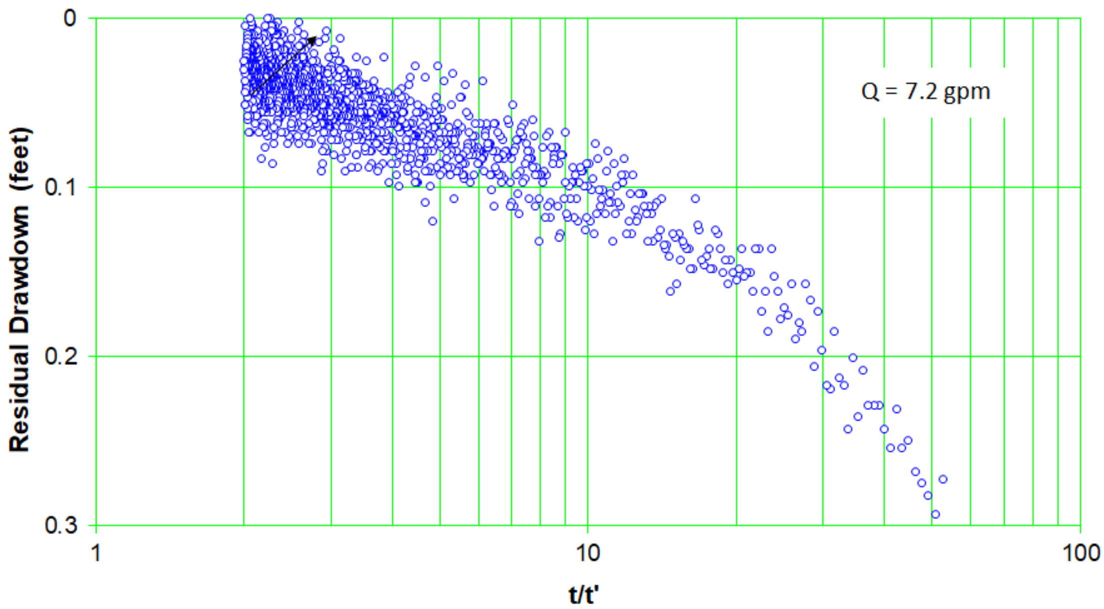


Figure C-8.3-6 Well R-7 screen 3 recovery – late data

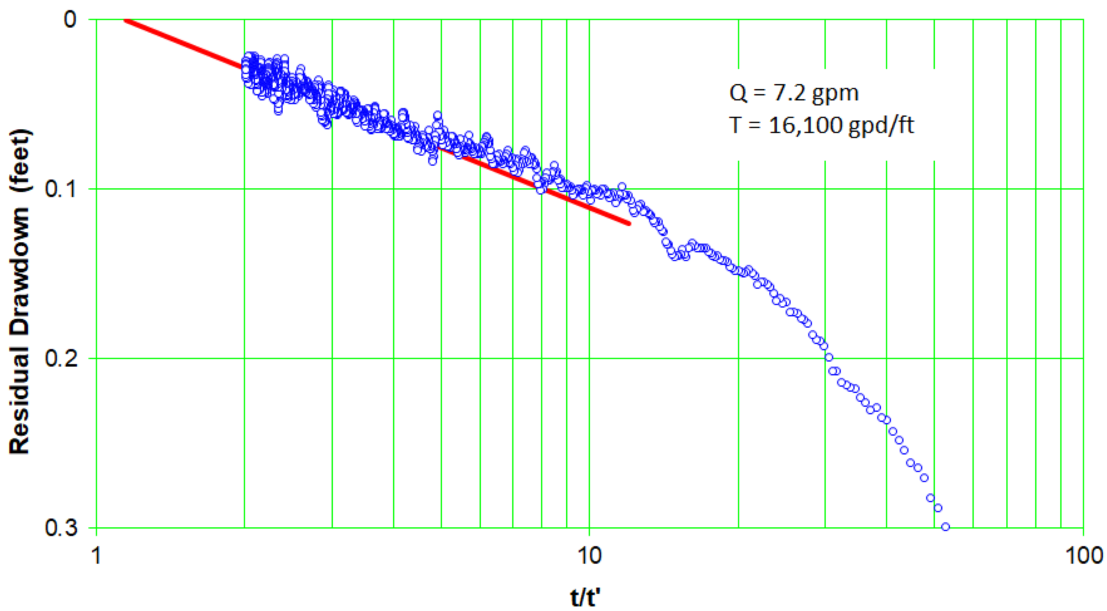


Figure C-8.3-7 Well R-7 screen 3 recovery – late data rolling average

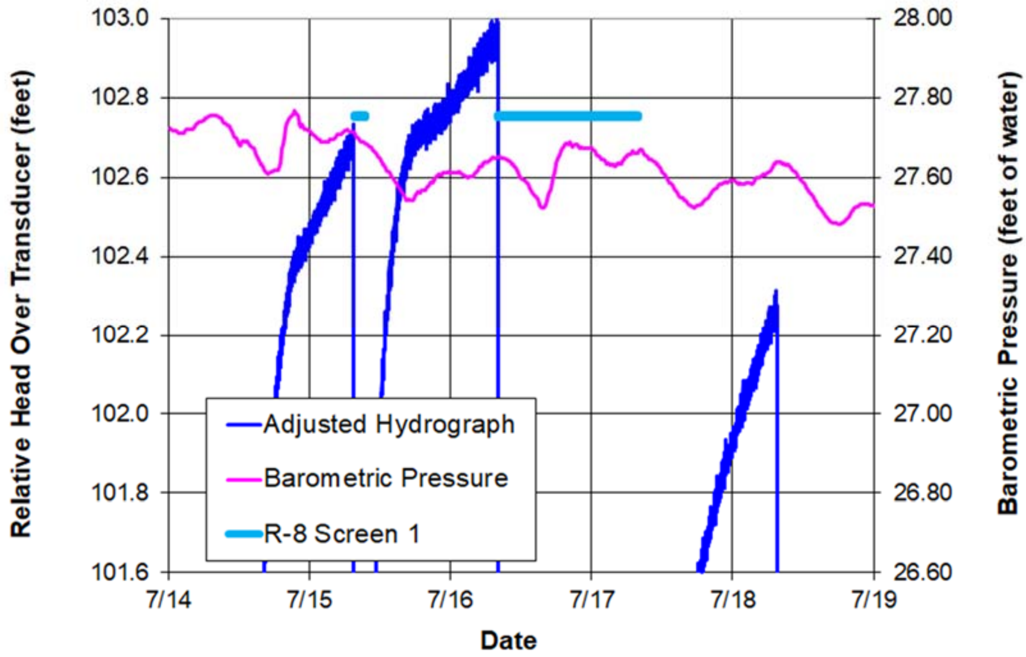


Figure C-9.2-1 Well R-8 screen 1 adjusted hydrograph during screen 1 pumping test

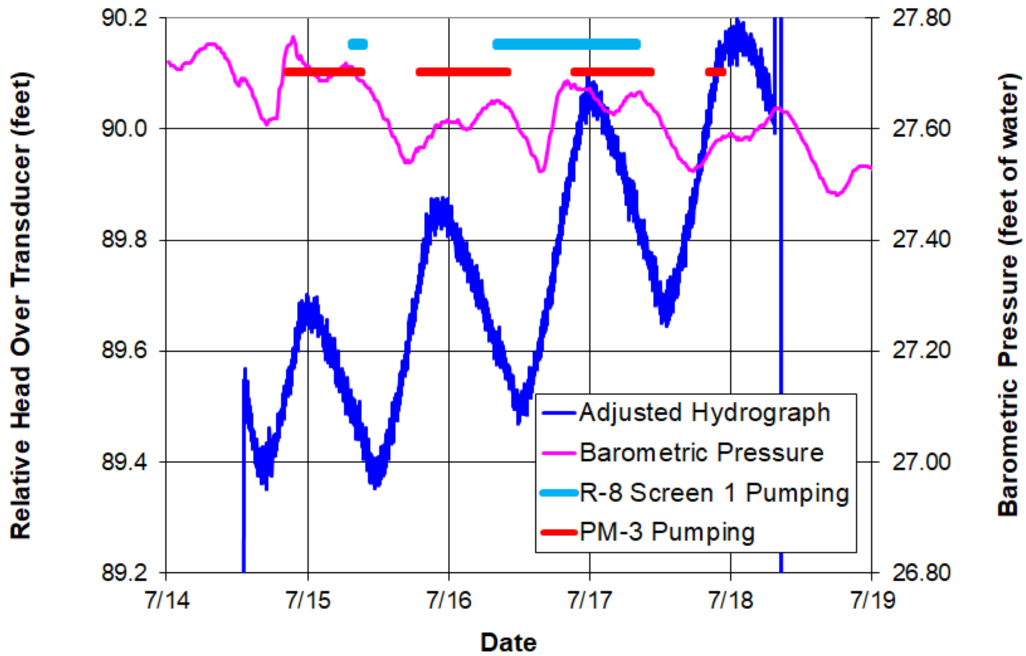


Figure C-9.2-2 Well R-8 screen 2 adjusted hydrograph during screen 1 pumping test

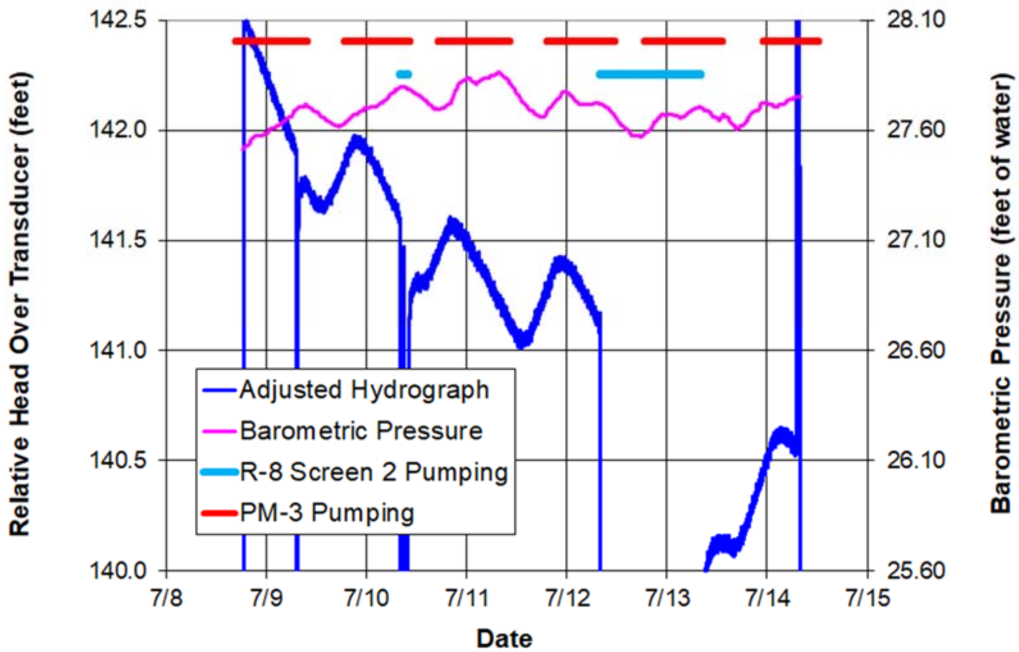


Figure C-9.2-3 Well R-8 screen 2 adjusted hydrograph during screen 2 pumping test

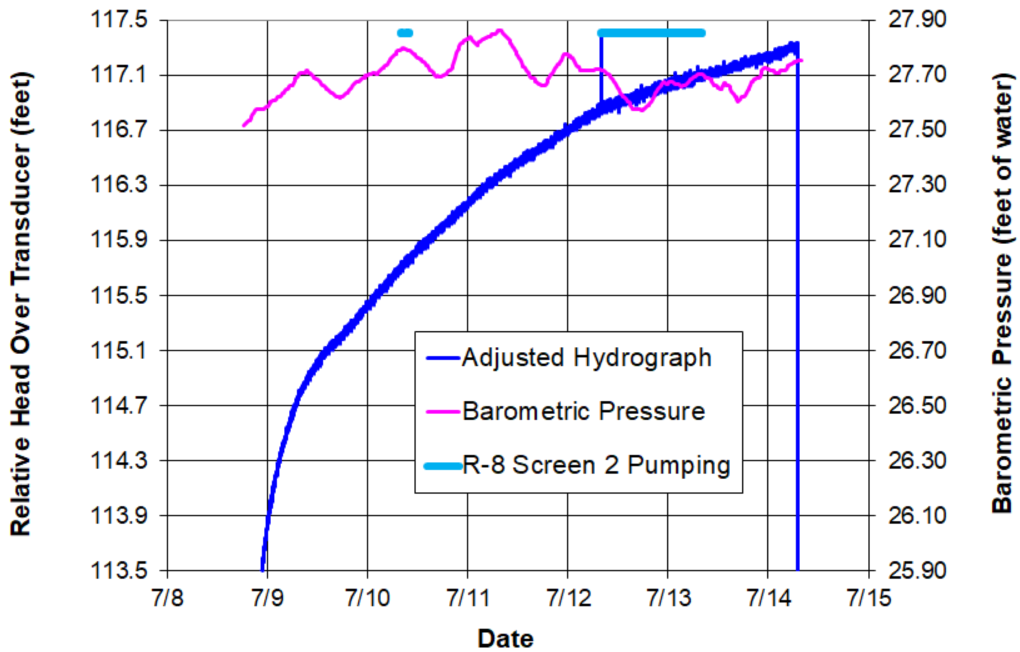


Figure C-9.2-4 Well R-8 screen 1 adjusted hydrograph during screen 2 pumping test

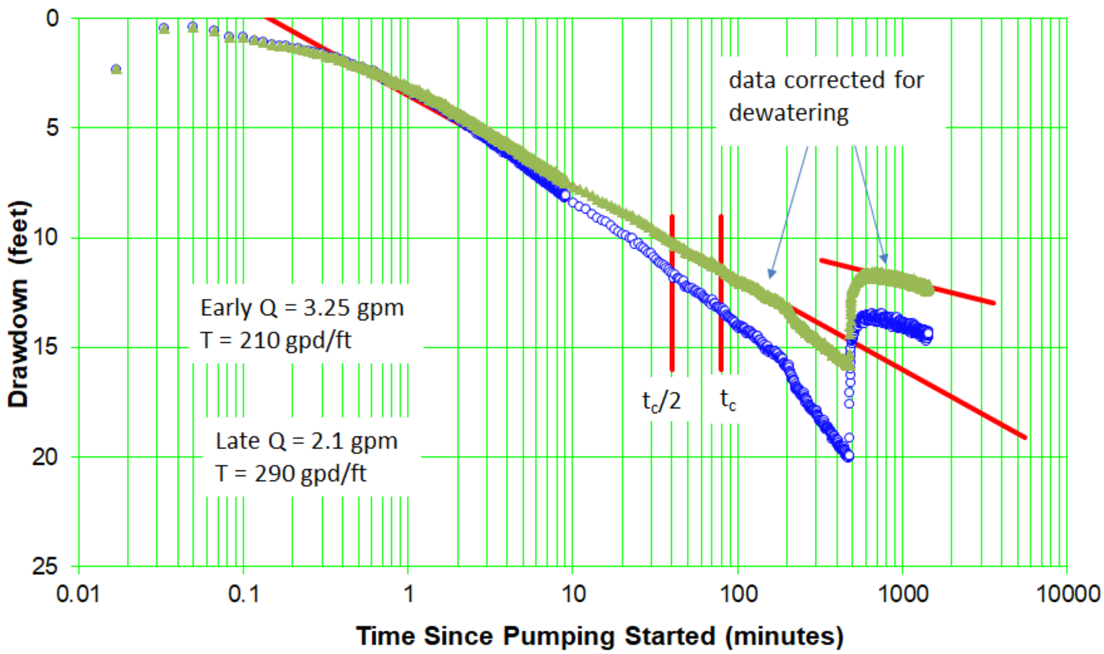


Figure C-9.3-1 Well R-8 screen 1 drawdown

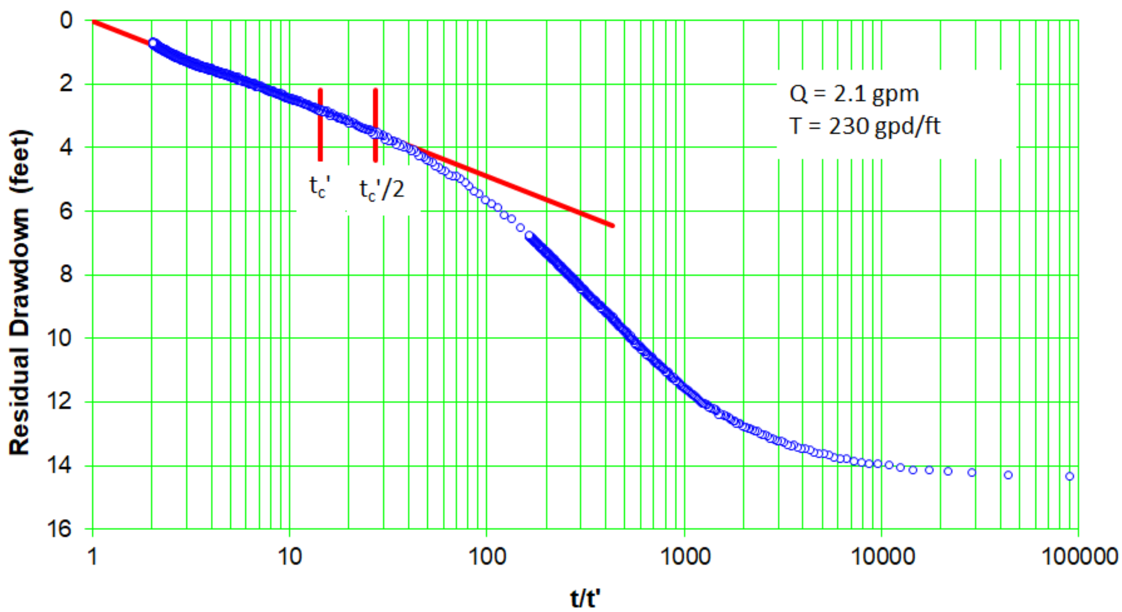


Figure C-9.3-2 Well R-8 screen 1 recovery

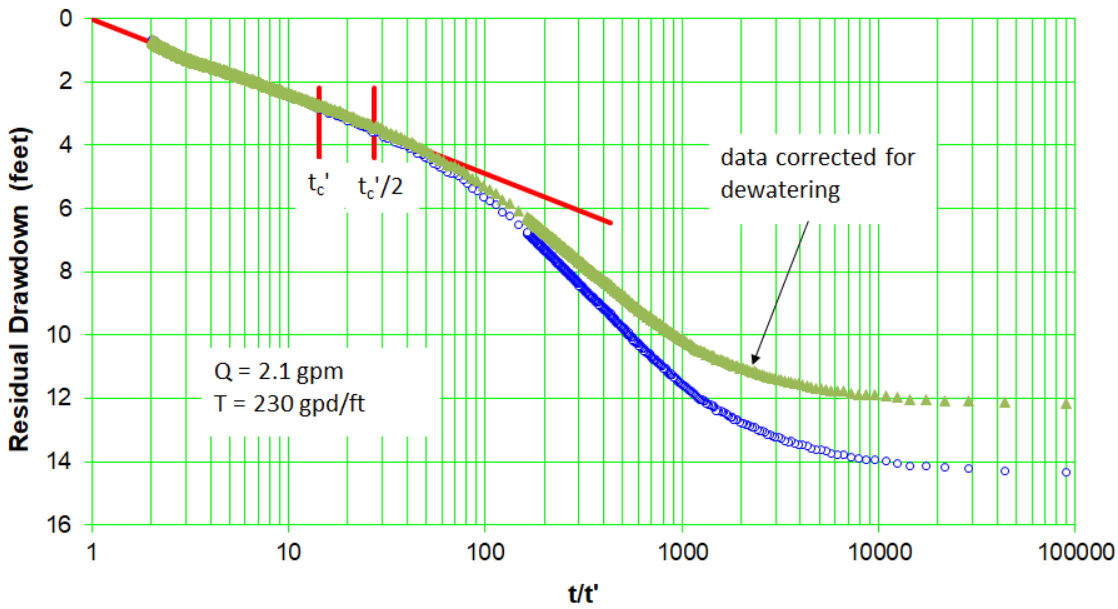


Figure C-9.3-3 Well R-8 screen 1 recovery corrected for dewatering

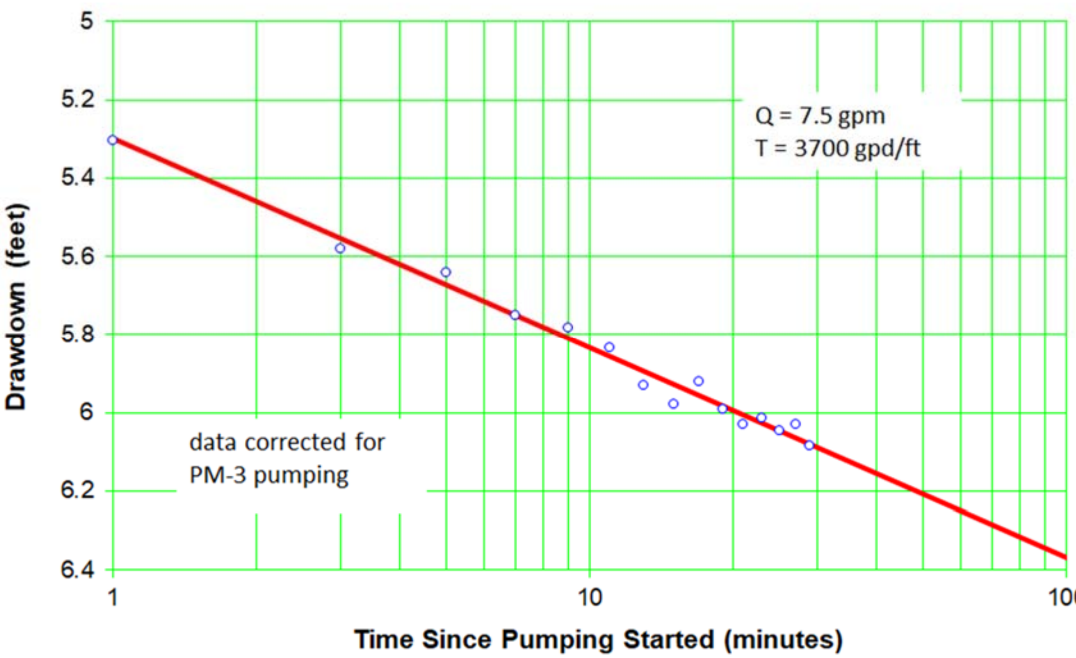


Figure C-9.5-1 Well R-8 screen 2 trial 1 drawdown

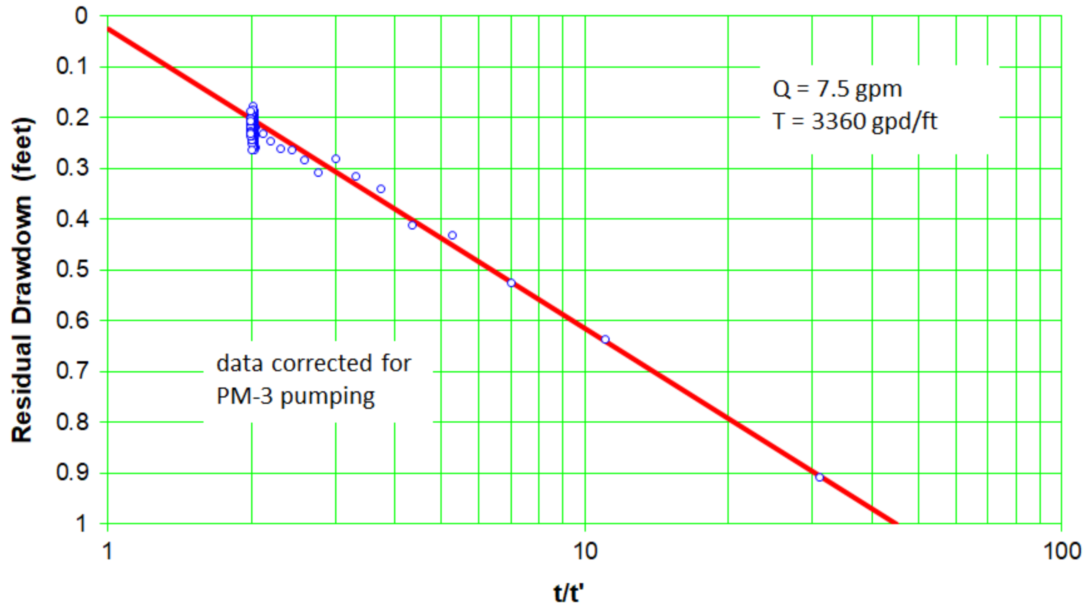
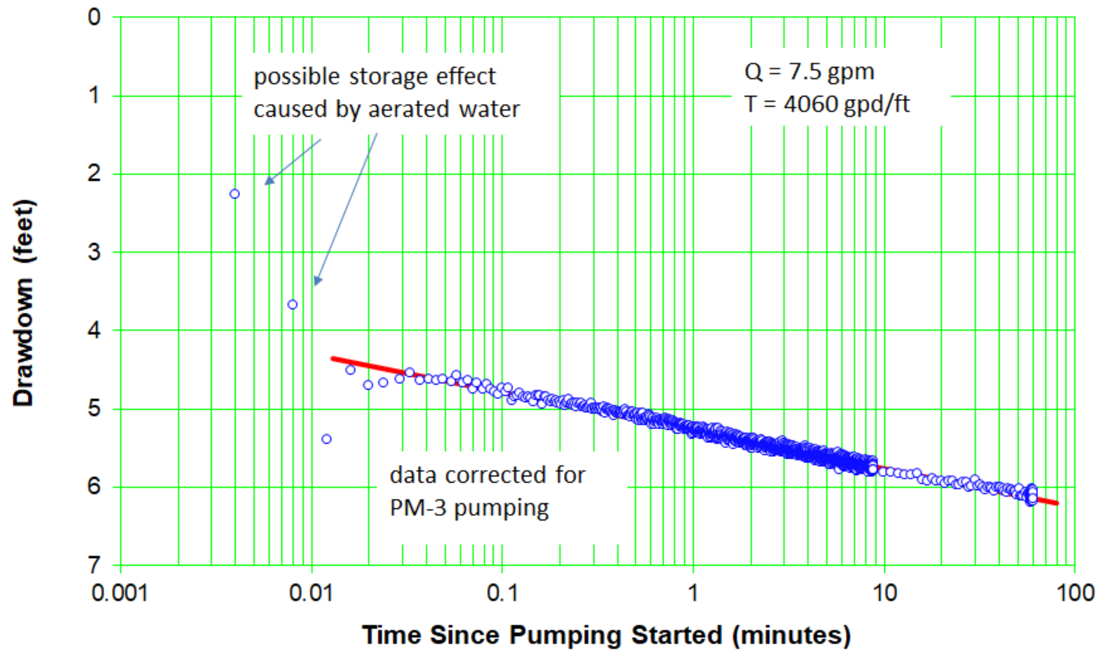


Figure C-9.5-2 Well R-8 screen 2 trial 1 recovery



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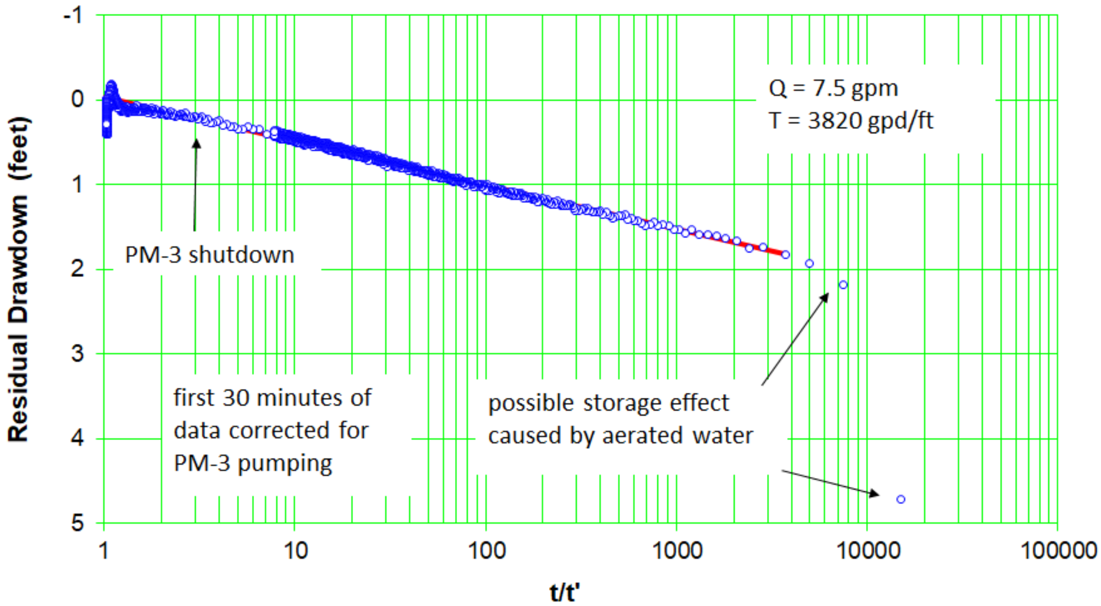


Figure C-9.5-4 Well R-8 screen 2 trial 2 recovery

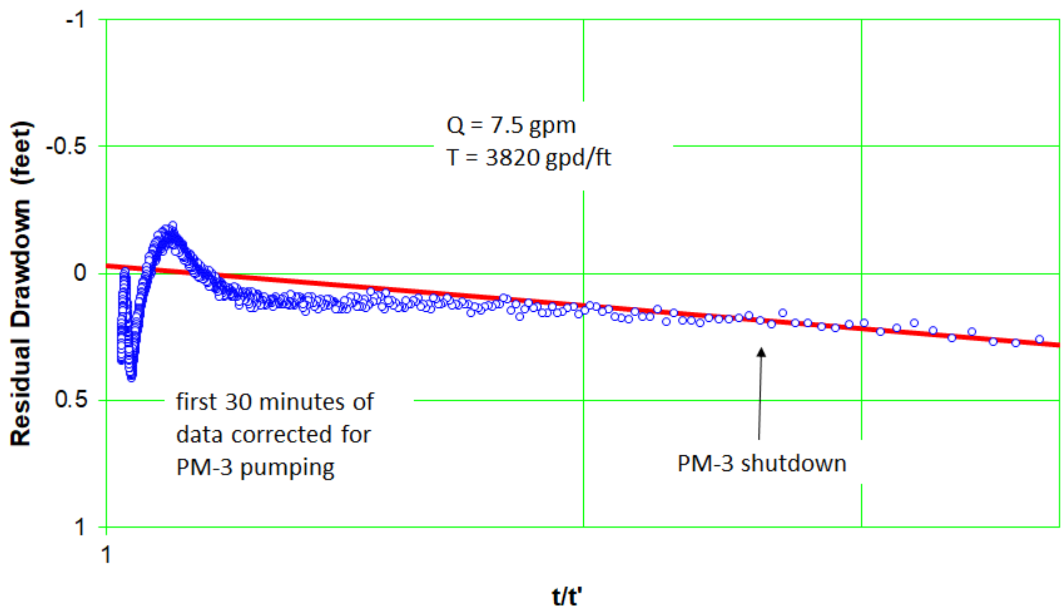


Figure C-9.5-5 Well R-8 screen 2 trial 2 recovery – expanded scale

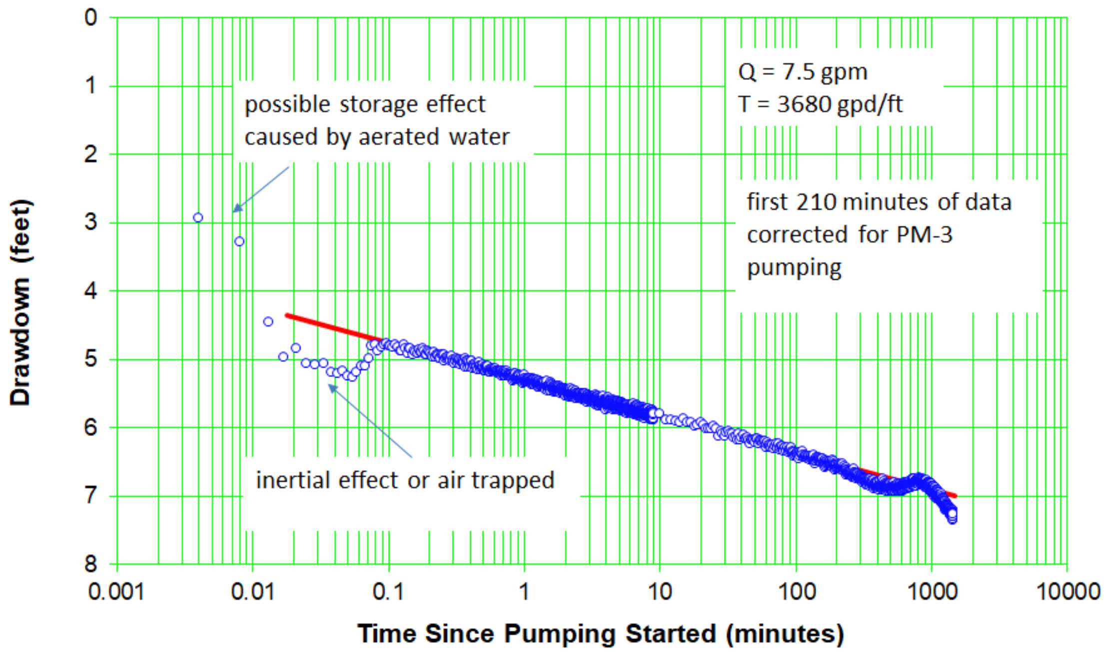


Figure C-9.5-6 Well R-8 screen 2 drawdown

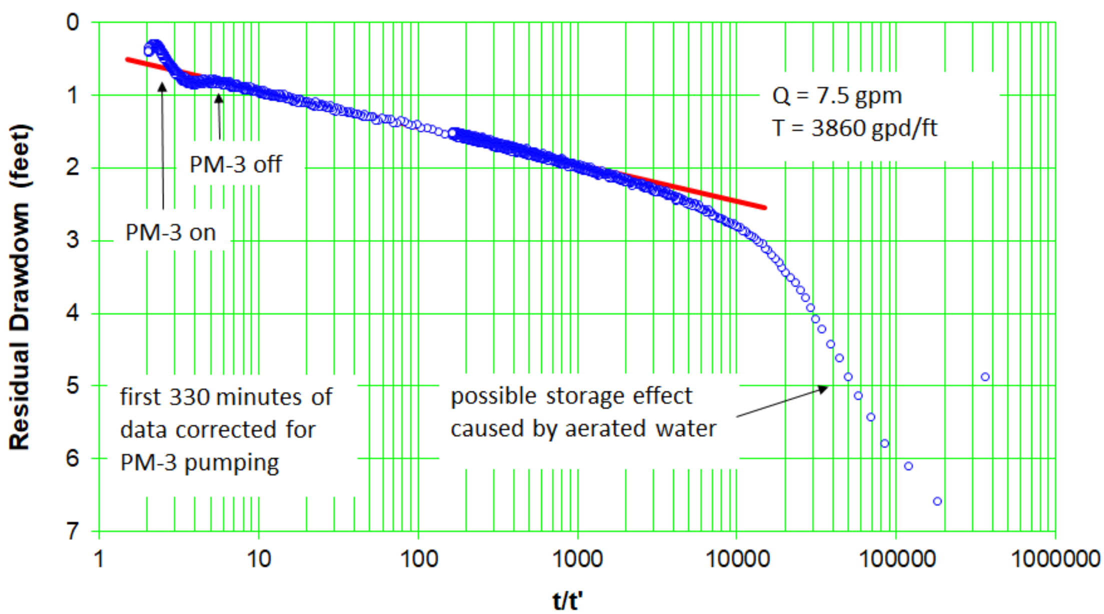


Figure C-9.5-7 Well R-8 screen 2 recovery

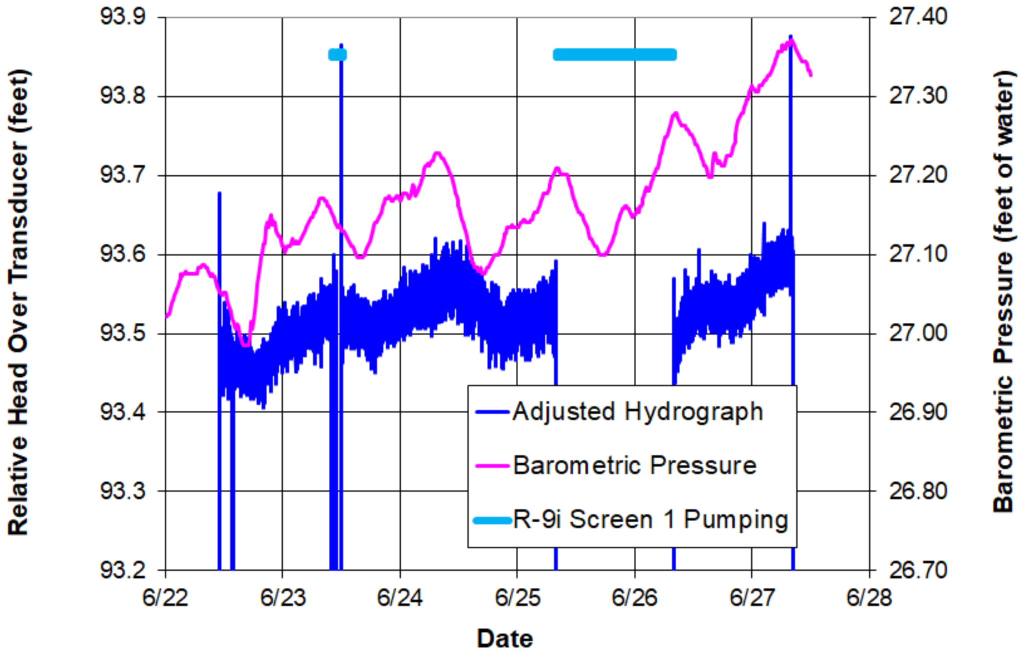


Figure C-10.2-1 Well R-9i screen 1 adjusted hydrograph

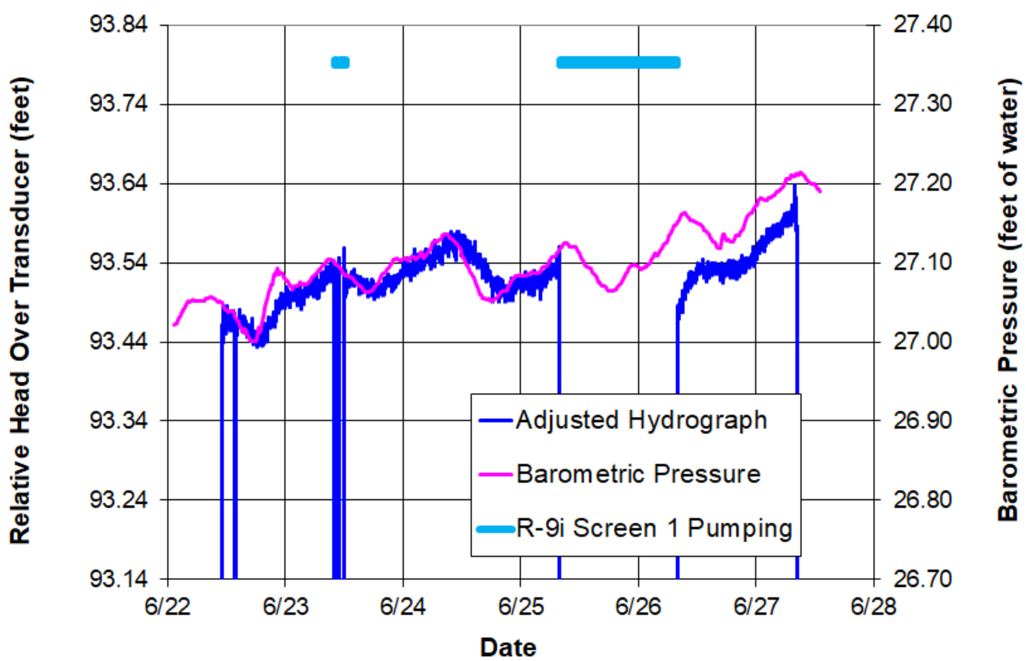


Figure C-10.2-2 Well R-9i screen 1 rolling average hydrograph and 45% barometric efficiency correction

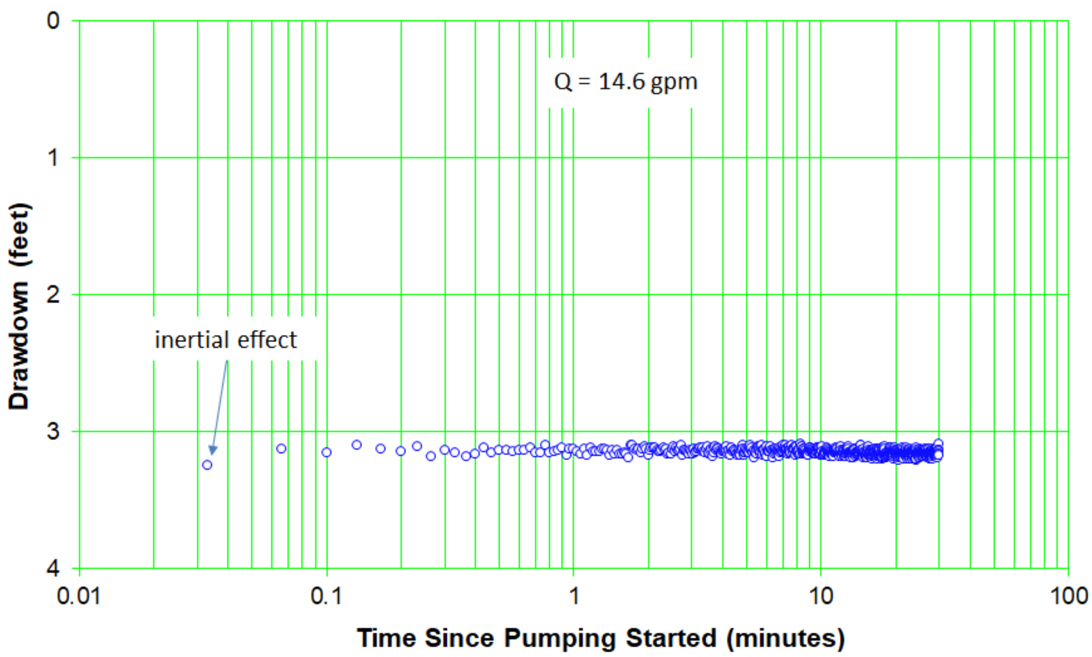


Figure C-10.3-1 Well R-9i screen 1 trial 1 drawdown

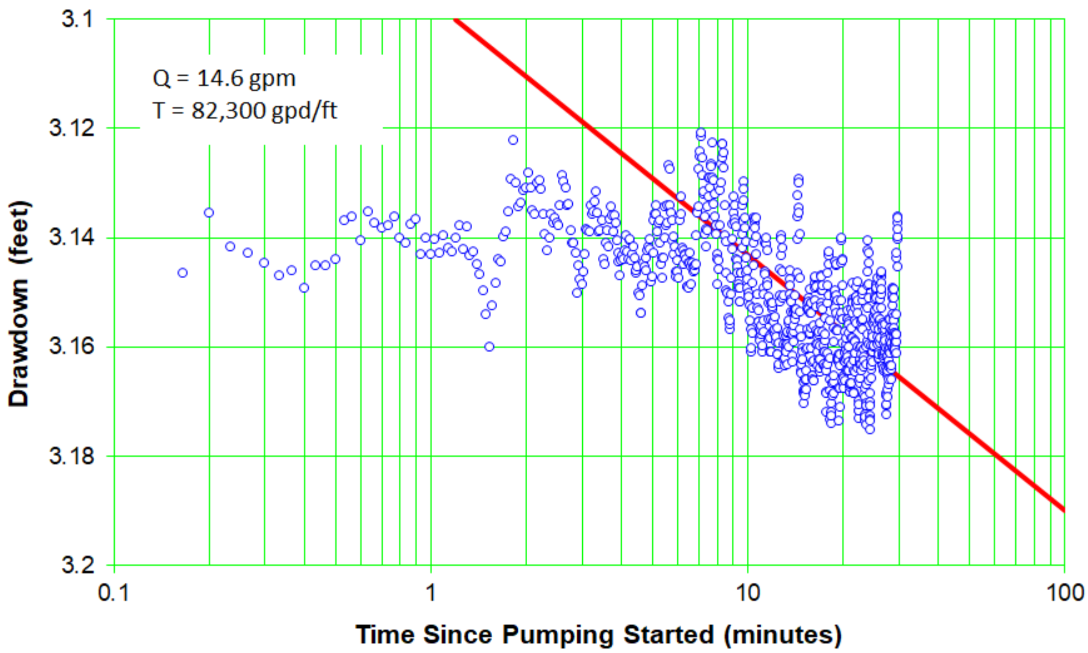


Figure C-10.3-2 Well R-9i screen 1 trial 1 rolling average drawdown – expanded scale

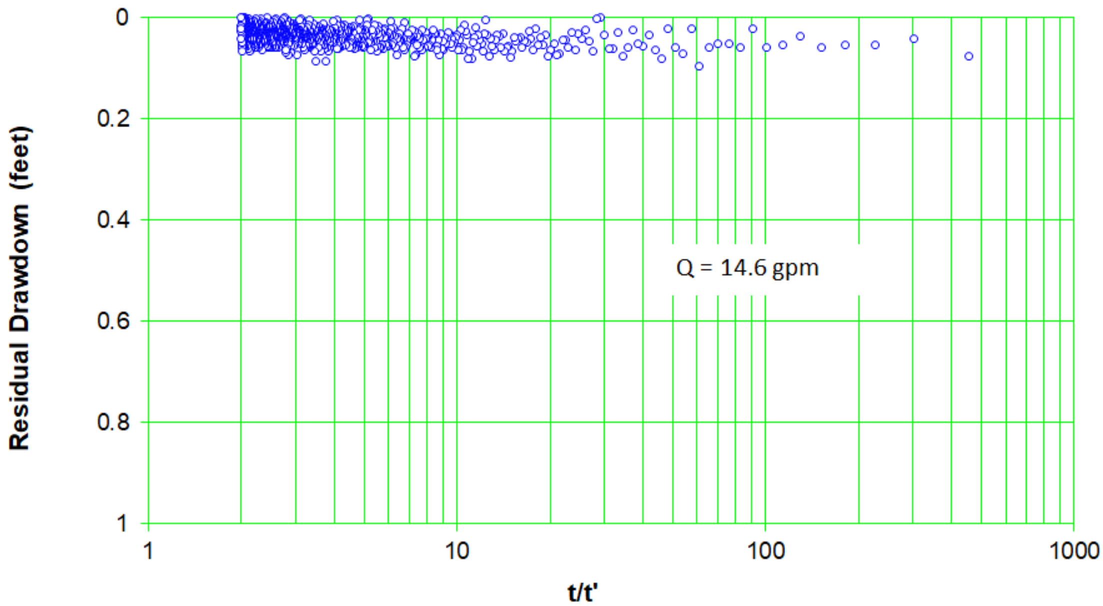
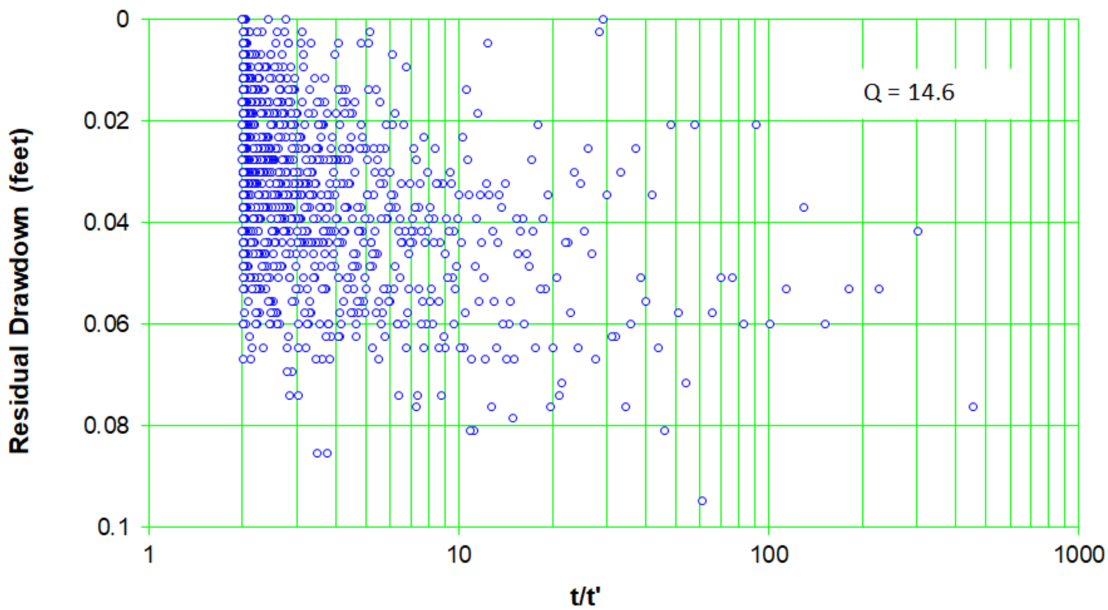


Figure C-10.3-3 Well R-9i screen 1 trial 1 recovery



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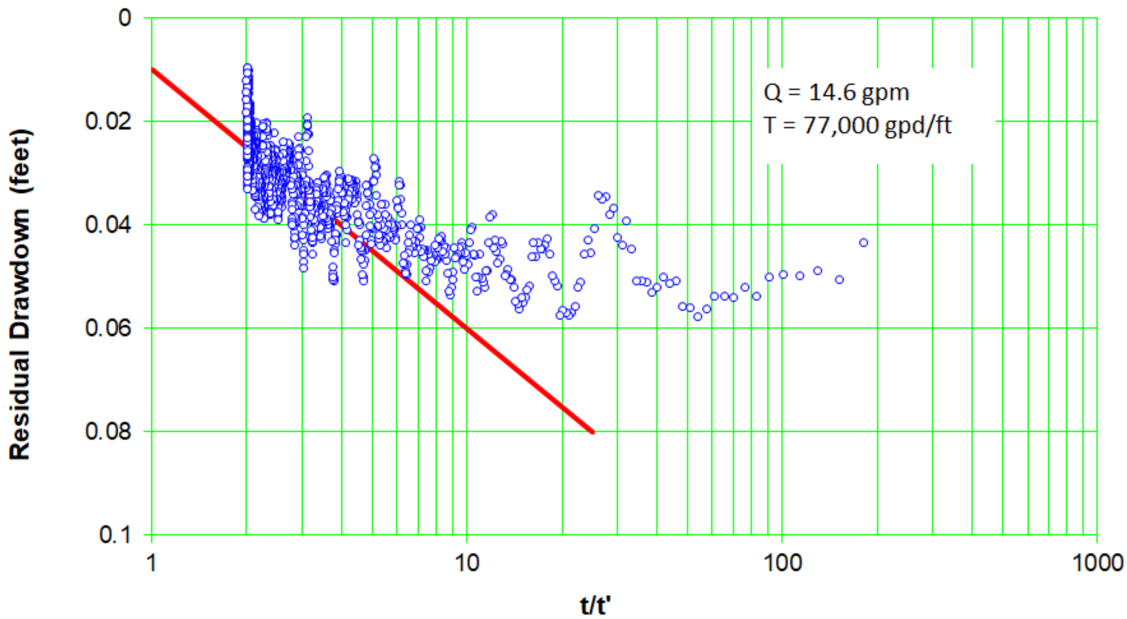


Figure C-10.3-5 Well R-9i screen 1 trial 1 recovery – rolling average

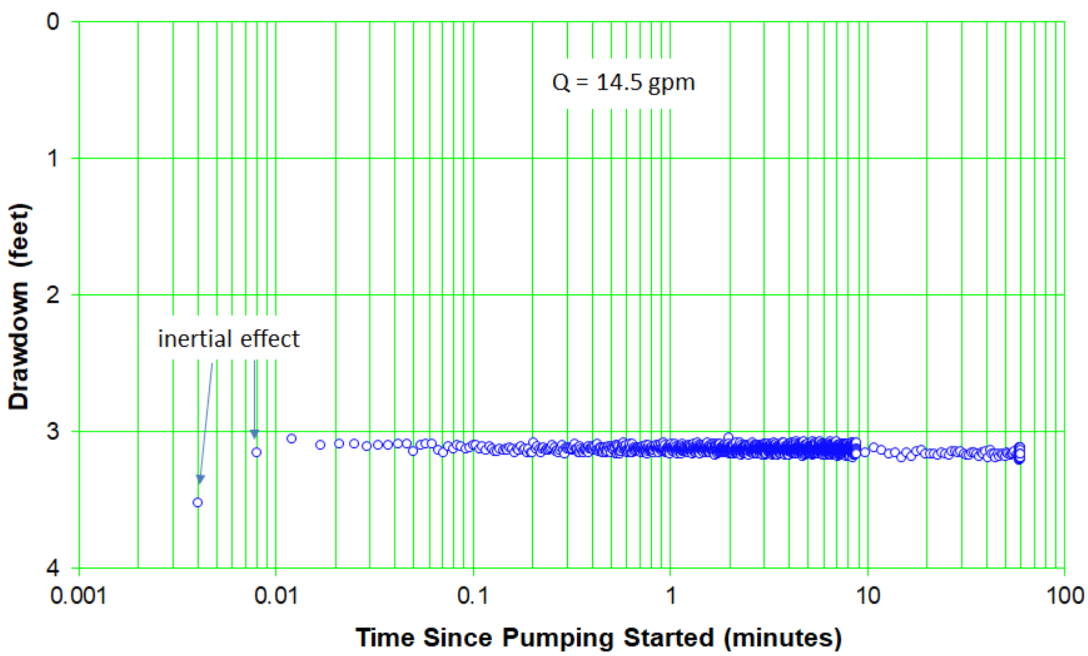
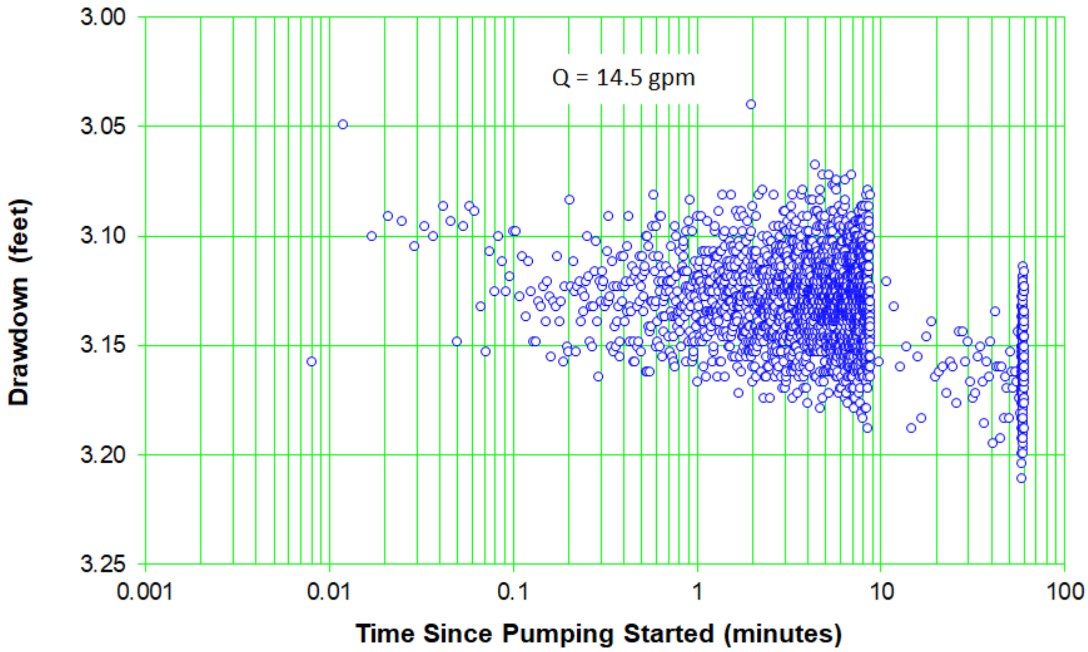


Figure C-10.3-6 Well R-9i screen 1 trial 2 drawdown



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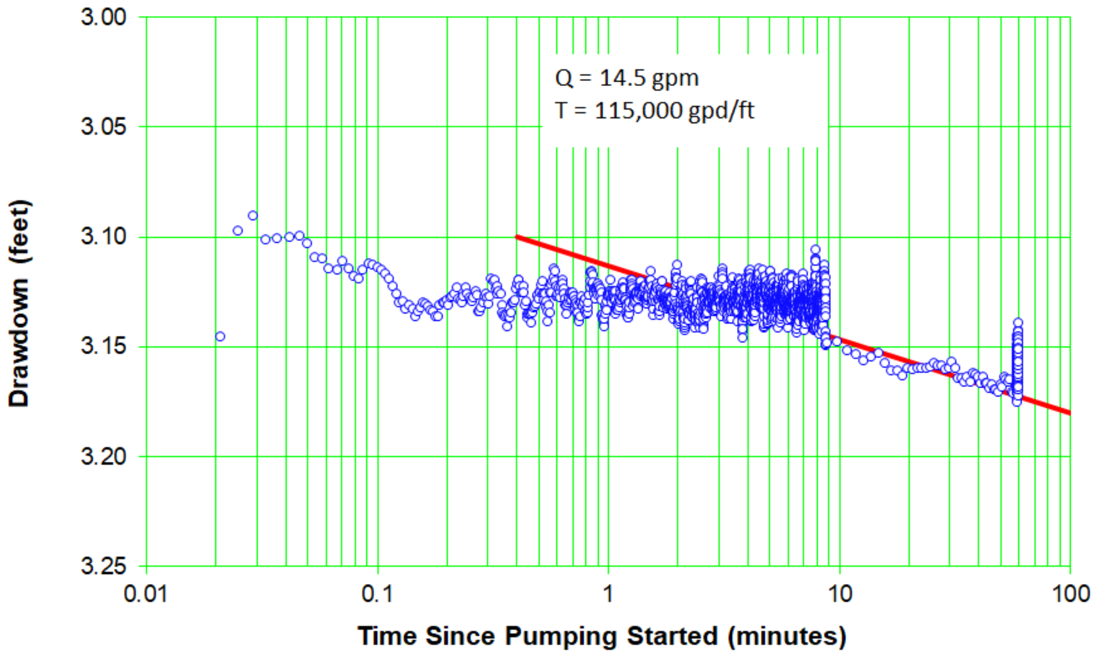

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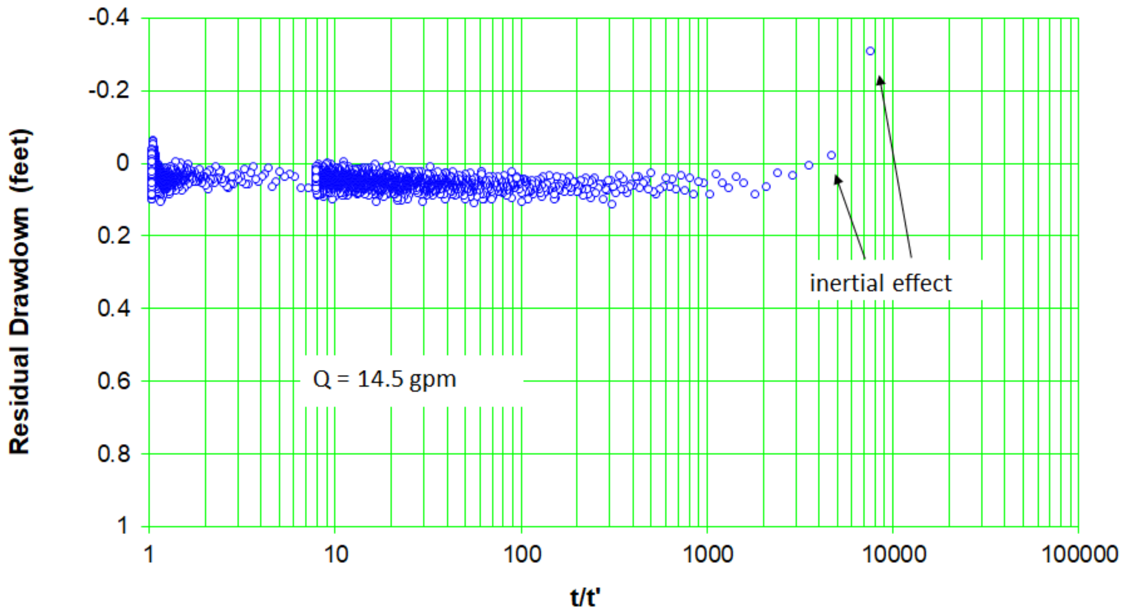

Figure C-10.3-9 Well R-9i screen 1 trial 2 recovery

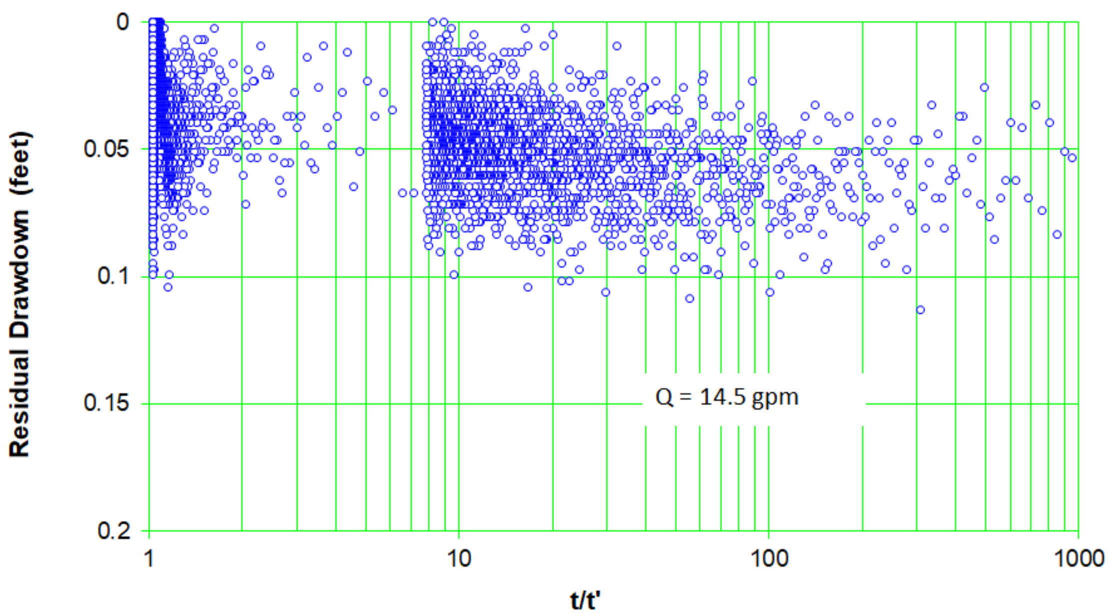

Figure C-10.3-10 Well R-9i screen 1 trial 2 recovery – expanded scale

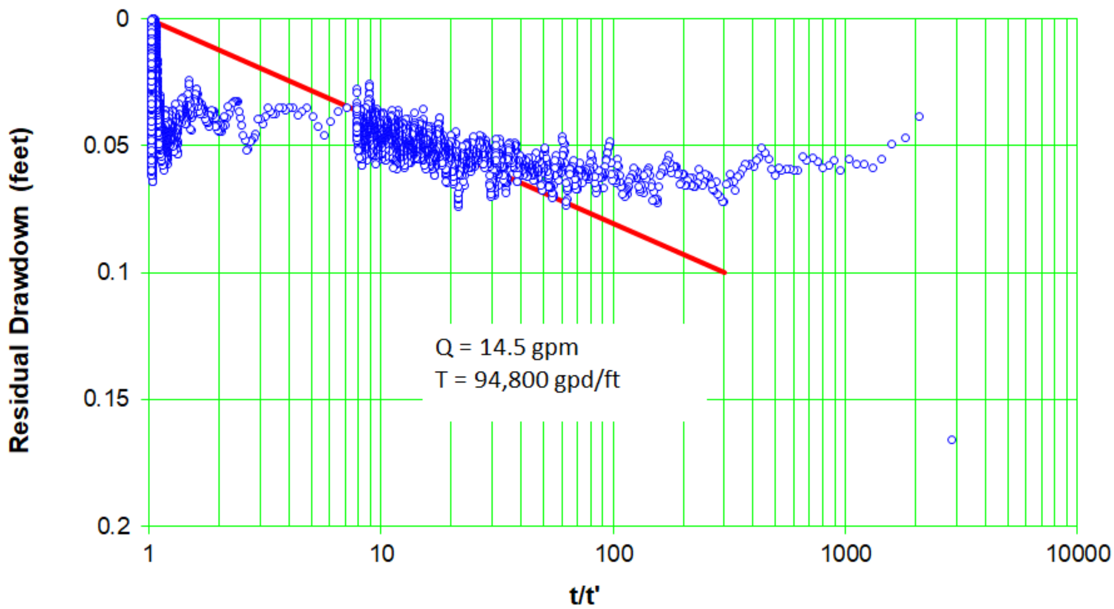

Figure C-10.3-11 Well R-9i screen 1 trial 2 recovery – rolling average

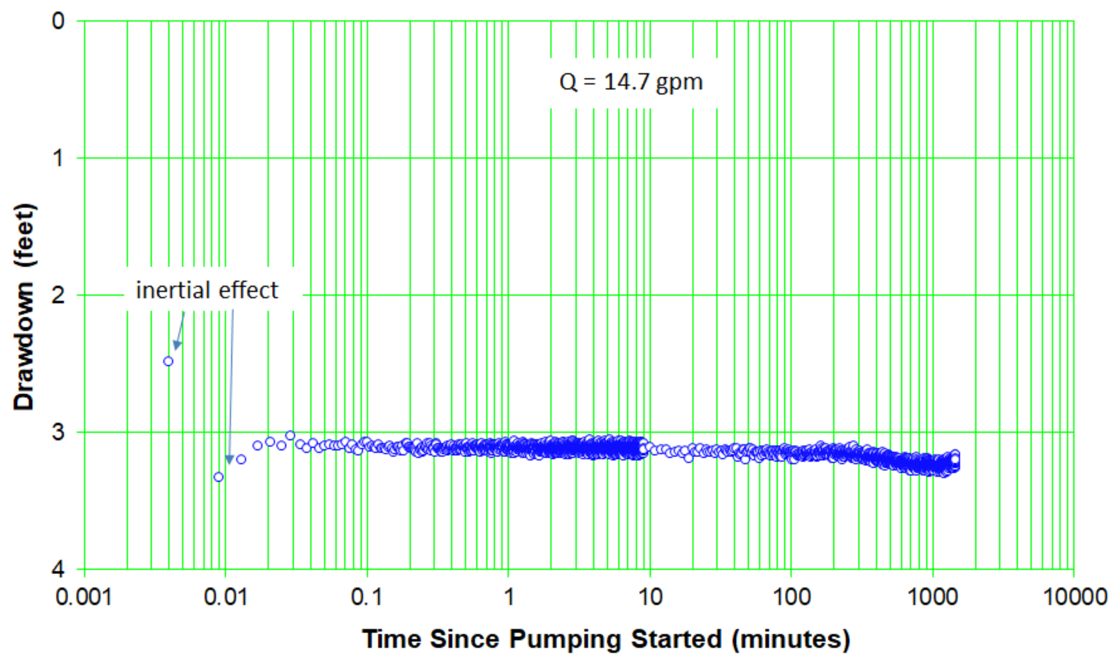

Figure C-10.3-12 Well R-9i screen 1 drawdown

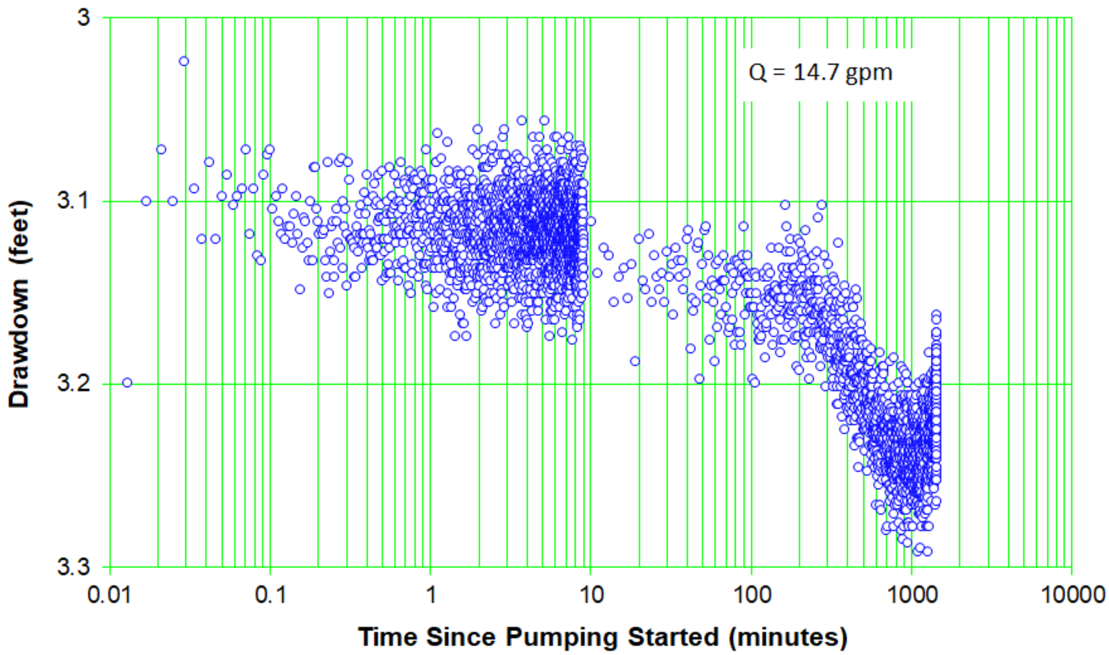

Figure C-10.3-13 Well R-9i screen 1 drawdown – expanded scale

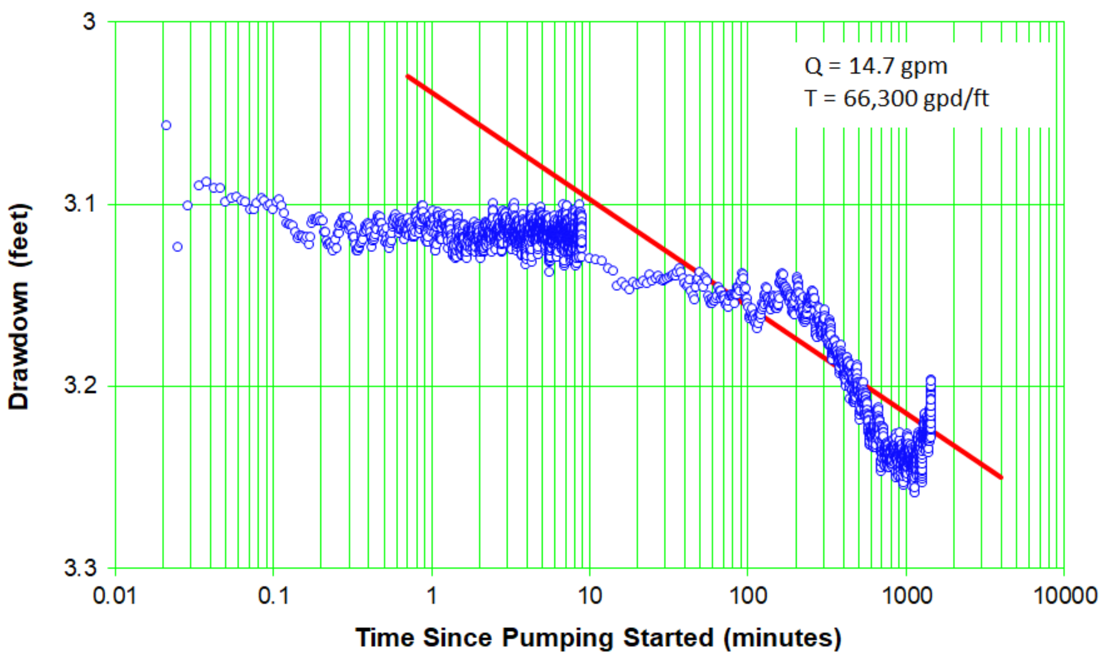

Figure C-10.3-14 Well R-9i screen 1 drawdown – rolling average

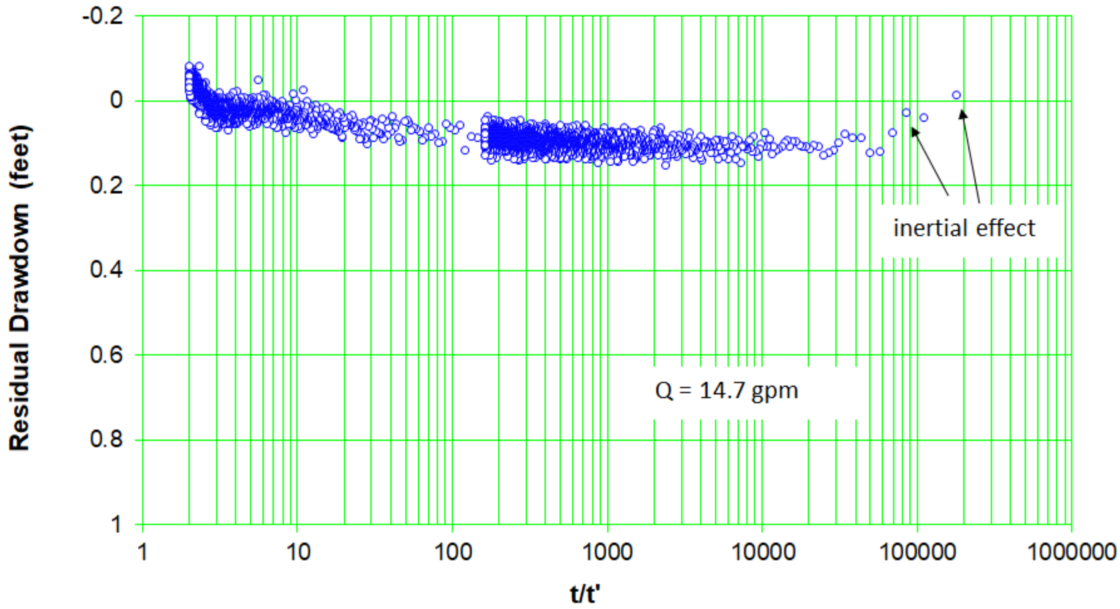

Figure C-10.3-15 Well R-9i screen 1 recovery

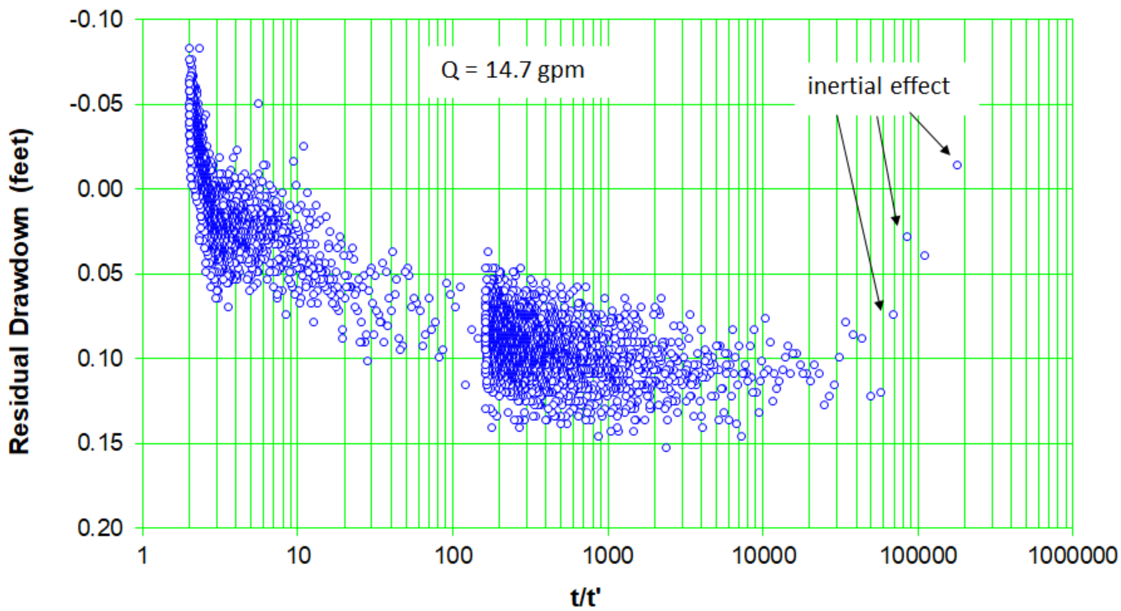

Figure C-10.3-16 Well R-9i screen 1 recovery – expanded scale

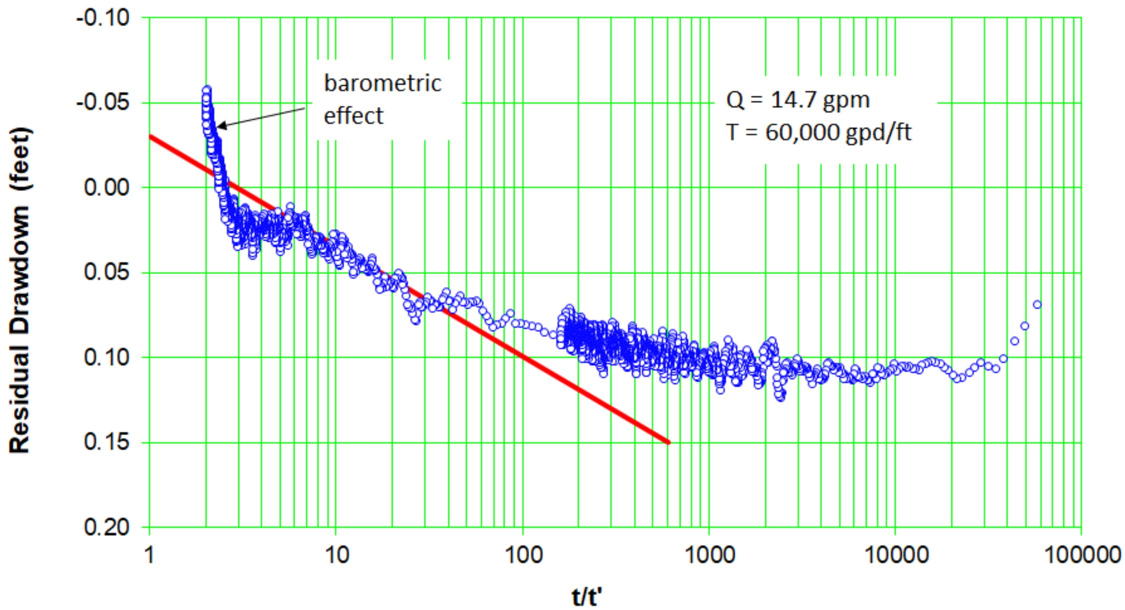

Figure C-10.3-17 Well R-9i screen 1 recovery – rolling average

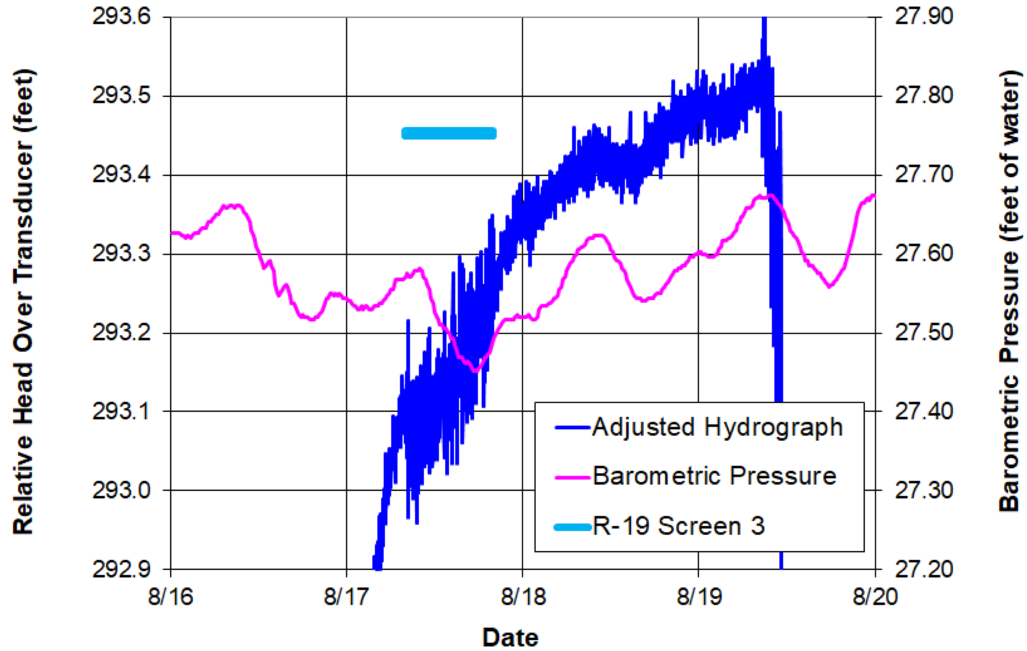

Figure C-11.2-1 Well R-19 screen 2 adjusted hydrograph

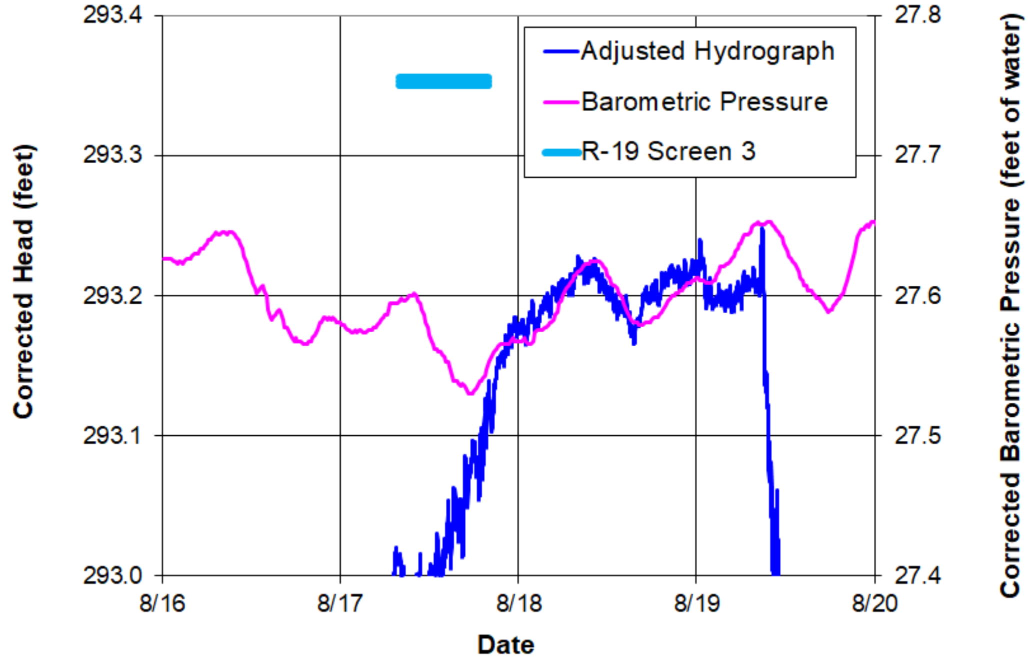

Figure C-11.2-2 Well R-19 screen 2 corrected for 0.105 ft/day water level rise and 55% barometric efficiency

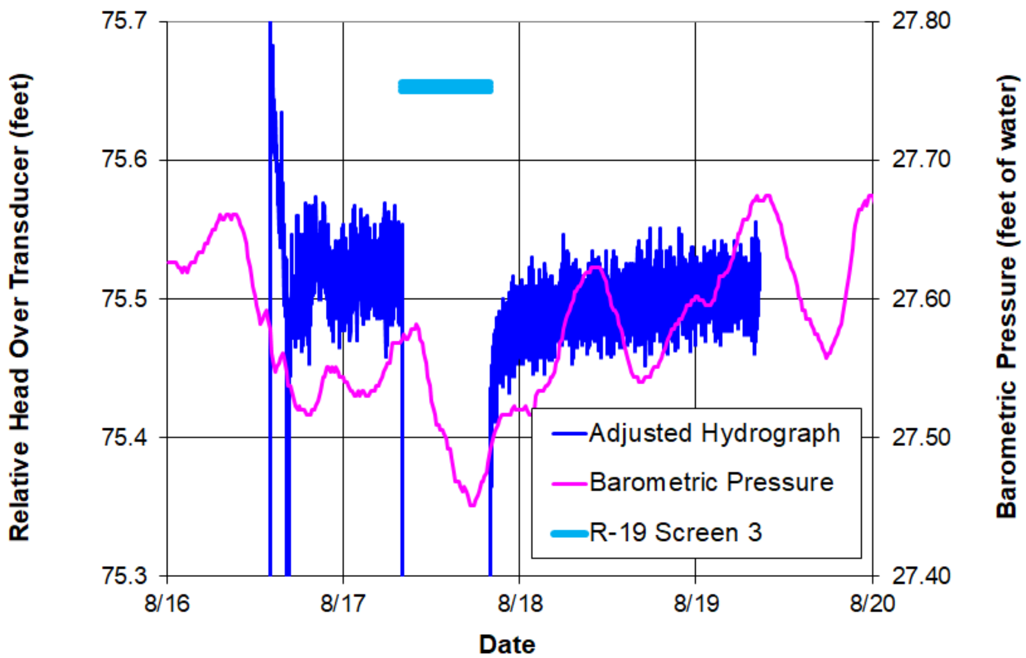

Figure C-11.2-3 Well R-19 screen 3 adjusted hydrograph

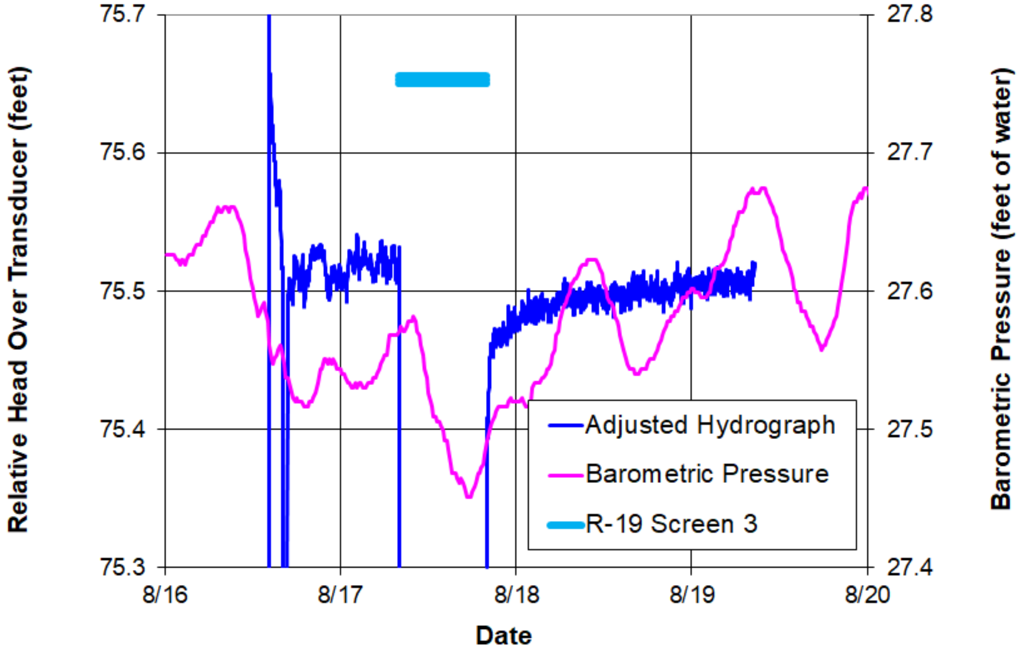

Figure C-11.2-4 Well R-19 screen 3 adjusted hydrograph – rolling average

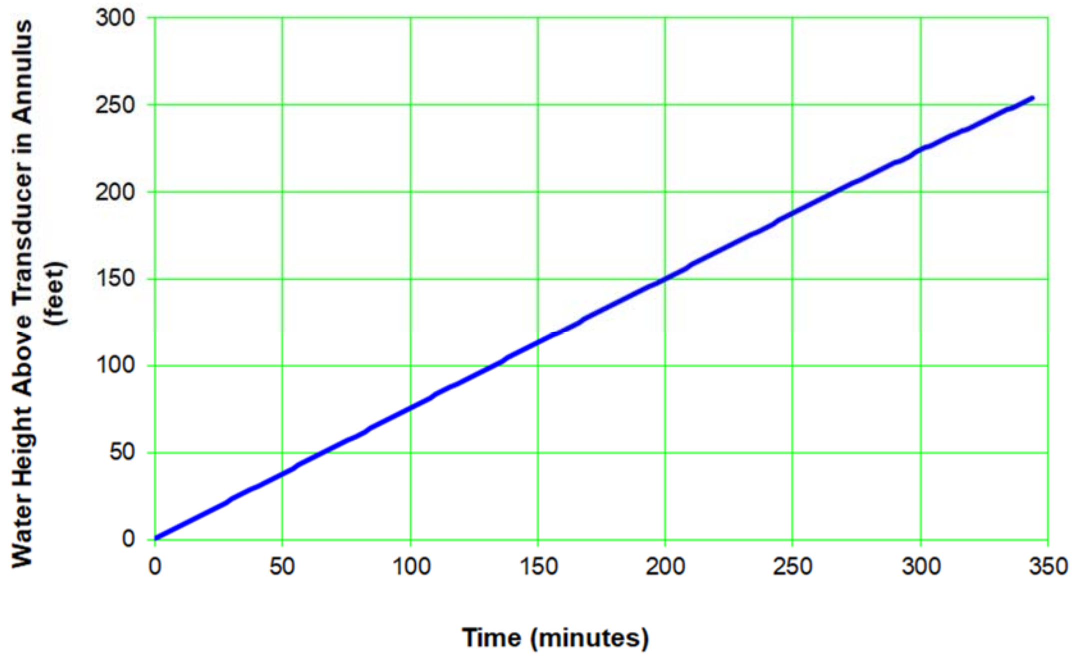

Figure C-11.3-1 Well R-19 screen 2 initial refill response

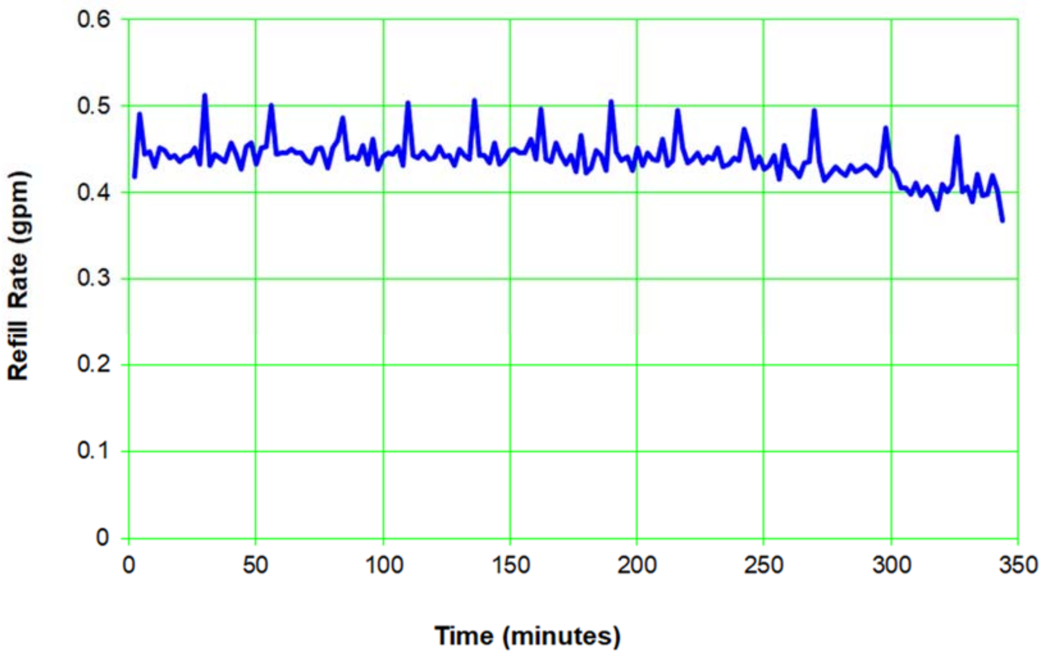

Figure C-11.3-2 Well R-19 screen 2 initial refill rate

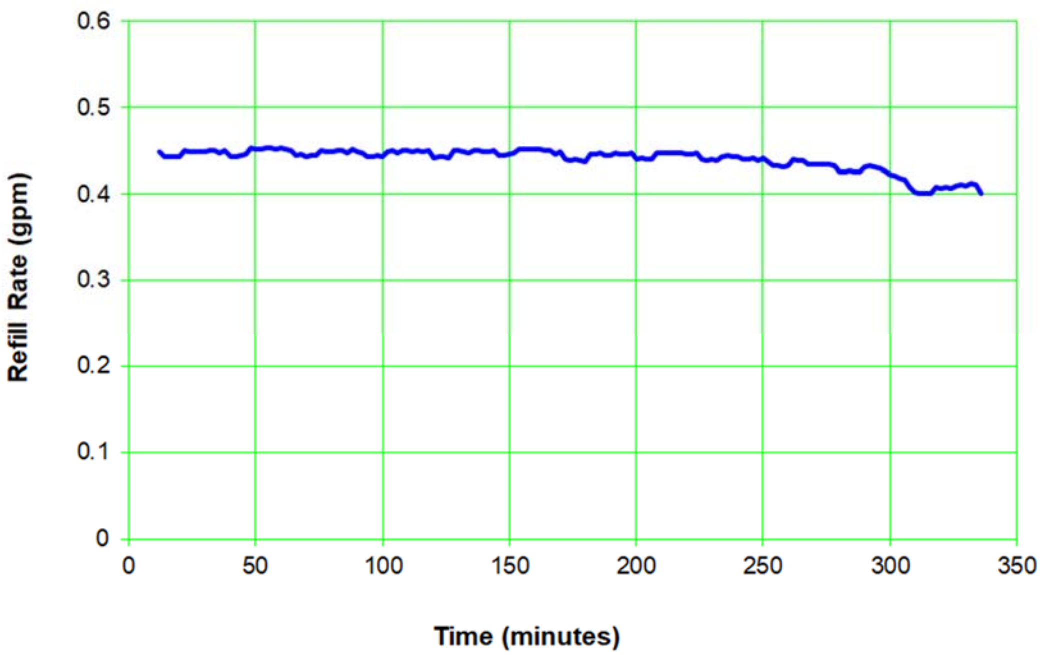

Figure C-11.3-3 Well R-19 screen 2 initial refill rate – rolling average

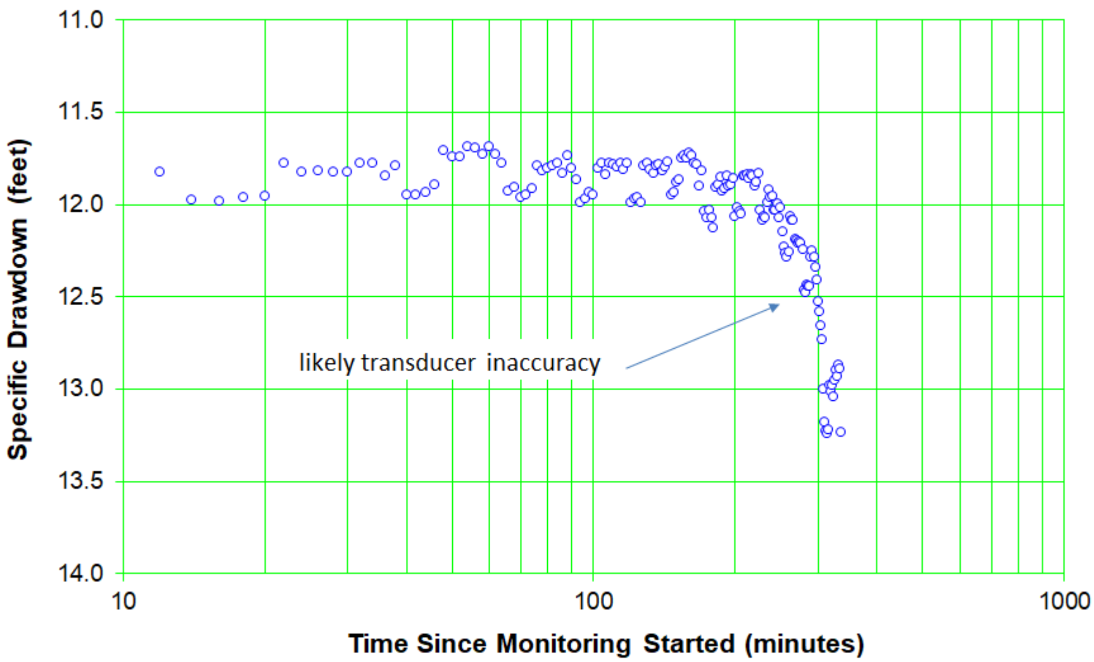

Figure C-11.3-4 Well R-19 screen 2 specific drawdown

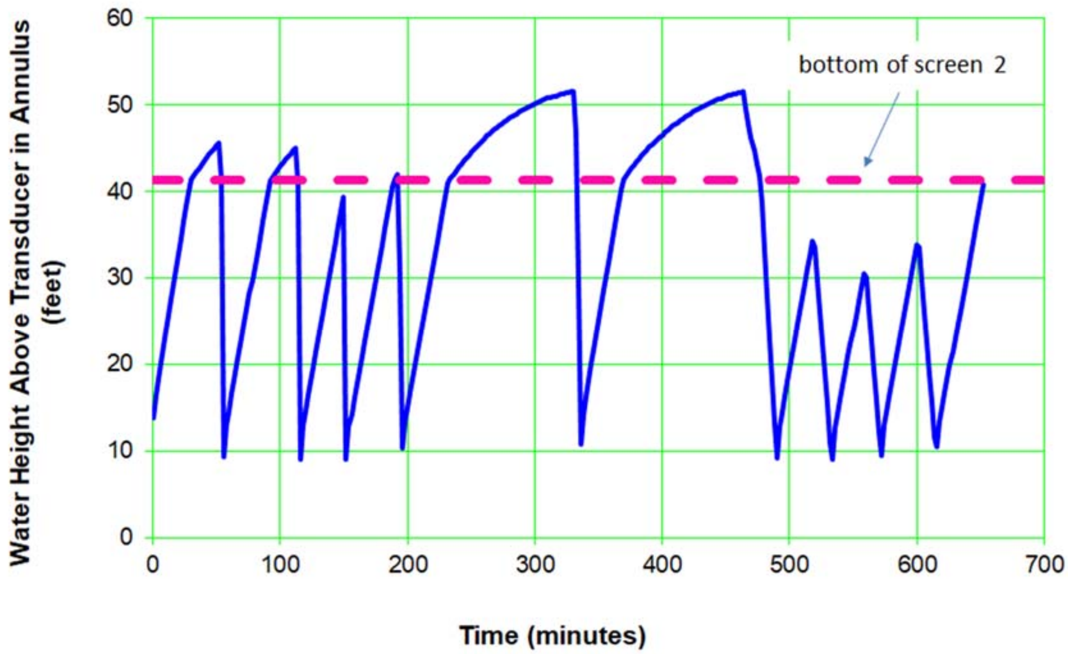

Figure C-11.3-5 Well R-19 screen 2 pumping and refill response

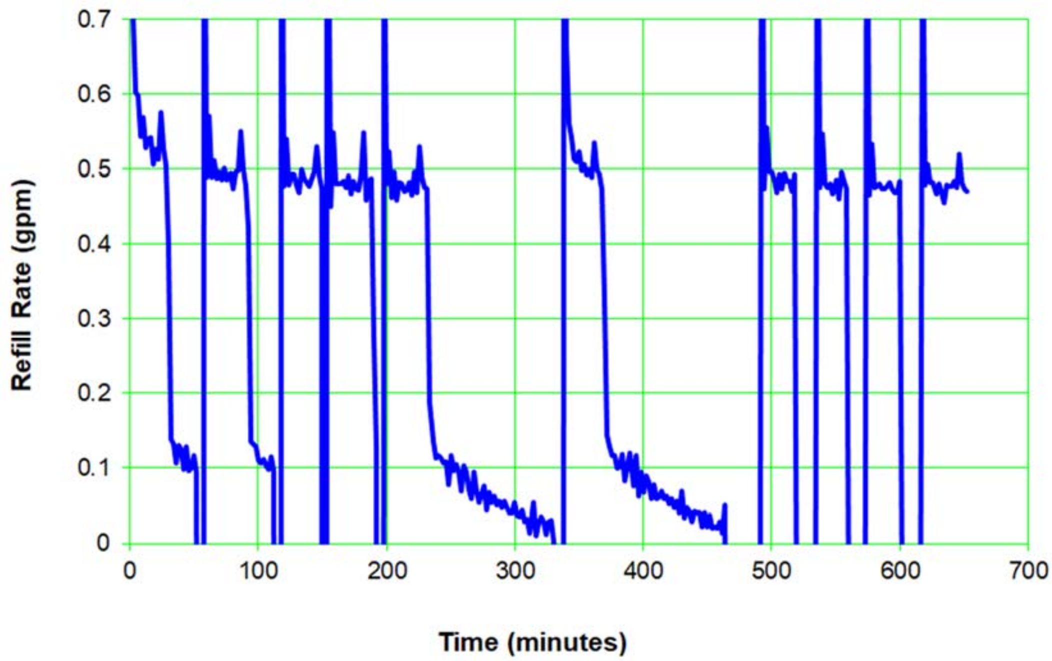

Figure C-11.3-6 Well R-19 screen 2 refill rate

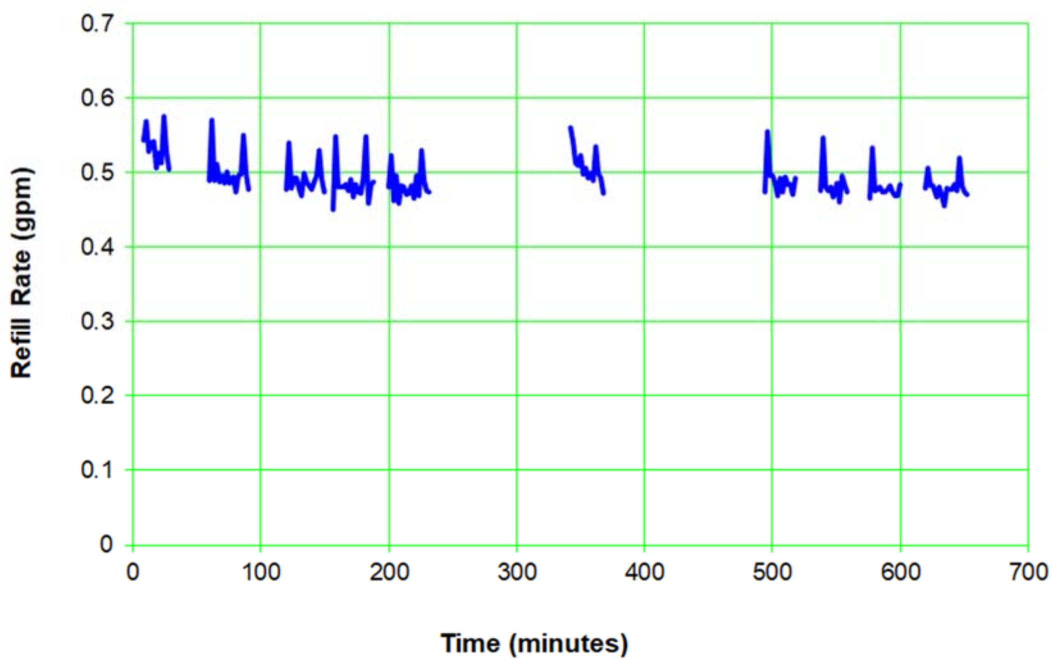

Figure C-11.3-7 Well R-19 screen 2 edited refill rate

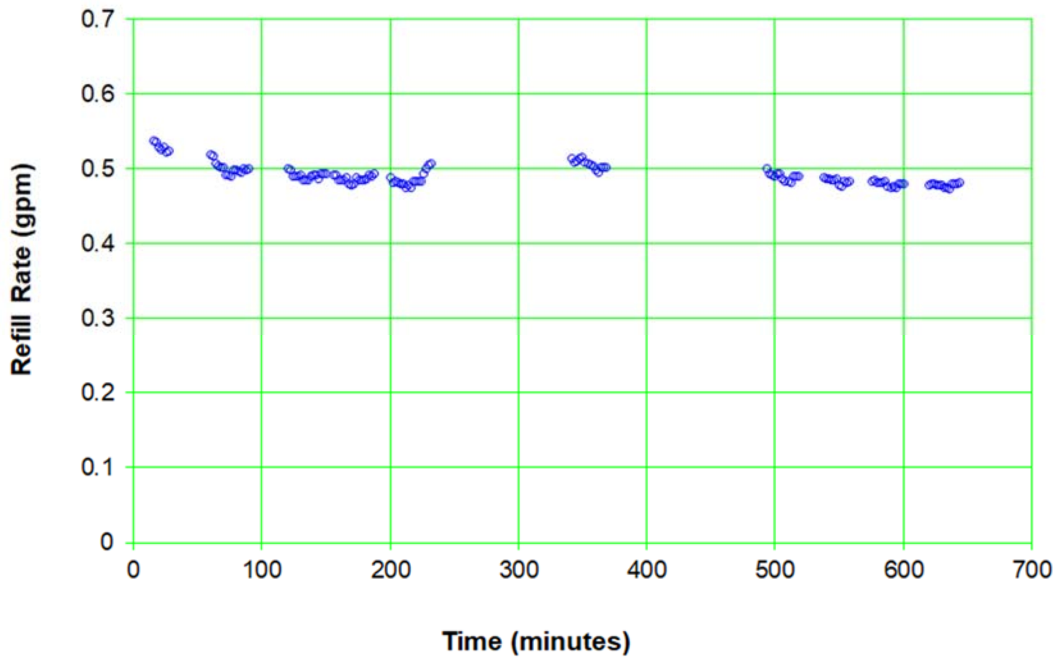

Figure C-11.3-8 Well R-19 screen 2 edited refill rate – rolling average

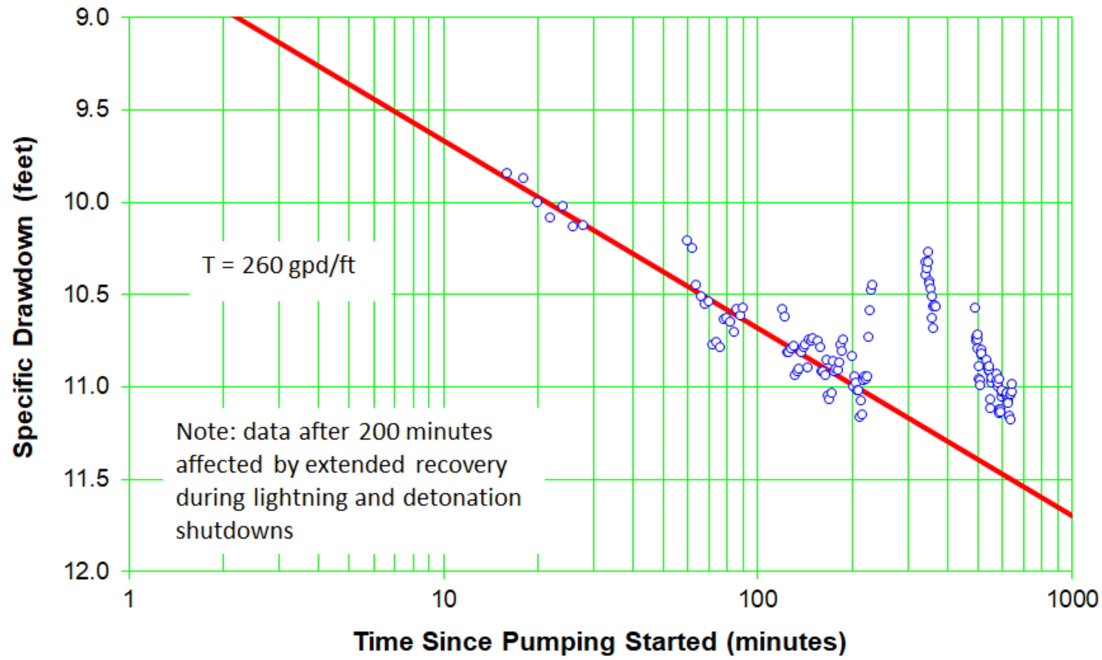

Figure C-11.3-9 Well R-19 screen 2 specific drawdown – extended test

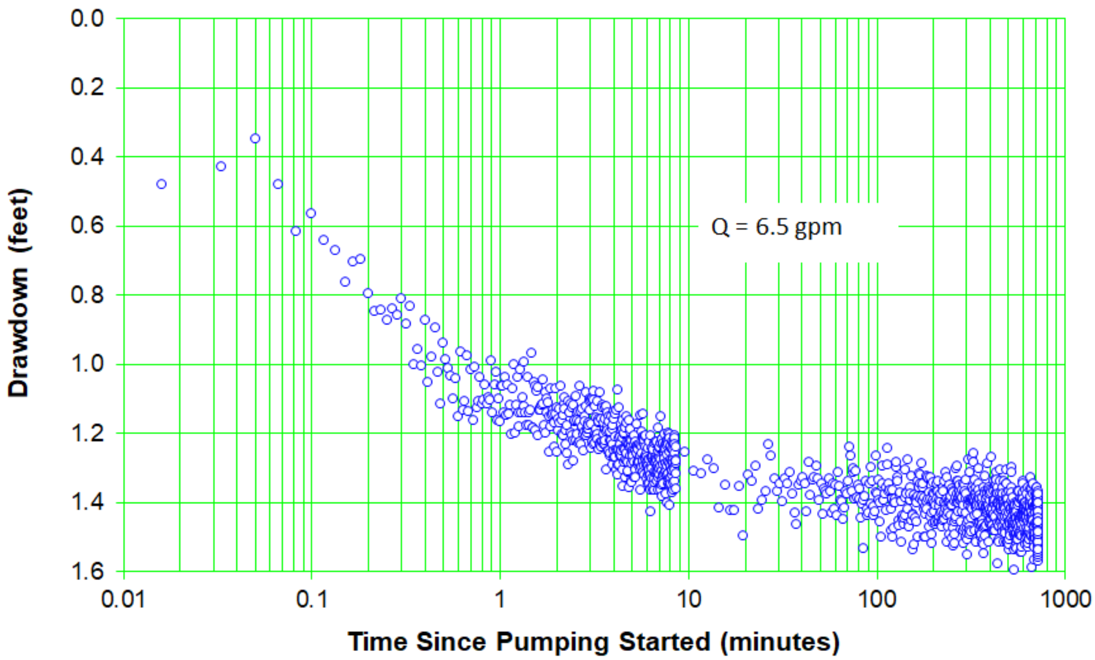

Figure C-11.5-1 Well R-19 screen 3 drawdown

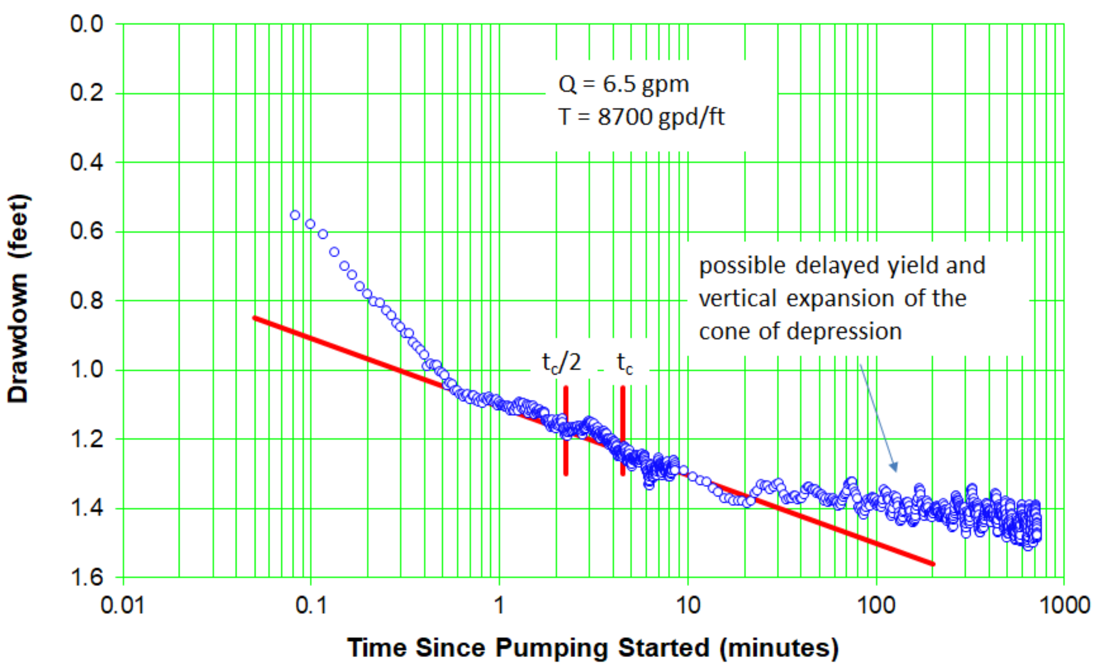

Figure C-11.5-2 Well R-19 screen 3 drawdown – rolling average

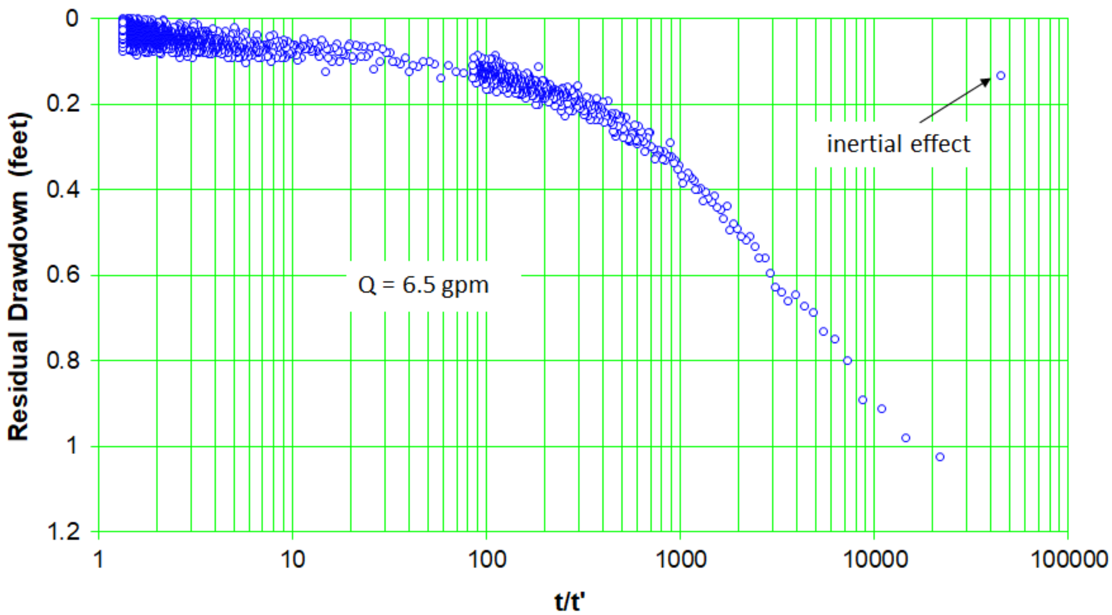

Figure C-11.5-3 Well R-19 screen 3 recovery

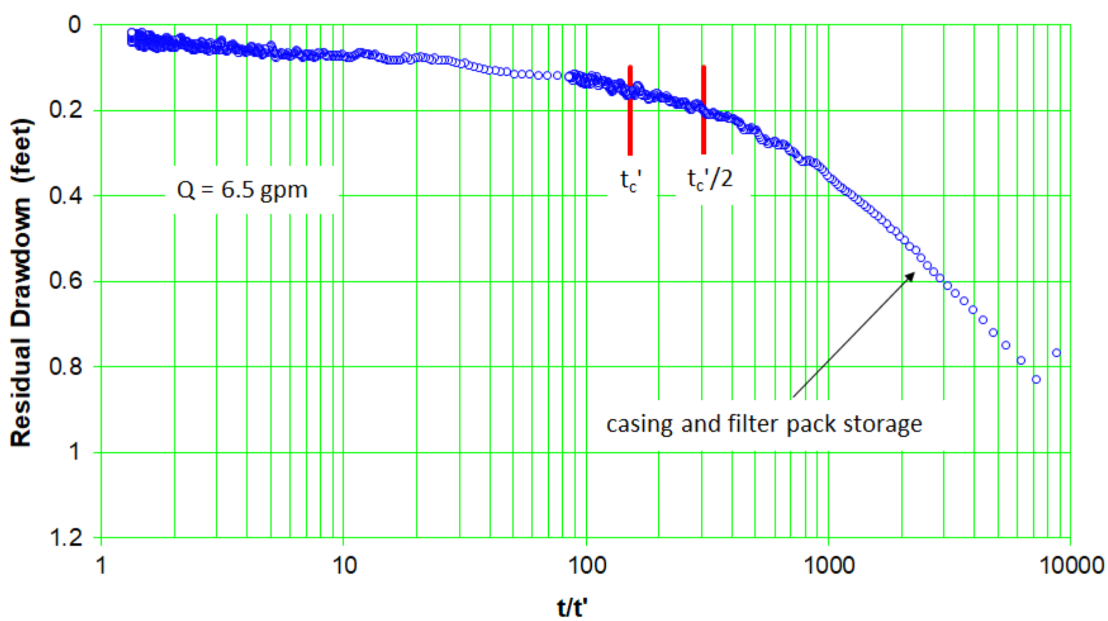

Figure C-11.5-4 Well R-19 screen 3 recovery – rolling average

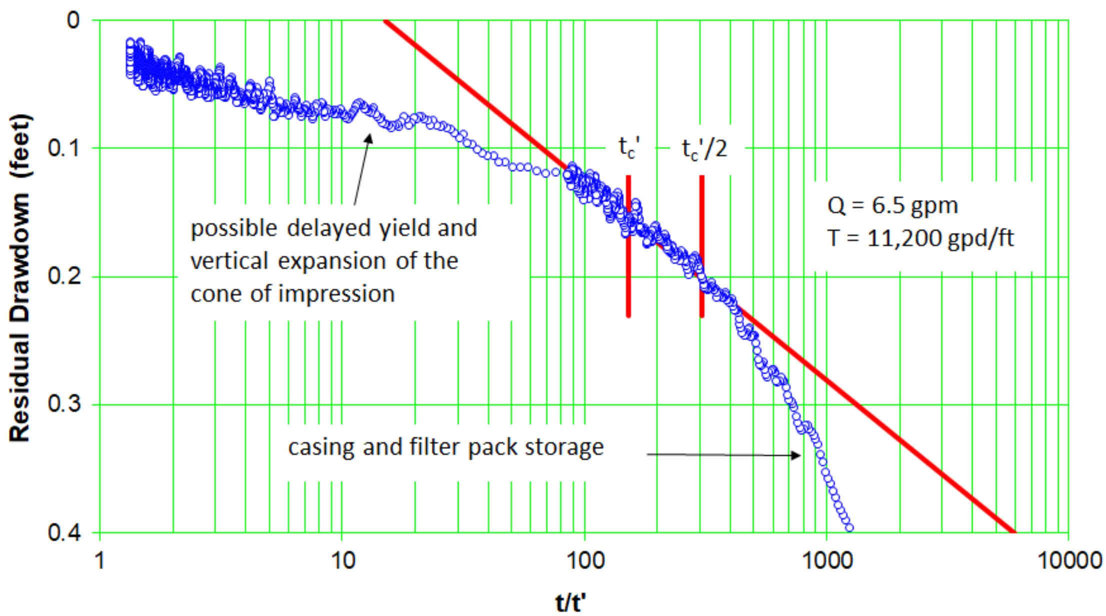

Figure C-11.5-5 Well R-19 screen 3 recovery – expanded scale

Appendix D

Westbay Packer Deflation Report

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 Westbay System MP55 monitoring wells from boreholes R-5, R-7, R-8, R-9i, and R-19 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 contained in Attachment D-1.

D-2.0 PREVIOUS SITE ACTIVITIES

The Westbay MP55 systems were installed by Westbay Instruments, Inc., from 2000 to 2002. The systems were installed in monitoring wells initially completed with 4.5- or 5-in. inside diameter stainless-steel casing and screen to various depths. Before the Westbay deflation processes, EDN staff removed MOSDAX probe/transducer strings from six of the seven Westbay systems. Table D-2.0-1 presents a summary of Westbay systems extraction activities.

D-3.0 WESTBAY SYSTEM PACKER DEFLATION

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

D-3.1 Equipment and Materials

EDN used equipment provided by both Westbay Instruments and T2S to complete the Westbay system packer deflations. 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)
- MOSDAX Automated Groundwater Interface (S/N: MGI5107)
- Electric water pump (S/N: IPW2724)
- Motorized inflation reel (S/N MIR3104)

T2S

- Westbay sampler probe (S/N 3346 [R-5, R-7, R-8])
- Westbay sampler probe (S/N 3079 [R-9i, R-19])
- 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.

Field records of pressure profiles and graphical representations of the data for each Westbay system are included in Attachment D-1 (on CD included with this document).

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.

Because of practical limitations, only the water level in R-5 was lowered before packer deflation. The large amount of water to be removed in the remaining Westbay systems 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 each Westbay system. The packers were then deflated in order from deepest to shallowest, with the exception of the packers in R-19, which were deflated in the reverse order because of the greater depth.

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 pounds per square inch (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 (nearly all in some wells) 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. In the shallower Westbay systems, the system weight was low enough for a single packer or the surface clamp to bear the additional weight. In the deeper Westbay system (R-19), the packers were deflated from the top down. A hoist, attached to the top of the Westbay string, was used to bear the increasing system weight as the packers were deflated. The hoist was provided and operated by Holt Services. 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 that hadn't 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 a 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 was 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 this case, 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 was 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 systems were allowed to sit for a minimum of 24 hr to allow sufficient time for the water in the packers to drain out and return as closely as possible to their initial uninflated diameter. Removal of the system was completed in wells R-5, R-7, R-8, R-9i, and R-19 with a pump hoist rig operated by Holt Services and Westbay lifting tools supplied by EDN, Holt Services, and Weatherford.

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	MP55 Casing Depth (ft bgs*)
R-5	May 14–17, 2019	10	883
R-7	May 18–20, 2019	9	972
R-8	May 20–22, 2019	6	848
R-9i	May 22–23, 2019	6	308
R-19	May 31–June 5, 2019	22	1870

*ft bgs = Feet below ground surface.

Attachment D-1

Supporting Documentation
(on CD included with this document)

Appendix E

New Mexico Office of the State Engineer Approvals

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 Westbay system-equipped, multi-zone monitor well is screened into four separate zones, including two zones of the local intermediate aquifer, and two zones of the deeper regional aquifer. The four 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 zone the well currently taps has gone dry while the lower intermediate zone remains 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 deeper of the two 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-97899-POD 1

Application File Date: March 4, 2019

Points of Diversion: RG-97899-POD1, AKA LANL R-5 (UTM, Zone 13N, WGS 84)

OSE File Number	OSE Tag No.	Applicant Well Number	Northing (Y)	Easting (X)
RG-97899	N/A	RG-97899-POD 1	1773061	1646709

Well will be located in Section 17, Township 19 North, Range 07 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.
MON	No water shall be diverted from the subject well(s) except for monitoring purposes.

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

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-97899-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-97899-POD 1 must be completed within one year of approval date of this permit, which will otherwise expire on May 29, 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 four-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 902' bgl.

    - The existing well casing shall be partially back-plugged using neat cement grout tremied from maximum depth to approximately 759' bgl, sealing-over the deepest existing screen section in the process.

    - Clean sand backfill will be placed from top of cement to a depth of approximately 722' 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.

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

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 partial 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 and pre- and post-reconfiguration schematics of the well design.

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 13 day of June, 2019.

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

By: [signature]
Ramona A. Martinez
Upper Rio Grande Basin Manager - District VI

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

File No. RG- 97899 POD 1

NEW MEXICO OFFICE OF THE STATE ENGINEER

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/

Purpose:

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

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: Department of Energy	Name:
Contact or Agent: check here if Agent ☐ Mark Everett	Contact or Agent: check here if Agent ☐
Mailing Address: 600 6th 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.:	Trn. No.:	Receipt No.:
Trans Description (optional):		
Sub-Basin:	PCW/LOG Due Date:	

2016 MAY -4 PM 4:27

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-5	1646709E	1773061N	SW 1/4 NE 1/4 SW 1/4 SW 1/4 of Sec 17 of T019N, R07E

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:
Located in lower Pueblo Canyon, approx 0.45 miles west of RG-92029

Well is on land owned by: Los Alamos County

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): 902 feet	Outside diameter of well casing (inches): 5.56
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.

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STATE ENGINEER OFFICE
SANTA FE, NEW MEXICO

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: RG- 97899 POD1 | 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 13 day of June 20 19, for the State Engineer,

John R. D'Antonio Jr., State Engineer

By: Ramona A. Martinez Ramona A. Martinez

Signature Print

Title: URG Basin Manager

Print

GREAT SEAL OF THE STATE OF NEW MEXICO 1912 — STATE ENGINEER OFFICE OF THE STATE OF NEW MEXICO

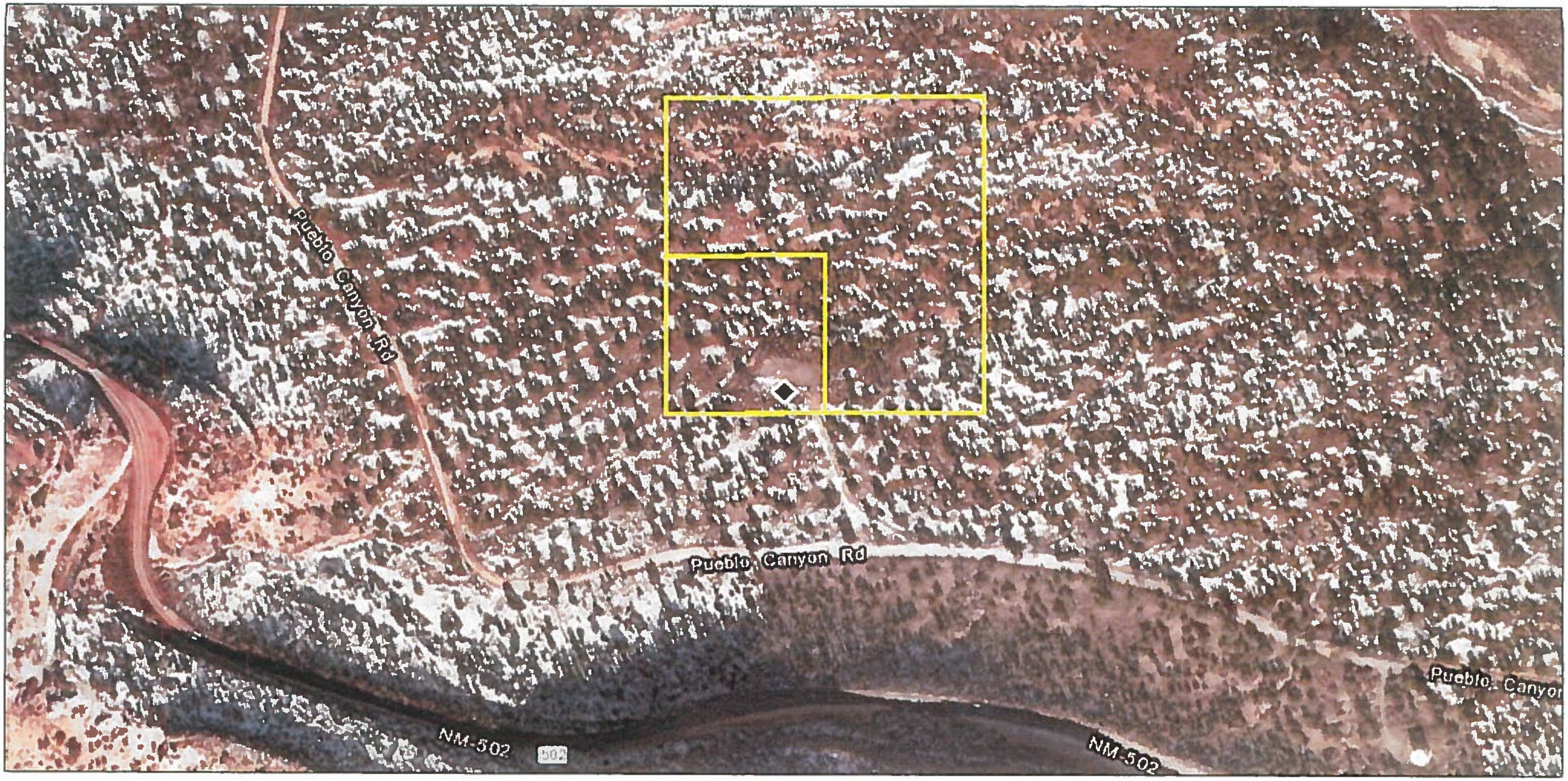
2019 MAR -4 PM 4:27

STATE ENGINEER OFFICE

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: RG- 97899 POD1	Trn No.:



NEW MEXICO OFFICE OF THE STATE ENGINEER

Coordinates

UTM - NAD 83 (m) - Zone 13

Easting 389074.852

Northing 3970566.721

State Plane - NAD 83 (f) - Zone C

Easting 1646709.000

Northing 1773061.000

Degrees Minutes Seconds

Latitude 35 : 52 : 23.054777

Longitude -106 : 13 : 43.573667

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: 1/27/2016

Resolution (m): 0.5

Accuracy (m): 10.16

Author:

Purpose:

2/27/2019

Spatial Information

OSE Administrative Area: District

County: Santa Fe

Groundwater Basin: Rio Grande

Abstract Area: Northern Rio Grande

Sub-Basin: Upper Rio Grande

Land Grant: Not in Land Grant

Restrictions:

NA

PLSS Description

SWNESWSW Qtr of Sec 17 of 019N 007E

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

R-5 Summary Information

Monitoring Well Completed May 2001

Location: X= 1646709 E ; Y =1773061 N; New Mexico State Plane Coordinates, New Mexico Central Zone in feet, 1983 North American datum

Latitude 35 deg 52 min 23.054777 sec Longitude -106 deg 13 min 43.573667 sec

PLSS: SW NE SW SW Section 17 T19 N R07E

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

Hydrologic characterization well R-5 was completed in May 2001 on the southern side of lower Pueblo Canyon. The primary purpose of this well is provide water-quality, geochemical, hydrologic, and geologic information that would contribute to understanding the hydrogeologic setting beneath LANL.

The well has a total depth of approximately 902 ft. The smallest borehole diameter across the well is 12.25 inches. The OD of the well casing is 5.563 inches. This provides a minimum of 6.6 inches of annular space.

The well currently has multiple screens - two in the intermediate zone and two in the regional aquifer. The uppermost intermediate zone has been historically dry. (See the attached hydrograph.) 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.)

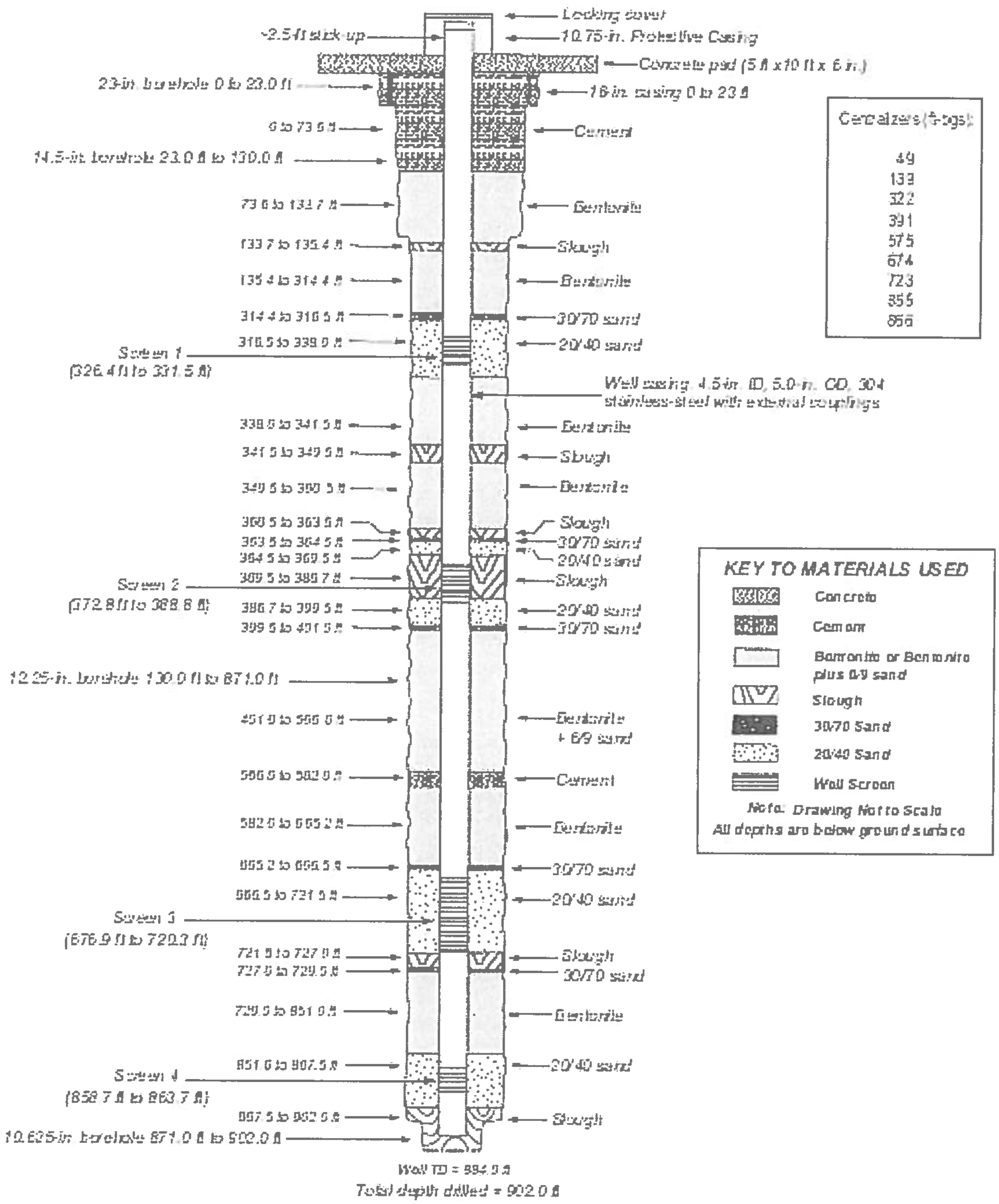
The well is equipped with a discrete Westbay sampling system which separates the screens and does not allow for commingling of aquifers.

The New Mexico Environment Department approved the reconfiguration of monitoring well R-5 in the "Work Plan for the Technical Area 21 Monitoring Well Network Reconfiguration, Los Alamos National Laboratory." In correspondence Dated August 26, 2011.

N3B has been contracted to replace the sampling system with a Baski discrete sampling system. As the lowermost screen in the regional aquifer is not needed, it will be abandoned by applying neat cement via tremie pipe from the well total depth, across the screen interval to approximately 100 ft above the top of the screen. The ID of the Well casing is 4.5 inches. A segment of the 2 inch PVC tremie will be left in the plugged interval. (See attached reconfiguration schematic.)

The new sampling system is by Baski and provides a packer between the intermediate zone and regional aquifer to separate the two water-bearing units.

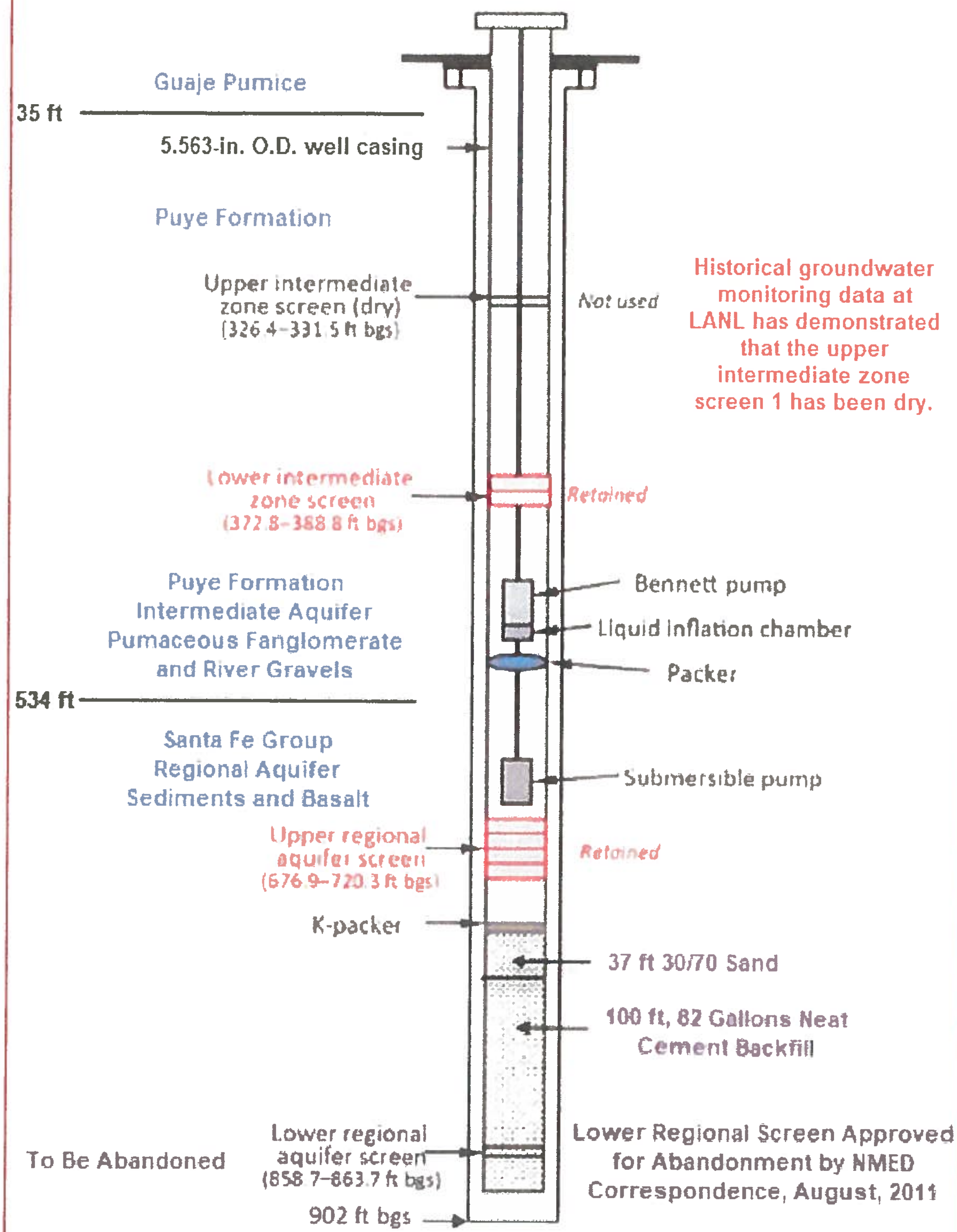
N3B respectfully requests to submit an OSE application for a monitoring well, receive the OSE approved permit, complete activities on the reconfiguration of well R-5 and submit the Well Record and Log for R-5 with the new, long-term well completion configuration.



Notes. 1. The screen interval lists the footage of the pipe perforations, not the top and bottom of screen joints.
2. Pipe-based screen: 4.5-in. ID, 5.563-in. OD, 304 stainless-steel with s.s. wire wrap, 0.010-in. slots.
3. The top interval of slough consists of Cerros del Rio sediments. The intervals of slough around screen 2 consist of Puye river gravels. The slough intervals below screens 3 and 4 consist of Santa Fe Group sediments and/or basalt.
4. Westbay multiport sampling system (MP-55) casing not shown.

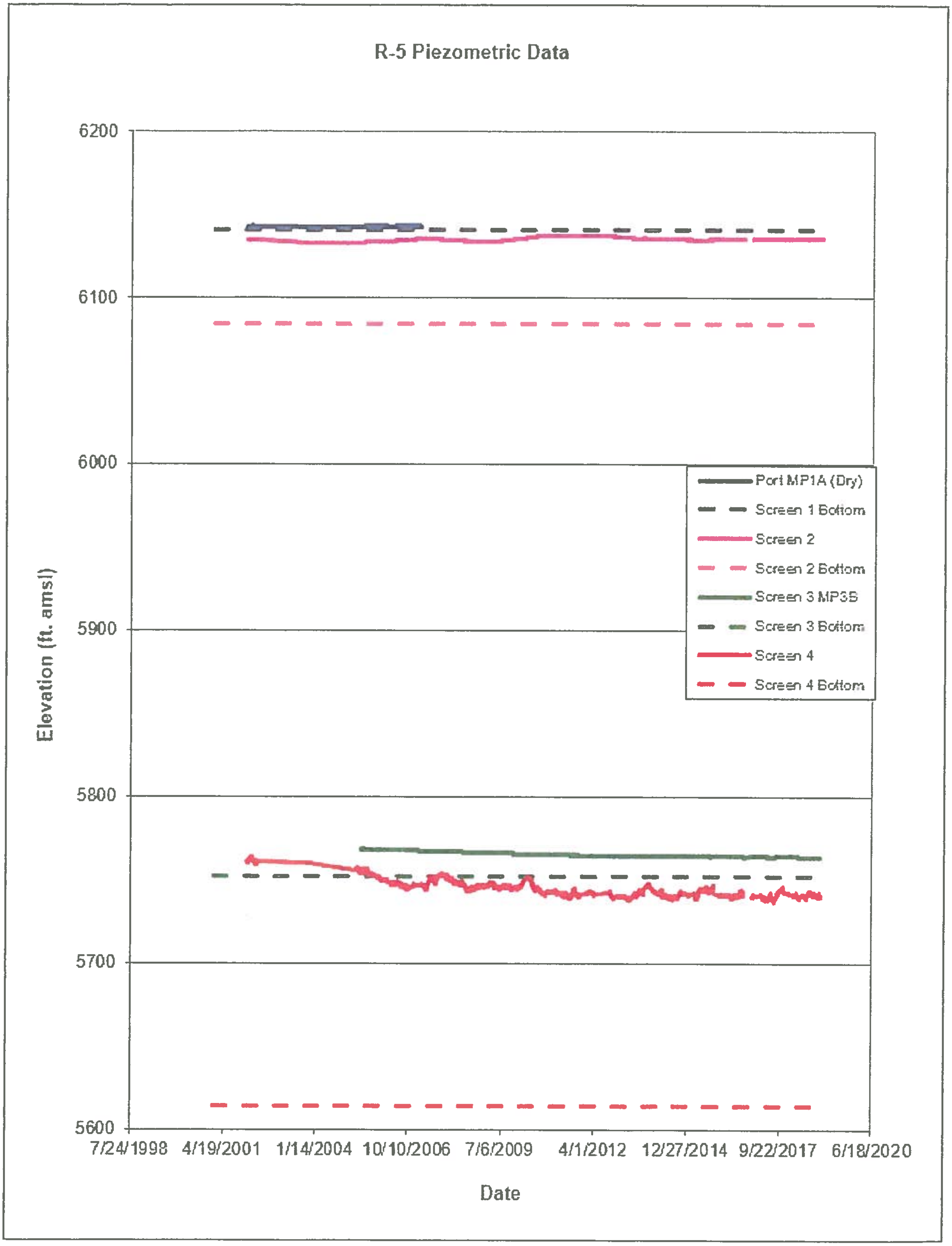
Figure 2.1.1 Well R-5 Current Well Construction Diagram

R-5 Reconfiguration Schematic



Dual-screen Baski sampling system.
APV = access port valve

NOT TO SCALE



R-5 Piezometric Data
6200
6100
6000
5900
5800
5700
5600
Elevation (ft. amsl)
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
Date
Port MP1A (Dry)
Screen 1 Bottom
Screen 2
Screen 2 Bottom
Screen 3 MP3B
Screen 3 Bottom
Screen 4
Screen 4 Bottom

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

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

PO Box 25102
Santa Fe, New Mexico 87504-5102
(505) 827-6120
FAX: (505) 827-6682

May 30, 2019

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

Re: **Approval of Permit RG-97897-POD1**

Greetings:

Enclosed are your copy of the above numbered permit that has been approved, subject to the conditions set forth in the attached conditions of approval. In accordance with the conditions of approval, the well can be used for monitoring only.

A Well Record and Log (OSE Form wr-20) shall be filed in this office within twenty (20) days after completion of drilling, but no later than May 30, 2020. Appropriate forms can be downloaded from the OSE website, www.ose.state.nm.us, or can be mailed upon request.

Please address any questions by telephone to me at 505.827-6120 or email at lorraine.garcia@state.nm.us.

Sincerely,

Ramona Martinez
Upper Rio Grande Basin Manager
Water Rights Division, District VI

Lorraine A. Garcia
Water Resource Specialist
Water Rights Division, District VI

Enclosure
Cc: file, WATERS

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

This application is approved 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-97897-POD 1

Application File Date: March 4, 2019

Points of Diversion: RG-97897-POD1, AKA R-9i (UTM, Zone 13N, WGS 84)

OSE File Number	OSE Tag No.	Applicant Well Number	Northing (Y)	Easting (X)
RG-97897	N/A	RG-97897-POD 1	1770834	1648208

Well will be located in Section 20, Township 19 North, Range 07 East, NMPM

Purpose of Use: Monitoring

Condition Code	Condition
B	The well shall be drilled by a driller licensed in the State of New Mexico in accordance with 72-12-12 NMSA 1978. A licensed driller shall not be required for the construction of a well driven without the use of a drill rig, provided that the casing shall not exceed two and three-eighths (2 3/8) inches outside diameter.
C	The well driller must file the Well Record with the State Engineer and the applicant within 20 days after the well is drilled or driven. It is the well owner's responsibility to ensure that the well driller files the well record. The well driller may obtain the 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 and casing of artesian wells.
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-97897-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

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

	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	Well RG-97897-POD 1 must be completed within one year of approval date of this permit and will expire on March 27, 2020.

Witness my hand and seal this 30 day of May A.D., 2019.

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

By: L A Garcia
Lorraine A. Garcia
Water Resource Specialist - District VI

STATE ENGINEER · GREAT SEAL OF THE STATE OF NEW MEXICO · 1912 · STATE OF NEW MEXICO

File No. RG- 97897

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: check here if Agent ☒ Mark Everett	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):

2019 MAR -4 PM 4:28

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

File No.: RG-97897	Trn. No.:	Receipt No.:
Trans Description (optional):		
Sub-Basin: URG	PCW/LOG Due Date: 5/30/2020	

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-9i	1648208 E	1770834 N	NE1/4 NE1/4 SE1/4 NW 1/4 Section 20, T19N R07E

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:
Located in lower Los Alamos Canyon

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): 322 feet	Outside diameter of well casing (inches): 5.56
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 2000.

2019 MAR -4 PM 4:28

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: RG97897	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: / Monitoring:	Pollution Control and/or Recovery:	Construction De-Watering: / Ground Source Heat Pump:	Mine De-Watering:
Exploratory: ☐ 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.	**Pollution Control and/or Recovery:** ☐ 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.	**Construction De-Watering:** ☐ 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.	**Mine De-Watering:** ☐ 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 30 day of May 20 19, for the State Engineer,

John R. D'Antonio Jr., State Engineer

By: L A Garcia
Signature

Lorraine Garcia
Print

Title: Water Resource Professional
Print

2019 MAR -4 PM 4:20

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: RG-97897	Trn No.:

NEW MEXICO OFFICE OF THE STATE ENGINEER

Coordinates

UTM - NAD 83 (m) - Zone 13

Easting 389523.213
Northing 3969882.457

State Plane - NAD 83 (f) - Zone C

Easting 1648208.800
Northing 1770834.700

Degrees Minutes Seconds

Latitude 35 : 52 : 1.032437
Longitude -106 : 13 : 25.355874

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

1:2,257

N

ft

0 45 90 180

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

Author:
Purpose:
2/28/2019

Spatial Information

OSE Administrative Area: District
County: Santa Fe
Groundwater Basin: Rio Grande
Abstract Area: Northern Rio Grande
Sub-Basin: Upper Rio Grande
Land Grant: Not in Land Grant
Restrictions:
NA

PLSS Description
NENESENW Qtr of Sec 20 of 019N 007E

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

R-9i Summary Information

Monitoring Well Completed March 2000.

Location: X= 1648208 E ; Y =1770834 N; New Mexico State Plane Coordinates, New Mexico Central Zone in feet, 1983 North American datum

Latitude 35 deg 52 min 1.032437 sec Longitude -106 deg 13 min 25.355874 sec

PLSS: NE NE SE NW Section 20 T19 N R07E

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

Hydrologic characterization Well R-9i is located at LANL near the mouth of Los Alamos Canyon. The primary purpose of this well is provide water-quality, geochemical, hydrologic, and geologic information that would contribute to understanding the hydrogeologic setting beneath LANL.

Well R-9i was completed during March 2000. The R-9i borehole was drilled to a total depth of 322 ft bgs. Well installation was completed in the intermediate aquifer with two screened intervals, and was equipped with a Westbay™ MP55 multiport sampling system. The two screens installed are: Screen 1, 189.1-199.5 ft bgs, upper intermediate zone aquifer and Screen 2, 269.6-280.3 ft bgs upper intermediate zone aquifer. The smallest borehole diameter across the well is 12.25 inches. The OD of the well casing is 5.563 inches. This provides a minimum of 6.6 inches of annular space.

The New Mexico Environment Department approved the reconfiguration of monitoring well R-9i in the "Work Plan for the Technical Area 21 Monitoring Well Network Reconfiguration, Los Alamos National Laboratory." In correspondence Dated August 26, 2011.

N3B has been contracted to replace the Westbay sampling system with a single pump system. As the lowermost screen in the intermediate aquifer is not needed, it will be abandoned by applying neat cement via tremie pipe from the well total depth, across the screen interval to approximately 40 ft above the top of the screen. A segment of the 2 inch PVC tremie will be left in the plugged interval. A K-packer will be installed between the retained screen in the upper intermediate zone and the plugged intermediate zone. (See attached reconfiguration schematic.)

N3B respectfully requests to submit an OSE application for a monitoring well, receive the OSE approved permit, complete activities on the reconfiguration of well R-9i and submit the Well Record and Log for R-9i with the new, long-term well completion configuration.

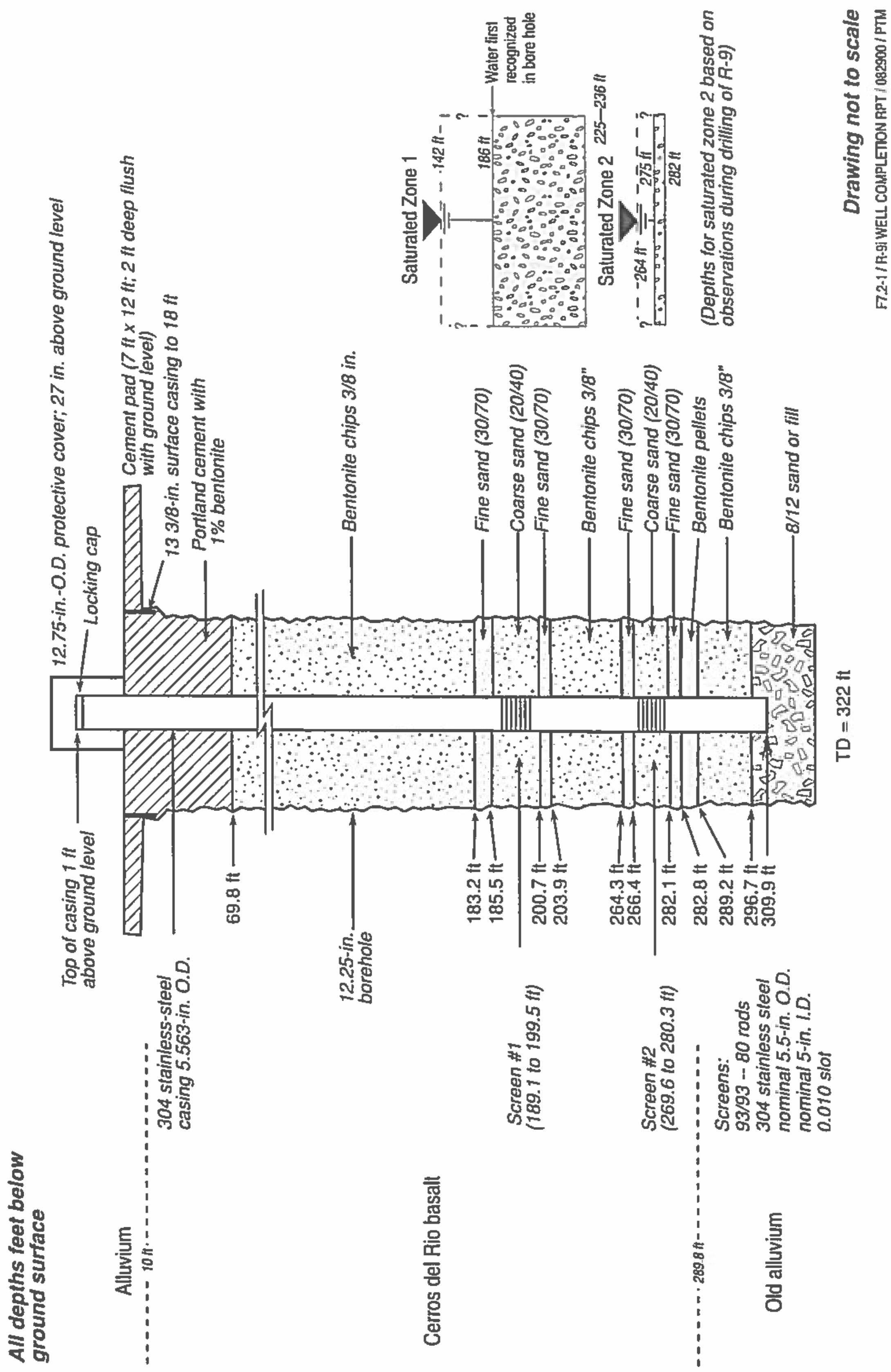
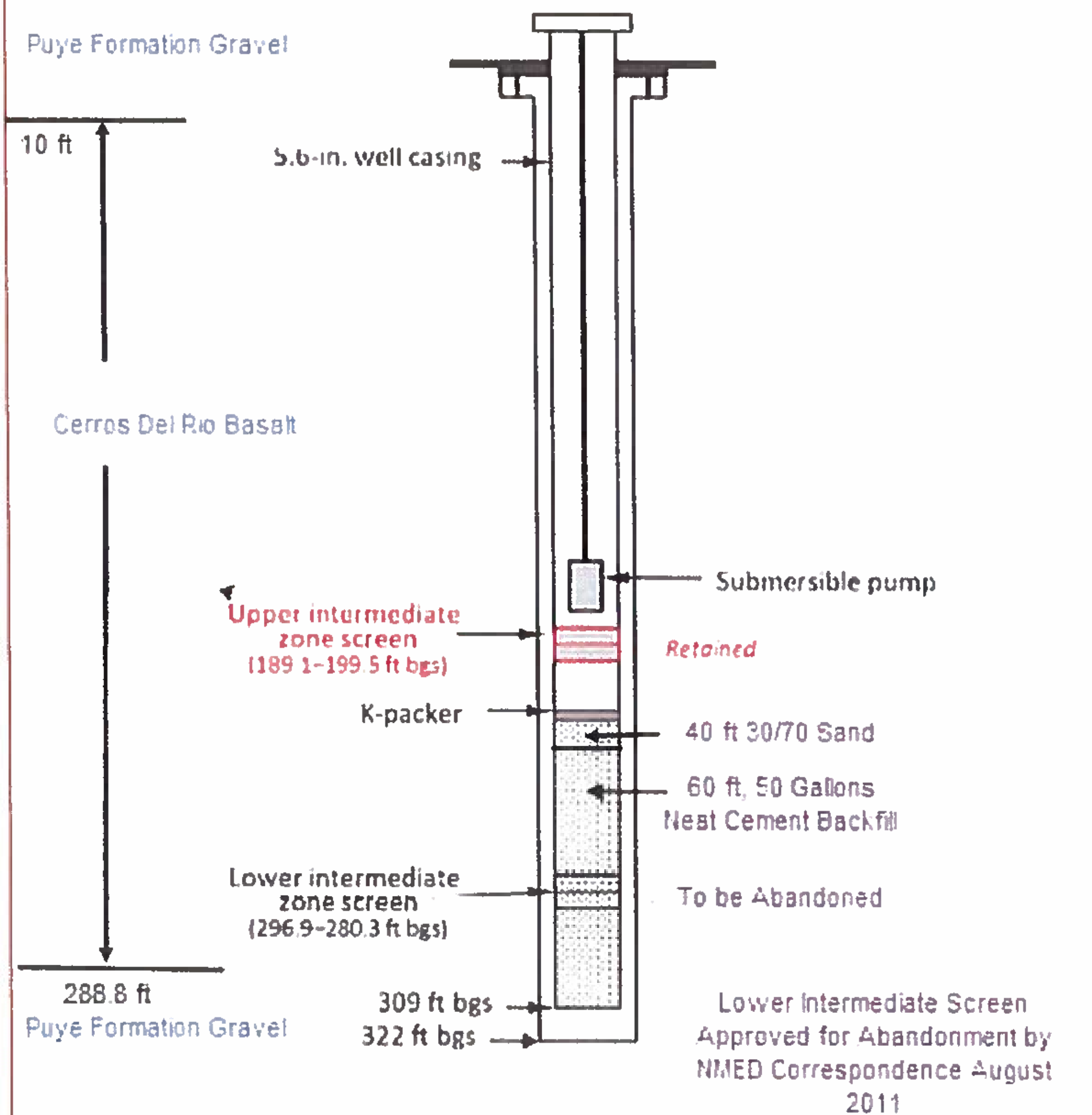


Figure 7.2-1. As-built well completion diagram of well R-9i

R-9i Reconfiguration Schematic



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 Westbay system-equipped, multi-zone monitor well is screened into seven separate zones, including two zones of the local intermediate aquifer, and five zones of the deeper regional aquifer. The seven 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 zone the well currently taps has gone dry while the lower intermediate zone remains 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 four of the five 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-97900-POD 1

Application File Date: March 4, 2019

Points of Diversion: RG-97900-POD1, AKA LANL R-19 (UTM, Zone 13N, WGS 84)

OSE File Number	OSE Tag No.	Applicant Well Number	Northing (Y)	Easting (X)
RG-97900	N/A	RG-97900-POD 1	1760252.1	1629918.4

Well will be located in Section 34, Township 19 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.
MON	No water shall be diverted from the subject well(s) except for monitoring purposes.

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

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-97900-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-97900-POD 1 must be completed within one year of approval date of this permit, which will otherwise expire on May 29, 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 1,877' bgl.
   - The existing well casing shall be partially back-plugged using neat cement grout tremied from maximum depth to approximately 1,372' bgl, sealing-over the four deepest existing screen sections in the process.
   - Clean sand backfill will be placed from top of cement to a depth of approximately 1,242' 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.

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

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 partial 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 and pre- and post-reconfiguration schematics of the well design.

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 13 day of June, 2019.

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

By: [signature]
Ramona A. Martinez
Upper Rio Grande Basin Manager- D[...]

STATE ENGINEER STATE OF NEW MEXICO — THE STATE OF NEW MEXICO GREAT SEAL 1912

File No. RG-97900 POD1

NEW MEXICO OFFICE OF THE STATE ENGINEER

Office of the State Engineer — Interstate Stream Commission

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/

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

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1. APPLICANT(S)

Name: Los Alamos National Laboratory	Name:
Contact or Agent: check here if Agent ☐ Mark Everett	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):

2019 MAR -4 PM 4:28

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

File No.:	Trn. No.:	Receipt No.:
Trans Description (optional):		
Sub-Basin:	PCW/LOG Due Date:	

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-19	1629918.4 E	1760252.1 N	SE1/4 NW1/4 SE1/4 NE1/4 Section 34, T19N 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): 1902.5 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.

2019 MAR -4 PM 4:28
STATE ENGINEER OFFICE
SANTA FE, NEW MEXICO

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: RG- 97900 POD 1	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 15 day of June 20 19, for the State Engineer,

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

By: [signature] Ramona A. Martinez

Signature

Title: URG Basin Manager

Print

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: RG-97900 POD 2	Trn No.:

R-19 Summary Information

Monitoring Well Completed March 2000.

Location: X= 1629918.4E; Y =1760252.1 N; New Mexico State Plane Coordinates, New Mexico Central Zone in feet, 1983 North American datum

Latitude 35 deg 50 min 16.358781 sec Longitude -106 deg 17 min 7.551058 sec

PLSS: SW NW SE NE Section 34 T19 N R06E

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

Hydrologic characterization well R-19 is located at LANL atop the mesa separating Threemile and Potrillo Canyons. R-19 was drilled to a depth of 1902.5 ft bgs, and it was completed in March 2000 as a multiscreen monitoring well containing seven screened intervals that can be sampled individually with the Westbay™ MP55 System. R-19 was primarily designed to provide water quality and water-level data for potential intermediate-depth perched zones and for the regional aquifer downgradient of at TA-16. The Westbay sampling system which separates the screens does not allow for commingling of aquifers.

The smallest borehole diameter across the well is 12.25 inches. The OD of the well casing is 5.25-in. with a 4.5-in. ID. This provides a minimum of 7 inches of annular space.

The well currently has multiple screens:

- Screen 1, 827.2-843.6 ft bgs intermediate aquifer (historic data shows this screen to be dry)
- Screen 2, 893.3-909.6 ft bgs intermediate aquifer
- Screen 3, 1171.4-1215.4 ft bgs top of the regional aquifer
- Screen 4, 1410.2-1417.4 ft bgs within the regional aquifer
- Screen 5, 1582.6-1589.8 ft bgs within the regional aquifer
- Screen 6, 1726.8-1733.9 ft bgs within the regional aquifer
- Screen 7, 1832.4-1839.5 ft bgs within the regional 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.)

In correspondence dated February 5, 2019, the New Mexico Environment Department approved the reconfiguration of monitoring well R-19 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 a Baski discrete sampling system.

The four lower screens in the lower regional aquifer, Screens, 4, 5, 6, and 7, 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 neat cement via tremie pipe from the well total depth, across the four screened intervals to approximately 38 ft above the top of Screen 4 to 1372 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. One hundred thirty feet of 30/70 sand will be installed through the tremie pipe above the cement interval to 1242 ft bgs. A stainless steel and Viton–coated K-packer will be installed above the sand near 1242 ft bgs to further isolate the plugged screens from retained Screen 3. (See the attached reconfiguration schematic.)

The new sampling system is by Baski and will sample Screen 2 (intermediate aquifer) and Screen 3 (regional aquifer) and provides a packer between Screen 2 and Screen 3 to separate the two water-bearing units. Uppermost Screen 1 has been determined to be dry during historical groundwater monitoring events. (See the attached hydrograph for R-19 Screens 1 and 2.)

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-19 and submit the Well Record and Log for R-19 with the new, long-term well completion configuration.

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NEW MEXICO OFFICE OF THE STATE ENGINEER

1:4,514
N
ft
0 90 180 360

Coordinates

UTM - NAD 83 (m) - Zone 13
Easting 383908.320
Northing 3966728.827

State Plane - NAD 83 (f) - Zone C
Easting 1629918.400
Northing 1760252.100

Degrees Minutes Seconds
Latitude 35 : 50 : 16.358781
Longitude -106 : 17 : 7.551058

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

Image Information
Source: DigitalGlobe
Date: 7/10/2016
Resolution (m): 0.5
Accuracy (m): 10.16

Author:
Purpose:
2/27/2019

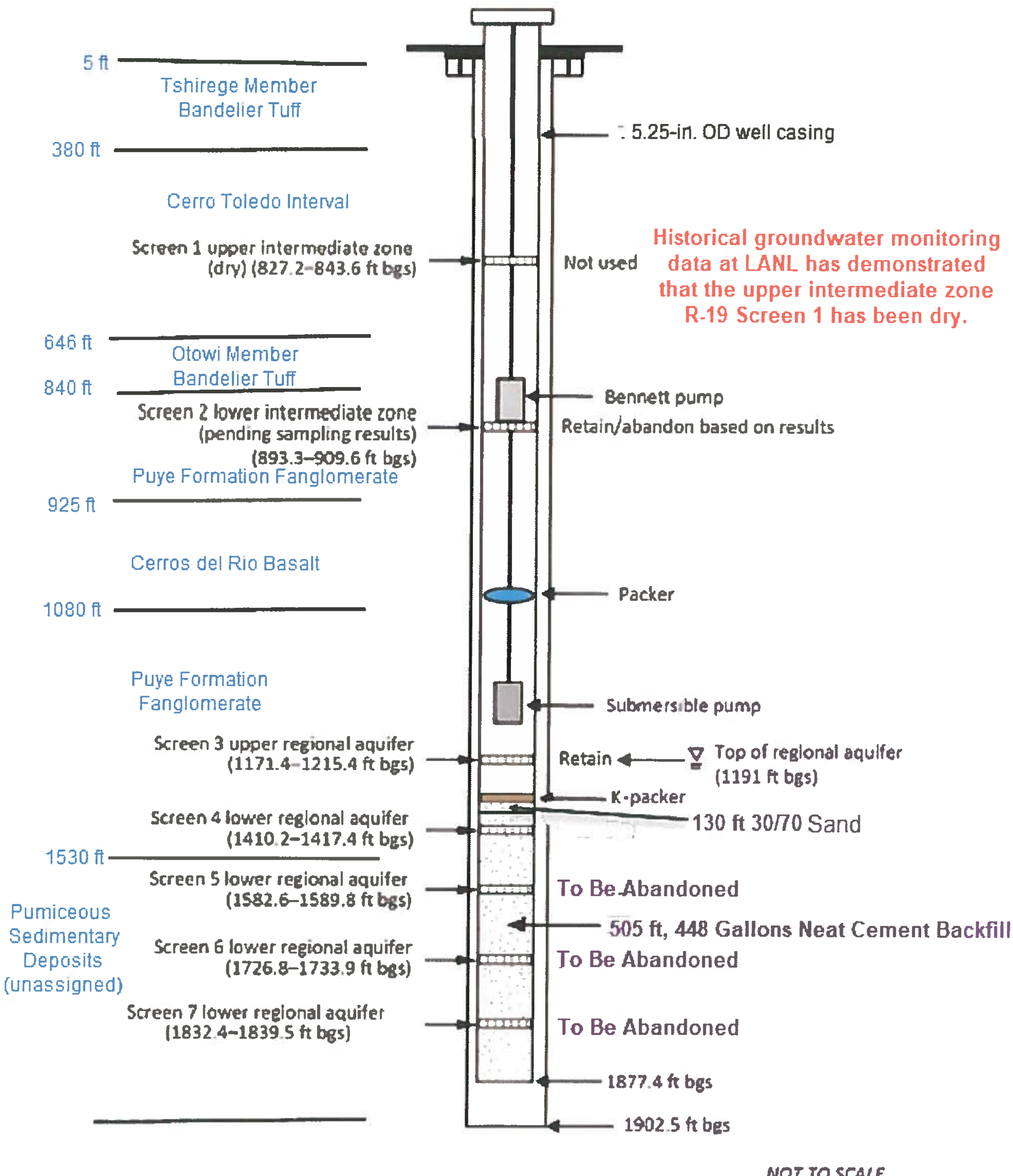
Spatial Information

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

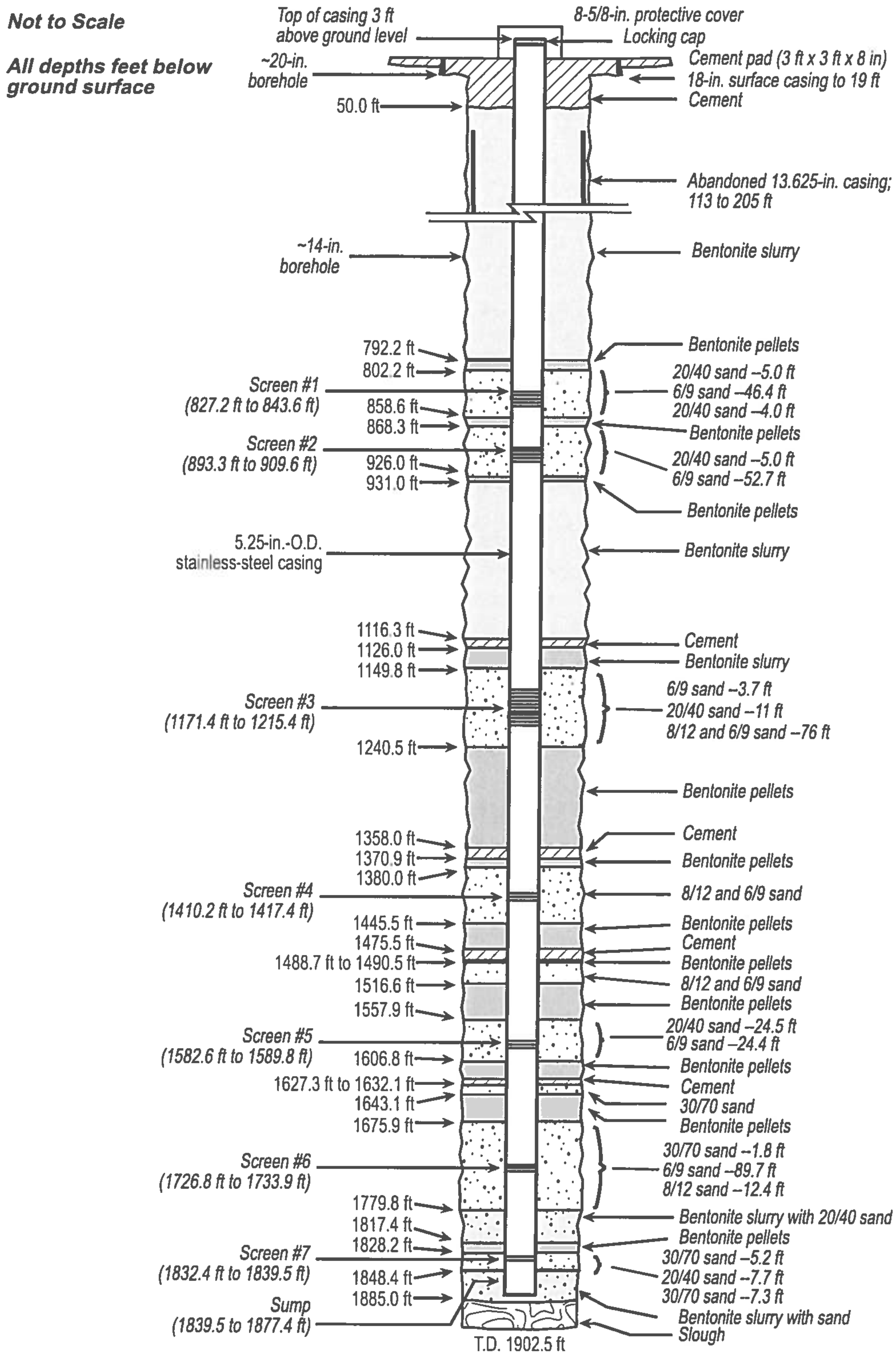
PLSS Description
SE NW SE NE Qtr of Sec 34 of 19N 6E

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

R-19 Reconfiguration Schematic



R-19 Lower Regional Aquifer Screens Approved for
Abandonment in NMED Correspondence, dated 2/5/19



Note: The screen intervals list the footages of the pipe perforations, not the tops and bottoms of screen joints.

F8.2-1 / R-19 WELL COMPLETION RPT / 083000 / PTM

Figure 8.2-1. As-built well-completion diagram of well R-19