ESHID-601081

Los Alamos
NATIONAL LABORATORY
EST. 1943

Associate Director for ESH
Environment, Safety, and Health
P.O. Box 1663, MS K491
Los Alamos, New Mexico 87545
505-667-4218/Fax 505-665-3811

Environmental Management
Los Alamos Field Office, MS A316
3747 West Jemez Road
Los Alamos, New Mexico 87544
(505) 665-5658/FAX (505) 606-2132

RECEIVED
JAN - 4 2016
NMED
Hazardous Waste Bureau

Date: JAN 0 4 2016
Refer To: ADESH-15-188
LAUR: 15-29666
Locates Action No.: n/a

John Kieling, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Submittal of Completion Report for Regional Aquifer Well SIMR-2

Dear Mr. Kieling:

Enclosed please find two hard copies with electronic files of the Completion Report for Regional Aquifer Well SIMR-2. This report describes the drilling, well construction, development, aquifer testing, and dedicated sampling system installation for regional aquifer well SIMR-2, located on Pueblo de San Ildefonso land within Mortandad Canyon. This well is intended to augment the chromium investigation monitoring network in and around Mortandad Canyon.

If you have questions, please contact Stephani Swickley at (505) 606-1628 (sfuller@lanl.gov) or Cheryl Rodriguez at (505) 665-5330 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Bruce Robinson, Program Director
Environmental Remediation Program
Los Alamos National Laboratory

Sincerely,

David S. Rhodes, Supervisor
Environmental Management
Los Alamos Field Office

BR/DR/SS:sm

Enclosure: Two hard copies with electronic files – Completion Report Regional Aquifer Well SIMR-2 (EP2015-0205)

Cy: (w/enc.)
Raymond Martinez, San Ildefonso Pueblo, NM
Terry Aguilar, San Ildefonso Pueblo, NM
Dino Chavarria, Santa Clara Pueblo, NM
emla.docs@em.doe.gov
Cheryl Rodriguez, DOE-EM-LA, MS A316
Stephani Swickley, ADEP ER Program, MS M992
Public Reading Room (EPRR)

Cy: (w/electronic enc.)
Laurie King, EPA Region 6, Dallas, TX
Steve Yanicak, NMED-DOE-OB, MS M894
Mark Everett, ADEP, MS M992
ADESH Records
PRS Database

Cy: (w/o enc./date-stamped letter emailed)
lasomailbox@nnsa.doe.gov
Kimberly Davis Lebak, DOE-NA-LA
Peter Maggiore, DOE-NA-LA
Douglas Hintze, DOE-EM-LA
David Rhodes, DOE-EM-LA
Bruce Robinson, ADEP ER Program
Randy Erickson, ADEP
Jocelyn Buckley, ADESH-ENV-CP
Mike Saladen, ADESH-ENV-CP
Alison Dorries, ADESH-ENV-DO
Michael Brandt, ADESH
Amy De Palma, PADOPS
Craig Leasure, PADOPS

LA-UR-15-29666
January 2016
EP2015-0205

Completion Report for Regional Aquifer Well SIMR-2

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by the Environmental Programs Directorate

EP2015-0205

Completion Report for Regional Aquifer Well SIMR-2

January 2016

Responsible project manager:

Printed Name	Signature	Title	Organization	Date
for Stephani Swickley		Project Manager	Environmental Remediation Program	12/22/15

Responsible LANS representative:

Printed Name	Signature	Title	Organization	Date
for Randall Erickson		Associate Director	Environmental Programs	12/22/15

Responsible DOE representative:

Printed Name	Signature	Title	Organization	Date
David S. Rhodes		Supervisor	DOE-EM-LA	12-28-2015

EXECUTIVE SUMMARY

This well completion report describes the drilling, well construction, development, aquifer testing, and dedicated sampling system installation for regional aquifer groundwater well SIMR-2, located on Pueblo de San Ildefonso land in New Mexico. The SIMR-2 monitoring well is intended to augment the existing monitoring well network to better define chromium contamination flow paths above and within the regional aquifer in Mortandad Canyon adjacent to Los Alamos National Laboratory in Los Alamos County, New Mexico, as required by the New Mexico Environment Department's 2014 Approval with Modifications of the Phase II Investigation Report for Sandia Canyon. The objectives of the well are to (1) delineate the off-site nature and extent of the plume; (2) potentially detect and monitor contaminants for the long term as well as monitor future remediation efforts; and (3) provide data and information to determine whether production well Pajarito Mesa 4 is susceptible to contamination from the chromium plume.

The SIMR-2 monitoring well borehole was drilled using dual-rotary air-drilling methods. Fluid additives used included potable water and foam. Foam-assisted drilling was used only to a depth of 773 ft below ground surface (bgs). SIMR-2 was drilled to a total depth of 981.4 ft bgs.

The following geologic formations were encountered at SIMR-2: Quaternary alluvium, Tshirege Member of the Bandelier Tuff, Cerro Toledo interval, Otowi Member of the Bandelier Tuff, Guaje Pumice Bed of the Otowi Member, the Puye Formation, Cerros del Rio volcanics, and additional Puye Formation sediments.

Well SIMR-2 was completed as a single-screen well, allowing evaluation of water quality and water levels within the regional aquifer. The screened interval is set between 885 and 905.4 ft bgs within Puye Formation sediments. The static depth to water after well installation was measured at 867.9 ft bgs.

The well was completed in accordance with an NMED- and Pueblo de San Ildefonso–approved well design. The well was developed and the regional aquifer groundwater met target water-quality parameters. Aquifer testing indicates that regional aquifer monitoring well SIMR-2 will perform effectively in meeting the planned objectives. A sampling system and transducer were placed in the screened interval, and groundwater sampling at SIMR-2 will be performed as part of the annual Interim Facility-Wide Groundwater Monitoring Plan.

CONTENTS

Figures

Tables

Appendixes

Acronyms and Abbreviations

amsl	above mean sea level
ASTM	American Society for Testing and Materials
bgs	below ground surface
Consent Order	Compliance Order on Consent
DO	dissolved oxygen
DTW	depth to water
Eh	oxidation-reduction potential
ENV-CP	Environmental Protection Division–Environmental Compliance Programs
EP	Environmental Programs
EPA	U.S. Environmental Protection agency
ESH	Environment, Safety, and Health (Laboratory directorate)
F	filtered
FD	field duplicate
FTB	field trip blank
gpd	gallons per day
gpm	gallons per minute
hp	horsepower
I.D.	inside diameter
LANL	Los Alamos National Laboratory
NAD	North American Datum
NMED	New Mexico Environment Department
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
PVC	polyvinyl chloride
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
SIMR	San Ildefonso Mortandad Regional
SOP	standard operating procedure
SVOC	semivolatile organic compound
TA	technical area
TD	total depth
TOC	total organic carbon
UF	unfiltered
VOC	volatile organic compound
WCSF	waste characterization strategy form

1.0 INTRODUCTION

This completion report summarizes borehole drilling, well construction, well development, aquifer testing, and dedicated sampling system installation for regional aquifer monitoring well San Ildefonso Mortandad Regional 2 (SIMR-2). The report is prepared in accordance with the requirements in Section IV.A.3.e.iv of the March 1, 2005 (revised 2012), Compliance Order on Consent (the Consent Order). The SIMR-2 monitoring well borehole was drilled between June 21 and July 10, 2015, and completed between July 18 and August 10, 2015, on Pueblo de San Ildefonso land adjacent to Los Alamos National Laboratory (LANL or the Laboratory) for the Environmental Programs (EP) Directorate.

Well SIMR-2 is located on Pueblo de San Ildefonso land in New Mexico (Figure 1.0-1). Well SIMR-2 was installed to provide groundwater monitoring for chromium and other potential contaminants within the regional aquifer identified in Mortandad and Sandia Canyons. Secondary objectives were to identify and establish water levels in perched-intermediate aquifers and to collect drill-cuttings samples for lithologic description.

The SIMR-2 borehole was drilled to a total depth (TD) of 981.4 ft below ground surface (bgs). During drilling, cuttings samples were collected at 5-ft intervals from ground surface to TD. A monitoring well was installed with a screened interval between 885 and 905.4 ft bgs within Puye Formation volcaniclastic sediments. The depth to water (DTW) of 867.9 ft bgs was recorded on August 11, 2015, after well installation.

Post-installation activities included well development, aquifer testing, surface completion, conducting a geodetic survey, sampling system installation, site restoration, and waste management.

The information presented in this report was compiled from field reports and daily activity summaries. Records, including field reports, field logs, and survey information, are on file at the EP Records Processing Facility. This report contains brief descriptions of activities and supporting figures, tables, and appendixes associated with the SIMR-2 project.

2.0 ADMINISTRATIVE PLANNING

The following documents were prepared to guide activities associated with the drilling, installation, and development of regional aquifer well SIMR-2:

- “Drilling Work Plan for Groundwater Monitoring Well SIMR-2” (LANL 2015, 600174);
- “Field Implementation Plan for Regional Aquifer Well SIMR-2” (TerranearPMC 2015, 601066);
- “IWD [Integrated Work Document] for Drilling and Installation of LANL Well SIMR-2” (TerranearPMC 2015, 601067);
- “Storm Water Pollution Prevention Plan SIMR-2 Well Pad and Construction Support Activities” (LANL 2015, 601070); and
- “Waste Characterization Strategy Form for Installation of Regional Well SIMR-2”.(LANL 2015, 600259)

3.0 DRILLING ACTIVITIES

This section describes the drilling approach and provides a chronological summary of field activities conducted at monitoring well SIMR-2.

3.1 Drilling Approach

The drilling method, equipment, and drill-casing sizes for the SIMR-2 monitoring well were selected to retain the ability to investigate and case/seal off any perched groundwater encountered above the regional aquifer. Further, the drilling approach ensured that a sufficiently sized drill casing was used to meet the required 2-in.-minimum annular thickness of the filter pack around a 5.88-in.–outside diameter (O.D.) well screen.

Dual-rotary drilling methods using a Foremost DR-24HD drill rig were employed to drill the SIMR-2 borehole. The drill rig was equipped with conventional drilling rods, tricone bits, downhole hammer bits, deck-mounted air compressor, and general drilling equipment. Auxiliary equipment included two Ingersoll Rand skid-mounted air compressors. Three sizes of A53 grade B flush-welded mild carbon-steel casing (16-in.-O.D., and 12-in.-and 10-in.–inside-diameter [I.D.]) were used for the SIMR-2 project.

The dual-rotary drilling technique at SIMR-2 used filtered compressed air and fluid-assisted air to evacuate cuttings from the borehole during drilling. Drilling fluids, other than air, used in the borehole (all within the vadose zone) included potable water and a mixture of potable water with Baroid Quik Foam foaming agent. The fluids were used to cool the bit and help lift cuttings from the borehole. Use of the foaming agent was terminated at 773 ft bgs, roughly 100 ft above the expected top of the regional aquifer. No additives other than potable water were used for drilling below 773 ft bgs. Total amounts of drilling fluids introduced into the borehole are presented in Table 3.1-1.

3.2 Chronology of Drilling Activities for the SIMR-2 Well

The DR-24HD drill rig, drilling equipment, and supplies were mobilized to the SIMR-2 drill site from June 18 to 21, 2015. The equipment and tooling were decontaminated before mobilization to the site. On June 21, following on-site equipment inspections, drilling of the monitoring well borehole began at 1943 h using dual-rotary methods with a 15-in. tricone bit and 16-in. drill casing.

The 16-in. surface casing was advanced to 94.4 ft bgs in Unit 1g of the Tshirege Member of the Bandelier Tuff. On June 22, open-hole drilling commenced using a 15-in. tricone bit. Drilling proceeded through the Tshirege Member, the Cerro Toledo interval, the Otowi Member of the Bandelier Tuff, the Guaje Pumice Bed of the Otowi Member, the Puye Formation, and into the Cerros del Rio volcanics to 462.7 ft bgs on June 25. Laboratory video, natural gamma, and induction logs were recorded on June 26. The 16-in. casing shoe was cut on June 27 at 90.0 ft bgs.

Between June 27 and June 28, a 12-in. casing string was installed in the open borehole to a depth of 462.7 ft bgs. Beginning June 28, a 12-in. underreaming hammer bit was used to advance the 12-in. casing through the Cerros del Rio volcanics and into the Puye Formation sediments to 842.2 ft bgs. The 12-in. casing shoe was unsuccessfully cut on July 1 at 837.2 ft bgs and was removed from the borehole along with the rest of the casing string during well construction.

Between July 2 and July 8, a 10-in. casing string was installed to a depth of 837.2 ft bgs. The 10-in. casing string and an underreaming hammer bit were advanced through the Puye Formation to a TD of 981.4 ft bgs on July 10 at 1345 h. After reaching TD, the 10-in. casing was retracted to 980.6 ft bgs to record water levels in the borehole. The 10-in. casing string was advanced back to 981.4 ft bgs, and the casing shoe was cut on July 10 at 976.4 ft bgs. A Laboratory natural gamma log was recorded on July 11.

During drilling from June 21 to July 10, field crews worked 24-h shifts, 7 d/wk. All associated activities proceeded normally without incident or delay.

4.0 SAMPLING ACTIVITIES

This section describes the cuttings and groundwater sampling activities for monitoring well SIMR-2. All sampling activities were conducted in accordance with applicable quality procedures.

4.1 Cuttings Sampling

Cuttings samples were collected from the SIMR-2 monitoring well borehole at 5-ft intervals from ground surface to the TD of 981.4 ft bgs. At each interval, approximately 500 mL of bulk cuttings were collected by the site geologist from the drilling discharge cyclone, placed in resealable plastic bags, labeled, and archived in core boxes. Whole rock and +35 and +10 sieve-size fractions were also processed, placed in chip trays, and archived for each 5-ft interval. Radiological control technicians screened the cuttings before removal from the site. All screening measurements were within the range of background values. The cuttings samples were delivered to the Laboratory's archive at the conclusion of drilling activities.

SIMR-2 stratigraphy is summarized in section 5.1 and a detailed lithologic log is presented in Appendix A.

4.2 Water Sampling

Three groundwater-screening samples were collected during development from the pump's discharge line for total organic carbon (TOC) analysis. (Table 4.2-1). The TOC results are presented in Appendix B. Two samples were collected during aquifer testing and analyzed for TOC; anions; metals; low-level tritium (LH_3); perchlorate (ClO_4); phosphate (PO_4); nitrite and nitrate (NO_2 and NO_3); and 1,4 dioxane (1,4-D).

Table 4.2-1 presents a summary of screening samples collected during the SIMR-2 monitoring well installation. The TOC results and field water-quality parameters are presented in Appendix B.

Groundwater characterization samples will be collected from the completed well in accordance with the Consent Order. For the first year, the samples will be analyzed for a full suite of constituents in accordance with the requirements of the Interim Facility-Wide Groundwater Monitoring Plan. The analytical results will be included in the Chromium Investigation periodic monitoring report issued by the Laboratory. After the first year, the analytical suite and sample frequency at SIMR-2 will be evaluated and presented in the annual Interim Facility-Wide Groundwater Monitoring Plan.

5.0 GEOLOGY AND HYDROGEOLOGY

The geologic and hydrogeologic features encountered at SIMR-2 are summarized below. The Laboratory's geology task leader and project site geologist examined cuttings and the natural gamma log to determine geologic contacts and hydrogeologic conditions. Drilling observations and water-level measurements were used to identify groundwater encountered at SIMR-2.

5.1 Stratigraphy

Rock units for the SIMR-2 borehole are presented below in order of youngest to oldest in stratigraphic occurrence. Lithologic descriptions are based on binocular microscope analysis of drill cuttings collected from the discharge hose. Figure 5.1-1 illustrates the stratigraphy at SIMR-2. A detailed lithologic log for SIMR-2 is presented in Appendix A.

Alluvium, Qal (0–23 ft bgs)

Quaternary alluvium was encountered from 0 to 23 ft bgs. The alluvium is composed of light orange to gray silt to subrounded gravel derived from weathered Bandelier Tuff.

Unit 1g, Tshirege Member of the Bandelier Tuff, Qbt 1g (23–110 ft bgs)

Unit 1g of the Tshirege Member of the Bandelier Tuff was encountered from 23 to 110 ft bgs. Unit 1g is a poorly welded vitric rhyolitic ash-flow tuff that is poorly to moderately indurated, strongly pumiceous, and crystal-bearing. White to pale orange, lustrous, glassy pumice lapilli are characteristic of Unit 1g. Cuttings contain abundant free quartz and sanidine crystals and glassy pumices.

Cerro Toledo Interval, Qct (110–140 ft bgs)

The Cerro Toledo interval was encountered from 110 to 140 ft bgs. The Cerro Toledo interval is a sequence of poorly consolidated tuffaceous and volcaniclastic sediments that occurs intermediately between the Tshirege and Otowi Members of the Bandelier Tuff. The Cerro Toledo interval at SIMR-2 contains grayish-orange to white pumice clasts and various dacitic and rhyolitic clasts. Sediments are largely stained with orange oxidation on grain surfaces.

Otowi Member of the Bandelier Tuff, Qbo (140–275 ft bgs)

The Otowi Member of the Bandelier Tuff was encountered from 140 to 275 ft bgs. The Otowi Member is composed of poorly welded vitric rhyolitic ash-flow tuffs that are pumiceous, and crystal- and lithic-bearing. Drill cuttings contain pale orange to white pumices, volcanic lithic clasts, and quartz and sanidine crystals. Lithic fragments are commonly subangular to subrounded and generally of intermediate volcanic composition, including porphyritic dacites.

Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff, Qbog (275–295 ft bgs)

The Guaje Pumice Bed represents an air-fall tephra deposit of rhyolitic pumice that forms the base of the Otowi Member. The Guaje deposit was encountered from 275 to 295 ft bgs. Drill cuttings in this interval contain abundant (up to 90% by volume) lustrous vitric pumice lapilli (up to 15 mm in diameter) with trace occurrences of small volcanic lithic fragments. The deposit is poorly consolidated.

Puye Formation, Tpf (295–339 ft bgs)

Puye Formation volcaniclastic sediments were encountered from 295 to 339 ft bgs. The Puye Formation consists of alluvial fan deposits eroded from volcanic rocks in the nearby Jemez Mountains. Cuttings from this interval consist of grey, red, and purple dacitic and rhyolitic gravels, volcaniclastic sands, and minor devitrified pumice clasts. Cuttings are generally angular to subangular.

Cerros del Rio Volcanics, Tb4 (339–645 ft bgs)

The Cerros del Rio volcanics were encountered from 339 to 645 ft bgs and consist of a series of basalt flows and basalt scoria deposits. Lava flows include both massive and vesicular basalts. Scoria deposits are often highly oxidized.

Puye Formation, Tpf (645–981 ft bgs)

Puye Formation volcaniclastic sediments were also encountered from 645 ft to TD of the borehole at 981 ft bgs. The Puye Formation consists of alluvial fan deposits eroded from volcanic rocks in the nearby Jemez Mountains. Cuttings from this interval consist of grey, red, and purple dacitic and rhyolitic gravels, volcaniclastic sands, and minor devitrified pumice clasts. Cuttings are generally angular to subangular.

5.2 Groundwater

Drilling at SIMR-2 proceeded without any groundwater indications until 900.0 ft bgs as noted by the drilling crew. The borehole was then advanced to the TD of 981.4 ft bgs. The water level was 868.1 ft bgs on July 10, 2015, before well installation. The DTW in the completed well was 867.9 ft bgs on August 11.

During development, the average pumping rate was approximately 23.5 gallons per minute (gpm) with varying pump placement throughout the screened interval.

6.0 BOREHOLE LOGGING

On June 26, 2015, a video survey, natural gamma ray, and induction logs were recorded below the 16-in. casing in open borehole from 94.4 to 462.7 ft bgs. A natural gamma ray log was recorded on July 11 inside the 10-in. casing from surface to 981.4 ft bgs after the borehole was advanced to TD. On September 15, video and gamma ray logs were recorded in the completed well to confirm screen placement depth and filter pack location. Logging was conducted with Laboratory logging equipment and by Laboratory staff (Appendix C and D). A summary of video and geophysical logging runs is presented in Table 6.0-1.

7.0 WELL INSTALLATION SIMR-2 MONITORING WELL

The SIMR-2 well was installed between July 18 and August 10, 2015.

7.1 Well Design

The SIMR-2 well was designed in accordance with requirements in the Consent Order, and NMED and Pueblo de San Ildefonso approved the final well design before the well was installed (Appendix E). The well was designed with a 20-ft-long screened interval between 885 and 905 ft bgs to monitor the groundwater quality near the top of the regional aquifer within the Puye Formation.

7.2 Well Construction

From July 11 to July 17, 2015, the stainless-steel well casing, screens, and tremie pipe were decontaminated, and the workover rig and initial well construction materials were mobilized to the site.

The SIMR-2 monitoring well was constructed of 5.0-in.-I.D./5.56-in.-O.D. type A304 passivated stainless-steel beveled casing fabricated to American Society for Testing and Materials (ASTM) A312 standards.

The screened section utilized two 10-ft lengths of 5.0-in.-I.D. rod-based 0.040-in. slot wire-wrapped screens to make up the 20-ft-long screen interval. All individual casing and screen sections were welded together using compatible stainless-steel welding rods. A 2-in. steel tremie pipe was used to deliver backfill and annular fill materials downhole during well construction. A short length of 16-in. (4.4-ft casing and shoe, from 90.0 to 94.4 ft bgs) and 10-in. drill casing (5.0-ft casing and shoe, from 976.4 to 981.4 ft bgs) remain in the borehole. The 16-in. casing stub was entombed in the upper bentonite seal, and the 10-in. casing stub was encased in slough below the bentonite backfill at the bottom of the borehole.

A 21.6-ft-long stainless-steel sump was placed below the bottom of the well screen. The well casing was started into the borehole on July 18 at 0815 h. The well casing was hung by wireline with the bottom at 927 ft bgs. Stainless-steel centralizers (two sets of four) were welded to the well casing approximately 2.0 ft above and below the screened interval. Figure 7.2-1 presents an as-built schematic showing construction details for the completed well.

The installation of annular materials began on July 24 after the bottom of the borehole was measured at 965.8 ft bgs (approximately 15.6 ft of slough had accumulated in the borehole). The bentonite backfill was installed between July 24 and 26 from 910.8 to 965.8 ft bgs using 28.0 ft^3 of 3/8-in. bentonite chips.

The filter pack was installed between July 26 and 27 from 880.2 to 910.8 ft bgs using 25.8 ft^3 of 10/20 silica sand. The actual volume of filter pack sand was 83% greater than the calculated volume and is likely from an oversized borehole caused by sloughing in the unconsolidated Puye Formation. The filter pack was surged to promote compaction. The fine-sand collar was installed above the filter pack from 876.1 to 880.2 ft bgs using 5.3 ft^3 of 20/40 silica sand.

From July 28 to August 9, the bentonite seal was installed from 60.1 to 876.1 ft bgs using 781.7 ft^3 of 3/8-in. bentonite chips. On August 10, a cement seal was installed from 3.0 to 60.1 ft bgs. The cement seal used 121.7 ft^3 of Portland Type I/II/V cement. This volume exceeded the calculated volume of 70.2 ft^3 by 73% and is likely from cement loss to the near surface formations.

Operationally, well construction proceeded smoothly 12 h/d, 7 d/wk from July 18 to 24 and 24 h/d, 7 d/wk from July 25 to August 10.

8.0 POST-INSTALLATION ACTIVITIES

Following well installation at SIMR-2, the well was developed and aquifer pumping tests were conducted. The wellhead and surface pad were constructed, a geodetic survey was performed, and a dedicated sampling system was installed. Site restoration activities were completed following the final disposition of contained drill cuttings and groundwater, per the NMED-approved decision trees for land application of drill cuttings and groundwater.

8.1 Well Development

The well was developed between August 11 and 16, 2015. Initially, the screened interval was swabbed and bailed to remove formation fines in the filter pack and well sump. Bailing continued until water clarity visibly improved. Final development was then performed with a submersible pump.

The swabbing tool employed was a 4.5-in.-O.D., 1-in.-thick nylon disc attached to a weighted steel rod. The wireline-conveyed tool was drawn repeatedly across the screened interval causing a surging action across the screen and filter pack. The bailing tool was a 4.0-in.-O.D. by 21.0-ft-long carbon steel bailer with a total capacity of 12 gal. The tool was repeatedly lowered by wireline, filled, withdrawn from the well, and emptied into the cuttings pit. Approximately 744 gal. of groundwater was removed during bailing activities.

After bailing, a 10-horsepower (hp-), 4-in. Berkeley submersible pump was installed in the well for the final stage of well development. The screened interval was pumped from top to bottom and from bottom to top in 2-ft increments each day and night from August 13 to August 14 and during the morning on August 16. The pump was then used to purge the well sump during the morning on August 16. During the afternoon on August 16, the pump intake was set at 905 ft bgs for purging. Approximately 29,460 gal. of groundwater were purged with the submersible pump during well development.

Total Volumes of Introduced and Purged Water

During drilling, approximately 3200 gal. of potable water was added below the top of the regional aquifer at approximately 868 ft bgs. Approximately 11,595 gal. was added during installation of the annular seals. In total, approximately 14,795 gal. of potable water was introduced to the borehole below 868 ft bgs during project activities.

Approximately 30,204 gal. of groundwater was purged at SIMR-2 during well development activities. Another 143,303 gal. was purged during aquifer testing. The total amount of groundwater purged during post-installation activities was 173,507 gal.

8.1.1 Well Development Field Parameters

During the pumping stage of well development, turbidity, temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductance in microSiemens per centimeter were measured. The required TOC and turbidity values for adequate well development are less than 2.0 ppm and less than 5 nephelometric turbidity units (NTU), respectively.

Field parameters were measured by collecting aliquots of groundwater from the discharge pipe with the use of a flow-through cell. The final parameters at the end of well development were pH of 7.06, temperature of 11.08ºC, specific conductance of 259 µS/cm, and turbidity of 3.0 NTU. Table B-2.2-1 in Appendix B shows field parameters and purge volumes measured during well development.

During the final 72-h aquifer test, the turbidity values ranged from 0 to 63.4 NTU, with the final recorded value of 0 NTU.

8.2 Aquifer Testing

Three aquifer pumping tests were conducted at SIMR-2. A 24-h aquifer test was attempted between August 18 and 22, 2015, but was suspended because of a leaky storage tank and concerns over the secondary containment measures used. A 72-h aquifer test was attempted between September 1 and 3 and was suspended when the submersible pump motor failed. A second 72-h aquifer test was then successfully conducted between September 7 and 14 after a new pump and motor was installed. The 72-h pump test was conducted with the pump shroud intake set at 898 ft bgs, followed by a 70-h recovery period. The average pumping rate for the 72-h test was approximately 23.5 gpm.

A 10-hp pump was used for the aquifer tests. Approximately 143,303 gal. of groundwater was purged during aquifer testing. Turbidity, temperature, pH, DO, ORP, and specific conductance were measured during the aquifer tests. Measured parameters are presented in Appendix B. The SIMR-2 aquifer test results and analysis are presented in Appendix F.

8.3 Dedicated Sampling System Installation

The dedicated sampling system for SIMR-2 was installed on October 20 and 21, 2015. The pumping system utilizes an environmentally retrofitted 4-in. 3-hp Grundfos submersible pump set near the top of the screened interval. The pump column is constructed of 1-in. threaded/coupled passivated stainless-steel pipe. A weep valve was installed at the bottom of the uppermost pipe joint to protect the pump column from freezing. To measure water levels in the well, two 1-in.-I.D. schedule 80 polyvinyl chloride (PVC) tubes were installed to sufficient depth to set a dedicated transducer and to provide access for manual water-level measurements. The PVC transducer tubes are equipped with 9-in. sections of 0.010-in. slot screen with a threaded end cap on the bottom of each tube. An In-Situ Level Troll 500 30-psig transducer was installed in one of the PVC tubes to monitor the water level in the well's screened interval.

Sampling system details for SIMR-2 are presented in Figure 8.3-1a. Figure 8.3-1b presents technical notes for the well. Figure 8.3-1c presents a performance curve for the submersible pump installed.

8.4 Wellhead Completion

A reinforced concrete surface pad, 5 ft × 5 ft × 6 in. thick, was installed at the SIMR-2 wellhead. The concrete pad was slightly elevated above the ground surface and crowned to promote runoff. The pad will provide long-term structural integrity for the well. An aluminum survey pin was embedded in the northwest corner of the pad. A 16-in.-O.D. steel protective casing with a locking lid was installed around the stainless-steel well riser. Four t-posts, painted yellow for visibility, were set at the outside corners of the pad to protect the well from traffic. Details of the wellhead completion are presented in Figure 8.3-1a.

8.5 Geodetic Survey

A New Mexico licensed professional land surveyor conducted a geodetic survey on September 24, 2015 (Table 8.5-1). The survey data conform to Laboratory Information Architecture project standards IA-CB02, "GIS Horizontal Spatial Reference System," and IA-D802, "Geospatial Positioning Accuracy Standard for A/E/C and Facility Management." All coordinates are expressed relative to the New Mexico State Plane Coordinate System Central Zone (North American Datum [NAD] 83); elevation is expressed in feet above mean sea level (amsl) using the National Geodetic Vertical Datum of 1929. Survey points include ground surface elevation near the concrete pad, the top of the aluminum pin in the concrete pad, the top of the well casing, and the top of the protective casing for the SIMR-2 monitoring well.

8.6 Waste Management and Site Restoration

Waste generated from the SIMR-2 project included drilling fluids, purged groundwater, drill cuttings, decontamination water, and contact waste. The waste characterization samples collected during drilling, well construction, and development of SIMR-2 are summarized in Table 8.6-1.

All waste streams produced during drilling and development activities were sampled in accordance with "Waste Characterization Strategy Form for Installation of Regional Well SIMR-2" (LANL 2015, 600259).

Fluids produced during drilling were transferred to evaporation ponds at the Laboratory's well R-42 drill pad. Fluids produced during well development and aquifer testing were transferred to storage tanks at the well R-28 drill pad and are expected to be land-applied in accordance with the waste characterization strategy form (WCSF) and the ENV-RCRA-QP-010.2, Land Application of Groundwater.

Cuttings produced during drilling were used to backfill the cuttings pit after a review of associated analytical results per the WCSF and ENV-RCRA-QP-011.2, Land Application of Drill Cuttings.

Decontamination fluid used for cleaning equipment is containerized. The fluid waste containers were moved to the well R-13 drill pad and will be disposed of at an authorized facility or one of the Laboratory's on-site wastewater treatment facilities. The polyethylene liner and contact waste were disposed of as industrial waste.

Site restoration activities included removing drilling fluids and cuttings from the pit and managing the fluids and cuttings as described above, removing the polyethylene liner, removing the containment area berms and backfilling the pit with cuttings and clean fill, and regrading the containment area.

9.0 DEVIATIONS FROM PLANNED ACTIVITIES

Drilling, sampling, and well construction at SIMR-2 were performed as specified in "Drilling Work Plan for Groundwater Monitoring Well SIMR-2" (LANL 2015, 600174).

10.0 ACKNOWLEDGMENTS

Boart Longyear drilled and installed the SIMR-2 monitoring well.

David C. Schafer designed, implemented, and analyzed the aquifer tests.

TerranearPMC provided oversight on all preparatory and field-related activities.

11.0 REFERENCES AND MAP DATA SOURCES

11.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

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

LANL (Los Alamos National Laboratory), January 2015. "Drilling Work Plan for Groundwater Monitoring Well SIMR-2," Los Alamos National Laboratory document LA-UR-15-20021, Los Alamos, New Mexico. (LANL 2015, 600174)

LANL (Los Alamos National Laboratory), February 3, 2015. "Waste Characterization Strategy Form for Installation of Regional Well SIMR-2," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2015, 600259)

LANL (Los Alamos National Laboratory), May 6, 2015. "Storm Water Pollution Prevention Plan, SIMR-2 Well Pad and Construction Support Activities, Los Alamos National Laboratory," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2015, 601070)

TerranearPMC, May 2015. “Field Implementation Plan for Regional Aquifer Well SIMR-2,” plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (TerranearPMC 2015, 601066)

TerranearPMC, June 4, 2015. “IWDs [Integrated Work Documents] for Drilling and Installation of LANL Well SIMR-2,” Los Alamos, New Mexico. (Terranear PMC 2015, 601067)

11.2 Map Data Sources

Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2008-0109; 12 April 2010.

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

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

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

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

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

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

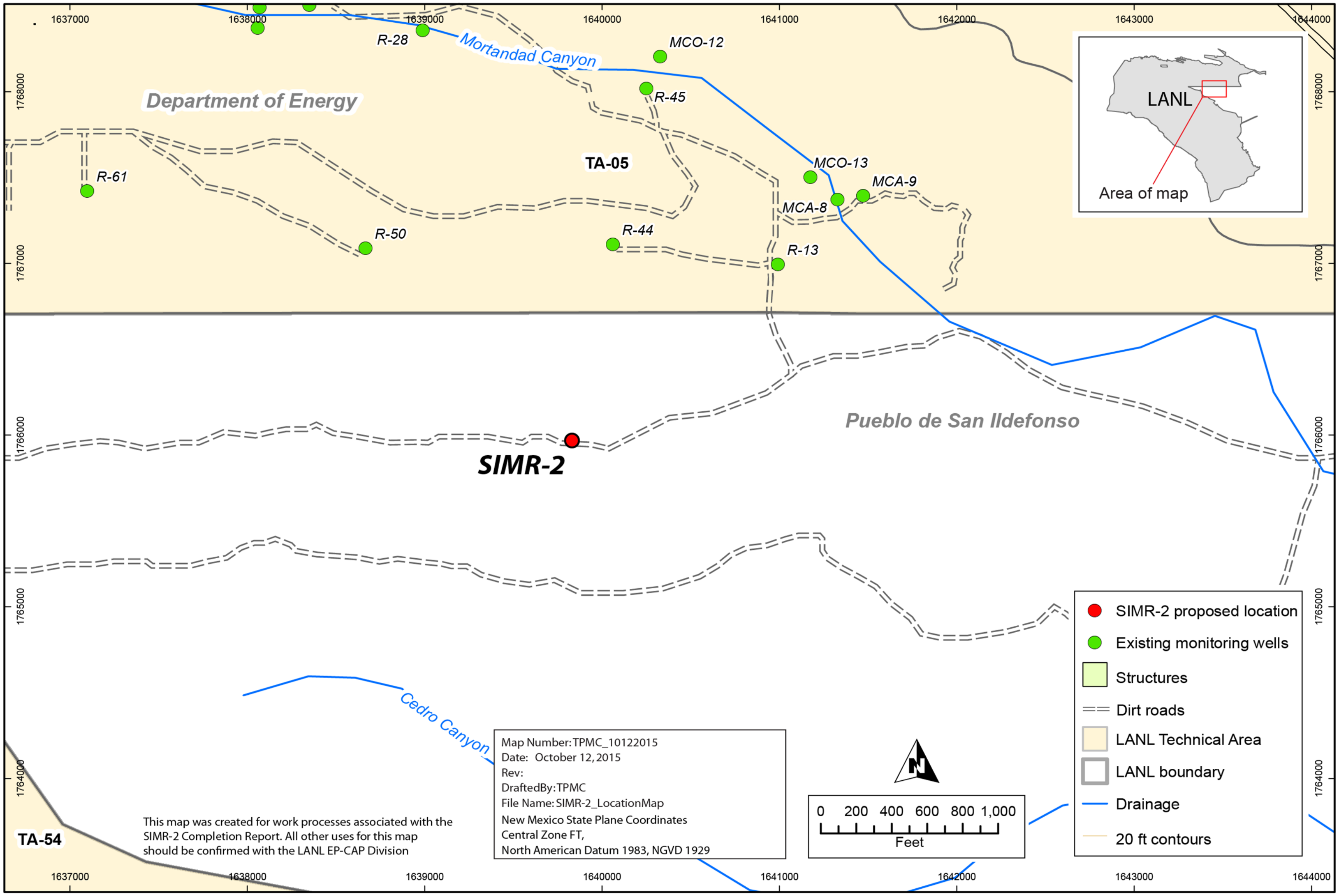
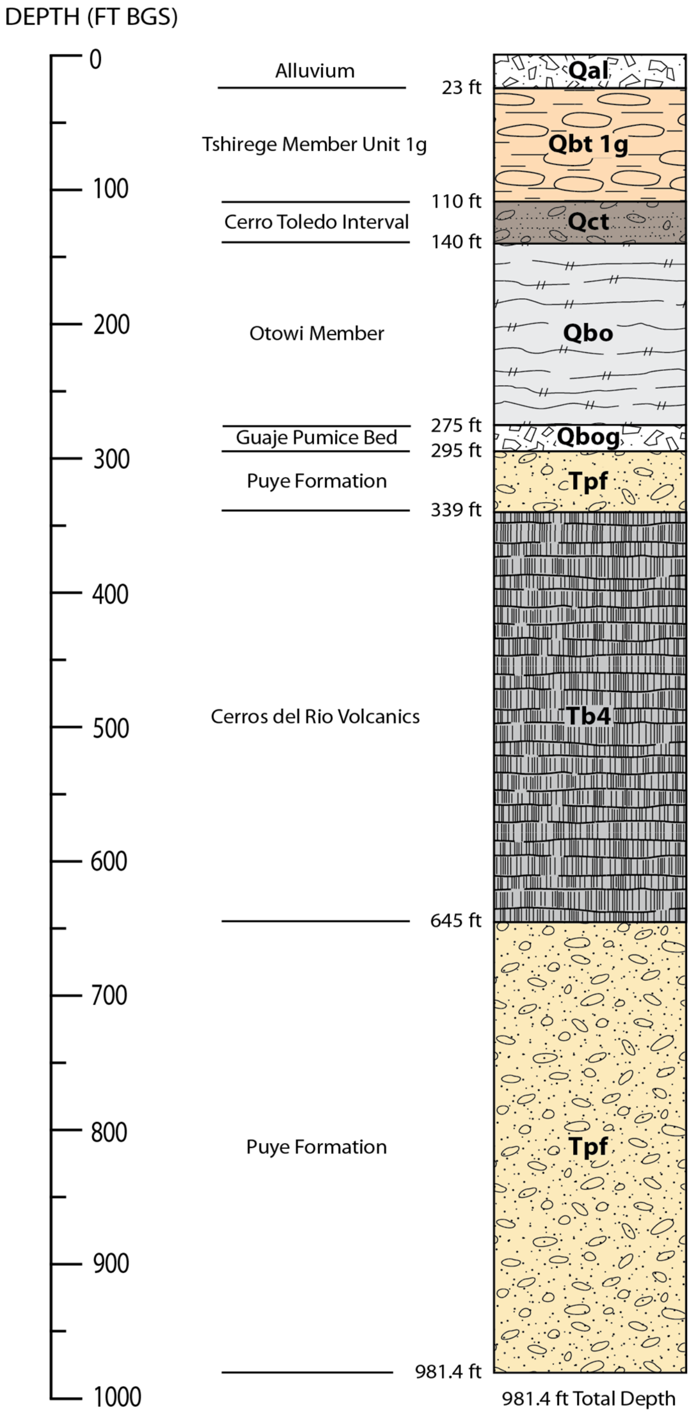


Figure 1.0-1 Location of monitoring well SIMR-2



DRILLING INFORMATION

DRILLING COMPANY/PERSONNEL:
Boart Longyear
D. Sandy, D. Tucker, R. Ostler

DRILL RIG: Foremost DR-24HD

DRILLING METHOD:
☒ DUAL ROTARY ☒ AIR ROTARY

DRILLING FLUID TYPE:

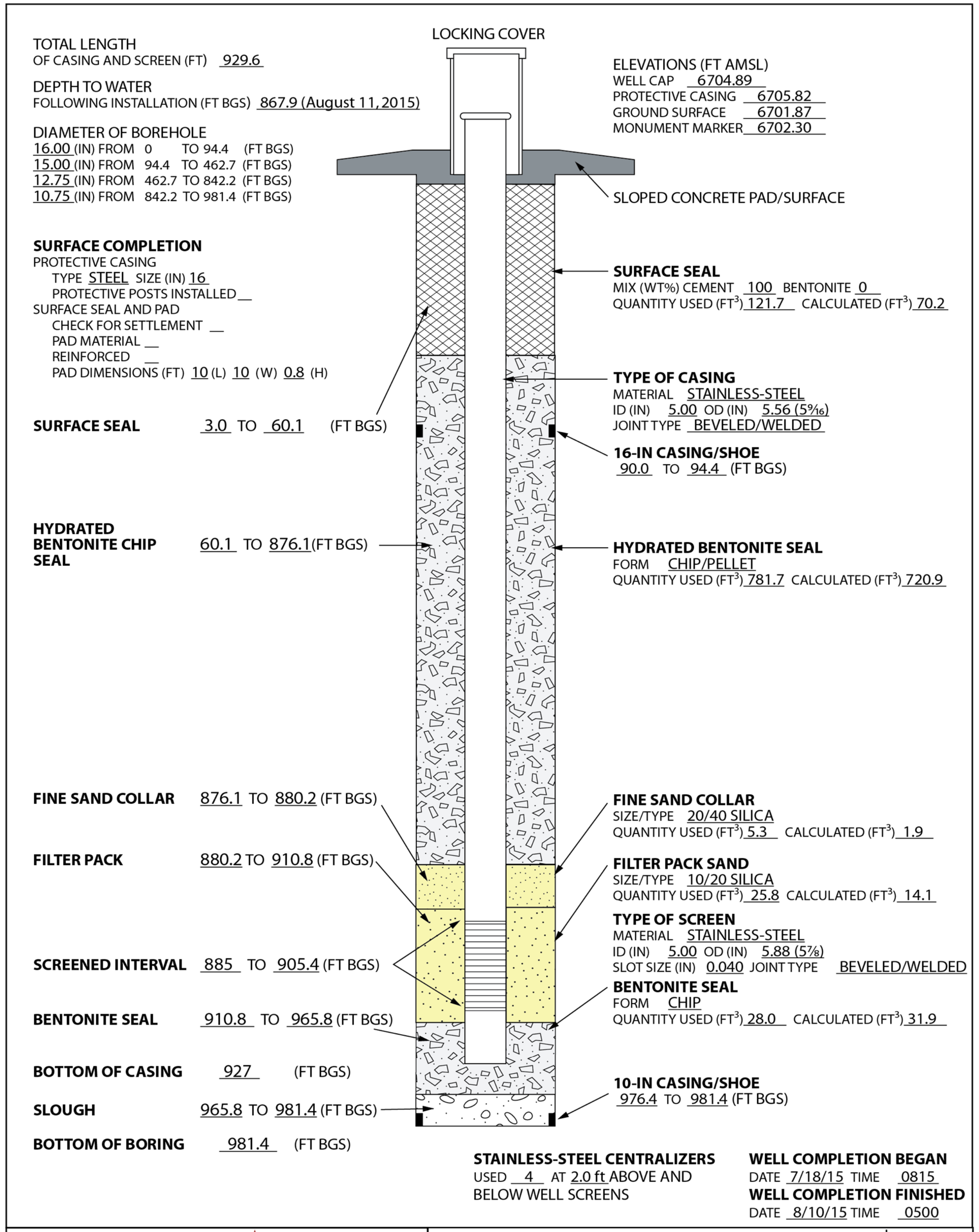
0–773 ft bgs	773–981.4 ft bgs
☒ WATER	☒ WATER
☒ AIR	☒ AIR
☒ QUIK FOAM FOAMING AGENT	

DRILLING START/FINISH:
DATE: 06/21/2015 TIME: 1943
DATE: 07/10/2015 TIME: 1345

▼ 868.1 ft bgs (07/10/15)
(pre well installation)

TerranearPMC	SIMR-2 BOREHOLE STRATIGRAPHY Pueblo de San Ildefonso Los Alamos, New Mexico	Figure 5.1-1 NOT TO SCALE
Drafted By: TPMC Project Number: 86317 Date: August 20, 2015 Filename: SIMR-2_Lithology_FactSheet		

Figure 5.1-1 Monitoring well SIMR-2 borehole stratigraphy



TOTAL LENGTH
OF CASING AND SCREEN (FT) 929.6

DEPTH TO WATER
FOLLOWING INSTALLATION (FT BGS) 867.9 (August 11, 2015)

DIAMETER OF BOREHOLE

16.00 (IN)	FROM	0	TO	94.4	(FT BGS)
15.00 (IN)	FROM	94.4	TO	462.7	(FT BGS)
12.75 (IN)	FROM	462.7	TO	842.2	(FT BGS)
10.75 (IN)	FROM	842.2	TO	981.4	(FT BGS)

SURFACE COMPLETION
PROTECTIVE CASING
TYPE STEEL SIZE (IN) 16
PROTECTIVE POSTS INSTALLED __
SURFACE SEAL AND PAD
CHECK FOR SETTLEMENT __
PAD MATERIAL __
REINFORCED __
PAD DIMENSIONS (FT) 10 (L) 10 (W) 0.8 (H)

SURFACE SEAL 3.0 TO 60.1 (FT BGS)

HYDRATED BENTONITE CHIP SEAL 60.1 TO 876.1 (FT BGS)

FINE SAND COLLAR 876.1 TO 880.2 (FT BGS)

FILTER PACK 880.2 TO 910.8 (FT BGS)

SCREENED INTERVAL 885 TO 905.4 (FT BGS)

BENTONITE SEAL 910.8 TO 965.8 (FT BGS)

BOTTOM OF CASING 927 (FT BGS)

SLOUGH 965.8 TO 981.4 (FT BGS)

BOTTOM OF BORING 981.4 (FT BGS)

ELEVATIONS (FT AMSL)
WELL CAP 6704.89
PROTECTIVE CASING 6705.82
GROUND SURFACE 6701.87
MONUMENT MARKER 6702.30

SURFACE SEAL
MIX (WT%) CEMENT 100 BENTONITE 0
QUANTITY USED (FT^3) 121.7 CALCULATED (FT^3) 70.2

TYPE OF CASING
MATERIAL STAINLESS-STEEL
ID (IN) 5.00 OD (IN) 5.56 (5 9⁄16)
JOINT TYPE BEVELED/WELDED

16-IN CASING/SHOE
90.0 TO 94.4 (FT BGS)

HYDRATED BENTONITE SEAL
FORM CHIP/PELLET
QUANTITY USED (FT^3) 781.7 CALCULATED (FT^3) 720.9

FINE SAND COLLAR
SIZE/TYPE 20/40 SILICA
QUANTITY USED (FT^3) 5.3 CALCULATED (FT^3) 1.9

FILTER PACK SAND
SIZE/TYPE 10/20 SILICA
QUANTITY USED (FT^3) 25.8 CALCULATED (FT^3) 14.1

TYPE OF SCREEN
MATERIAL STAINLESS-STEEL
ID (IN) 5.00 OD (IN) 5.88 (5 7⁄8)
SLOT SIZE (IN) 0.040 JOINT TYPE BEVELED/WELDED

BENTONITE SEAL
FORM CHIP
QUANTITY USED (FT^3) 28.0 CALCULATED (FT^3) 31.9

10-IN CASING/SHOE
976.4 TO 981.4 (FT BGS)

STAINLESS-STEEL CENTRALIZERS
USED 4 AT 2.0 ft ABOVE AND BELOW WELL SCREENS

WELL COMPLETION BEGAN
DATE 7/18/15 TIME 0815
WELL COMPLETION FINISHED
DATE 8/10/15 TIME 0500

TerranearPMC

Drafted By: TPMC
Project Number: 86317
Date: August 20, 2015
File Name: SIMR-2_WellAsBuiltFactSheet

SIMR-2 As-Built Well Construction
Pueblo de San Ildefonso
Los Alamos, New Mexico

Figure
7.2-1
NOT TO SCALE

Figure 7.2-1 Monitoring well SIMR-2 as-built well construction diagram

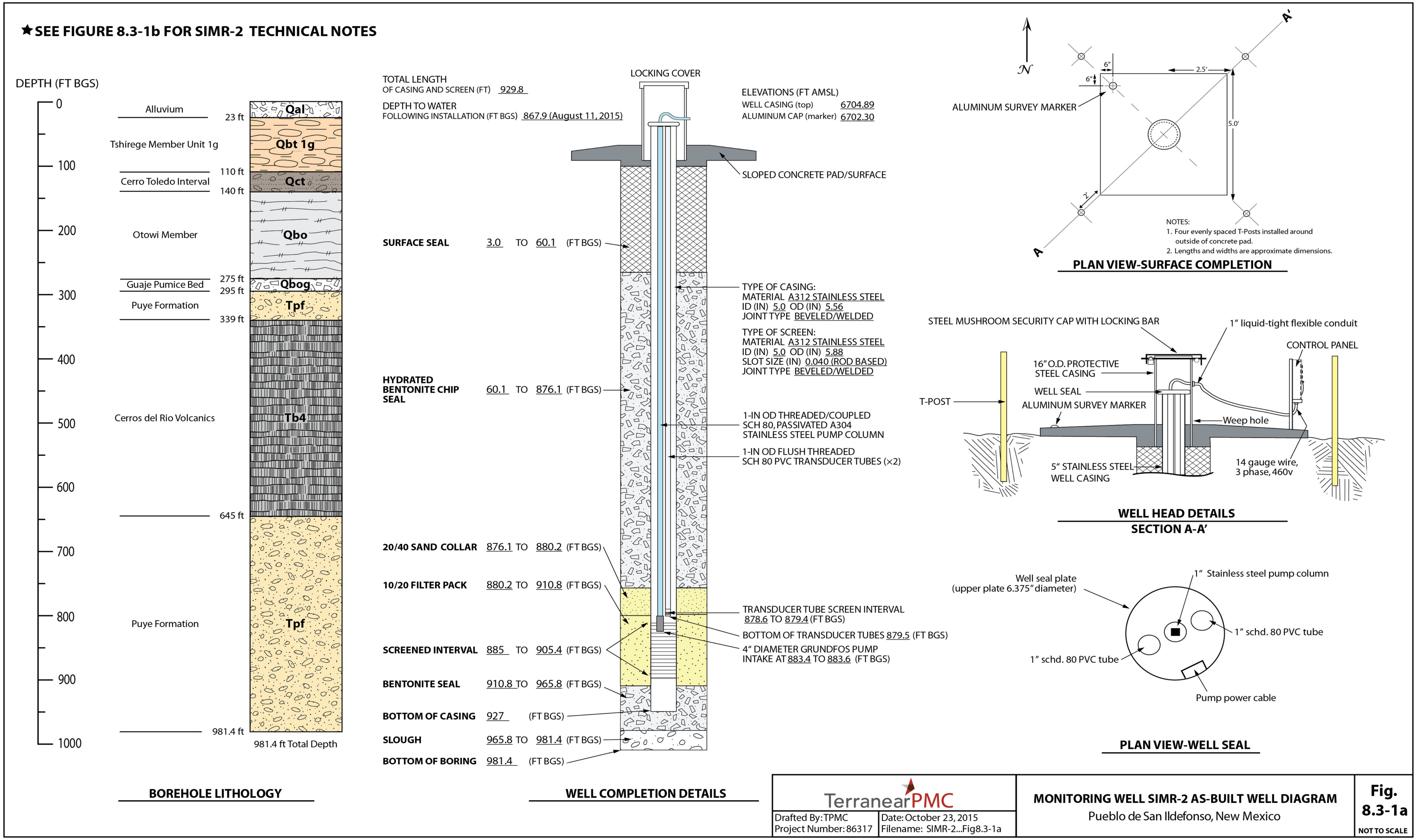


Figure 8.3-1a Monitoring well SIMR-2 as-built diagram with borehole lithology and technical well completion details

SIMR-2 TECHNICAL NOTES:

SURVEY INFORMATION*

Aluminum Marker

Northing:	1766027.98 ft
Easting:	1639845.89 ft
Elevation:	6702.30 ft AMSL

Well Casing (top of stainless steel)

Northing:	1766026.31ft
Easting:	1639847.72 ft
Elevation:	6704.89 ft AMSL

BOREHOLE GEOPHYSICAL LOGS

LANL video, induction, and natural gamma logs

DRILLING INFORMATION

Drilling Company
Boart Longyear

Drill Rig
Foremost DR-24HD

Drilling Methods
Dual Rotary
Fluid-assisted air rotary, Foam-assisted air rotary

Drilling Fluids
Air, potable water, AQF-2 foam (to 773 ft bgs)

MILESTONE DATES

Drilling

Start:	6/21/2015
Finished:	7/10/2015

Well Completion

Start:	7/18/2015
Finished:	8/10/2015

Well Development

Start:	8/11/2015
Finished:	8/16/2015

WELL DEVELOPMENT

Development Methods
Performed swabbing, bailing, and pumping
Total Volume Purged: 30,204 gal.

Parameter Measurements (Final)

pH:	7.06
Termperature:	11.08˚C
Specific Conductance:	259 µs/cm
Turbidity:	3.0 NTU

AQUIFER TESTING

Constant Rate Pumping Test

Water Produced:	143,303 gal.
Average Flow Rate	23.5 gpm
Performed on:	08/18-09/14/2015

DEDICATED SAMPLING SYSTEM

Pump
Make: Grundfos
Model: 5S30-820CBM
S/N: P114110089
Environmental retrofit

Top of Pump Intake:	883.4 ft bgs

Motor
Make: Franklin Electric
Model: 2343268602
3 hp, 3-phase, 460V

Pump Column
1-in. threaded/coupled schd. 80, pickled and passivated A304 stainless steel tubing
Weep valve installed at 7.3 ft bgs
Check valve installed at 858.3 ft bgs

Transducer Tubes
2 × 1-in. flush threaded schd. 80 PVC tubing, 0.010-in. slot screens at 878.6-879.4 ft bgs

Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 425237

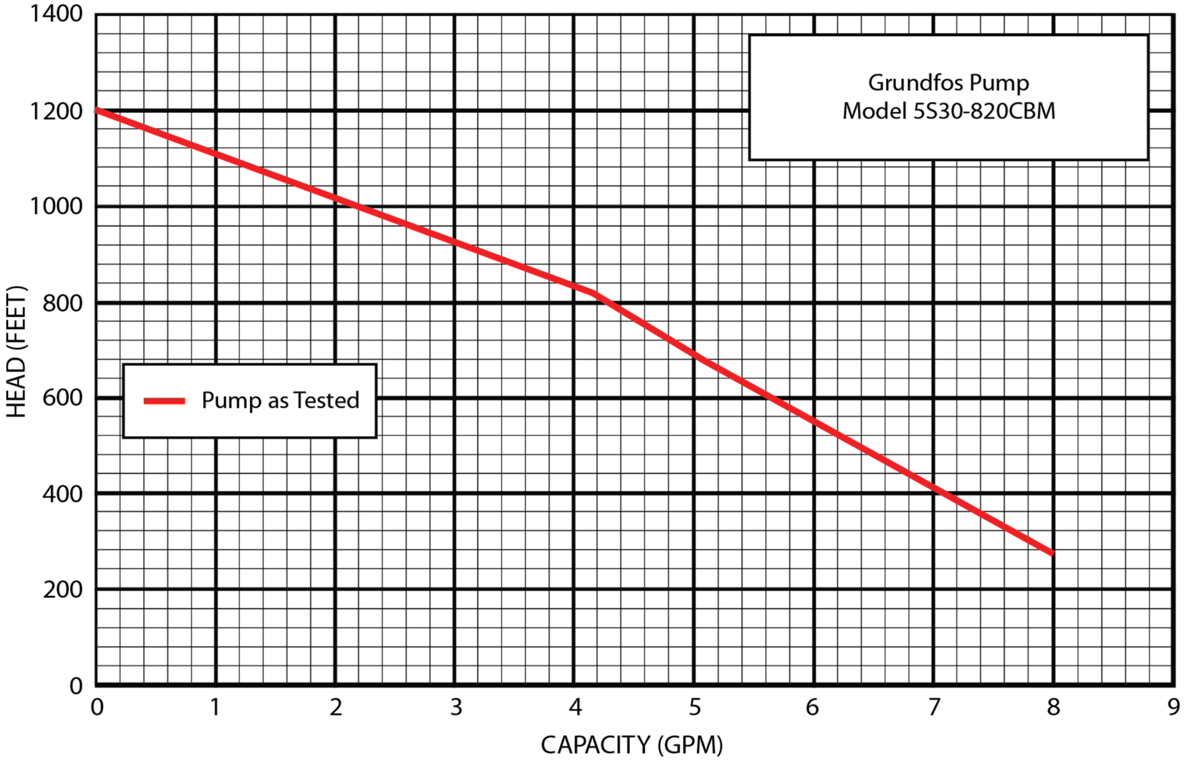
NOTES:
* Coordinates based on New Mexico State Plane Grid Coordinates, Central Zone (NAD83);
Elevation expressed in feet amsl using the National Geodetic Vertical Datum of 1929.

TerranearPMC

Drafted By: TPMC Project Number: 86317	Date: October 23, 2015 Filename: SIMR-2_SampSysTechnicalFig8.3-1b	**SIMR-2 TECHNICAL NOTES** Pueblo de San Ildefonso, New Mexico	**Fig. 8.3-1b** **NOT TO SCALE**

Figure 8.3-1b As-built technical notes for monitoring well SIMR-2

SIMR-2 PUMP CURVE:



TerranearPMC

Drafted By: TPMC
Project Number: 86317

Date: Octobe 23, 2015
Filename: SIMR-2_PumpCurves_Fig8-3-1c

SIMR-2 DEDICATED PUMP PERFORMANCE CURVE
Pueblo de San Ildefonso, New Mexico

Fig. 8.3-1c
NOT TO SCALE

Figure 8.3-1c Pump curve for monitoring well SIMR-2

Table 3.1-1
Fluid Quantities Used during SIMR-2 Drilling and Well Construction

Date	Depth Interval (ft bgs)	Water (gal.)	Cumulative Water (gal.)	Quick Foam (gal.)	Cumulative Quick Foam (gal.)
Drilling					
6/21/2015	0–74	1025	1025	1.25	1.25
6/22/2015	74–340	5000	6025	11	12.25
6/23/2015	340–424	6435	12,460	20.5	32.75
6/24/2015	424–434	3925	16,385	15	47.75
6/25/2015	434–463	1780	18,165	8.75	56.5
6/28/2015	463–600	5000	23,165	18.75	75.25
6/29/2015	600–741	5200	28,365	18.5	93.75
6/30/2015	741–842	3250	31,615	4.25	98
7/9/2015	842–901	1250	32,865	0	98
7/10/2015	901–981.4	2200	35,065	0	98
Well Construction					
7/24/2015	981.4–957	980	980	n/a	n/a
7/25/2015	957–923	6442	7422	n/a	n/a
7/26/2015	923–895	3904	11,326	n/a	n/a
7/27/2015	895–876	2215	13,541	n/a	n/a
7/28/2015	876–843	3914	17,455	n/a	n/a
7/31/2015	843–806	4567	22,022	n/a	n/a
8/1/2015	806–761	4833	26,855	n/a	n/a
8/2/2015	761–723	5231	32,086	n/a	n/a
8/3/2015	723–674	5465	37,551	n/a	n/a
8/4/2015	674–629	2183	39,734	n/a	n/a
8/5/2015	629–515	241	39,975	n/a	n/a
8/6/2015	515–314	2685	42,660	n/a	n/a
8/7/2015	314–97	1478	44,138	n/a	n/a
8/8/2015	97–70	1462	45,600	n/a	n/a
8/9/1205	70–3	1683	47,283	n/a	n/a
Total Water Volume (gal.)					
SIMR-2	**82,348**				

*n/a = Not applicable.

Table 4.2-1
Summary of Groundwater Screening Samples Collected during Well Development and Aquifer Testing at Well SIMR-2

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Analysis
Well Development					
SIMR-2	SIMR-2-15-101812	8/14/2015	887	Groundwater, Pumped	TOC
SIMR-2	SIMR-2-15-101813	8/14/2015	891	Groundwater, Pumped	TOC
SIMR-2	SIMR-2-15-101814	8/16/2015	905	Groundwater, Pumped	TOC
Aquifer Testing					
SIMR-2	SIMR-2-15-104242	9/11/2015	898	Groundwater, Pumped	TOC, Anions, LH_3, ClO_4, PO_4, NO_2, NO_3, 1,4-D
SIMR-2	SIMR-2-15-104243	9/11/2015	898	Groundwater, Pumped	Metals

Table 6.0-1
SIMR-2 Video and Geophysical Logging Runs

Date	Logging Interval	Description
6/26/2015	94.4–462.7 ft bgs	Laboratory video, natural gamma ray, and induction logs run below 16-in. casing
7/11/2015	0–981.4 ft bgs	Laboratory natural gamma ray log run through 10-in. casing to TD at 981.4 ft bgs
9/15/2015	2.6–927 ft bgs	Laboratory video and natural gamma ray logs run in the completed well casing

Table 7.2-1
SIMR-2 Monitoring Well Annular Fill Materials

Material	Volume
Upper surface seal: cement slurry	121.7 ft^3
Upper bentonite seal: bentonite chips/pellets	781.7 ft^3
Fine-sand collar: 20/40 silica sand	5.3 ft^3
Filter pack: 10/20 silica sand	25.8 ft^3
Backfill: bentonite chips	28.0 ft^3

Table 8.5-1
SIMR-2 Survey Coordinates

Identification	Northing	Easting	Elevation
SIMR-2 aluminum pin embedded in pad	1766027.98	1639845.89	6702.30
SIMR-2 ground surface near pad	1766029.36	1639844.65	6701.87
SIMR-2 top of stainless-steel well casing	1766026.31	1639847.72	6704.89
SIMR-2 top of 16-in. protective casing	1766026.76	1639848.17	6705.82

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

Table 8.6-1
Summary of Waste Samples Collected during Drilling, Development, and Sampling System Installation at SIMR-2

Location ID	Sample ID	Date Collected	Description	Sample Type
SIMR-2	WSTSIP-15-100907	6/21/2015	Drill fluids VOC/SVOC initial sample–UF	Liquid
SIMR-2	WSTSIP-15-100910	6/21/2015	Drill fluids VOC/SVOC initial sample–UF FD	Liquid
SIMR-2	WSTSIP-15-100913	6/21/2015	Drill fluids VOC/SVOC initial sample–UF FTB	Liquid
SIMR-2	WSTSIP-15-100908	6/29/2015	Drill fluids VOC/SVOC midpoint sample–UF	Liquid
SIMR-2	WSTSIP-15-100911	6/29/2015	Drill fluids VOC/SVOC midpoint sample–UF FD	Liquid
SIMR-2	WSTSIP-15-100914	6/29/2015	Drill fluids VOC/SVOC midpoint sample–UF FTB	Liquid
SIMR-2	WSTSIP-15-100909	7/10/2015	Drill fluids VOC/SVOC final sample–UF	Liquid
SIMR-2	WSTSIP-15-100912	7/10/2015	Drill fluids VOC/SVOC final sample–UF FD	Liquid
SIMR-2	WSTSIP-15-100915	7/10/2015	Drill fluids VOC/SVOC final sample–UF FTB	Liquid
SIMR-2	WSTSIP-15-103065	8/11/2015	Drill fluids non-VOC sample–UF	Liquid
SIMR-2	WSTSIP-15-103064	8/11/2015	Drill fluids non-VOC sample–F	Liquid
SIMR-2	WSTSIP-15-101022	6/21/2015	Drill cuttings VOC initial sample	Solid
SIMR-2	WSTSIP-15-101025	6/21/2015	Drill cuttings VOC initial sample–FTB	Solid
SIMR-2	WSTSIP-15-101023	6/29/2015	Drill cuttings VOC midpoint sample	Solid
SIMR-2	WSTSIP-15-101026	6/29/2015	Drill cuttings VOC midpoint sample–FTB	Solid
SIMR-2	WSTSIP-15-101024	7/10/2015	Drill cuttings VOC final sample	Solid
SIMR-2	WSTSIP-15-101027	7/10/2015	Drill cuttings VOC final sample–FTB	Solid
SIMR-2	WSTSIP-15-101063	8/11/2015	Drill cuttings non-VOC sample	Solid
SIMR-2	WSTSIP-15-103881	8/12/2015	New Mexico Special Waste sample	Solid
SIMR-2	WSTSIP-15-103882	8/12/2015	New Mexico Special Waste sample–FTB	Solid
SIMR-2	WSTSIP-15-105123	9/28/2015	Decontamination fluids sample–F	Liquid
SIMR-2	WSTSIP-15-105124	9/28/2015	Decontamination fluids sample–UF	Liquid
SIMR-2	WSTSIP-15-105125	9/28/2015	Decontamination fluids sample–FD	Liquid
SIMR-2	WSTSIP-15-105126	9/28/2015	Decontamination fluids sample–FTB	Liquid

Table 8.6-1 (continued)

Location ID	Sample ID	Date Collected	Description	Sample Type
SIMR-2	WSTSIP-15-105119	9/28/2015	Development fluids sample–F	Liquid
SIMR-2	WSTSIP-15-105120	9/28/2015	Development fluids sample–UF	Liquid
SIMR-2	WSTSIP-15-105121	9/28/2015	Development fluids sample–FD	Liquid
SIMR-2	WSTSIP-15-105122	9/28/2015	Development fluids sample–FTB	Liquid

Notes: VOC = volatile organic compound; SVOC = semivolatile organic compound; UF = unfiltered sample; FD = field duplicate; F = filtered sample; FTB = field trip blank.

Appendix A

Borehole SIMR-2 Lithologic Log

BOREHOLE IDENTIFICATION (ID): SIMR-2	**TECHNICAL AREA (TA):** Pueblo de San Ildefonso	
DRILLING COMPANY: Boart Longyear Company	**START DATE/TIME:** 06/21/2015; 1943	**END DATE/TIME:** 07/10/2015; 1345
DRILLING METHOD: Dual Rotary	**MACHINE**: Foremost DR-24 HD	**SAMPLING METHOD:** Grab
GROUND ELEVATION: 6701.87 ft amsl		**TOTAL DEPTH:** 981.4 ft
DRILLERS: D. Sandy, D. Tucker, R. Ostler	**SITE GEOLOGISTS:** T. Naibert, T. Sower, J. Jordan, L. Anderson	

DEPTH (ft bgs)	LITHOLOGY	LITHOLOGIC SYMBOL	NOTES
0–23	**ALLUVIUM:** Tuffaceous sediments—light orange and gray (10YR 8/6 to N6) silt to gravel from weathered tuff. 0–25 ft WR/+10F: 95% subrounded to rounded clasts of orange tuff; 5% subrounded clasts of dacite and rhyolite. +35F: 40%–70% subangular quartz grains; 30%–60% subrounded to rounded clasts of tuff; trace clasts of dacite.	Qal	Note: Drill cuttings for descriptive analysis were collected at 5-ft intervals from ground surface to borehole total depth (TD) at 981.4 ft below ground surface (bgs). The Qal/Qbt1g contact, estimated at 23 ft bgs, is based on the natural gamma log.
23–55	**UNIT 1G OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** Rhyolitic Tuff—light gray to grayish orange (N7 to 10R 8/2), poorly welded, crystal-rich tuff with glassy pumice. 23–55 ft WR: 70–80% glassy pumices; 20%–30% quartz and sanidine crystals; <5% dacite lithics. +10F: 90%–95% glassy pumices; 5%–10% dacite lithics. +35F: 50%–75% quartz and sanidine crystals; 25%–50% glassy pumice; <5% rhyolitic tuff fragments; trace lithic fragments.	Qbt1g	Unit 1g of the Tshirege Member of the Bandelier Tuff (Qbt1g), encountered from 23 to 110 ft bgs, is approximately 87 ft thick. Note: some WR and +10F fractions have a reddish coating on pumices, especially in 45- to 50-ft interval.
55–70	Rhyolitic Tuff—light gray (N7 to N8) to very pale orange (5Y 9/2), poorly welded, crystal-rich tuff with glassy pumice. 55–70 ft WR: 70%–80% glassy pumices; 20%–30% quartz and sanidine crystals; <5% dacite lithics. +10F: 90%–95% glassy pumices; 5%–10% dacite lithics. +35F: 40%–70% glassy pumice; 30%–60% quartz and sanidine crystals; <5% rhyolitic tuff fragments; trace lithic fragments.	Qbt1g	

DEPTH (ft bgs)	LITHOLOGY	LITHOLOGIC SYMBOL	NOTES
70–75	Rhyolitic Tuff—light gray to grayish orange (N7 to 10R 8/2), poorly welded, crystal-rich tuff with glassy pumice. 70–75 ft WR: 70%–80% glassy pumices; 20%–30% quartz and sanidine crystals; <5% dacite lithics. +10F: 90%–95% glassy pumices; 5%–10% dacite lithics; trace quartz crystals. +35F: 90% quartz and sanidine crystals; 10% glassy pumice; trace rhyolitic tuff fragments; trace lithic fragments.	Qbt1g	
75–95	Rhyolitic Tuff—light gray (N7 to N8) to very pale orange (5Y 9/2), poorly welded, crystal-rich tuff with glassy pumice. 75–95 ft WR: 70%–80% glassy pumices; 20%–30% quartz and sanidine crystals; <5% dacite lithics. +10F: 90%–95% glassy pumices; 5%–10% dacite lithics. +35F: 40%–70% glassy pumice; 30%–60% quartz and sanidine crystals; <5% rhyolitic tuff fragments; trace lithic fragments.	Qbt1g	
95–110	Rhyolitic Tuff—White (N9), pumice-rich, poorly welded tuff. 95–110 ft WR: 80%–95% glassy pumices; 5%–20% quartz and sanidine crystals; trace dacite lithics. +10F: 100% glassy pumices. +35F: 50%–70% glassy pumice; 30%–50% quartz and sanidine crystals; trace lithic fragments.	Qbt1g	The Qbt1g/Qct contact, estimated at 110 ft bgs, is based on the natural gamma log and drilling observations.
110–115	**CERRO TOLEDO INTERVAL:** Volcaniclastic Sediments—silt to granule-size tuff fragments and pumice with pale orange oxidation staining, and dacite and rhyolite clasts. 110–115 ft WR/+10F: 95% pumices; 5% dacite clasts; trace quartz grains. +35F: 60% quartz and sanidine crystals; 40% white pumice and tuff fragments with orange staining.	Qct	The Cerro Toledo interval (Qct), encountered from 110 to 140 ft bgs, is approximately 30 ft thick.
115–140	Volcaniclastic Sediments—silt to granule-size tuff fragments and pumice with pale orange oxidation staining, and dacite and rhyolite clasts. 115–140 ft WR/+10F: 60%–80% pumices; 20%–40% dacite and rhyolite clasts; trace quartz grains. +35F: 30%–70% quartz and sanidine crystals; 30%–50% pumice and tuff fragments; 20%–30% subrounded dacite and rhyolite clasts.	Qct	The Qct/Qbo contact, estimated at 140 ft bgs, is based on the natural gamma log and drill cuttings.

DEPTH (ft bgs)	LITHOLOGY	LITHOLOGIC SYMBOL	NOTES
140–190	**OTOWI MEMBER OF THE BANDELIER TUFF:** Rhyolitic Tuff—white (N9) to light brown (10YR 8/2) poorly welded, pumice- and lithic-rich, crystal-poor tuff. 140–190 ft WR: 30%–60% white to orange/brown pumices; 20%–60% dacite lithics; 5%–20% glassy ash; trace quartz grains. +10F: 40%–60% dacite and rhyolite lithics; 40%–60% pumice clasts; trace quartz grains. +35F: 40%–60% angular quartz grains; 30%–50% pumice; 10%–30% volcanic lithics.	Qbo	The Otowi Member of the Bandelier Tuff (Qbo), encountered from 140 to 275 ft bgs, is approximately 135 ft thick.
190–220	Rhyolitic Tuff—white (N9) to light brown (10YR 8/2) poorly welded, pumice- and lithic-rich, crystal-poor tuff. 190–220 ft WR: 30–60% white to orange/brown pumices; 20%–60% dacite lithics; 5%–20% glassy ash; trace quartz grains. +10F: 40%–60% dacite and rhyolite lithics; 40%–60% pumice clasts; trace quartz grains. +35F: 60%–80% angular quartz grains; 10%–30% pumice; 10%–30% volcanic lithics.	Qbo	
220–250	Rhyolitic Tuff—white (N9) poorly welded, pumice- and lithic-rich, crystal-poor tuff. 220–250 ft WR: 40%–70% white to orange/brown pumices; 20%–60% dacite lithics; 5%–10% glassy ash; trace quartz grains. +10F: 40%–70% dacite and rhyolite lithics; 30%–60% pumice clasts; trace quartz grains. +35F: 60%–80% angular quartz grains; 10%–30% pumice; 10%–30% volcanic lithics.	Qbo	Note: Pumice is whiter and dacite and rhyolite lithics are larger in this section.
250–275	Rhyolitic Tuff—white (N9) poorly welded, pumice- and lithic-rich, crystal-poor tuff. 250–275 ft WR: 70%–90% white to orange/brown pumices; 10%–30% dacite lithics; trace quartz grains. +10F: 50%–80% pumice clasts; 20%–50% dacite and rhyolite lithics; trace quartz grains. +35F: 50%–70% pumice; 30%–45% volcanic lithics; 5%–20% angular quartz grains.	Qbo	The Qbo/Qbog contact, estimated at 275 ft bgs, is based on observations of increased pumice while drilling.

DEPTH (ft bgs)	LITHOLOGY	LITHOLOGIC SYMBOL	NOTES
275–295	**GUAJE PUMICE BED OF THE OTOWI MEMBER OF THE BANDELIER TUFF:** Rhyolitic Tuff—white (N9) poorly welded, pumice-rich, crystal-poor tuff. 275–295 ft WR/+10F: 70%–90% white pumice; 10%–30% gray dacite or purple rhyolite lithics; trace quartz crystals. +35F: 80%–90% rounded white pumice; 10%–20% rounded gray dacite or purple rhyolite lithic fragments; <5% quartz crystals.	Qbog	The Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff (Qbog), encountered from 275 to 295 ft bgs, is approximately 20 ft thick. The Qbog/Tpf contact, estimated at 295 ft bgs, is based on color change and sediments in cuttings and the natural gamma log.
295–315	**PUYE FORMATION:** Volcaniclastic Sediments—brown (5YR 6/4) weathered tuff clasts and varicolored dacitic and rhyolitic clasts. 295–315 ft WR/+10F: 80%–95% brown ash flow tuff and pumice clasts; 5%–20% dacite and rhyolite clasts; trace quartz grains. +35F: 75%–90% brown ash flow tuff and pumice clasts; 5%–15% dacite and rhyolite clasts; 5%–15% quartz clasts.	Tpf	The Puye Formation (Tpf), encountered from 295 to 339 ft bgs, is 44 ft thick. **Note**: This interval is contaminated with white pumice from the above Guaje Pumice Bed. White pumice is not included in the lithologic description.
315–339	Volcaniclastic Sediments—brown (5YR 6/4) weathered tuff clasts and varicolored dacitic and rhyolitic clasts. 315–339 ft WR/+10F: 80%–95% brown ash flow tuff and pumice clasts; 5%–20% dacite and rhyolite clasts; trace quartz grains. +35F: 75%–90% brown ash flow tuff and pumice clasts; 5%–15% dacite and rhyolite clasts; 5%–15% quartz clasts.	Tpf	The Tpf/Tb4 contact, estimated at 339 ft bgs, is based on drill cuttings and observations while drilling.
339–355	**CERROS DEL RIO VOLCANICS:** Massive, dark gray (N3-N4), olivine-bearing basalt flows with minor vesicles. 339–355 ft WR/+10F/+35F: 50%–95% aphanitic basalt fragments; 5%–50% brown ash flow tuff clasts (from overlying Tpf).	Tb4	The Cerros del Rio volcanics (Tb4), encountered from 339 to 645 ft bgs, is 306 ft thick.
355–435	Massive, dark gray to gray (N4-N5), basalt flows. Fine-grained groundmass contains plagioclase and reddish-brown, altered pyroxene. Small (<2 mm) olivine phenocrysts are locally altered. 355–435 ft WR/+10F/+35F: 100% aphanitic basalt fragments.	Tb4	
435–480	Massive, dark gray (N3-N4), basalt flows. Fine-grained groundmass contains plagioclase and reddish-brown, altered pyroxene. 355–435 ft WR/+10F/+35F: 100% aphanitic basalt fragments with minor vesicular basalt and red oxidation.	Tb4	Note: Interval from 455 to 465 ft contaminated with pumice from above, not included in lithologic description.

DEPTH (ft bgs)	LITHOLOGY	LITHOLOGIC SYMBOL	NOTES
480–500	Vesiculated, dark gray (N3-N4) to oxidized red, basalt scoria. 480–500 ft WR/+10F/+35F: 100% vesiculated, aphanitic basalt scoria, largely oxidized to purple-red.	Tb4	
500–550	Massive, dark gray (N3-N4), basalt flows with some cinders. Fine-grained groundmass contains plagioclase and reddish-brown, altered pyroxene. 500–550 ft WR/+10F/+35F: 100% aphanitic basalt fragments with minor vesicular basalt and red oxidation.	Tb4	Note: Interval from 515 ft to 520 ft contaminated with pumice from above, not included in lithologic description.
550–580	Massive, dark gray (N3-N4), basalt flows. Fine-grained groundmass contains plagioclase and reddish-brown, altered pyroxene. 550–580 ft WR/+10F/+35F: 100% aphanitic basalt fragments with minor purple-red oxidation.	Tb4	
580-600	Dark gray (N3-N4), basalt flows and scoria. Fine-grained groundmass contains plagioclase and reddish-brown, altered pyroxene. 580–600 ft WR/+10F/+35F: 98% aphanitic basalt fragments with minor purple-red oxidation; <2% tan siltstone in subrounded clasts and as coating on basalt scoria.	Tb4	
600–645	Massive, dark gray to gray (N4-N5), basalt flows. Fine-grained groundmass contains plagioclase and reddish-brown, altered pyroxene. 600–645 ft WR/+10F/+35F: 100% aphanitic basalt fragments.	Tb4	The Tb4/Tpf contact, estimated at 645 ft bgs, is based on drill cuttings and observations while drilling
645–660	**PUYE FORMATION:** Volcaniclastic and Silicic Sediments—tan to brown (5YR 6/4) mudstone to siltstone with basalt gravel. 645–660 ft WR/+10F/+35F: 60%–70% tan to brown siltstone possibly baked by overlying basalt; 30%–40% rounded basalt clasts up to 25 mm.	Tpf	The Puye Formation (Tpf), encountered from 645 to 981 ft bgs, is at least 336 ft thick.
660–680	Volcaniclastic and Silicic Sediments—varicolored grains of dacite and rhyolite. 660–680 ft WR/+10F/+35F: 100% subangular to subrounded clasts of dacite and rhyolite up to 20-mm; trace quartz grains.	Tpf	
680–685	Volcaniclastic and Silicic Sediments—very fine to medium sand with minor coarse sand. 680–685 ft WR/+35F: 75%–80% quartz grains; 20%–25% rhyolite and dacite clasts. +10F: 65% dacite and rhyolite clasts; 25% ash flow tuff clasts and pumices; 10% siltstone clasts.	Tpf	

DEPTH (ft bgs)	LITHOLOGY	LITHOLOGIC SYMBOL	NOTES
685–690	Volcaniclastic and Silicic Sediments—siltstone bed and fine to medium sand with minor coarse sand. 680–685 ft WR/+10F: 50–80% clasts of tan siltstone; 20%–50% hydrothermally altered basalt/dacite clasts. +35F: 75%–80% quartz grains; 20%–25% rhyolite, basalt, and dacite clasts.	Tpf	
690–700	Phreatomagmatic deposits—fine-grained, ashy, basaltic deposits, including subrounded clasts of typical Puye Formation sediments. 690–700 ft WR/+10F+35F: 95%–99% clasts of lithic-bearing basaltic tuff or hydrothermally altered basalt; 1%–5% rhyolite and dacite clasts.	Tpf	**Note:** This interval may represent a maar deposit overlain by silty lake deposits.
700–760	Volcaniclastic and Silicic Sediments—siltstone beds and varicolored grains of dacite and rhyolite. 700–760 ft WR/+10F/+35F: 75%–95% subangular to rounded clasts of dacite and rhyolite; 5%–25% clasts of tan siltstone.	Tpf	
760–840	Volcaniclastic and Silicic Sediments—varicolored grains of dacite and rhyolite. 760–840 ft WR/+10F/+35F: 100% subangular to rounded clasts of dacite and rhyolite up to 15-mm; trace quartz grains.	Tpf	
840–855	Volcaniclastic and Silicic Sediments— varicolored grains of dacite and rhyolite and siltstone beds. 840–855 ft WR/+10F/+35F: 95%–99% subangular to rounded clasts of dacite and rhyolite often coated with silt; 1%–5% clasts of tan siltstone.	Tpf	
855–960	Volcaniclastic and Silicic Sediments—varicolored grains of dacite and rhyolite. 855–960 ft WR/+10F/+35F: 100% subangular to rounded clasts of dacite and rhyolite up to 15-mm; trace quartz grains.	Tpf	
960–965	Volcaniclastic and Silicic Sediments—varicolored medium to coarse dacite and rhyolite sand. 855–960 ft WR/+10F/+35F: 100% subangular to rounded clasts of dacite and rhyolite up to coarse sand; trace quartz grains.	Tpf	
965–981.4	Volcaniclastic and Silicic Sediments—varicolored grains of dacite and rhyolite. 965–981.4 ft WR/+10F/+35F: 100% subangular to rounded clasts of dacite and rhyolite up to 20-mm; trace quartz grains.	Tpf	TD = 981.4 ft

ABBREVIATIONS

5YR 8/4 (example) = Munsell rock color notation where hue (e.g., 5YR), value (e.g., 8), and chroma (e.g., 4) are expressed. Hue indicates soil color's relation to red, yellow, green, blue, and purple. Value indicates soil color's lightness. Chroma indicates soil color's strength.

% = estimated percent by volume of a given sample constituent

amsl = above mean sea level

bgs = below ground surface

TD = total depth

Qal = Alluvium

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

Qct = Cerro Toledo interval

Qbo = Otowi Member of Bandelier Tuff

Qbog = Guaje Pumice Bed

Tpf = Puye Formation

Tb4 = Cerros del Rio volcanic rocks

+10F = plus No. 10 sieve sample fraction

+35F = plus No. 35 sieve sample fraction

WR = whole rock (unsieved sample)

1 mm = 0.039 in.

1 in = 25.4 mm

Appendix B

Screening Groundwater Analytical Results for Well SIMR-2

B-1.0 SCREENING GROUNDWATER ANALYSES AT SIMR-2

SIMR-2 is a regional aquifer monitoring well with one well screen from 885 to 905.4 ft below ground surface (bgs) in Puye Formation volcaniclastic sediments. This appendix presents screening analytical results for samples collected during well development and aquifer testing at SIMR-2.

Laboratory Analyses

Three groundwater samples were collected during development and two groundwater samples were collected during aquifer testing. Los Alamos National Laboratory's (LANL's or the Laboratory's) Earth and Environmental Sciences Group 14 analyzed the development samples for total organic carbon (TOC) and the aquifer test samples for TOC; anions; metals; low-level tritium (LH_3); perchlorate (ClO_4); phosphate (PO_4); nitrogen dioxide and nitrates (NO_2 and NO_3); and 1,4 dioxane (1,4-D). Table B-1.0-1 lists the samples submitted for TOC analyses from SIMR-2.

Field Analyses

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

B-2.0 SCREENING ANALYTICAL RESULTS

This section presents the TOC concentrations and field parameters measured during well development and aquifer testing.

B-2.1 Total Organic Carbon

TOC concentrations were between 2.0 mgC/L and 2.2 mgC/L in three groundwater samples collected during well development at well SIMR-2 (Table B-2.1-1). TOC concentration was at the target concentration of 2.0 mgC/L at the end of well development. Table B-2.1-1 also presents the U.S. Environmental Protection Agency (EPA) method by which the samples were analyzed.

B-2.2 Field Parameters

Field parameters measured during well development and aquifer testing are summarized in Table B-2.2-1. Well development was initially conducted for 5 d. Aquifer testing was then conducted for 16 d. A 24-h aquifer test was attempted but was suspended from a leaky storage tank and concerns over secondary containment measures employed. A 72-h aquifer test was then attempted and suspended when the submersible pump motor failed. A second 72-h aquifer test was then successfully conducted after a new pump and motor was installed. These activities were conducted consecutively and the field parameters are summarized below.

During well development and aquifer testing, pH varied from 6.68 to 7.96 and temperature ranged from 6.3°C to 12.7°C. DO concentrations varied from 5.17 mg/L to 13.19 mg/L. Specific conductance ranged from 146 µS/cm to 261 µS/cm, and turbidity values varied from 0 to 1025 nephelometric turbidity units (NTU). Corrected oxidation-reduction potential (Eh) values, determined from field ORP measurements, varied from 246.9 mV to 402.9 mV. One temperature-dependent correction factor was used to calculate

Eh values from field ORP measurements: 208.9 mV at 15°C. Figure B-2.2-1 shows the field parameters measured over the course of well development and aquifer testing.

The final parameters measured at the end of the aquifer testing period were pH of 7.10, temperature of 12.54°C, DO of 10.28 mg/L, specific conductance of 169 µS/cm, and turbidity of 0.0 NTU.

B-3.0 SUMMARY OF SCREENING ANALYTICAL RESULTS

TOC concentration was below the target level of 2.0 mgC/L and turbidity was 0.0 NTU at the end of aquifer testing. SIMR-2 will be sampled quarterly for 1 yr and data collected will be assessed and incorporated into the Interim Facility-Wide Groundwater Monitoring Plan. Data from ongoing sampling at SIMR-2 will be analyzed and presented in the appropriate Laboratory periodic monitoring report.

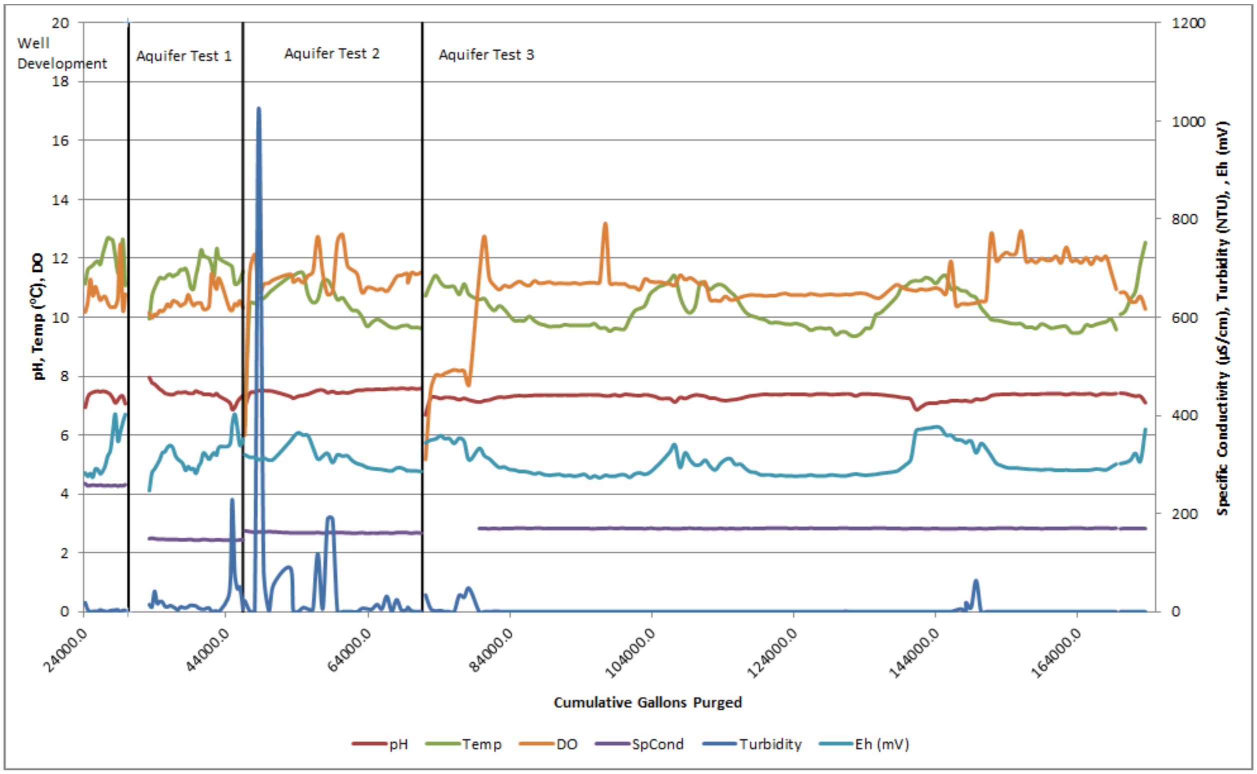


Figure B-2.2-1 **Field parameters versus volume purged during SIMR-2 well development and aquifer testing**

Table B-1.0-1
Summary of Groundwater Screening Samples Collected during Well Development and Aquifer Testing at Well SIMR-2

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Analysis
Well Development					
SIMR-2	SIMR-2-15-101812	8/14/15	887	Groundwater, Pumped	TOC
SIMR-2	SIMR-2-15-101813	8/14/15	891	Groundwater, Pumped	TOC
SIMR-2	SIMR-2-15-101814	8/16/15	905	Groundwater, Pumped	TOC
Aquifer Testing					
SIMR-2	SIMR-2-15-104242	9/11/15	898	Groundwater, Pumped	TOC, Anions, LH_3, ClO_4, PO_4, NO_2, NO_3, 1,4-D
SIMR-2	SIMR-2-15-104243	9/11/15	898	Groundwater, Pumped	Metals

Table B-2.1-1
TOC Results

Sample ID	EPA Method	TOC Concentration (mgC/L)
SIMR-2-15-101812	SW-846:9060	2.2
SIMR-2-15-101813	SW-846:9060	2.0
SIMR-2-15-101814	SW-846:9060	2.0
SIMR-2-15-104242	SW-846:9060	1.0

Table B-2.2-1
Purge Volumes and Field Parameters during Well Development and Aquifer Testing at SIMR-2

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
Well Development									
8/11/15	n/r*; bailing							78	78
8/12/15	n/r; bailing							666.5	744.5
8/13/15	n/r; pumping through screen							15327	16071.5
8/14/15	n/r; pumping through screen							2604	18675.5
8/16/15	6.94	11.14	10.18	74	282.9	261	18.5	5488.2	24163.7
	7.29	11.62	10.52	67	275.9	257	3.8	352.5	24516.2
	7.41	11.70	11.29	73	281.9	257	0	352.5	24868.7
	7.45	11.77	10.73	65	273.9	258	0.4	352.5	25221.2
	7.48	11.86	11.04	82	290.9	258	0.4	352.5	25573.7
	7.49	11.91	10.80	81	289.9	257	0.8	352.5	25926.2
	7.47	11.80	10.58	72	280.9	258	3.8	352.5	26278.7
	7.49	12.16	10.68	78	286.9	257	1.5	352.5	26631.2
	7.48	12.45	10.70	89	297.9	257	1.0	352.5	26983.7
	7.44	12.70	10.49	109	317.9	258	0	352.5	27336.2
	7.38	12.66	10.35	119	327.9	256	2.4	352.5	27688.7
	7.26	12.60	10.35	158	366.9	257	2.8	352.5	28041.2
	7.09	12.06	10.36	194	402.9	258	3.4	352.5	28393.7
	7.19	11.50	10.66	139	347.9	256	3.9	352.5	28746.2
	7.31	11.50	12.48	157	365.9	257	0	352.5	29098.7
	7.32	12.65	10.26	177	385.9	257	2.8	352.5	29451.2
	7.06	11.08	10.79	193	401.9	259	3.0	352.5	29803.7
	n/r; purged prior to shutting off pump							400.5	30204.2
Aquifer Pump Test 1									
8/18/15	n/r, pumping, fill discharge lines							453.5	30657.7
8/19/15	n/r, pumping, mini-tests							2127	32784.7
8/21/15	7.96	9.95	10.15	38	246.9	149	14.5	405	33189.7
	7.78	10.71	9.98	74	282.9	150	9.8	366.9	33556.6
	7.73	10.99	10.10	82	290.9	149	41.7	364.5	33921.1
	7.65	11.18	10.10	91	299.9	148	16.7	364.5	34285.6
	7.56	11.35	10.23	101	309.9	147	20.6	364.5	34650.1
	7.50	11.32	10.20	115	323.9	148	20.1	364.5	35014.6
	7.42	11.33	10.29	117	325.9	148	11.0	364.5	35379.1
	7.40	11.43	10.45	126	334.9	147	9.9	364.5	35743.6

Table B-2.2-1 (continued)

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
8/21/15	7.37	11.46	10.36	130	338.9	147	12.3	364.5	36108.1
	7.37	11.39	10.55	126	334.9	147	10.4	364.5	36472.6
	7.41	11.44	10.54	110	318.9	147	7.0	364.5	36837.1
	7.45	11.48	10.49	102	310.9	147	4.1	364.5	37201.6
	7.44	11.62	10.39	98	306.9	146	9.4	364.5	37566.1
	7.45	11.61	10.44	92	300.9	147	8.7	364.5	37930.6
	7.46	11.66	10.50	79	287.9	146	7.7	364.5	38295.1
	7.42	11.42	10.77	87	295.9	147	10.2	364.5	38659.6
	7.41	11.00	10.56	81	289.9	147	13.4	364.5	39024.1
	7.42	10.96	10.40	83	291.9	146	12.6	364.5	39388.6
	7.50	11.41	10.47	73	281.9	146	11.7	364.5	39753.1
	7.45	11.81	10.49	87	295.9	146	7.4	364.5	40117.6
	7.44	12.29	10.47	97	305.9	147	5.8	364.5	40482.1
	7.38	12.09	10.27	115	323.9	147	4.9	364.5	40846.6
	7.39	12.00	10.36	102	310.9	146	7.8	729	41575.6
	7.36	11.79	11.46	109	317.9	146	0.6	364.5	41940.1
	7.35	11.39	11.18	115	323.9	146	1.2	364.5	42304.6
	7.41	12.32	10.96	110	318.9	147	1.3	364.5	42669.1
	7.32	12.00	11.32	127	335.9	146	0.6	364.5	43033.6
	7.11	11.79	10.28	131	339.9	146	40.8	1458	44491.6
	6.87	11.70	10.23	172	380.9	146	228.4	364.5	44856.1
	6.94	11.14	10.46	194	402.9	146	77.8	364.5	45220.6
	7.13	11.14	10.40	165	373.9	146	46.5	364.5	45585.1
	7.25	11.27	10.56	130	338.9	146	49.9	364.5	45949.6
	7.34	11.56	10.32	143	351.9	147	4.8	437.4	46387.0

Table B-2.2-1 (continued)

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
Aquifer Pump Test 2									
9/1/15	n/r, pumping, fill discharge lines							161	46548.0
9/2/15 to 9/3/15	6.97	6.30	5.99	111	319.9	165	22.5	92.4	46640.4
	7.42	10.48	11.52	106	314.9	163	1.5	693	47333.4
	7.46	10.47	12.14	106	314.9	162	0.2	693	48026.4
	7.51	10.64	10.86	101	309.9	163	1025.1	600.6	48627.0
	7.51	10.65	11.12	104	312.9	163	79.7	693	49320.0
	7.50	10.82	11.16	100	308.9	163	1.7	693	50013.0
	7.48	10.97	11.28	102	310.9	163	55.8	693	50706.0
	7.31	11.40	11.46	139	347.9	161	89.3	2346	53052.0
	7.25	11.41	11.20	147	355.9	161	1.3	415.8	53467.8
	7.32	11.51	11.30	156	364.9	160	0.4	690	54157.8
	7.35	11.50	11.18	151	359.9	160	8.3	690	54847.8
	7.39	10.77	11.42	150	358.9	161	5.5	690	55537.8
	7.46	10.50	11.55	126	334.9	160	4.9	690	56227.8
	7.52	10.60	12.74	102	310.9	161	118.6	690	56917.8
	7.53	11.22	11.49	108	316.9	160	6.1	693	57610.8
	7.44	11.26	10.77	114	322.9	161	189.2	693	58303.8
	7.48	10.97	10.88	95	303.9	161	188.8	693	58996.8
	7.42	10.60	12.59	111	319.9	161	0	692.5	59689.3
	7.45	10.67	12.81	108	316.9	161	0	696	60385.3
	7.43	10.44	11.77	109	317.9	161	0	694.8	61080.1
	7.47	10.24	11.61	99	307.9	160	0	694.8	61774.9
	7.52	10.22	11.46	93	301.9	160	0	694.8	62469.7
	7.52	10.01	10.84	90	298.9	161	6.7	694.8	63164.5
	7.55	9.69	11.01	85	293.9	160	5.7	694.8	63859.3
	7.54	9.83	11.00	83	291.9	161	5.3	694.8	64554.1
	7.56	9.93	10.93	82	290.9	160	14.8	718	65272.1
	7.55	9.86	10.97	81	289.9	160	5.4	671.6	65943.7
	7.56	9.74	10.88	79	287.9	161	31.5	694.8	66638.5
	7.58	9.65	11.11	78	286.9	160	1.2	694.8	67333.3
	7.57	9.64	11.38	84	292.9	161	24.5	694.8	68028.1
	7.59	9.71	11.43	84	292.9	161	3.0	694.8	68722.9
	7.57	9.73	11.48	78	286.9	161	5.6	833.8	69556.7
	7.56	9.73	11.17	79	287.9	161	9.2	46.3	69603.0

Table B-2.2-1 (continued)

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
	7.59	9.65	11.51	78	286.9	160	1.8	509.5	70112.5
	7.57	9.66	11.46	78	286.9	161	0	694.8	70807.3
	7.58	9.63	11.53	77	285.9	160	0	694.8	71502.1
	n/r; purged prior to pump shutting off (motor failure)							139.2	71641.3
Aquifer Pump Test 3									
9/7/15	n/r, pumping, fill discharge lines							245.7	71887.0
9/8/15 to 9/11/15	6.68	10.73	5.17	135	343.9	n/r, not calibrated correctly	34.3	211.8	72098.8
	7.25	11.13	7.49	141	349.9	n/r, not calibrated correctly	6.5	706.2	72805.0
	7.29	11.42	8.03	143	351.9	n/r, not calibrated correctly	1.6	707.1	73512.1
	7.24	11.18	8.01	150	358.9	n/r, not calibrated correctly	2.4	707.1	74219.2
	7.28	11.05	8.09	144	352.9	n/r, not calibrated correctly	0	542.1	74761.3
	7.28	11.04	8.16	144	352.9	n/r, not calibrated correctly	0	707.1	75468.4
	7.26	11.04	8.22	134	342.9	n/r, not calibrated correctly	0	659.4	76127.8
	7.2	10.78	8.18	145	353.9	n/r, not calibrated correctly	33.2	706.5	76834.3
	7.25	11.13	8.17	138	346.9	n/r, not calibrated correctly	29.5	706.5	77540.8
	7.19	10.77	7.73	100	308.9	n/r, not calibrated correctly	47.7	706.2	78247.0
	7.12	10.61	11.40	124	332.9	170	0	1413	79660.0
	7.17	10.64	12.75	109	317.9	170	0	707.1	80367.1
	7.19	10.39	11.34	103	311.9	169	0	707.1	81074.2
	7.25	10.23	11.08	93	301.9	170	0.7	707.1	81781.3
	7.29	10.39	10.94	85	293.9	169	0.4	707.1	82488.4
	7.28	10.27	11.08	86	294.9	170	0.1	707.1	83195.5
	7.30	10.06	11.03	81	289.9	169	0	707.1	83902.6
	7.33	9.89	11.13	80	288.9	170	0	707.1	84609.7
	7.34	9.89	11.22	77	285.9	170	0.3	707.1	85316.8
	7.33	9.89	11.12	77	285.9	170	0	707.1	86023.9
	7.34	10.03	11.08	75	283.9	170	0	707.1	86731.0
	7.35	9.88	11.24	72	280.9	170	0	707.1	87438.1

Table B-2.2-1 (continued)

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
	7.35	9.78	11.15	74	282.9	171	0	707.1	88145.2
	7.36	9.74	11.17	70	278.9	169	0	707.1	88852.3
	7.35	9.68	11.20	69	277.9	170	0	707.1	89559.4
	7.36	9.70	11.14	70	278.9	170	0	707.1	90266.5
	7.35	9.69	11.16	71	279.9	170	0	707.1	90973.6
	7.36	9.75	11.15	68	276.9	169	0	707.1	91680.7
	7.35	9.73	11.14	69	277.9	169	0	707.1	92387.8
	7.35	9.73	11.17	67	275.9	169	0	707.1	93094.9
	7.36	9.73	11.13	69	277.9	169	0	707.1	93802.0
	7.36	9.72	11.16	71	279.9	170	0	707.1	94509.1
	7.37	9.73	11.18	64	272.9	169	0	707.1	95216.2
	7.36	9.78	11.18	68	276.9	169	0	707.1	95923.3
	7.36	9.64	11.19	64	272.9	170	0	707.1	96630.4
	7.33	9.64	13.19	69	277.9	170	0	801.4	97431.8
	7.33	9.53	11.16	67	275.9	170	0	612.8	98044.6
	7.37	9.62	11.15	67	275.9	170	0	707.1	98751.7
	7.33	9.60	11.13	70	278.9	170	0	707.1	99458.8
	7.38	9.61	11.13	70	278.9	170	0	707.1	100165.9
	7.37	9.96	11.03	65	273.9	170	0	707.1	100873.0
	7.35	10.22	11.02	72	280.9	170	0	707.1	101580.1
	7.34	10.30	10.94	74	282.9	170	0	707.1	102287.2
	7.37	10.40	11.30	71	279.9	169	0	707.1	102994.3
	7.35	10.78	11.22	75	283.9	170	0	708.2	103702.5
	7.31	10.94	11.19	84	292.9	170	0	708.6	104411.1
	7.24	11.06	11.20	94	302.9	169	0	708.6	105119.7
	7.24	11.11	11.16	105	313.9	170	0	708.6	105828.3
	7.24	11.26	11.13	117	325.9	170	0	708.6	106536.9
	7.12	11.40	11.09	131	339.9	169	0	708.6	107245.5
	7.28	10.70	11.43	85	293.9	169	0	708.6	107954.1
	7.24	10.30	11.28	115	323.9	170	0	708.6	108662.7
	7.31	10.15	11.34	100	308.9	170	0	708.6	109371.3
	7.36	10.37	11.24	90	298.9	169	0	708.6	110079.9
	7.35	11.17	11.12	91	299.9	170	0	708.6	110788.5
	7.32	11.08	11.19	100	308.9	169	0	708.6	111497.1
	7.25	10.95	10.59	87	295.9	170	0	708.6	112205.7

Table B-2.2-1 (continued)

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
	7.25	11.08	10.58	80	288.9	169	0	708.6	112914.3
	7.19	11.12	10.56	93	301.9	170	0	708.6	113622.9
	7.17	11.03	10.71	101	309.9	169	0	708.6	114331.5
	7.19	10.86	10.59	103	311.9	170	0	708.6	115040.1
	7.21	10.71	10.61	91	299.9	169	0	708.6	115748.7
	7.24	10.42	10.68	92	300.9	169	0	707.1	116455.8
	7.29	10.18	10.73	83	291.9	170	0	707.1	117162.9
	7.33	10.06	10.76	76	284.9	169	0	707.1	117870.0
	7.35	10.01	10.75	75	283.9	170	0	708.6	118578.6
	7.37	9.95	10.75	70	278.9	170	0	707.1	119285.7
	7.39	9.91	10.72	70	278.9	170	0	707.1	119992.8
	7.37	9.81	10.74	70	278.9	171	0	707.1	120699.9
	7.38	9.83	10.74	68	276.9	170	0	708	121407.9
	7.37	9.81	10.79	69	277.9	171	0	707.1	122115.0
	7.39	9.77	10.81	68	276.9	171	0	706.5	122821.5
	7.39	9.76	10.76	68	276.9	169	0	707.1	123528.6
	7.38	9.79	10.76	67	275.9	171	0	707.1	124235.7
	7.38	9.75	10.76	68	276.9	169	0	707.1	124942.8
	7.38	9.68	10.75	68	276.9	170	0	707.1	125649.9
	7.36	9.56	10.80	70	278.9	170	0	707.1	126357.0
	7.39	9.62	10.77	68	276.9	170	0	707.1	127064.1
	7.39	9.64	10.75	68	276.9	170	0	707.1	127771.2
	7.40	9.61	10.77	68	276.9	170	0	707.1	128478.3
	7.37	9.62	10.78	70	278.9	170	0	707.1	129185.4
	7.38	9.41	10.76	69	277.9	170	0	706.8	129892.2
	7.39	9.50	10.76	68	276.9	171	0	706.5	130598.7
	7.40	9.50	10.78	68	276.9	171	0.9	705.9	131304.6
	7.39	9.38	10.77	70	278.9	170	0	705.9	132010.5
	7.33	9.36	10.81	72	280.9	170	0	705.7	132716.2
	7.39	9.45	10.82	70	278.9	169	0	705.6	133421.8
	7.39	9.63	10.80	69	277.9	170	0	705.6	134127.4
	7.39	9.65	10.73	70	278.9	170	0	705.6	134833.0
	7.38	10.09	10.66	71	279.9	171	0	705.6	135538.6
	7.37	10.16	10.68	73	281.9	170	0	705.6	136244.2
	7.31	10.67	11.10	77	285.9	169	0	2116.8	138361.0

Table B-2.2-1 (continued)

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
	7.28	10.98	11.04	83	291.9	169	0	705.6	139066.6
	7.26	11.06	10.96	91	299.9	169	0	705.6	139772.2
	7.21	11.21	10.93	102	310.9	170	0	705.6	140477.8
	6.87	11.24	10.90	159	367.9	170	0	705.6	141183.4
	6.95	11.24	10.96	163	371.9	170	0	705.9	141889.3
	7.06	11.35	10.93	165	373.9	169	0	705.9	142595.2
	7.08	11.29	10.96	166	374.9	169	0.2	705.9	143301.1
	7.08	11.15	11.00	168	376.9	170	0	706.2	144007.3
	7.13	11.35	10.93	165	373.9	169	0	706.5	144713.8
	7.12	11.41	10.80	151	359.9	169	0	706.5	145420.3
	7.17	10.96	11.90	151	359.9	169	0	706.5	146126.8
	7.17	11.01	10.40	142	350.9	169	3.1	706.2	146833.0
	7.16	10.91	10.45	141	349.9	170	5.8	706.2	147539.2
	7.17	10.89	10.46	135	343.9	170	0	682.7	148221.9
	7.17	10.89	10.44	135	343.9	170	18.7	23.5	148245.4
	7.14	10.74	10.46	139	347.9	169	8.3	706.2	148951.6
	7.22	10.66	10.49	115	323.9	169	63.4	705.9	149657.5
	7.20	10.32	10.55	134	342.9	170	0	705.3	150362.8
	7.24	10.12	10.58	124	332.9	169	0	705.9	151068.7
	7.34	9.93	12.84	109	317.9	170	0	705.3	151774.0
	7.37	9.90	11.93	94	302.9	170	0	705.9	152479.9
	7.38	9.87	12.07	89	297.9	170	0	705.3	153185.2
	7.38	9.83	12.20	85	293.9	170	0	705.6	153890.8
	7.39	9.79	12.13	84	292.9	171	0	705.3	154596.1
	7.39	9.78	12.19	84	292.9	169	0	705.6	155301.7
	7.37	9.78	12.93	83	291.9	171	0	704.7	156006.4
	7.39	9.66	11.90	82	290.9	170	0	704.7	156711.1
	7.39	9.67	11.95	81	289.9	170	0	704.7	157415.8
	7.38	9.62	11.86	81	289.9	170	0	704.7	158120.5
	7.40	9.77	12.00	80	288.9	169	0	705	158825.5
	7.40	9.72	11.94	81	289.9	170	0	705.3	159530.8
	7.40	9.63	11.94	81	289.9	170	0	705.3	160236.1
	7.40	9.66	12.07	79	287.9	170	0	705.3	160941.4
	7.40	9.69	11.85	79	287.9	170	0	705.6	161647.0
	7.37	9.69	12.38	80	288.9	170	0	705.6	162352.6

Table B-2.2-1 (continued)

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Eh (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
	7.40	9.49	11.92	79	287.9	171	0	705.6	163058.2
	7.40	9.47	11.95	79	287.9	171	0	705	163763.2
	7.39	9.51	11.85	79	287.9	170	0	705.6	164468.8
	7.40	9.74	12.02	79	287.9	169	0	704.4	165173.2
	7.40	9.70	11.80	80	288.9	170	0	705.6	165878.8
	7.35	9.76	12.05	82	290.9	171	0	705.7	166584.5
	7.40	9.81	11.94	81	289.9	171	0	704.1	167288.6
	7.40	9.85	12.06	80	288.9	170	0	704.1	167992.7
	7.39	9.94	11.53	86	294.9	170	0	704.1	168696.8
	7.41	9.58	10.95	92	300.9	170	0	704.1	169400.9
	n/r, pump temporarily shut off for 5min								
	7.42	10.10	10.84	93	301.9	169	0	586.7	169987.6
	7.41	10.22	10.83	95	303.9	170	0	704.1	170691.7
	7.36	10.61	10.56	100	308.9	170	0	704.1	171395.8
	7.32	10.89	10.52	114	322.9	170	0	703.9	172099.7
	7.32	11.83	10.71	98	306.9	170	0	703.8	172803.5
	7.10	12.54	10.28	163	371.9	169	0	703.8	173507.3

Note: One temperature-dependent correction factor was used to calculate Eh values from field ORP measurements: 208.9 mV at 15°C.

*n/r = Not recorded.

Appendix C

Geophysical Logs
(on CD included with this document)

Appendix D

Borehole Video Logging
(on DVD included with this document)

Appendix E

Final Well Design and
New Mexico Environment Department Approval

The following chronology summarizes the SIMR-2 well design–approval process.

- July 11, 2015 (Attachment E-1)
    - ❖ Los Alamos National Laboratory submits proposed well design to Pueblo de San Ildefonso and the New Mexico Environment Department (NMED).
- July 12, 2015 (Attachment E-2)
    - ❖ NMED approves the well design with a recommendation to increase the transition sand length to 4 ft.
    - ❖ Pueblo de San Ildefonso approves the well design with conditions.
- July 14, 2015 (Attachment E-3)
    - ❖ The U.S. Department of Energy responds to Pueblo de San Ildefonso’s Approval with Conditions, addressing all conditions, including accepting the recommendation to increase the transition sand length to 4 ft.
    - ❖ Pueblo de San Ildefonso approves the well design with the transition sand length increased to 4 ft.

Attachment E-1

Proposed Well Design for SIMR-2

From: Everett, Mark Capen
Sent: Saturday, July 11, 2015 3:27 PM
To: rmartinez@sanipueblo.org; Michael Dale (Michael.Dale@state.nm.us)
Cc: Rodriguez, Cheryl L; Swickley, Stephani Fuller; Katzman, Danny
Subject: Proposed well design
Attachments: SIMR-2 Well Design 071115.pdf

NE 12/22/15
Document is no longer OUO.

~~OFFICIAL USE ONLY~~
~~May be exempt from public release under the Freedom of Information Act (5 U.S.C §552 [1966]) as amended, exemption and category:~~
~~Exemption 9—Wells: Protects information concerning geological and geophysical information and data, including maps, concerning wells.~~

~~Document transmitted contains OUO information.~~

Michael and Raymond,

Please find DOE/LANL's proposed well design for SIMR-2 attached to this e-mail. If you have questions or comments, please contact me on my cell phone (number below) or respond to this e-mail. If the design is acceptable, please respond to this e-mail with your concurrence.

Thanks,

Mark Everett, PG
ER-ES LANL
(505) 667-5931 (o)
(505) 231-6002 (c)

Proposed Well Design for Regional Aquifer Well SIMR-2

SIMR-2 Well Objectives

Regional aquifer well SIMR-2 is being installed downgradient of the chromium plume centered beneath Mortandad Canyon to satisfy a requirement by the New Mexico Environment Department (NMED) approval with modifications of the Phase II Investigation Report for Sandia Canyon dated February 19, 2014 (NMED 2014, 524467). The approval with modifications requires installation of a single-screen regional well south of well R-50 with the following objectives: 1) delineate the offsite nature and extent of the plume; 2) potentially be used for long-term contaminant detection and monitoring, and monitoring of any future remediation efforts; and 3) provide data and information as to whether production well Pajarito Mesa #4 (PM-4) is susceptible to contamination from the chromium plume. The SIMR-2 location was selected collaboratively with NMED, Pueblo de San Ildefonso, and the Laboratory and is shown in Figure 1.

SIMR-2 Recommended Well Design

It is recommended that SIMR-2 be installed as a single-screen well with a 20-ft stainless-steel, 40 slot, wire-wrapped well screen extending from 885 ft to 905 ft bgs. The primary filter pack will consist of 10/20 sand extending 5 ft above and 5 ft below the screen openings. A 2-ft secondary filter pack will be placed above the primary filter pack. The proposed well design is shown in Figure 2.

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

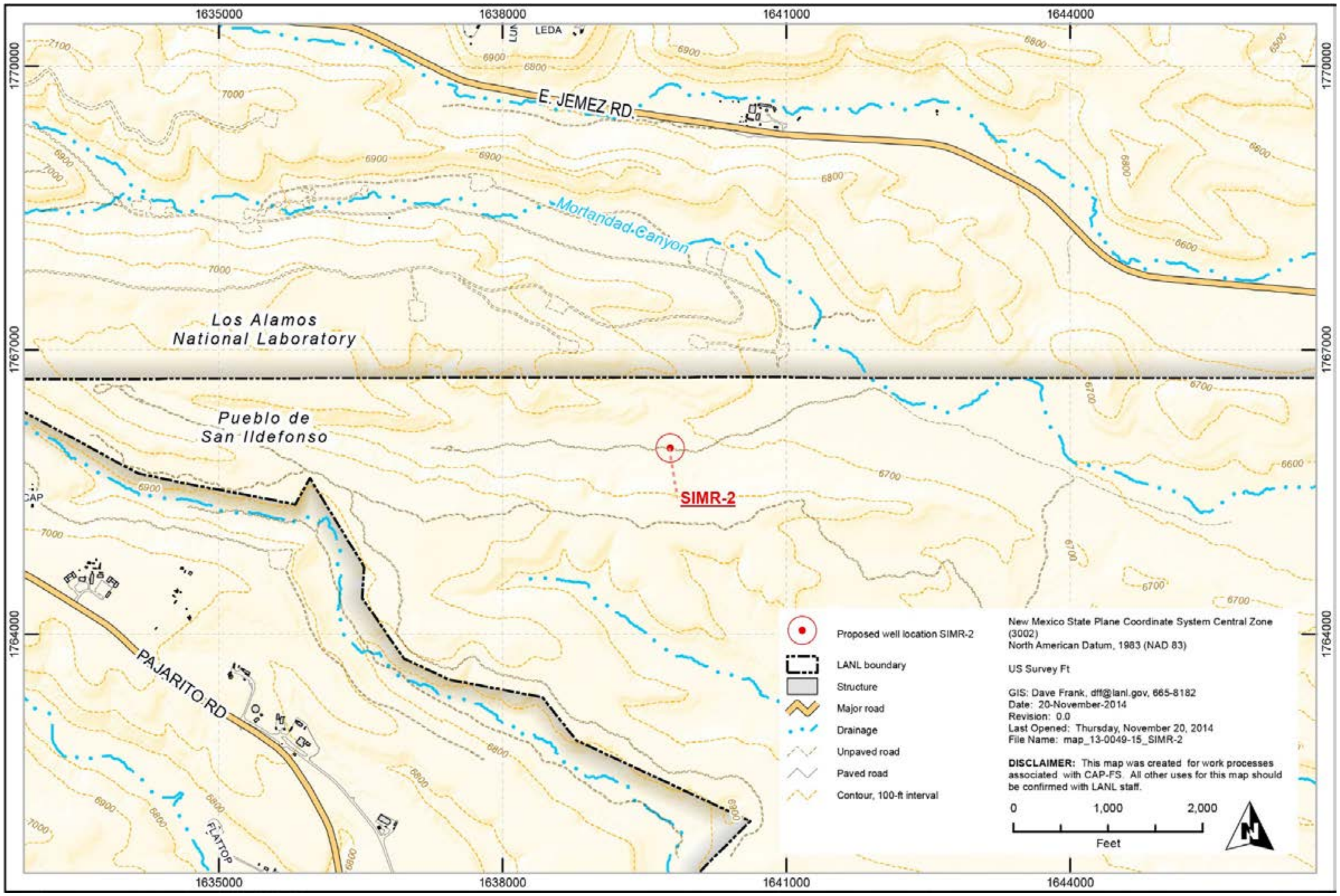
SIMR-2 Well Design Considerations

At total depth (TD), the SIMR-2 borehole was cased with 16-in drill casing from 0 to 94.5 ft, 12-in drill casing from 0 to 842 ft, and 10-in casing from 0 to 981 ft. Preliminary lithological logs indicate that the geologic contacts are, in descending stratigraphic order: Quaternary alluvium, Quaternary ash-flow tuffs of the Tshirege and Otowi Members of the Bandelier Tuff with intercalated sedimentary deposits of the Cerro Toledo interval (0–292 ft), Pliocene lava flows and breccias of the Cerros del Rio basalt (292 to 675 ft), and Pliocene cobbles, gravels, sands, and silts of the Puye Formation (675–981 ft TD). The Puye Formation is the primary target for the well screen. Well cuttings from SIMR-2 and information from nearby wells indicate that the Puye Formation is a volcanogenic fanglomerate deposit made up of stacked beds of cobbles, and pebbles in a matrix of sand with minor silt.

Characterization activities included the collection of cuttings at 5 ft intervals, open-hole gamma and induction logs from 95 to 460 ft, an open-hole video log from 95 to 455 ft, a cased-hole gamma log from 0 to 981 ft (TD), and water-level measurements in the regional aquifer. Based on drillers' observations of water production and water-level measurements, the regional piezometric surface occurs at a depth of approximately 868 ft. The top of regional saturation was predicted to occur at a depth of about 873 ft based on water table maps of the area that included information from nearby wells. Thus, the measured water level of 868 ft is about 5 ft higher than predicted.

The well screen targets the 885 to 905 ft interval because it allows groundwater samples to be collected from the uppermost part of the regional aquifer downgradient of the chromium plume beneath Mortandad Canyon. Rocks making up the Puye Formation in this interval contain relatively little matrix silt and clay and appear to have good characteristics for water production. A 10-ft well screen was evaluated as a means to monitor a more discrete zone of groundwater near the top of saturation. However, the longer 20-ft screen was chosen because the longer screen provides greater assurance that the well screen will be adequately submerged for development and periodic sampling.

The 17 ft. of submergence to the top of the well screen permits thorough well development and a sufficient life span for the well given the 0.7 ft/yr average water level decline in the area. Moving the screen interval higher may compromise our ability to clean out the filter pack during development, will likely reduce the usable life of the well, and may eliminate our ability to set the pump above the screen for sampling.



New Mexico State Plane Coordinate System Central Zone (3002)
North American Datum, 1983 (NAD 83)

US Survey Ft

GIS: Dave Frank, dff@lanl.gov, 665-8182
Date: 20-November-2014
Revision: 0.0
Last Opened: Thursday, November 20, 2014
File Name: map_13-0049-15_SIMR-2

DISCLAIMER: This map was created for work processes associated with CAP-FS. All other uses for this map should be confirmed with LANL staff.

Figure 1. Map of well SIMR-2 location.

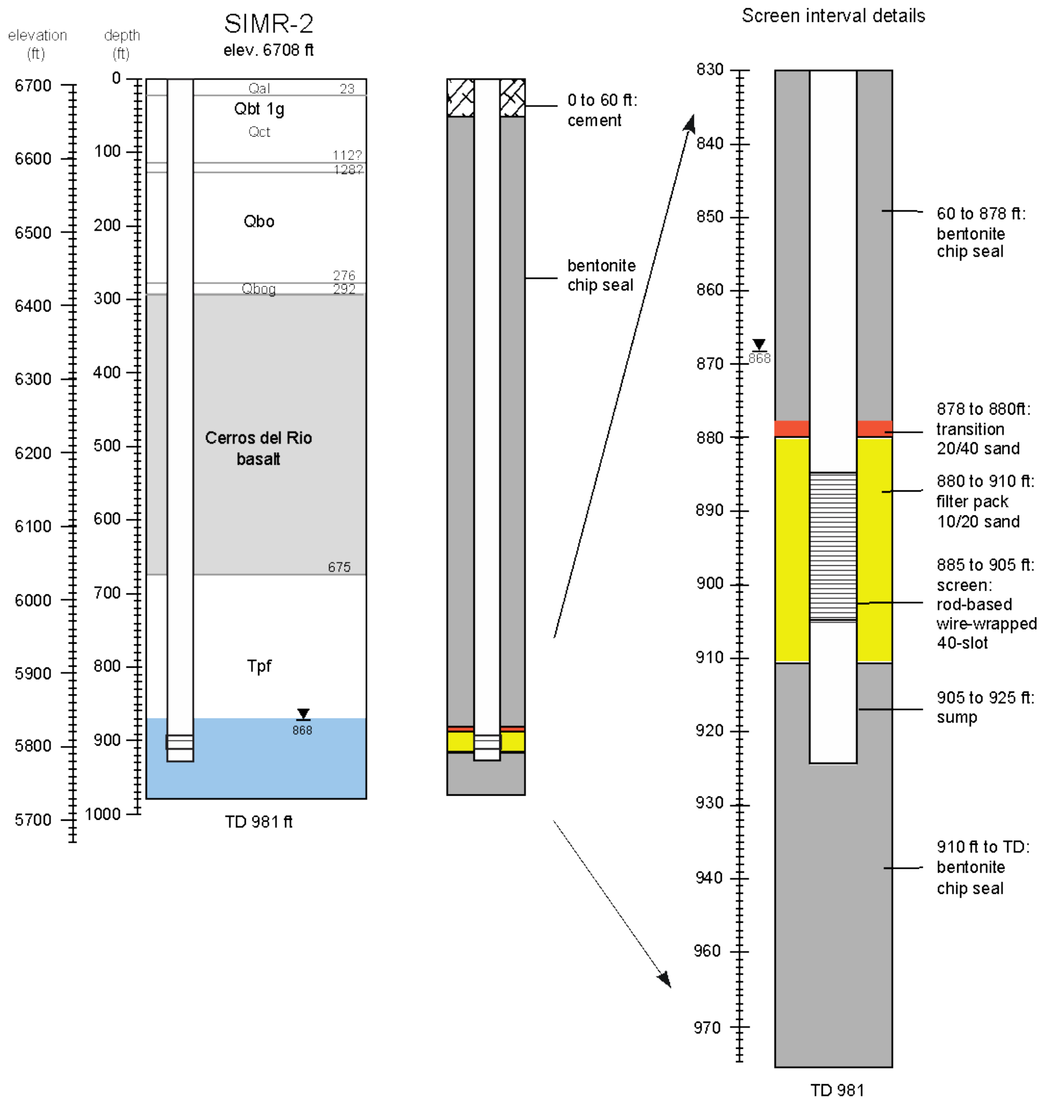


Figure 2. Proposed well design for SIMR-2

Attachment E-2

NMED and San Ildefonso Initial Approvals
for SIMR-2 Well Design

From: Dale, Michael, NMENV <Michael.Dale@state.nm.us>
Sent: Sunday, July 12, 2015 6:54 PM
To: Everett, Mark Capen
Cc: James Mountain; Flynn, Ryan, NMENV; Roberts, Kathryn, NMENV; Kieling, John, NMENV; Cobrain, Dave, NMENV; Wear, Benjamin, NMENV; rmartinez@sanipueblo.org; stmartinez@sanipueblo.org; Yanicak, Steve, NMENV; longmire@cybermesa.com; terry@lawoffice-lh.com; Rodriguez, Cheryl L; Swickley, Stephani Fuller; Fellenz, David, NMENV
Subject: RE: Proposed well design

Mark,

New Mexico Environment Department (NMED) hereby approves the installation of monitoring well SIMR-2 as proposed in your e-mail received on July 11, 2015 at 3:26 PM. This approval is based on information available to NMED at the time of the approval. LANL must provide the results of groundwater sampling, any modifications to the well design proposed in the above-mentioned e-mail, and any additional information relevant to the installation of SIMR-2 as soon as such data or information becomes available.

NMED does recommend that an additional two feet of 20/40 transition filter-pack sand be added from depths 876' to 878' bgs. The extra two feet of transition sand would help insure that bentonite sealant positioned above does not migrate downward into the screened interval during well development, aquifer testing or during normal purge pumping for groundwater sampling.

Please let me know if you have any questions.

Michael R. Dale
New Mexico Environment Department
1183 Diamond Drive, Suite B
Los Alamos, NM 87544
LANL MS M894
Cell Phone: (505) 231-5423
Office Phone (505) 476-3078

Pueblo de San Ildefonso
Office of the Governor

July 12, 2015

Ms. Christine Gelles
Los Alamos Site Manager
Environmental Management
Los Alamos Field Office
3747 West Jemez Road
Los Alamos, NM 87544

Dear Ms. Gelles;

The Pueblo de San Ildefonso is in receipt of the “Proposed Well Design for Regional Aquifer Well SIMR-2” submitted by the Department of Energy, Environmental Projects Office, Los Alamos Field Office/NNSA (DOE/LANS) on July 11, 2015 at 3:30 pm. The Pueblo de San Ildefonso (Pueblo) hereby approves the “Proposed Well Design for Regional Aquifer Well SIMR-2” subject to DOE/LANS agreement to the following conditions:

1. The Regional aquifer well SIMR-2 is being installed downgradient of the chromium plume centered beneath Mortandad Canyon. “SIMR-2” requires installation of a single-screen with the objective to detect contaminants and delineate the offsite nature and extent of the plume; to potentially be used for long-term contaminant detection and monitoring, and monitoring of any future remediation efforts; and to provide data and information as to whether production of Pajarito Mesa #4 (PM-4) well is susceptible to contamination from the chromium plume.

2. Due to the cultural sensitivity of the area, it is our belief that SIMR-2 will be our one and only chance to detect any contaminants in the regional aquifer.

3. In light of the information provided by DOE/LANS and the New Mexico Environmental Department (NMED), the Pueblo supports the recommendation by NMED to amend the “well design” to add an extra 2 feet of transition sand from 876' to 878'. The extra sand will help alleviate the potential for sealant to migrate downward towards the screened interval.

4. The Pueblo approves the installation of a single-screen for the purpose of detecting contaminants in SIMR-2. However the Pueblo reserves the right to go to a dual screen system if the well is used for long-term monitoring. It is the Pueblo's understanding that the short-term objective of SIMR-2 is to determine whether there are contaminants and the level of those contaminants in the Pueblo's water. The Pueblo believes this can be achieved with the single screen system.

5. In the event, SIMR-2 is to be utilized for long-term monitoring and the intent is to check for a greater area of water depth and movement of the plume, the Pueblo reserves the option of the dual screen system for monitoring the cleanup efforts if it is determined that this would be better achieved by a duel screen system.

6. Prior to use of the injection well process, for any reason, the Pueblo shall be notified before further action.

Ms. Gelles, the Pueblo has been working diligently with the NMED, DOE, and LANL on well SIMR-2 so as to understand and respond to DOE/LANS about the impact of a well that could potentially detect contamination on it's land. Therefore, we request confirmation that DOE/LANS accepts the above conditions required for the Pueblo's **approval** of the "Proposed Well Design for Regional Aquifer Well SIMR-2" submitted by the Department of Energy, Environmental Projects Office, Los Alamos Field Office/NNSA (DOE LANS).

If there are any questions or concerns, please contact me at (505) 412-3974 as soon as possible so we can expedite the process.

Sincerely,

James R. Mountain
Governor
Pueblo de San Ildefonso

cc: Cabinet Secretary Ryan Flynn, NMED
Mr. Michael Dale, NMED
Mr. Pat Longmire, NMED

Attachment E-3

DOE Response and Pueblo de San Ildefonso Final Approval for SIMR-2 Well Design

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

JUL 14 2015

The Honorable James R. Mountain
Governor
Pueblo de San Ildefonso
02 Tunyo Po
Santa Fe, NM 87506

Subject: Response to Pueblo de San Ildefonso, July 12, 2015 letter regarding the Proposed Well Design for Regional Aquifer Well SIMR-2

Dear Governor Mountain:

Thank you for the quick review and response to the Department of Energy's (DOE) proposed design for regional aquifer well SIMR-2. We understand that the Pueblo agrees with the well design proposed by DOE via email at 3:26 p.m. July 11, 2015 and that the New Mexico Environment Department (NMED) approved the proposed design through an email sent at 6:54 p.m. July 12, 2015. Specifically, DOE proposed a single-screen well with a 20-foot stainless-steel, 40 slot, wire-wrapped well screen extending from 885 feet to 905 feet bgs. We further understand the Pueblo supports NMED's recommendation to add an additional two feet of 20/40 transition filter-pack sand from depths 876 feet to 878 feet bgs, which will be incorporated into the final well design.

The Pueblo asked that DOE confirm that it will accept two conditions the Pueblo proposes in its letter: 1) the Pueblo "reserves the right to go to a dual screen system if the well is used for long-term monitoring," and 2) "prior to use of the injection well process, for any reason, the Pueblo shall be notified before future action."

With regard to the first condition regarding modifying SIMR-2 to utilize a dual screen system in the event the well is to be used for long-term monitoring, please note that pursuant to the Limited Access Agreement, we have committed that SIMR-2 not be used for long-term monitoring. Should NMED require DOE to use SIMR-2 for long-term monitoring, DOE and the Pueblo would have to enter into a new agreement. Additionally, DOE must comply with NMED requirements. Regarding feasibility of a future modification of SIMR-2 to employ dual screens, we do not believe a future modification to dual screens is technically feasible without adversely impacting the existing well.

As DOE EM-LA staff explained to Mr. Terry Aguilar, during a phone conversation on July 13, 2015, the depth of the SIMR-2 borehole cannot be increased further as the drilling shoe and the bottom five feet of drill string have been cut off and remain at the bottom of the hole. This means that a dual screen well would have to be installed within the 113 feet of the aquifer currently penetrated. Therefore, there would only be 45 feet of separation between the proposed screen interval and a second, lower screen. The lower screen could be no longer than 10 feet and the well sump would have to be shortened to 10 feet as well. Additional risks in installing dual screens are the potential for cross contamination from the upper screen to the lower screen, potential issues with packer separation between the screened intervals, along with the time and money necessary for additional development and aquifer testing. Neither DOE nor the NMED require a dual screen well to meet the mission of the well as currently described. Additionally, DOE feels that the depth at which a second, deeper screen could be installed would not add benefit to a "long-term monitoring" effort related to overall plume remedy and therefore proposes to remain with a single screen well with the understanding that it would not be turned into a dual screen well at a later date.

With regard to the Pueblo's condition that it be notified prior to use of the injection well process, DOE would like to assure the Pueblo that there is no intent to change the purpose of SIMR-2 into an injection well. As presented to the Tribal Council on July 6, 2015, injection wells within DOE property have been identified and are being proposed as a measure to expedite the efficiency of halting potential offsite migration of the chromium plume. As presented, two of the six proposed injection wells are located near the boundary between Los Alamos National Laboratory and the Pueblo. As previously committed, DOE will continue to share information regarding the details of the Interim Measure and will notify the Pueblo prior to injection well operation. I would like to reiterate that the injection wells at the boundary are proposed as a means to expedite the halt of possible offsite migration of the chromium plume.

We are currently on stand-by status awaiting the Pueblo's confirmation of support for the well design, in light of DOE's response to the Pueblo's conditions. We respectively request your timely attention to this matter, as the longer the borehole remains open in the current state, the greater the risk of complications during the completion of the well.

If there are any questions or concerns, please contact me at (202) 213-2454 as soon as possible in order to expedite this process.

Sincerely,

Christine Gelles
Acting Manager
Environmental Management
Los Alamos Field Office

cc:
Ryan Flynn
Secretary
New Mexico Environment Department
P.O. Box 5469
Santa Fe, NM 87502-5469

Michael Dale
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Patrick Longmire
New Mexico Environment Department
Oversight Bureau, Los Alamos Field Office
P.O. Box 1663, MS-M894
Los Alamos, NM 87544

C. Rodriguez EM-LA
Records Center, EM-LA
Official Contract File, EM-LA

EPO-32CR-805-633735

From: Rodriguez, Cheryl L
Sent: Tuesday, July 14, 2015 6:31 PM
To: Everett, Mark Capen; Douglass, Craig R; Robinson, Bruce Alan; Swickley, Stephani Fuller; Katzman, Danny; Rhodes, David
Cc: Gelles, Christine
Subject: FW: SIMR2 Response to Well Design
Attachments: SIMR2_Response_Gelles_071415.pdf

Importance: High

Got the green light to move forward with SIMR-2. Of course with NMED modifications incorporated.

Regards,

Cheryl L. Rodriguez
Federal Project Director
NEW Environmental Management
NEW Los Alamos Field Office
3747 West Jemez Road, Rm. 116 (MS-A316)
Los Alamos, NM 87544
Office: (505) 665-5330
Cell: (505) 414-0450
Fax: (505) 606-2132
NEW email: cheryl.rodriguez@em.doe.gov

From: Terry Aguilar [mailto:terry@lawoffice-lh.com]
Sent: Tuesday, July 14, 2015 6:28 PM
To: Rodriguez, Cheryl
Subject: Fwd: SIMR2 Response to Well Design

---------- Forwarded message ----------
From: **James Mountain** <governor@sanipueblo.org>
Date: Tue, Jul 14, 2015 at 6:25 PM
Subject: Re: SIMR2 Response to Well Design
To: "Gelles, Christine" <Christine.Gelles@em.doe.gov>
Cc: "Carolyn J. Abeita" <cabeita@nmlawgroup.com>, Terry Aguilar <terry@lawoffice-lh.com>, "ryan.flynn@state.nm.us" <ryan.flynn@state.nm.us>, "Dale, Michael, NMENV" <Michael.Dale@state.nm.us>, Patrick Longmire <longmire@cybermesa.com>

From: James Mountain <governor@sanipueblo.org>
Date: Tuesday, July 14, 2015 at 6:22 PM
To: "Gelles, Christine" <Christine.Gelles@em.doe.gov>
Cc: "Carolyn J. Abeita" <cabeita@nmlawgroup.com>, Terry Aguilar <terry@lawoffice-lh.com>, "ryan.flynn@state.nm.us" <ryan.flynn@state.nm.us>, "Dale, Michael, NMENV" <Michael.Dale@state.nm.us>, Patrick Longmire <longmire@cybermesa.com>
Subject: SIMR2 Response to Well Design

Ms. Gelles,

Please find attached the Pueblo's response. If you have any questions, please contact me directly.

Good day,

--

Terry Aguilar,
Of Counsel
The Law Office of Lucero and Howard, LLC
PO Box 25391, Albuquerque, NM 87125
P: (505) 225-8778 F: (505) 288-3473
terry@lawoffice-lh.com
www.lawoffice-lh.com

Pueblo de San Ildefonso
Office of the Governor

July 13, 2015

Ms. Christine Gelles,
Los Alamos Site Manager
Environmental Management
Los Alamos Field Office
3747 West Jemez Road
Los Alamos, NM 87544

Dear Ms. Gelles:

The Pueblo de San Ildefonso is in receipt of the "Response to Pueblo's July 12, 2015 letter regarding the Proposed Well Design for Regional Aquifer Well SIMR-2" on July 13, 2015 at 11:50 a.m. The Pueblo de San Ildefonso (Pueblo) hereby approves the "Proposed Well Design for Regional Aquifer Well SIMR-2" based on your response to Governor Mountain's letter on July 12, 2015.

The Pueblo appreciates your response to our questions and concerns regarding Well SIMR-2, especially on the impact of a well that could potentially detect contamination on Pueblo land and it's impact to the Pueblo de San Ildefonso in general.

If there are any questions or concerns, please contact me at (505) 412-3974.

Sincerely,

James R. Mountain

James R. Mountain
Governor
Pueblo de San Ildefonso

cc: Cabinet Secretary Ryan Flynn, NMED
Mr. Michael Dale, NMED
Mr. Patrick Longmire, NMED

02 Tunyo Po · Santa Fe, NM 87506 · (505) 455-2273 · (505) 455-7351 Fax

Appendix F

Well SIMR-2 Aquifer Testing Report

F-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of pumping tests conducted during August and September 2015 at well SIMR-2, a regional aquifer well located on Pueblo de San Ildefonso property in a small tributary to Mortandad Canyon. The tests on SIMR-2 were conducted to characterize the saturated materials, quantify the hydraulic properties of the screened interval, and evaluate the hydraulic connection between SIMR-2 and other R-wells in the vicinity. Testing consisted of brief trial pumping, background water-level data collection, and several longer-term pumping tests.

Initially, plans called for performing brief trial tests followed by a 24-h constant-rate test beginning on August 21. However, 9.5 h into the 24-h test, the pump was shut down and the test was aborted because pumped water was found to be leaking from one of the on-site storage tanks. The decision was made to replace the tanks, redesign the spill-containment system, and rerun the pumping test, this time with a 72-h test starting on September 2, 2015. Just over 18 h into the attempted 72-h test, the pump motor failed, necessitating terminating the test and replacing the motor. Subsequently, a third test having a duration of 72 h was performed beginning on September 8. The start of the final test was delayed for 3 h when the on-site electric generator was found to be defective and had to be replaced. Data from all of the tests were retained for analysis.

As in most of the R-well pumping tests conducted on the Pajarito Plateau, an inflatable packer system was installed in SIMR-2 to eliminate casing storage effects on the test data. This setup was effective and produced good data.

Conceptual Hydrogeology

SIMR-2 is completed within Puye deposits. The well screen is 20.4 ft long, extending from 885 to 905.4 ft below ground surface (bgs). The static water level measured on August 18, 2015, before testing, was 870.36 ft below the top of the 5-in. stainless-steel casing. The casing elevation was 6704.89 ft above mean sea level (amsl), making the groundwater elevation 5834.53 ft amsl. The aluminum survey marker elevation at the well was surveyed at 6702.30 ft amsl, placing the water level 867.77 ft below the aluminum survey marker.

Puye sediments extended from above the static water level to a depth of at least 981.4 ft bgs where the pilot hole was terminated during drilling. The presence of the water table within the permeable Puye sediments implied locally unconfined conditions.

SIMR-2 Testing

SIMR-2 was tested from August 18 to September 14, 2015. On August 18, the pump was installed and operated long enough to fill the drop pipe to prepare for brief trial tests the following morning.

Trial testing of SIMR-2 (trial 1) began at 8:00 a.m. on August 19 at a discharge rate of 23.6 gallons per minute (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 23.7 gpm. Following shutdown, recovery/background data were recorded for 2760 min until the start of the attempted 24-h pumping test.

Following background data collection, the 24-h pumping test (test 1) began at 8:00 a.m. on August 21, at a discharge rate of 23.9 gpm. Pumping continued for 570 min until 5:30 p.m. when the pump was shut down, and the test was aborted because of a slow leak from one of the on-site water storage tanks. Following shutdown, recovery data were recorded for 3759 min until 8:09 a.m. on August 24 when the preprogrammed transducer timed out.

Of note was that each of the pumping tests exhibited slightly different discharge rates, even though all tests were conducted under identical head conditions with the discharge valve wide open. The pumped water was slightly aerated—either an artifact of compressed air introduced into the aquifer during well drilling or, possibly, because of naturally occurring gas in the formation. Varying gas content resulted in different pumping rates from one test to another and slightly varying rates during each of the tests.

Following the terminated pumping test attempt, a 72-h test was scheduled (test 2). Pumping began at 8:00 a.m. on September 2 at a discharge rate of 23.1 gpm. At approximately 2:05 a.m. on September 3, after 1085 min of pumping, the pump motor failed and pumping ceased. Recovery data were collected for 330 min until 7:35 a.m. when pulling operations began for pump removal and motor replacement.

The 72-h pumping test (test 3) was rescheduled for 8:00 a.m. on September 8. In anticipation of this schedule, the downhole pressure transducer was programmed to collect dense data at around 8:00 a.m. on September 8 and again at 8:00 a.m. on September 11, when shutdown was scheduled, to provide snapshots of very early pumping and recovery data, as was done during the previous tests. However, shortly before the scheduled starting time on September 8, the electric generator was found to be defective. Replacing the generator delayed the starting time until 11:00 a.m. and dictated subsequent pump shutoff at 11:00 a.m. on September 11, threatening the loss of valuable dense data collection. To retain this benefit, a brief shutdown and restart (trial 3) was performed at 8:00 a.m. on September 11. Pumping began at a discharge rate of 23.6 gpm at 11:00 a.m. on September 8 and continued for 72 h, except for the short, planned interruption. To take advantage the preprogrammed dense data collection protocol on the morning of September 11, the pump was shut down briefly at 8:00 a.m. and restarted 5 min later at 8:05 a.m. (trial 3). Pumping then was resumed until shutdown at 11:00 a.m. Following shutdown, recovery data were recorded for 4195 min until 8:55 a.m. on September 14 when pump removal operations began.

F-2.0 BACKGROUND DATA

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

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

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

Subsequent pumping tests, including SIMR-2, have utilized nonvented transducers. These devices simply record the total pressure on the transducer, that is, the sum of the water height plus the barometric pressure. This results in an attenuated “apparent” hydrograph in a barometrically efficient well. Take as an example a 90% barometrically efficient well. When monitored using a vented transducer, an increase in barometric pressure of 1 unit causes a decrease in recorded downhole pressure of 0.9 unit because the water level is forced downward 0.9 unit by the barometric pressure change. However, using a nonvented transducer, the total measured pressure increases by 0.1 unit (the combination of the barometric pressure increase and the water-level decrease). Thus, the resulting apparent hydrograph changes by a factor of 100 minus the barometric efficiency and in the same direction as the barometric pressure change rather than in the opposite direction.

Barometric pressure data were obtained from Technical Area 54 (TA-54) tower site from the Environmental Protection Division–Environmental Compliance Programs (ENV-CP). The TA-54 measurement location is at an elevation of 6548 ft amsl, whereas the wellhead aluminum survey marker elevation is at 6702.3 ft amsl. The static water level in SIMR-2 was 867.77 ft below the aluminum survey marker, making the water-table elevation 5834.53 ft amsl. Therefore, the measured barometric pressure data from TA-54 had to be adjusted to reflect the pressure at the elevation of the water table within SIMR-2.

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

$$P_{WT} = P_{TA54} \exp\left[-\frac{g}{3.281R} \left(\frac{E_{SIMR-2} - E_{TA54}}{T_{TA54}} + \frac{E_{WT} - E_{SIMR-2}}{T_{WELL}} \right) \right] \qquad \textbf{Equation F-1}$$

Where, P_{WT} = barometric pressure at the water table inside SIMR-2

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

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

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

E_{SIMR-2} = aluminum survey marker elevation at SIMR-2 site, in feet (6702.3 ft)

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

E_{WT} = elevation of the water level in SIMR-2, in feet (5834.53 ft)

T_{TA54} = air temperature near TA-54, in degrees Kelvin (assigned a value of 68.5 degrees Fahrenheit, or 293.5 degrees Kelvin)

T_{WELL} = air column temperature inside SIMR-2, in degrees Kelvin (assigned a value of 66.1 degrees Fahrenheit, or 292.1 degrees Kelvin)

This formula is an adaptation of an equation ENV-CP 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 to the water-level hydrograph to discern the correlation between the two and determine whether water level corrections would be needed prior to data analysis.

F-3.0 IMPORTANCE OF EARLY DATA

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

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

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

Equation F-2

Where, t_c = duration of casing storage effect, in minutes

D = inside diameter of well casing, in inches

d = outside diameter of column pipe, in inches

Q = discharge rate, in gallons per minute

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

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

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

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

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

In some instances, it is possible to eliminate casing storage effects by setting an inflatable packer above the tested screen interval before conducting the test. This was done successfully in the testing performed on SIMR-2.

F-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 F-4**

where,

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

and

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

and where, s = drawdown, in feet

Q = discharge rate, in gallons per minute

T = transmissivity, in gallons per day per foot

S = storage coefficient (dimensionless)

t = pumping time, in days

r = distance from center of pumpage, in feet

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

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

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

where, T = transmissivity, in gallons per day per foot
S = storage coefficient
Q = discharge rate, in gallons per minute
$W(u)$ = match-point value
s = match-point value, in feet
u = match-point value
t = match-point value, in minutes

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

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

Equation F-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 F-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 F-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 F-12**

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

F-5.0 RECOVERY METHODS

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

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

$$T = \frac{264Q}{\Delta s}$$ **Equation F-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.

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

F-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 computation algorithm that includes the effects of partial penetration. One such approach was introduced by Brons and Marting (1961, 098235) and augmented by Bradbury and Rothchild (1985, 098234).

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

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

Equation F-14

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

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

Equation F-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. For SIMR-2, the test data and well log suggested unconfined conditions, so calculations were performed for an assigned storage coefficient range of 0.01 to 0.2. The lower-bound transmissivity calculation result is not particularly sensitive to the choice of storage coefficient value, so a rough estimate is generally adequate to support the calculations.

The analysis also requires assigning a value for the saturated aquifer thickness, b. For SIMR-2, b was assigned a value of 74 ft, the saturated thickness of Puye Formation penetrated by the borehole before backfilling and well completion. The 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.

F-7.0 BACKGROUND DATA ANALYSIS

Background aquifer pressure data collected during the SIMR-2 tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure F-7.0-1 shows aquifer pressure data from SIMR-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 SIMR-2 data are referred to in the figure as the “apparent hydrograph” because the measurements reflect the sum of water pressure and barometric pressure, having been recorded using a nonvented pressure transducer. The times of the pumping test periods for the SIMR-2 pumping tests are included on the figure for reference. Also shown are the pumping times for Los Alamos County municipal production well PM-4, located approximately 0.8 mi west-southwest of SIMR-2. The pumping record for PM-4 was included because previous pumping tests on nearby Mortandad Canyon R-wells have shown that local water levels respond fairly rapidly to pumping at PM-4.

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 negligible change in the apparent hydrograph, meaning the changes in water level were equal to and opposite of changes in barometric pressure. Expanded-scale plots of apparent hydrograph data from each of the three pumping tests (test 1, test 2 and test 3) are shown in Figures F-7.0-2, F-7.0-3, and F-7.0-4, respectively. Inspection of these plots confirms a barometric efficiency in SIMR-2 of essentially 100%.

The most noticeable feature of the apparent hydrograph data in Figure F-7.0-1 is that water levels showed the effects of operation of well PM-4. The background data showed a flat response from August 18 to 20, 2015, while PM-4 was shut down, followed by a steady decline once PM-4 resumed pumping on August 20. From September 4 to 15 (times leading up to, and following, the 72-h pumping test [test 3]), the drawdown effect of PM-4 operation was nearly linear, averaging approximately 0.0066 ft/d decline in head.

An apparent anomaly shown in Figure F-7.0-2 (test 1) was a “step” in the apparent hydrograph at 11:42 a.m. on August 23. This irregularity coincided with a single elevated data point visible on the plot located approximately 0.2 ft above the rest of the hydrograph. These data were plotted on the expanded scale shown in Figure F-7.0-5. The elevated water level was caused by deflating the downhole packer and releasing water trapped in the annulus above the packer between the 5-in. well casing and the 2-in. drop pipe. The presence of water was an indication of leakage through the threaded joints in the drop pipe during the project. Even though the measured buildup was only 0.2 ft, the sudden buildup that occurred at the instant of packer deflation could have been many tens of feet. The high specific capacity of SIMR-2 would have allowed dissipation of a large quantity of water in a matter of seconds. Because drawdown data were collected at 1-min intervals, a large head buildup likely would have gone undetected.

The step down in the hydrograph happened immediately following packer deflation and was probably an elastic effect of some sort. Although its cause is not known for certain, a possible explanation is that the warm drop pipe installed in the well cooled significantly from contact with groundwater once pumping began, placing the drop pipe string in tension. When the packer was deflated, the tension was released, allowing the pipe to contract. This would have had the effect of raising the transducer slightly and reducing the measured height of water above the transducer. Regardless of the cause, the step in the hydrograph on Figure F-7.0-2 did not indicate an actual change in water level.

Hydrograph data from several nearby R-wells were examined to look for possible response to pumping SIMR-2. Data from all wells within half a mile of SIMR-2 were collected for analysis. These included R-13, R-28, R-44 screens 1 and 2, R-45 screens 1 and 2, and R-50 screens 1 and 2.

Figure F-7.0-6 shows hydrograph data from R-13 for the period from September 4 to 16—the period leading up to the successful 72-h pumping test on SIMR-2, the test period itself, and the subsequent recovery period. The barometric pressure is included on the plot for comparison to the hydrograph. Note that the barometric pressure scale on the graph is reversed, with pressure increasing downward. In addition, the pumping period corresponding to the 72-h test is included for reference.

The hydrograph and barometric pressure curves appeared similar because the water levels were measured using a vented, rather than nonvented, transducer. The only differences between the curves were that (1) the amplitudes of the peaks in the hydrograph were slightly less than those of the barometric pressure curve, and (2) there was a steady, gradual decline in the hydrograph, presumably a response to operation of PM-4.

To refine the comparison of the two curves, both the hydrograph and barometric pressure curves were modified. The barometric pressure data were corrected for the barometric efficiency of the well and the hydrograph data were adjusted for a linear trend associated with operation of PM-4. The barometric efficiency and linear trend were varied repeatedly and the resulting curves were compared. The best fit obtained from this procedure is shown in Figure F-7.0-7 suggesting a barometric efficiency of 92% and a drawdown effect of 0.0062 ft/d from operation of PM-4.

As indicated in the figure, agreement between the two curves was good. However, the hydrograph showed a discernible departure from the barometric pressure curve during the SIMR-2 pumping test. It appeared that the pumping test induced a drawdown of approximately 0.01 to 0.02 ft in R-13.

Figure F-7.0-8 shows a similar comparison of adjusted water levels and barometric pressure data for R-28. The PM-4 effect required to provide the match shown on the figure was 0.004 ft/d. No adjustment in the barometric pressure curve was needed, indicating a barometric efficiency of essentially 100%. The data showed no discernible drawdown in R-28 as a result of the SIMR-2 pumping test.

Figure F-7.0-9 shows a comparison of water levels in R-44 screen 1 adjusted for a PM-4 drawdown effect of 0.0064 ft/d and a barometric efficiency of 94%. The data showed a distinct drawdown in R-44 screen 1 of 0.01 to 0.02 ft in response to pumping SIMR-2.

Figure F-7.0-10 shows data from R-44 screen 2 adjusted for a PM-4 drawdown effect of 0.0062 ft/d and a barometric efficiency of 88%. The plot suggested a drawdown in R-44 screen 2 of approximately 0.03 to 0.04 ft caused by test pumping SIMR-2.

Figure F-7.0-11 shows data from R-45 screen 1 with no adjustments in either the hydrograph or barometric pressure curve. The good match between the two curves implied a barometric efficiency of essentially 100% and no effect from operation of PM-4. In addition, there appeared to be no discernible effect from the SIMR-2 pumping test.

The plot in Figure F-7.0-11 suggested hydrograph fluctuation amplitudes *greater than* the changes in the barometric pressure—ostensibly impossible because it would imply a barometric efficiency greater than 100%. However, the expanded-scale plot on Figure F-7.0-12, showing a portion of the record, indicated that the two data sets matched very well with just an occasional, random water level plotting slightly above or below the trend. It is probable the data discrepancies were a function of minor erratic transducer output.

Figure F-7.0-13 shows data from R-45 screen 2 with no adjustments in either the hydrograph or barometric pressure curve. Examination of the plot suggested that erroneous water level data were obtained from screen 2. Previous testing has shown that the barometric efficiency of screen 2 is nearly 100% meaning that the hydrograph fluctuations should have the same magnitude as the barometric pressure fluctuations. That is, the hydrograph in Figure F-7.0-13 should look the same as the screen 1 hydrograph in Figure F-7.0-11. Indeed, when R-45 was put into service in 2009, the magnitudes of the temporal water-level changes in screen 2 were the same as those in screen 1.

Figure F-7.0-14 shows a comparison of the water levels in R-45 screen 1 and screen 2. The smaller amplitude of the screen 2 fluctuations confirmed that the data were not accurate. When barometric pressure was low and water levels in both screens were at their highest, the screen 2 level was approximately 0.1 ft lower than the screen 1 level, typical of conditions previously observed in R-45 during the municipal well pumping season. This suggested that the water level peaks in the screen 2 record may have been approximately correct. However, when the barometric pressure increased, driving water levels in the screen zones downward, the level recorded in the screen 2 transducer tube had the appearance of declining sluggishly compared with the likely actual head changes within the aquifer.

Possible causes of the data inaccuracies seen in R-45 screen 2 include (1) a damaged/partially clogged transducer cable vent tube, and (2) a partially clogged .25-in. water level pass-through tube connecting the screen 2 aquifer zone to the 2-in. polyvinyl chloride (PVC) screen 2 transducer tube.

Figure F-7.0-15 shows a comparison of water levels in R-50 screen 1 adjusted for a PM-4 drawdown effect of 0.0064 ft/d but with no adjustment for barometric efficiency (implying a barometric efficiency near 100%). The data showed the possibility of just a hint of response to the SIMR-2 pumping test, although it was not conclusive.

Figure F-7.0-16 shows data from R-50 screen 2 adjusted for a PM-4 drawdown effect of 0.007 ft/d and a barometric efficiency of 96%. The plot suggested a drawdown in R-44 screen 2 of approximately 0.02 to 0.03 ft caused by test pumping SIMR-2.

The three R-wells closest to SIMR-2 were R-13, R-44, and R-50 located approximately 1200 to 1600 ft away. Drawdown responses to SIMR-2 pumping were observed in all of the screen zones in these wells, with the possible exception of R-50 screen 1 where the data were inconclusive. The two more distant wells—R-28 and R-45, located approximately 2200 to 2500 ft away—showed no discernible response to the SIMR-2 pumping test.

The data suggested good hydraulic connection between the saturated permeable sediments on Pueblo de San Ildefonso property and those beneath the Laboratory. The observed drawdown responses were similar in magnitude to interwell responses measured during individual pumping tests on R-28, R-44, and R-45 some years ago.

F-8.0 WELL SIMR-2 DATA ANALYSIS

This section presents the data obtained from the SIMR-2 pumping tests and the results of the analytical interpretations. Data are presented for trial 1, trial 2, test 1, test 2, test 3 and trial 3.

F-8.1 Well SIMR-2 Trial 1

Brief trial testing was performed to obtain “snapshots” of early pumping and recovery response to try to quantify properties of the subsurface materials immediately around the wellbore.

Figure F-8.1-1 shows a semilog plot of the drawdown data collected from trial 1 on SIMR-2 at a discharge rate of 23.6 gpm. The transmissivity determined from the line of fit on the graph was 12,900 gallons per day per foot (gpd/ft). Based on the well screen length of 20.4 ft, this implied an average hydraulic conductivity value of 632 gpd/ft^2, or 85 ft/d.

This transmissivity calculation was based on data limited to the first minute or two of pumping. Subsequent data showed a distinct flattening of the curve associated with vertical expansion of the cone of depression around the partially penetrating well screen. In addition to partial penetration effects, the flattening of the drawdown slope could include a delayed yield component as well.

Limitations of the early data must be borne in mind when evaluating the calculations. Several variables can alter the data pattern from theoretical predictions, as follows:

1. In highly permeable zones, such as this one, inertial effects can influence data observed in the first few seconds of pumping and recovery.
2. Aerated groundwater, as occurs here, can allow a minor quantity of gas/air to accumulate in the well casing beneath the downhole inflatable packer or within the filter pack in the annulus above the well screen just under the bentonite seal. A small amount of trapped gas can expand/contract during pumping/recovery and cause a minor casing storage like effect on the earliest pumping and recovery data.
3. Leaky couplings in the drop pipe string can allow a small amount of water to drain out before pumping, creating empty space (a vacuum) beneath the nearest overlying check valve. The effect would be reduced head momentarily on pump startup and a brief, slightly elevated discharge rate.
4. Dissolved gas in the formation can come out of solution in response to rapid drawdown when the pump starts. Also, gas already in the pore spaces will expand in response to pressure reduction associated with drawdown. Temporal changes in the gas volume content in the pore spaces in the formation can cause transient changes in the hydraulic conductivity, resulting in drawdown patterns that differ from theoretical predictions.

Because of these phenomena, some of the data points can fail to fit the straight line or type curve used in the analysis, creating a measure of uncertainty in the calculated aquifer parameters.

Figure F-8.1-2 shows the recovery data obtained from trial 1. The transmissivity determined from the line of fit on the graph was 12,700 gpd/ft, implying an average hydraulic conductivity value of 623 gpd/ft^2, or 83 ft/d

F-8.2 Well SIMR-2 Trial 2

Figure F-8.2-1 shows a semilog plot of the drawdown data collected from trial 2 on SIMR-2 at a discharge rate of 23.7 gpm. The transmissivity value determined from the analysis was 13,900 gpd/ft, corresponding to a hydraulic conductivity value of 681 gpd/ft^2, or 91 ft/d. Note that the very early data showed some scatter, perhaps related to the limitations described in section F-8.1. The late data showed the expected flattening.

Figure F-8.2-2 shows recovery data recorded for 2760 min following cessation of pumping. The transmissivity determined from the slope of the graph was 14,400 gpd/ft corresponding to a hydraulic conductivity value of 706 gpd/ft^2, or 94 ft/d.

As indicated on the plot, the very early data fell off the line of fit, possibly an indication that the u value was greater than 0.05. To check this, Theis curve matching was used to verify the analysis.
Figure F-8.2-3 shows the resulting plot of recovery versus time since pumping stopped. The resulting curve match yielded an estimated transmissivity of 14,300 gpd/ft, corresponding to a hydraulic conductivity value of 701 gpd/ft^2, or 94 ft/d, in agreement with the semilog analysis. The early data points still fell off the line of fit, possibly as a result of the limitations discussed above.

F-8.3 Well SIMR-2 Test 1

Figure F-8.3-1 shows a semilog plot of the drawdown data collected from test 1—the attempt to run a 24-h test—at a discharge rate of 23.9 gpm. The slow leak from the on-site storage tank forced a premature shutdown of this test, limiting the pumping time to 570 min. The transmissivity value determined from the analysis was 14,200 gpd/ft, corresponding to a hydraulic conductivity value of 696 gpd/ft^2, or 93 ft/d. Note that the very early data showed some scatter, while the late data showed the expected flattening.

Figure F-8.3-2 shows recovery data recorded for 3759 min following cessation of pumping. The transmissivity determined from the line of it on the graph was 15,000 gpd/ft, corresponding to a hydraulic conductivity value of 735 gpd/ft^2, or 98 ft/d.

The late recovery data showed a decline in water levels, a response to operation of PM-4.

F-8.4 Well SIMR-2 Test 2

Figure F-8.4-1 shows a semilog plot of the drawdown data collected from test 2 at a discharge rate of 23.1 gpm. Plans called for performing a 72-h test, but the pump motor failed 1085 min into the test forcing an early termination. The transmissivity value determined from the analysis was 13,800 gpd/ft, corresponding to a hydraulic conductivity value of 676 gpd/ft^2, or 90 ft/d.

Figure F-8.4-2 shows recovery data recorded for 330 min following cessation of pumping. The data are included here for completeness but may not support a reliable analysis. The exact time of the pump motor failure was not known and could not be ascertained accurately, making it impossible to determine reliable values for the time since pumping stopped, *t'*. The plot shown on the figure was generated by making a rough estimate of the stopping time based on recovery rates and times observed in the other tests. Another unknown was whether the pump stopped instantaneously or if it operated erratically briefly before stopping completely.

The transmissivity determined from the line of it on the graph was 12,100 gpd/ft, corresponding to a hydraulic conductivity value of 593 gpd/ft^2, or 79 ft/d. While these results were of the same order of magnitude as previous values, they should not be considered as reliable as the other results.

F-8.5 Well SIMR-2 Test 3

Figure F-8.5-1 shows a semilog plot of the drawdown data collected from test 3—the successful 72-h test—at a discharge rate of 23.6 gpm. The transmissivity value determined from the analysis was 11,000 gpd/ft, corresponding to a hydraulic conductivity value of 539 gpd/ft^2, or 72 ft/d. The flattening of the curve after the first few minutes of pumping reflects vertical growth of the cone of depression and possibly a delayed yield effect. The spike in water level at the end of the data set represents the brief trial 3 shutdown and restart.

Figure F-8.5-2 shows an expanded-scale plot of the late data from the 72-h pumping test. The line of fit shown on the graph yielded a transmissivity value of 94,000 gpd/ft. This may be a realistic estimate of the transmissivity of the aquifer in the general area. It is also possible this slope could be affected by various phenomena such as continuing delayed yield or varying gas content in the formation pores.

The data in Figure F-8.5-2 showed a great deal of scatter. To clean up the presentation, a half-hour rolling average plot was generated as shown in Figure F-8.5-3. This graph shows more clearly the leveling off of water levels after more than a day of pumping followed by a small rise in level over the final day of pumping. These effects could not be readily explained. It was possible that a small gradual reduction in gas content in the aquifer pores near the borehole, along with a corresponding permeability increase, was the cause.

Figure F-8.5-4 shows recovery data recorded for 4195 min following cessation of pumping. The transmissivity determined from the line of fit on the graph was 14,200 gpd/ft corresponding to a hydraulic conductivity value of 696 gpd/ft^2, or 93 ft/d. The late recovery data showed a flattening associated with vertical growth of the cone of impression and possible delayed yield. Furthermore, the water level trend showed reversal over the final day of recovery in response to operation of PM-4.

F-8.6 Well SIMR-2 Trial 3

At 8:00 a.m. on September 11, 2015, 3 h before the 72-h test was shut down, a temporary (5-min) shutdown was performed to obtain early recovery and restart data (trial 3).

Figure F-8.6-1 shows a semilog plot of the recovery data collected from trial 3 immediately after shutdown. The transmissivity value determined from the analysis was 14,900 gpd/ft, corresponding to a hydraulic conductivity value of 730 gpd/ft^2, or 98 ft/d.

Figure F-8.6-2 shows drawdown data recorded during the first few minutes following restart. The transmissivity determined from the slope of the graph was 15,000 gpd/ft corresponding to a hydraulic conductivity value of 735 gpd/ft^2, or 98 ft/d.

F-8.7 Combined Results

Table F-8.7-1 summarizes the results of the analyses determining the hydraulic properties of the screened zone in SIMR-2. The value obtained from the test 2 recovery was omitted from the summary because the results were not considered reliable, as discussed in section F-8.4. Transmissivity values ranged from 11,000 to 15,000 gpd/ft, averaging 13,860 gpd/ft. The resulting hydraulic conductivity values ranged from 72 to 98 ft/d, averaging 91 ft/d.

F-8.8 Well SIMR-2 Specific Capacity Data

Specific capacity data were used along with well geometry to estimate a lower-bound hydraulic conductivity value for the permeable zone penetrated by SIMR-2 to provide a frame of reference for evaluating the above analyses.

The total saturated thickness of Puye sediments was not known. In applying partial penetration analysis, however, it is only necessary to assign an aquifer thickness substantially greater than the well screen length because sediments far from the screened interval have a negligible effect on yield. The aquifer thickness was arbitrarily assigned a value of 74 ft—the length of saturated sediments penetrated during drilling of the borehole. The well screen length of 20.4 ft was used in the partial penetration calculations.

SIMR-2 produced 23.6 gpm with 1.8 ft of drawdown for a specific capacity of 13.1 gpm/ft after the first 1440 min of pumping during the 72-h test. In addition to specific capacity and pumping time, other input values used in the calculations included assigned storage coefficient values ranging from 0.01 to 0.2 and a borehole radius of 0.58 ft (inferred from the volume of filter pack required to backfill the screen zone).

Applying the Brons and Marting method to these inputs yielded the lower-bound hydraulic conductivity estimates shown in Figure F-8.8-1. Depending on the assumed storage coefficient value, the calculated lower-bound hydraulic conductivity values ranged from approximately 78 to 86 ft/d. This was consistent with the values obtained from test analysis which produced an average hydraulic conductivity value of 91 ft/d and suggested a fairly efficient well.

F-9.0 SUMMARY

Constant-rate pumping tests were conducted on SIMR-2 to gain an understanding of the hydraulic characteristics of the aquifer. Three extended tests (test 1, test 2, and test 3) were conducted. Test 1 was shut down prematurely when a slow leak was discovered in the on-site storage tank, limiting the duration to 570 min. During test 2, the pump motor failed after 1085 min of pumping. Finally, test 3 was performed successfully for 72 h. In addition, three short-duration trial tests (trial 1, trial 2, and trial 3) were conducted to obtain very early pumping and recovery response data.

Several important observations and conclusions from the test pumping include the following:

1. A comparison of barometric pressure and SIMR-2 water level data showed a highly barometrically efficient screen zone. Large changes in barometric pressure caused almost no change in the apparent hydrograph from the well, obtained using a non-vented transducer.
2. Early data supported a determination of aquifer properties while late data showed a flattening of the time-drawdown and recovery graphs consistent with vertical expansion of the cone of depression and/or delayed yield effects associated with unconfined aquifer conditions. Transmissivity values for the screened interval determined from the analyses ranged from 11,000 to 15,000 gpd/ft, averaging 13,860 gpd/ft. The corresponding hydraulic conductivity values ranged from 72 to 98 ft/d, averaging 91 ft/d.
3. Intermediate to late data from the 72-h pumping test suggested a transmissivity of the upper granular aquifer of 94,000 gpd/ft. This value was consistent with the large hydraulic conductivity value obtained for the screened interval and the known upper aquifer thickness in the general area ranging typically between 100 and 200 ft.
4. Wells nearest SIMR-2 showed responses to pumping ranging from 0.01 to 0.04 ft. These wells included R-13, R-44, and R-50, located from approximately from 1200 to 1600 ft away. This result implied good hydraulic continuity between aquifer sediments beneath Pueblo de San Ildefonso and those at the Laboratory.
5. More distant wells R-28 and R-45, approximately 2200 to 2500 ft away, showed no measurable drawdown response to pumping.
6. Most of the monitored wells, including SIMR-2, showed a drawdown response to operation of Los Alamos County well PM-4.
7. The specific capacity of SIMR-2 implied lower-bound hydraulic conductivity values in the range of 78 to 86 ft/d, consistent with the results of the hydraulic analyses (91 ft/d average) and suggested a fairly efficient screen zone in SIMR-2.
8. The transducer in R-45 screen 2 produced erroneous data, showing apparently sluggish response to water level changes. This effect can be explained by either (1) a damaged or partially clogged transducer cable vent tube, or (2) a clogged .25-in. pass-through tube connecting the screen 2 aquifer zone to the 2-in. PVC screen 2 transducer tube.

F-10.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

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

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

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

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

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

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

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

Kruseman, G. P. and N. A. de Ridder, 1991. “Analysis and Evaluation of Pumping Test Data” International Institute for Land Reclamation and Improvement, The Netherlands.

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)

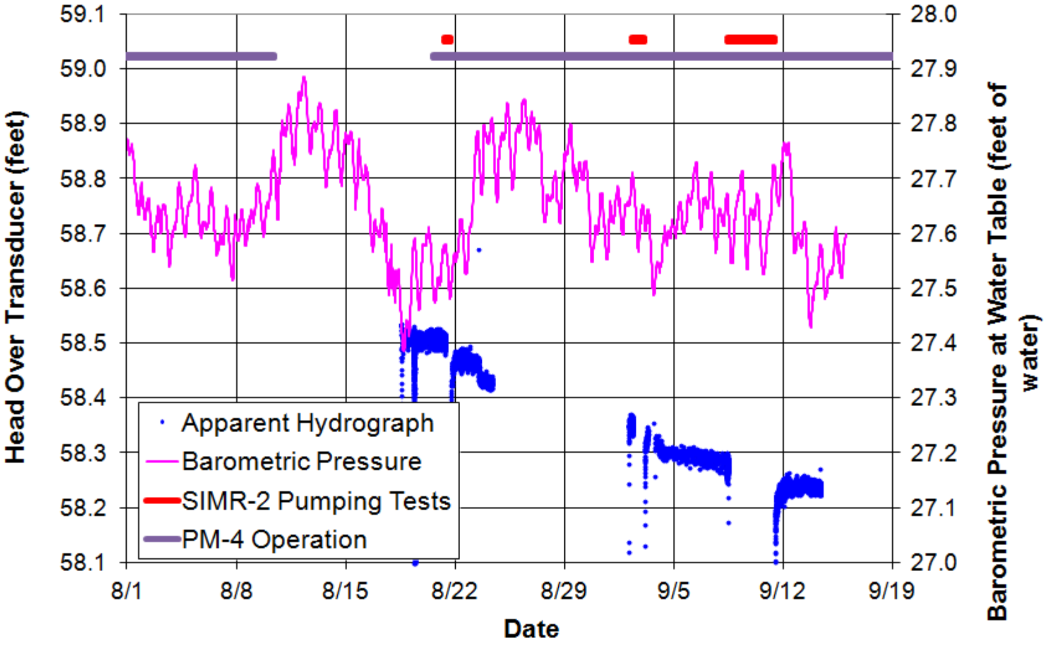


Figure F-7.0-1 Well SIMR-2 apparent hydrograph—all tests

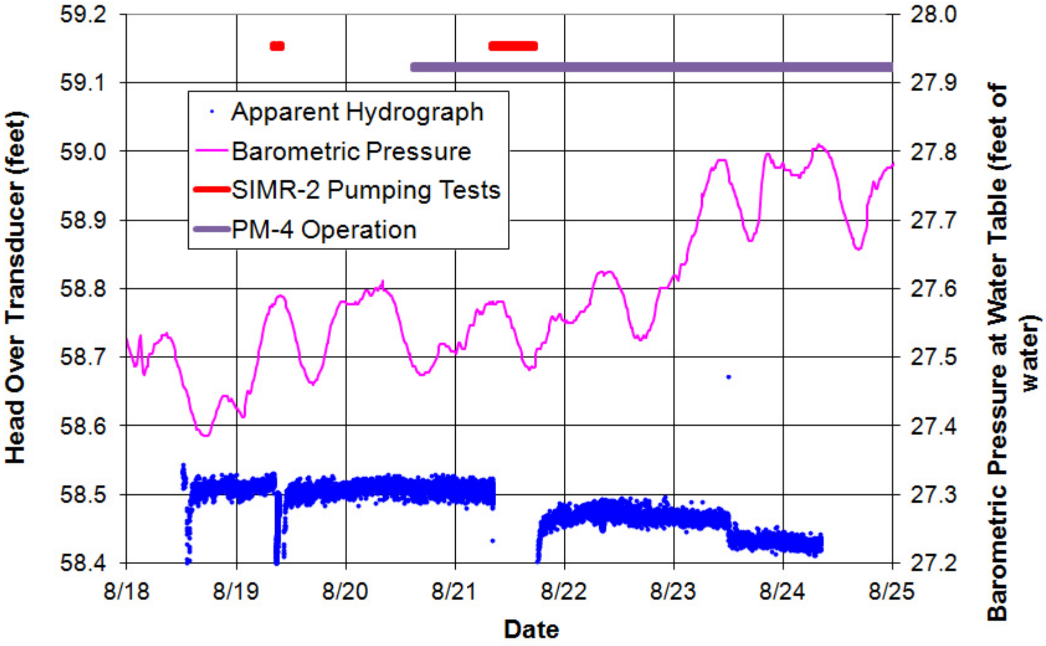


Figure F-7.0-2 Well SIMR-2 apparent hydrograph—test 1 expanded scale

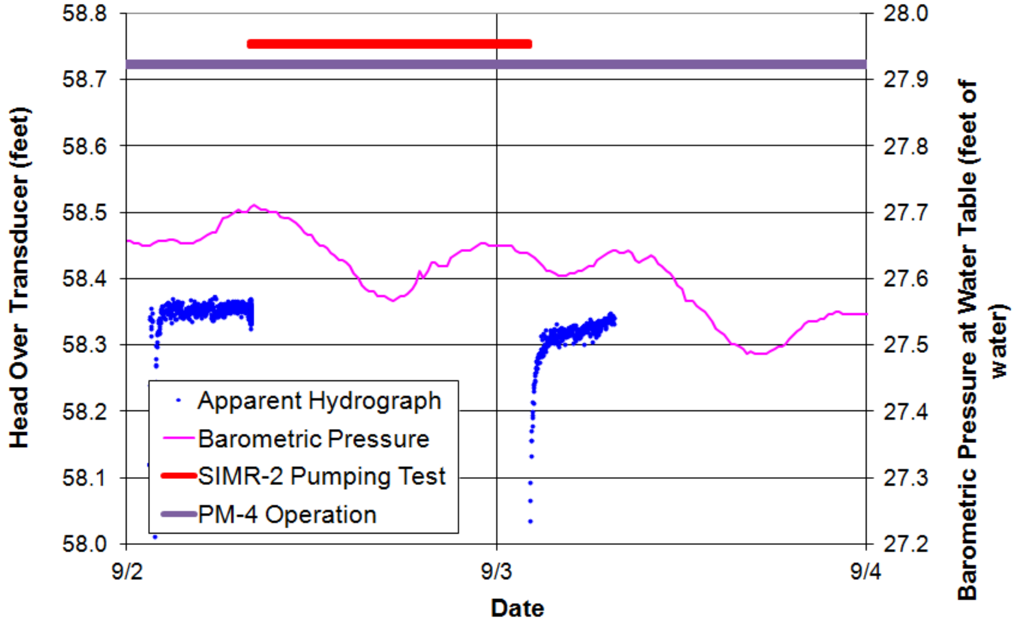


Figure F-7.0-3 Well SIMR-2 apparent hydrograph—test 2 expanded scale

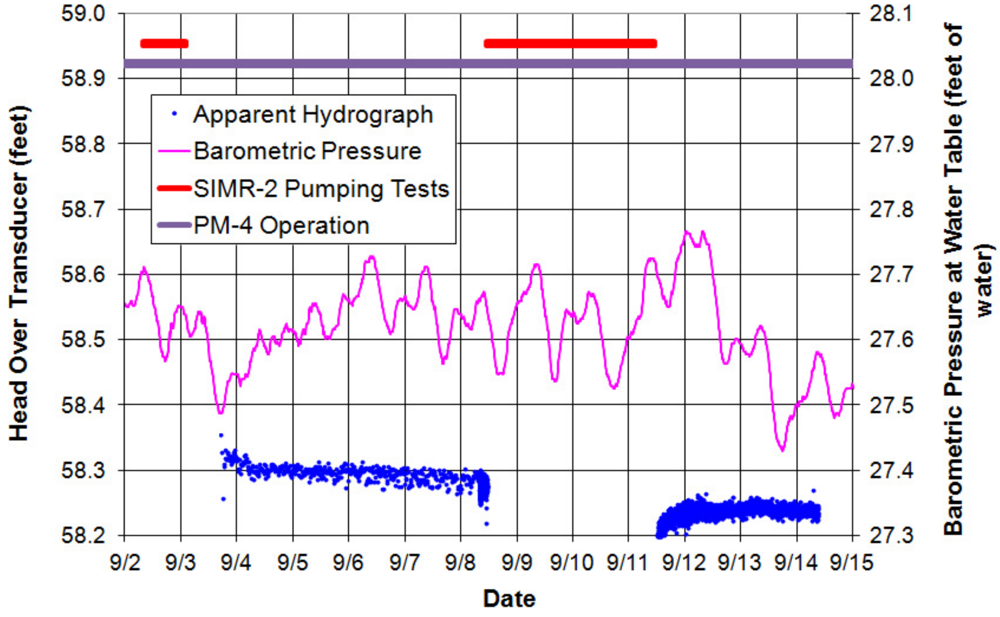


Figure F-7.0-4 Well SIMR-2 apparent hydrograph—test 3 expanded scale

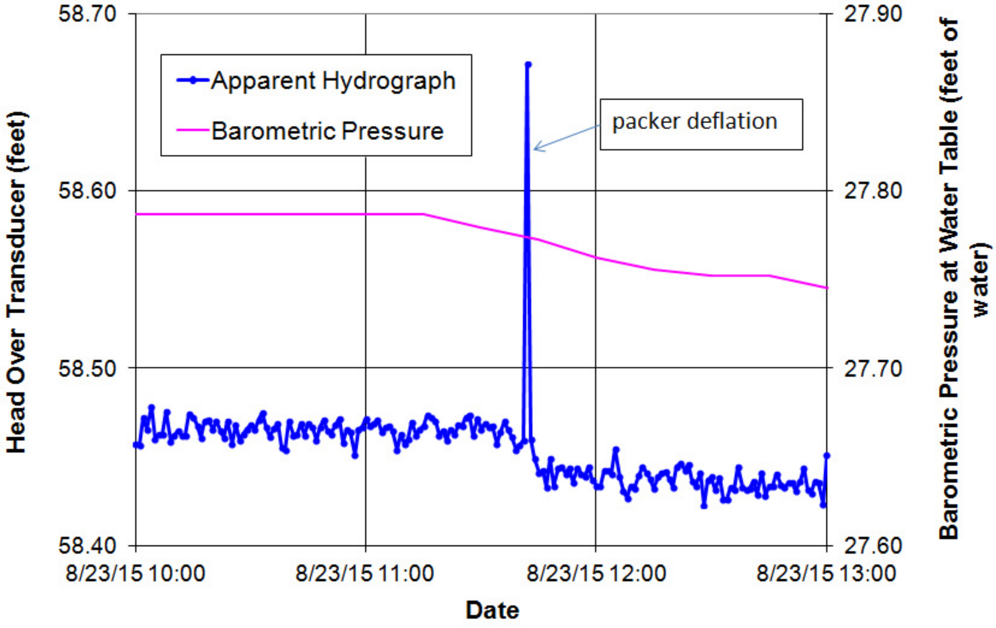


Figure F-7.0-5 Well SIMR-2 apparent hydrograph—packer deflation effect

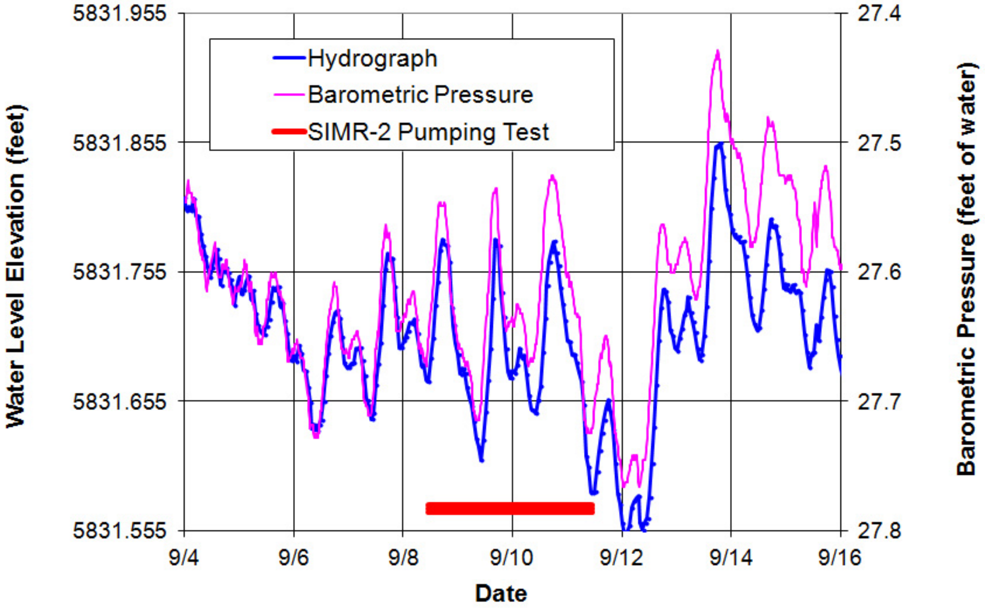


Figure F-7.0-6 Well R-13 actual hydrograph

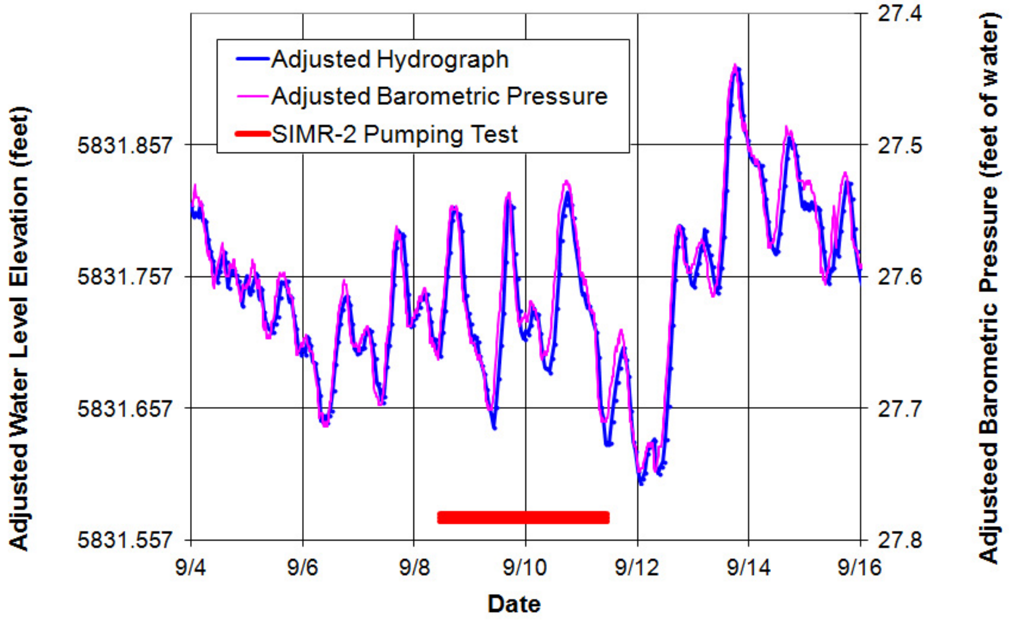


Figure F-7.0-7 Well R-13 hydrograph for 92% barometric efficiency and 0.0062 ft/d PM-4 effect

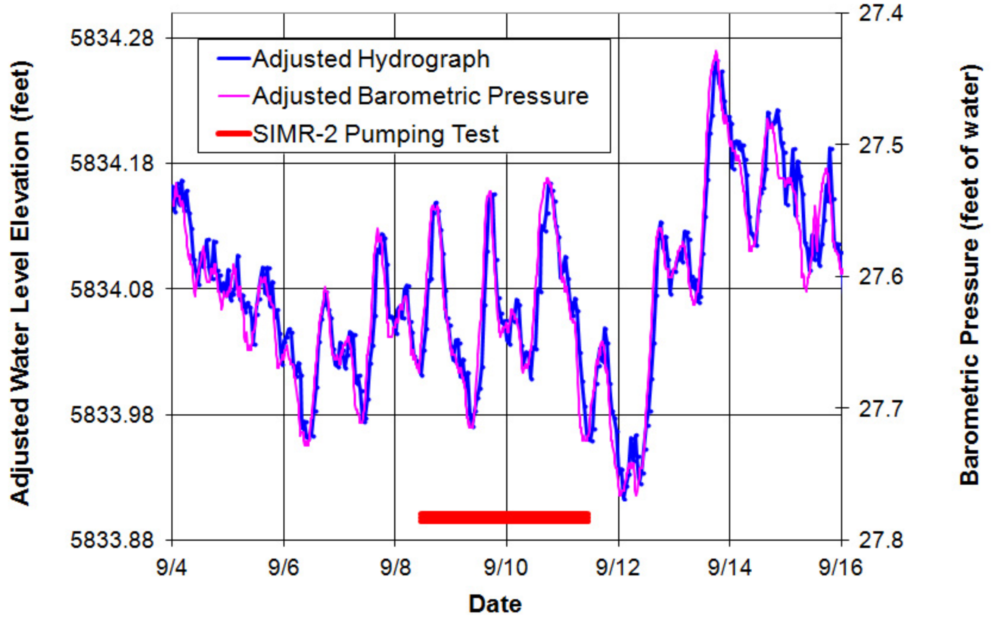


Figure F-7.0-8 Well R-28 hydrograph for 100% barometric efficiency and 0.004 ft/d PM-4 effect

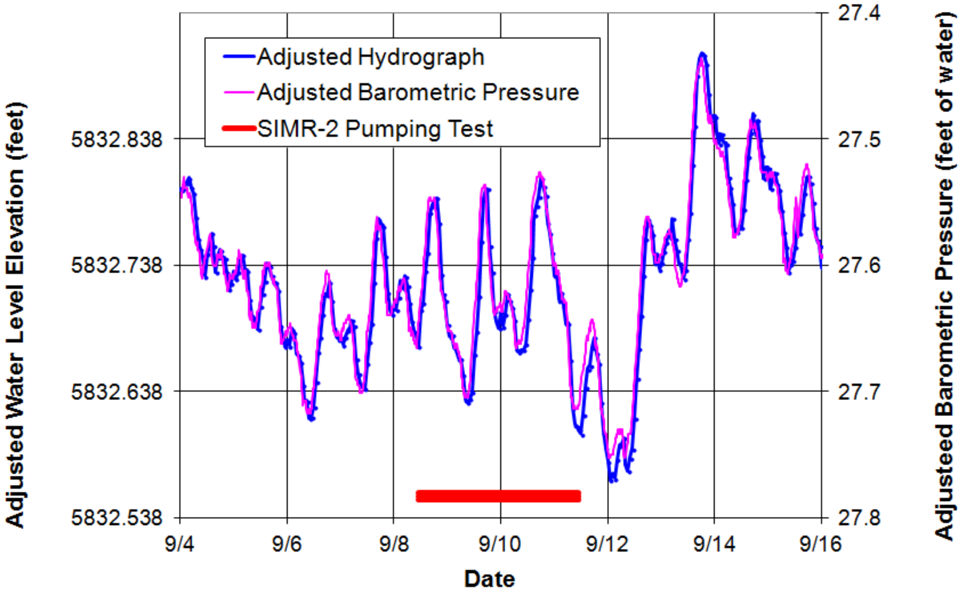


Figure F-7.0-9 Well R-44 screen 1 hydrograph for 94% barometric efficiency and 0.0064 ft/d PM-4 effect

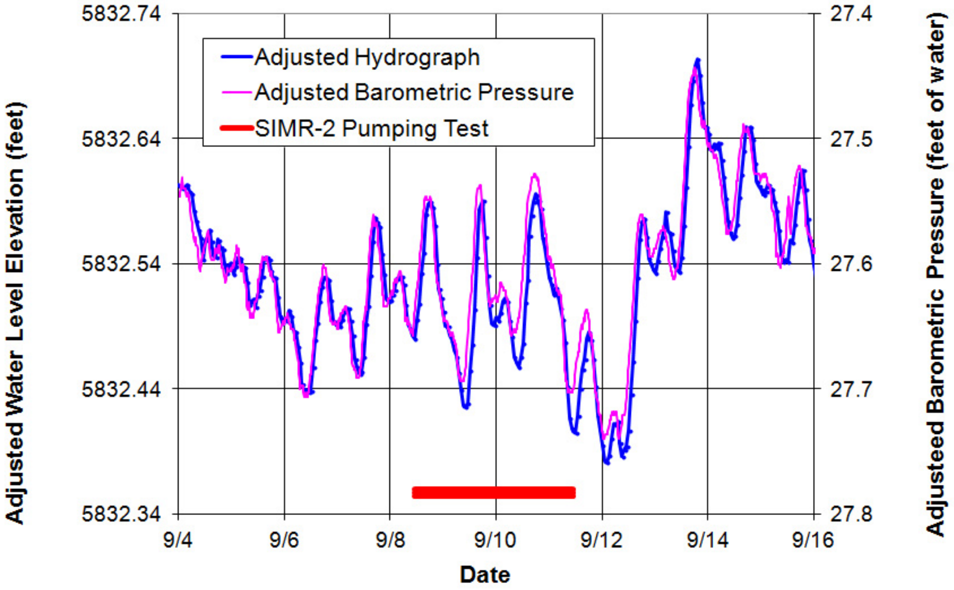


Figure F-7.0-10 Well R-44 screen 2 hydrograph for 88% barometric efficiency and 0.0062 ft/d PM-4 effect

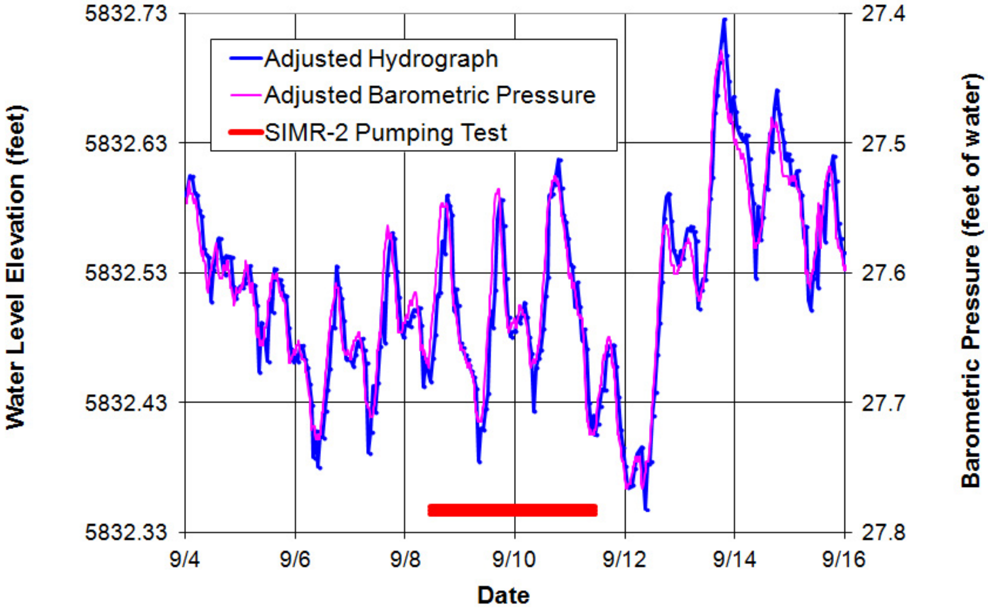


Figure F-7.0-11 Well R-45 screen 1 actual hydrograph

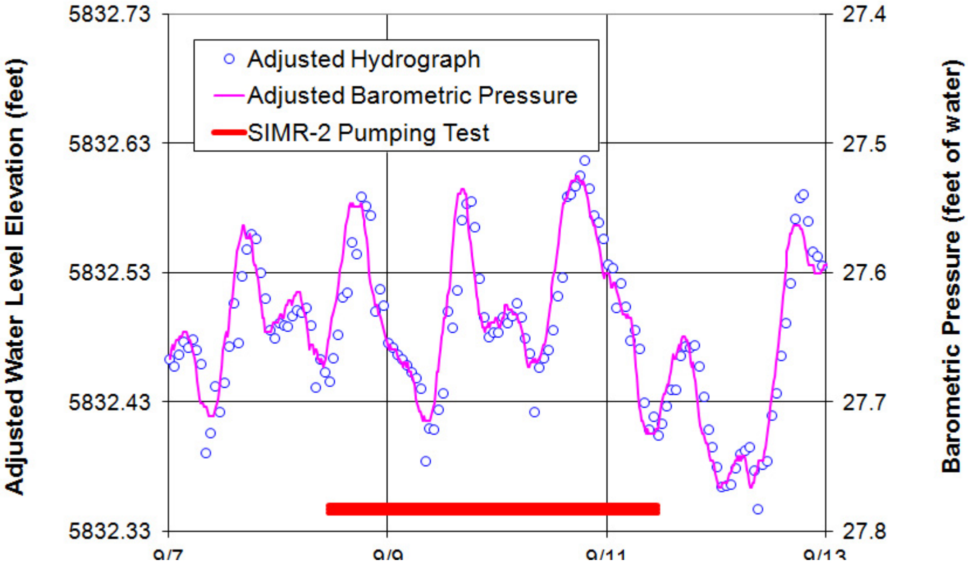


Figure F-7.0-12 Well R-45 screen 1 actual hydrograph—expanded scale

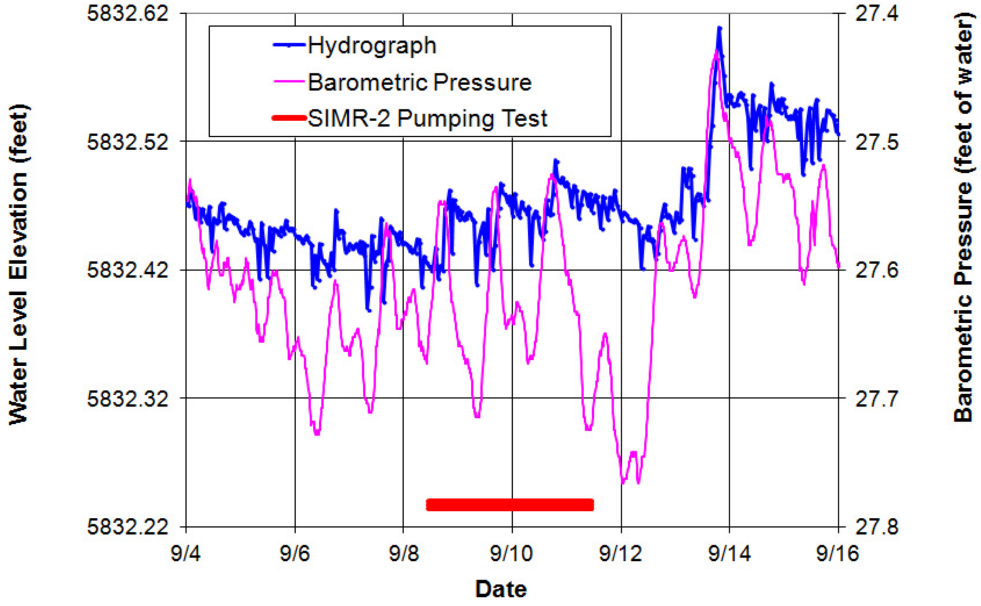


Figure F-7.0-13 Well R-45 screen 2 actual hydrograph

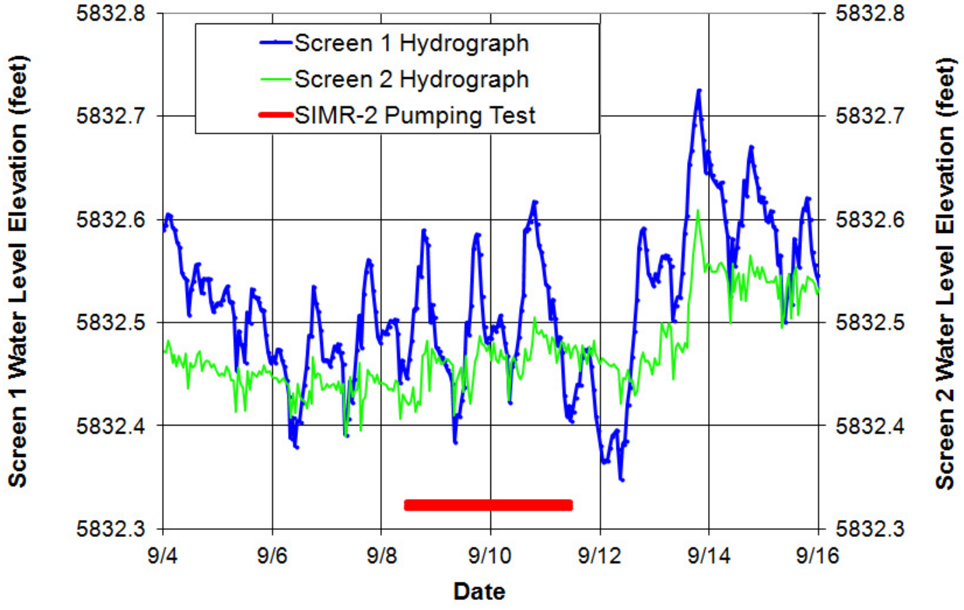


Figure F-7.0-14 Well R-45 screen 1 and screen 2 actual hydrograph comparison

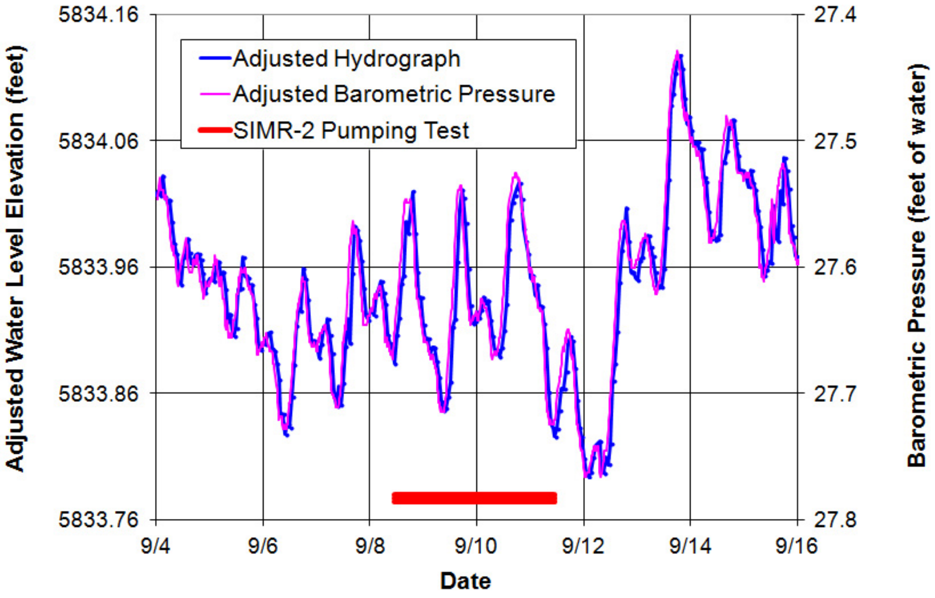


Figure F-7.0-15 **Well R-50 screen 1 hydrograph for 100% barometric efficiency and 0.0064 ft/d PM-4 effect**

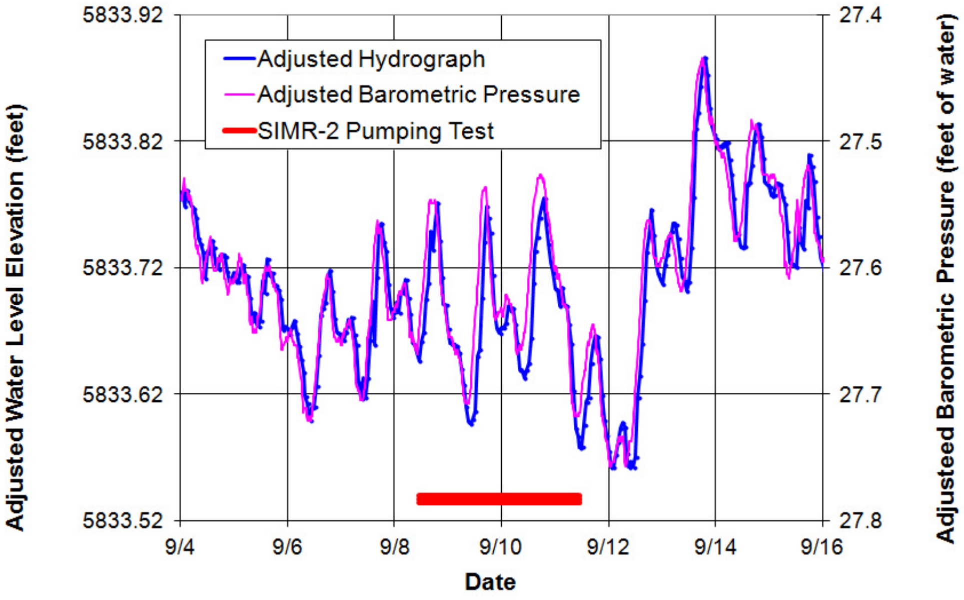


Figure F-7.0-16 **Well R-50 screen 2 hydrograph for 96% barometric efficiency and 0.007 ft/d PM-4 effect**

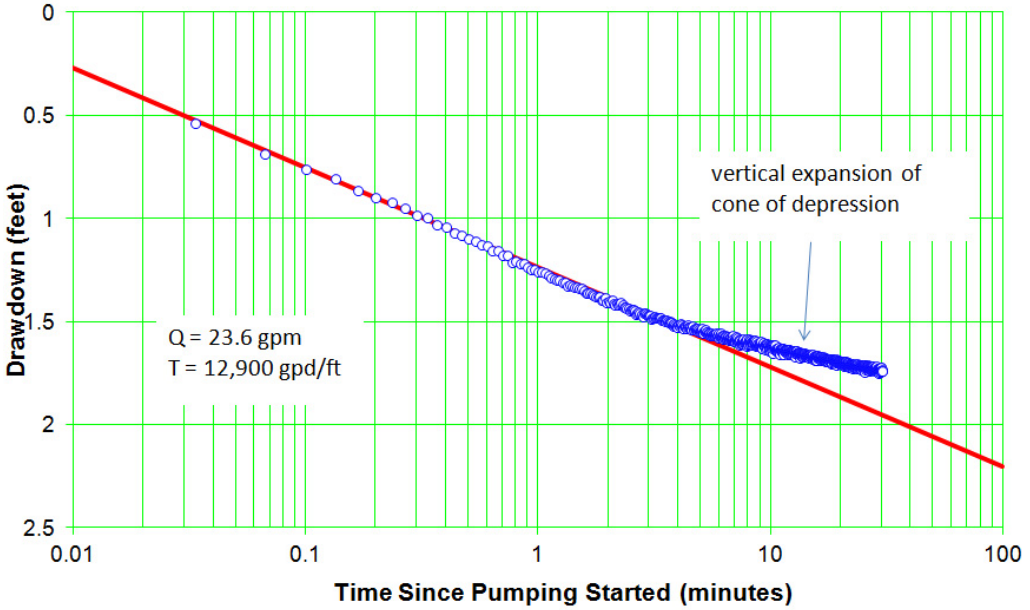


Figure F-8.1-1 **Well SIMR-2 trial 1 drawdown**

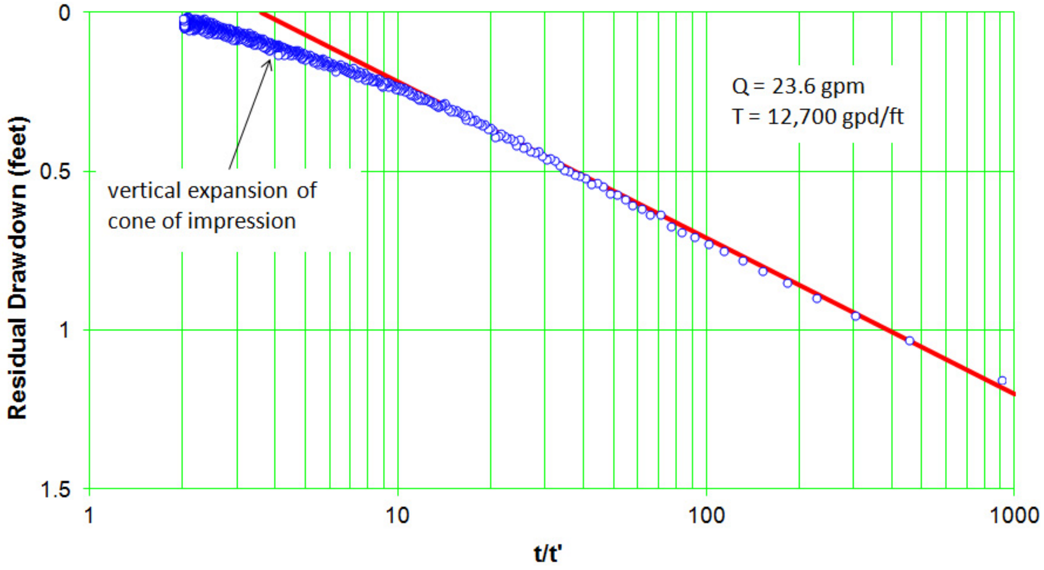


Figure F-8.1-2 **Well SIMR-2 trial 1 recovery**

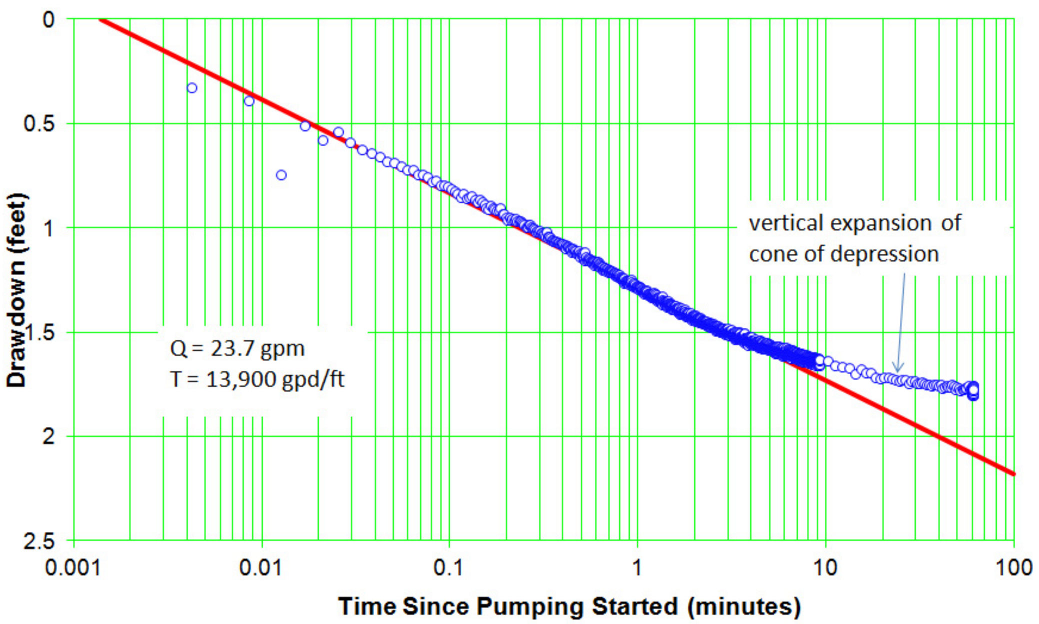


Figure F-8.2-1 Well SIMR-2 trial 2 drawdown

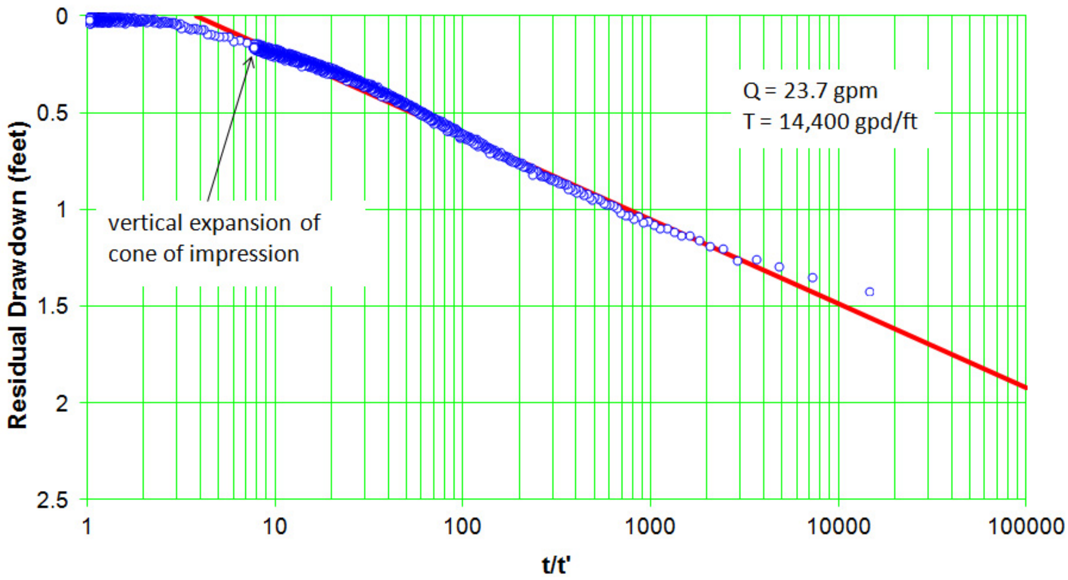


Figure F-8.2-2 Well SIMR-2 trial 2 recovery

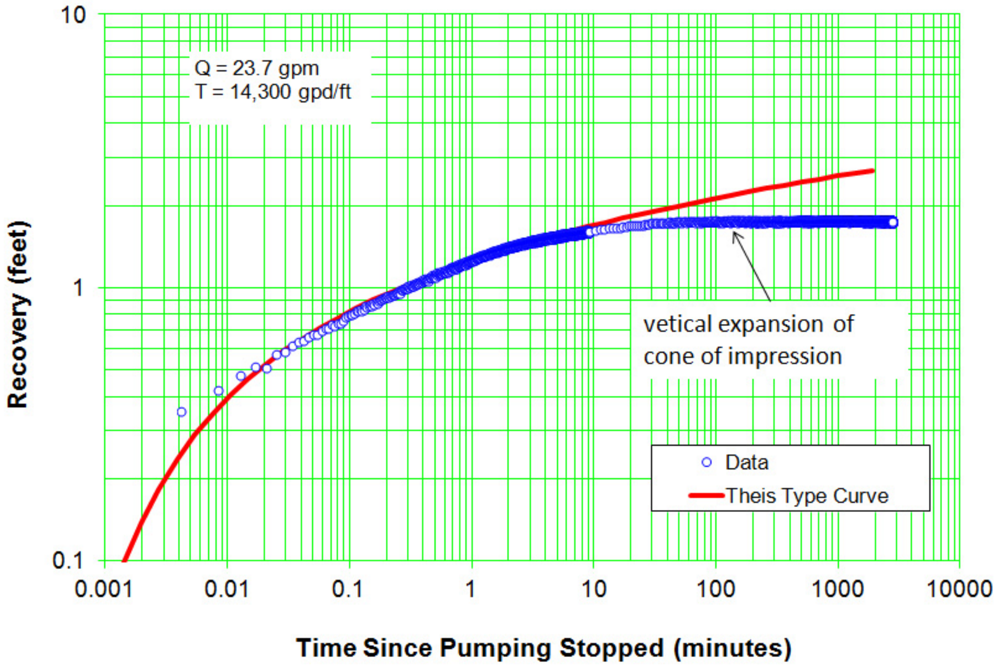


Figure F-8.2-3 Log-log plot of well SIMR-2 trial 2 recovery

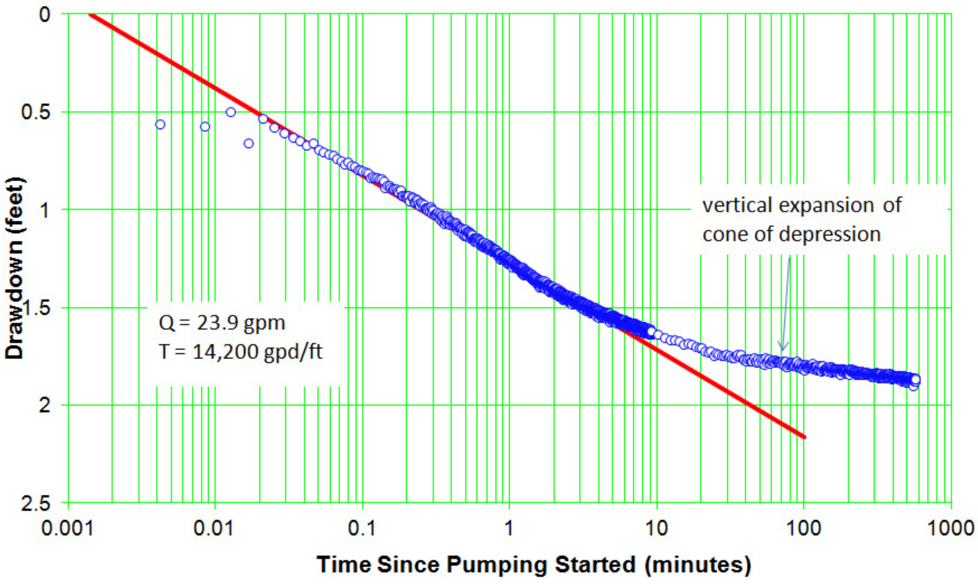


Figure F-8.3-1 Well SIMR-2 test 1 drawdown

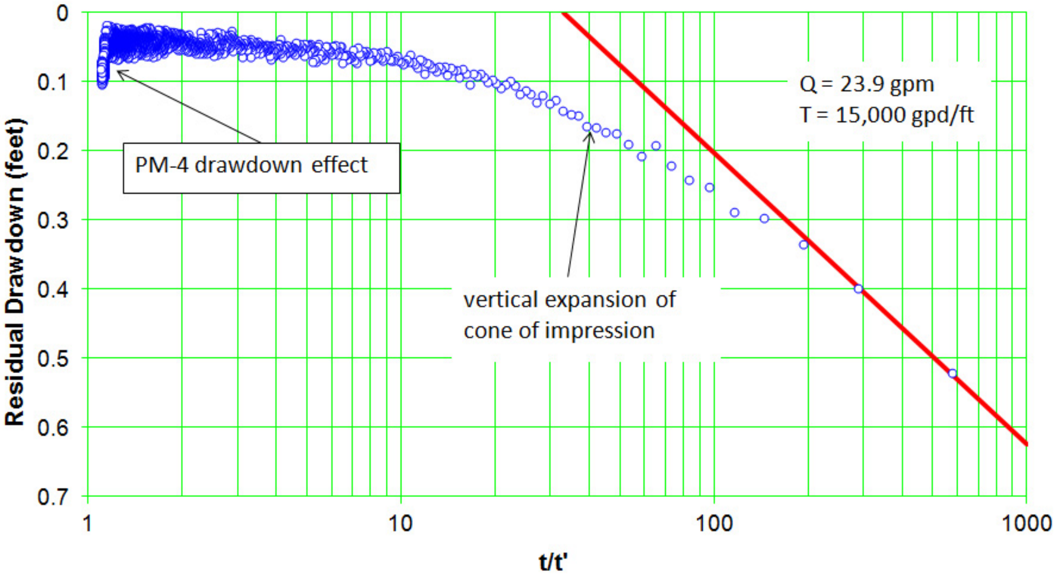


Figure F-8.3-2 Well SIMR-2 test 1 recovery

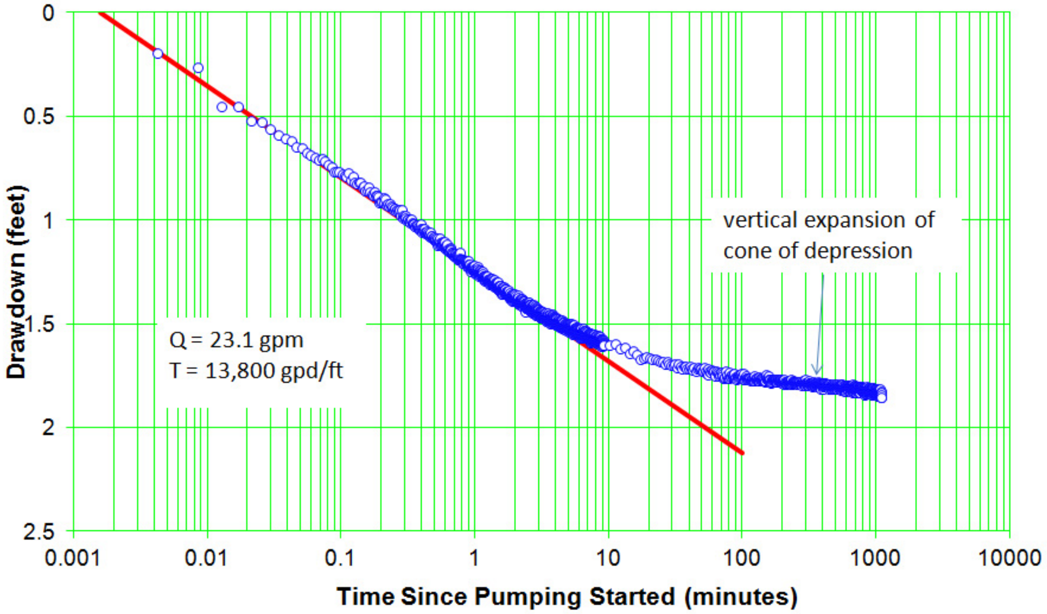


Figure F-8.4-1 Well SIMR-2 test 2 drawdown

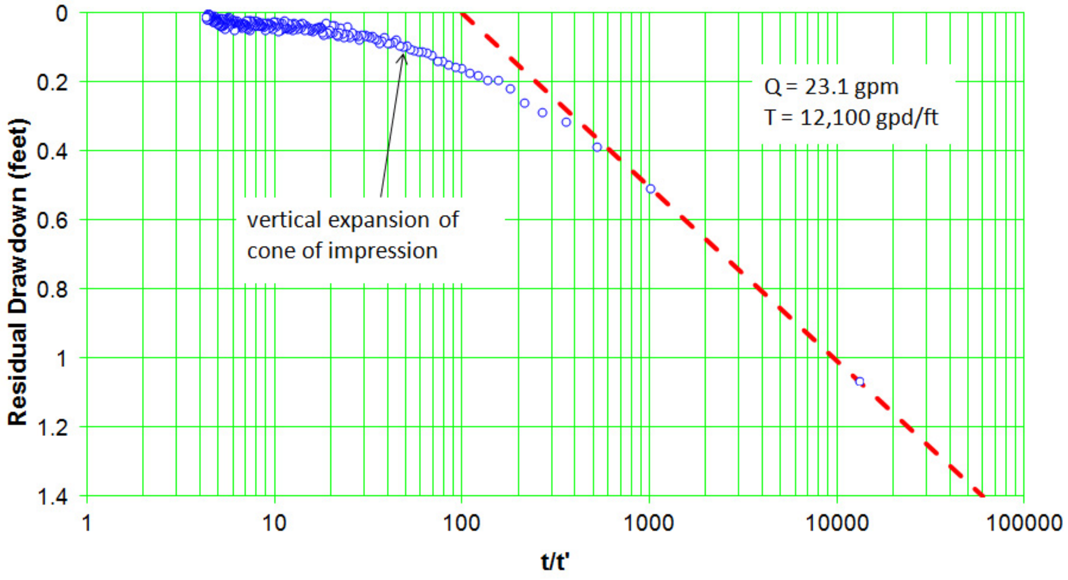


Figure F-8.4-2 Well SIMR-2 test 2 recovery

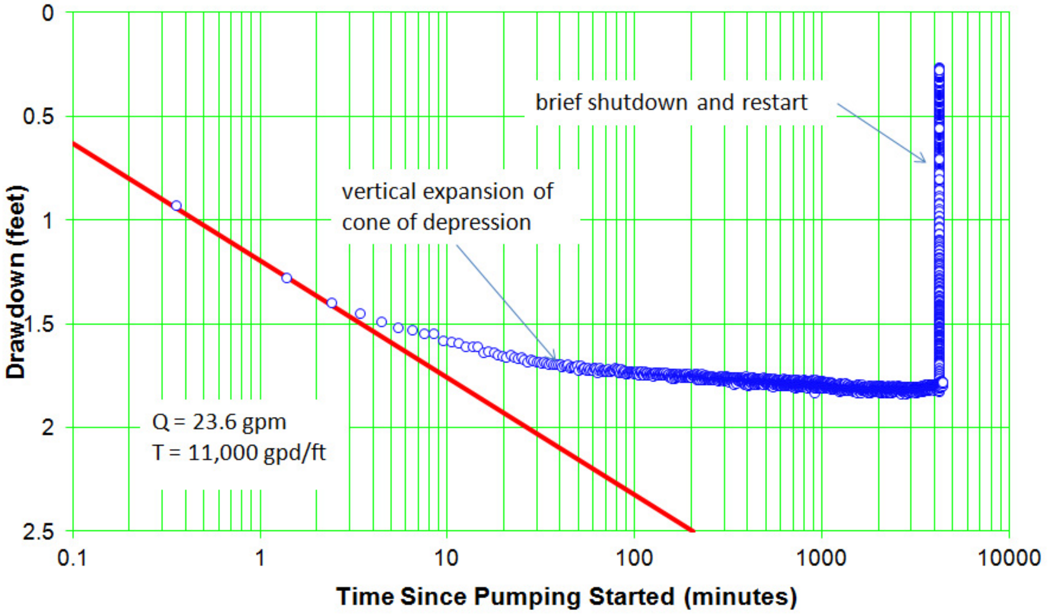


Figure F-8.5-1 Well SIMR-2 test 3 drawdown

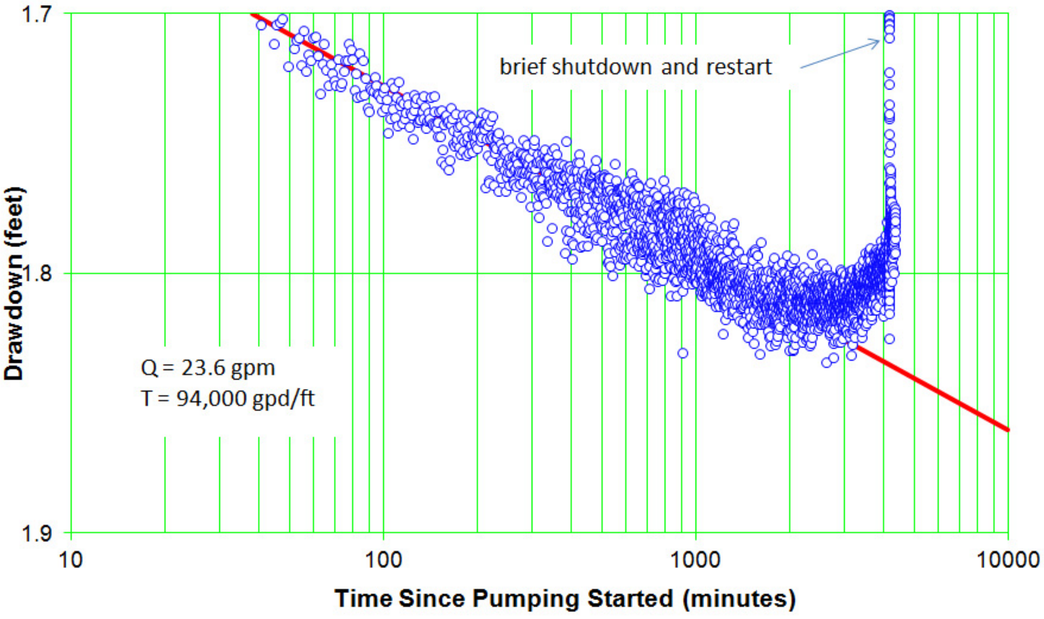


Figure F-8.5-2 Well SIMR-2 test 3 drawdown—late data

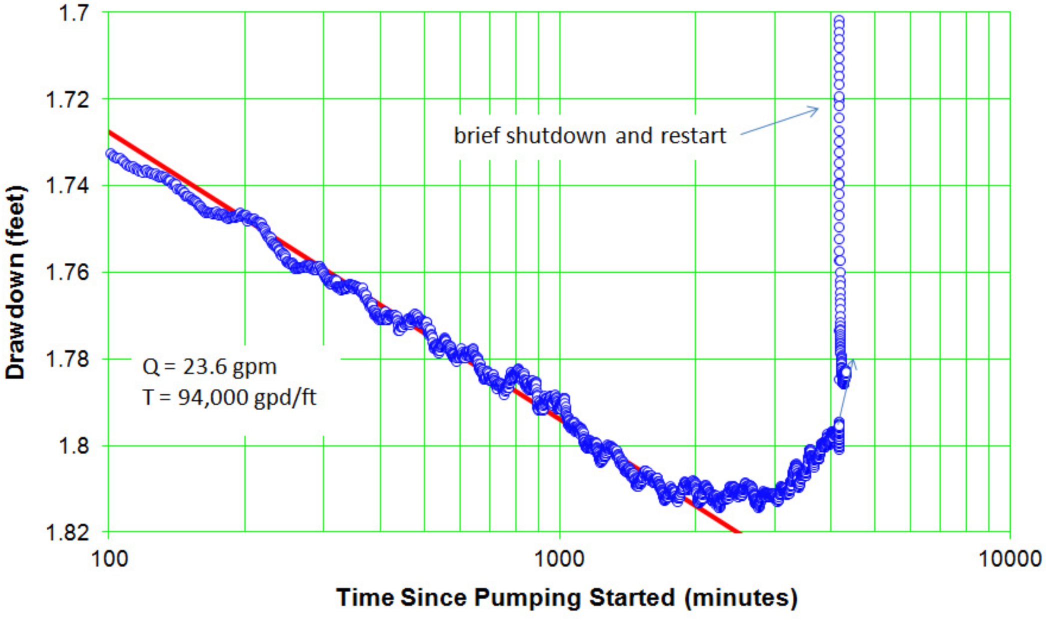


Figure F-8.5-3 Well SIMR-2 test 3 drawdown— rolling average

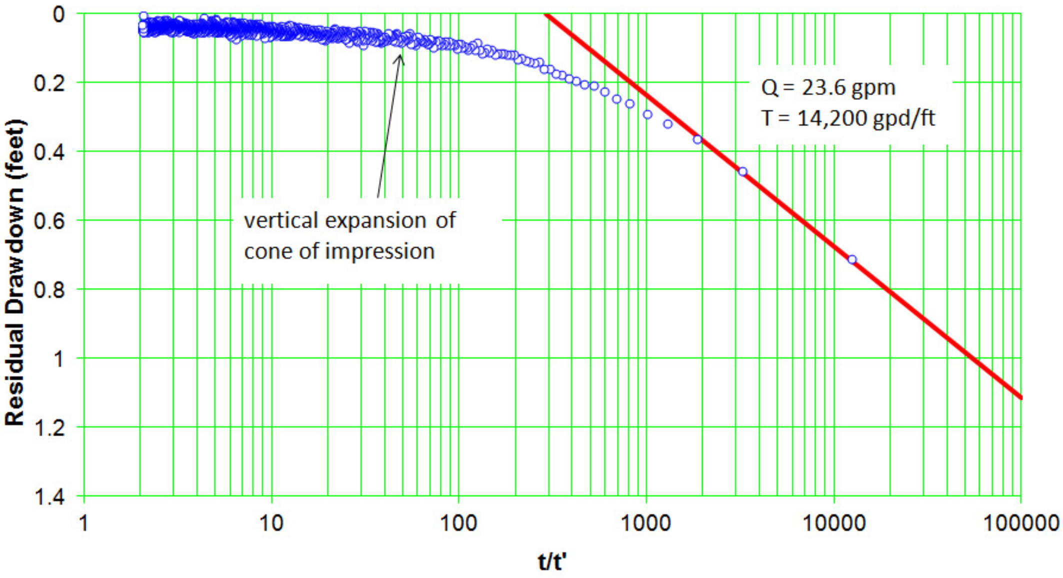


Figure F-8.5-4 Well SIMR-2 test 3 recovery

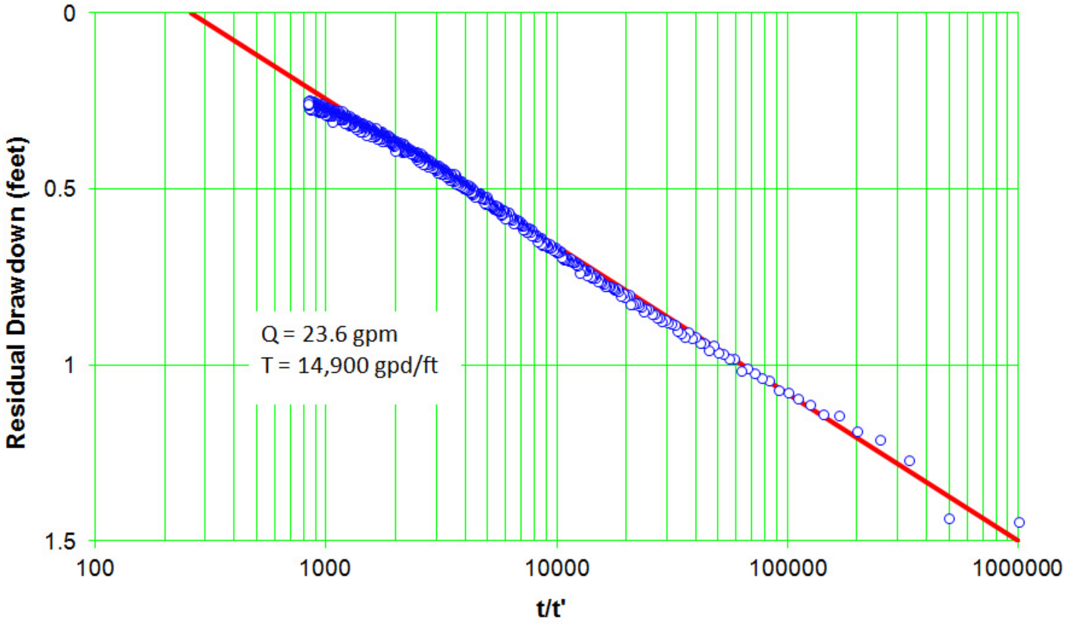


Figure F-8.6-1 Well SIMR-2 trial 3 recovery

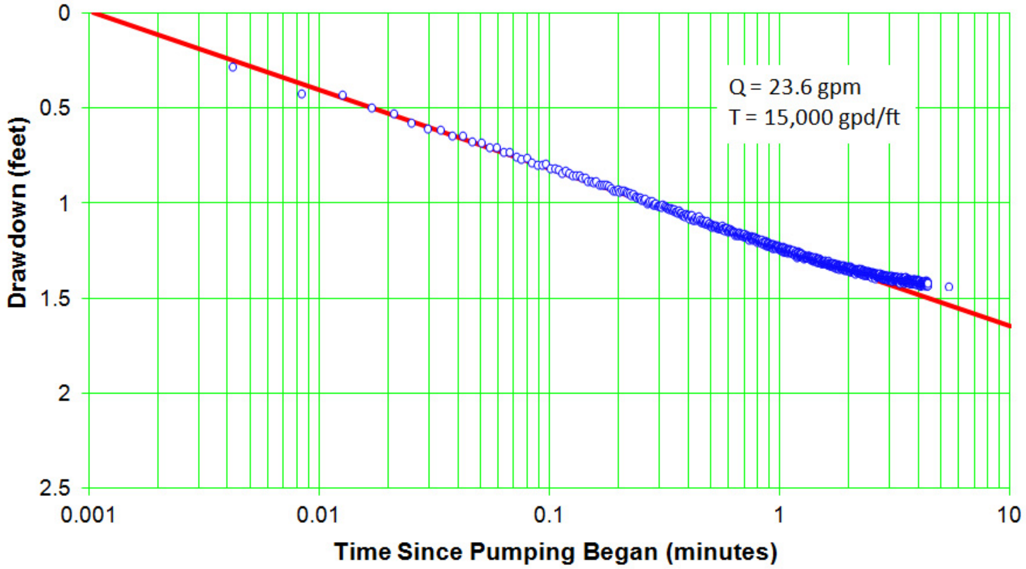


Figure F-8.6-2 **Well SIMR-2 trial 3 drawdown**

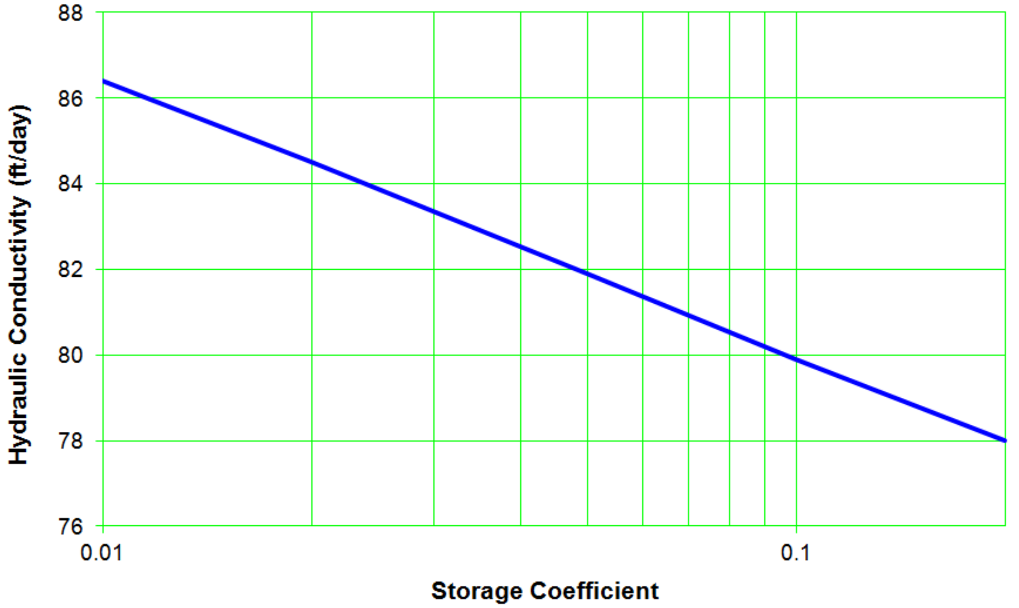


Figure F-8.8-1 **Well SIMR-2 lower-bound hydraulic conductivity**

Table F-8.7-1
Aquifer Parameter Values

Test	Method	T (gpd/ft)	K (gpd/ft^2)	K (ft/d)
Trial 1	Drawdown	12,900	632	85
Trial 1	Residual Drawdown	12,700	623	83
Trial 2	Drawdown	13,900	681	91
Trial 2	Residual Drawdown	14,400	706	94
Trial 2	Log-Log Recovery	14,300	701	94
Test 1	Drawdown	14,200	696	93
Test 1	Residual Drawdown	15,000	735	98
Test 2	Drawdown	13,800	676	90
Test 3	Drawdown	11,000	539	72
Test 3	Residual Drawdown	14,200	696	93
Trial 3	Residual Drawdown	14,900	730	98
Trial 3	Drawdown	15,000	735	98
Average	All	13,860	679	91