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Date: APR 29 2010
Refer To: EP2010-0182

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

Subject: Submittal of the Completion Report for Intermediate Well CdV-37-1i

Dear Mr. Bearzi:

Enclosed please find two hard copies with electronic files of the Completion Report for Intermediate Well CdV-37-1i.

If you have any questions, please contact Ted Ball at (505) 665-3996 (tedball@lanl.gov) or Tom Whitacre at (505) 665-5042 (twhitacre@doeal.gov).

Sincerely,

Bruce Schappell, Executive Director
Environmental Programs – Recovery Act Projects
Los Alamos National Laboratory

Sincerely,

Everett Trollinger, Federal Project Director
Environmental Projects – ARRA
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BS/ET/TB/ME:sm

Enclosures: Two hard copies with electronic files – Completion Report for Intermediate Well CdV-37-1i (LA-UR-10-1771)

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LA-UR-10-1771
May 2010
EP2010-0182

Completion Report for Intermediate Aquifer Well CdV-37-1i

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by the Environmental Programs Directorate

LA-UR-10-1771
EP2010-0182

Completion Report for Intermediate Aquifer Well CdV-37-1i

May 2010

Responsible project manager:

Printed Name	Signature	Title	Organization	Date
Ted Ball	[signature]	Project Manager	Environmental Programs	4/28/10

Responsible LANS representative:

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Bruce Schappell	[signature]	Executive Director	Environmental Programs	4/28/10

Responsible DOE representative:

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Everett Trollinger	[signature]	Federal Project Director	DOE-LASO	4/28/10

EXECUTIVE SUMMARY

This well completion report describes the drilling, installation, development, and aquifer testing of Los Alamos National Laboratory's perched-intermediate monitoring well CdV-37-1i as well as coring done at a collocated shallow corehole. Both are located at the confluence of Water Canyon and Cañon de Valle, immediately below the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility in Technical Area 15 (TA-15) in Los Alamos County, New Mexico. The well was installed at the direction of the New Mexico Environment Department (NMED) to supplement existing characterization of perched-intermediate groundwater beneath the general area of TA-16. Additionally, corehole samples were collected from the adjacent corehole for pore-water analysis. The location of the well near the confluence of Water Canyon and Cañon de Valle will help define the eastern extent of contaminated perched-intermediate groundwater associated with Laboratory operations at TA-16.

The CdV-37-1i 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 above the anticipated perched-water zone; no drilling-fluid additives, other than small amounts of potable water, were used below 490.0 ft below ground surface (bgs). Additive-free drilling provides minimal impacts to the groundwater and aquifer materials. The CdV-37-1i borehole was successfully drilled to total depth (TD) using dual-rotary casing-advance drilling methods.

During drilling, a retractable 16-in. casing was advanced to a depth of 395.0 ft bgs. A retractable 12-in. casing was then advanced to a TD of 803.0 ft bgs. Geologic units encountered while drilling CdV-37-1i included, in descending stratigraphic order, alluvium, Tshirege Member of the Bandelier Tuff, Cerro Toledo interval, Otowi Member of the Bandelier Tuff, Guaje Pumice Bed, an upper interval of Puye Formation, Cerros del Rio basalt, and a lower section of Puye Formation. The CdV-37-1i monitoring well was completed with a single screened interval to evaluate water quality and measure water levels in an intermediate-perched aquifer within the upper portion of the Puye Formation. The 20-ft-long screened interval is set between 632.0 ft and 652.5 ft bgs.

The well was completed in accordance with an NMED-approved well design. Well development and aquifer testing activities indicate monitoring well CdV-37-1i is productive and will perform effectively to meet the planned objective. A permanent pump and a water-level transducer have been installed in the screened interval in the CdV-37-1i well, and groundwater sampling will be performed as part of the facility-wide groundwater-monitoring program.

The CdV-37-1i corehole was continuously cored using sonic coring methods from surface to 305.0 ft bgs, with 26 analytical samples collected from the recovered core for pore water analyses. No groundwater was detected during coring, and the corehole was subsequently plugged and abandoned in accordance with NMED requirements.

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Acronyms and Abbreviations

AK	acceptable knowledge
amsl	above mean sea level
ASTM	American Society for Testing and Materials
bgs	below ground surface
Consent Order	Compliance Order on Consent
DARHT	Dual Axis Radiographic Hydrodynamic Test
DO	dissolved oxygen
EES-14	Earth and Environmental Sciences Group 14
EP	Environmental Programs Directorate
EPA	Environmental Protection Agency (U.S.)
HE	high explosives

HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
ICPOES	inductively coupled (argon) plasma optical emission spectroscopy
ICPMS	inductively coupled (argon) plasma mass spectrometry
I.D.	inside diameter
LANL	Los Alamos National Laboratory
LH3	low-level tritium
µS/cm	microsiemens per centimeter
mV	millivolt
NMED	New Mexico Environment Department
NMEDE	NMED explosives suite
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
PETN	pentaerythritol tetranitrate
PVC	polyvinyl chloride
QAL	alluvium
Qbo	Otowi Member of the Bandelier Tuff
Qbog	Guaje Pumice Bed of Otowi Member of the Bandelier Tuff
Qbt	Tshirege Member of the Bandelier Tuff
Qct	Cerro Toledo interval
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
SU	standard unit
RPF	Records Processing Facility
SOP	standard operating procedure
SU	standard unit
TA	technical area
TATB	triaminotrinitrobenzene
Tb 4	Cerros del Rio basalt
TD	total depth
TOC	total organic carbon
Tpf	Puye Formation
TU	tritium unit
VOC	volatile organic compound
WCSF	waste characterization strategy form

WES-EDA	Waste and Environmental Services Division–Environmental Data and Analysis
wt%	weight percent

1.0 INTRODUCTION

This completion report summarizes site preparation, borehole drilling, well construction, well development, aquifer testing, and dedicated sampling system installation for intermediate-perched groundwater monitoring well CdV-37-1i and a collocated shallow CdV-37-1i corehole. The report has been written in accordance with the requirements in Section IV.A.3.e.iv of the Compliance Order on Consent (the Consent Order). The CdV-37-1i monitoring well borehole was drilled from October 9 to 27, 2009, and completed from November 6 to December 2, 2009, while the corehole was drilled and abandoned between December 12 and 16 at Los Alamos National Laboratory (LANL or the Laboratory) for the Environmental Programs (EP) Directorate.

The CdV-37-1i project site is located in Technical Area 15 (TA-15) at the confluence of Water Canyon and Cañon de Valle, immediately below the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility in Los Alamos County, New Mexico (Figure 1.0-1). Both boreholes shared the same drill pad. The purpose of drilling at CdV-37-1i is to determine if perched-intermediate groundwater zone(s) occurs in the area of the confluence of Cañon de Valle and Water Canyon and, if so, to monitor the perched water. Monitoring at this location will help characterize potential groundwater contamination and pathways from potential upgradient sources.

The primary objective of the drilling activities at CdV-37-1i was to drill and install a single-screen intermediate-depth perched-aquifer monitoring well. Secondary objectives were to collect drill-cutting samples, collect borehole geophysical data, and sample potential perched groundwater zones as well as collect multiple undisturbed depth-specific analytical core samples.

The CdV-37-1i borehole was drilled to a total depth (TD) of 803.0 ft below ground surface (bgs). A monitoring well was then installed with one 20-ft screen interval between 632.0 and 652.5 ft bgs. The depth to water after well installation was 627.9 ft bgs on December 3. During drilling, cuttings samples were collected at 5-ft intervals in the borehole from ground surface to TD. For the corehole, coring was continuous from surface to 305.0 ft bgs, with a total of 26 analytical samples collected from the recovered core. The corehole was abandoned after successful drilling and core collection to the planned TD.

Postwell installation activities included well development, aquifer testing, surface completion, installation of a dedicated sampling system, and geodetic surveying. Future activities will include site restoration and waste management.

The information presented in this report was compiled from field reports and daily activity summaries. Records, including field reports, field logs, and survey information, are on file at EP’s Records Processing Facility (RPF). This report contains brief descriptions of activities and supporting figures, tables, and appendices completed to date associated with the CdV-37-1i project. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to the New Mexico Environment Department (NMED) in accordance with U.S. Department of Energy policy.

2.0 PRELIMINARY ACTIVITIES

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

2.1 Administrative Preparation

The following documents helped guide the implementation of the scope of work for the CdV-37-1i project:

- "Drilling Work Plan for Perched-Intermediate Aquifer Well CdV-37-1i" (LANL 2009, 106689);
- "Drilling Plan for Intermediate Well CdV-37-1i and CdV-37-1i Corehole" (TerranearPMC 2009, 106980);
- "Integrated Work Document for Regional and Intermediate Aquifer Well Drilling (Mobilization, Site Preparation and Setup Stages)" (LANL 2007, 100972);
- "Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan" (LANL 2006, 092600); and
- "Waste Characterization Strategy Form for South Canyon Wells CdV-37-1i and R-27i Intermediate Aquifer Well Installation and Corehole Drilling" (LANL 2009, 106895).

2.2 Site Preparation

Site preparation and access road upgrading was performed by Laboratory personnel before rig mobilization. Because of Laboratory access restrictions related to active daytime operations in the area, activities at CdV-37-1i were conducted exclusively on 12-h night shifts.

During the evening hours of October 7 to 9, activities involved moving the dual-rotary drill rig, air compressors, trailers, and support vehicles to the drill site and staging alternative drilling tools and construction materials at both the Pajarito Road laydown yard and the nearby R-27/R-27i well site. A track-mounted sonic drilling rig for the CdV-37-1i corehole was brought on-site on December 10.

Potable water was obtained from a large 21,000-gal. frac tank staged at the R-27/R-27i well site because of the remoteness of the CdV-37-1i drill site. The tank was replenished as necessary by Laboratory personnel. Safety barriers and signs were installed around the borehole cuttings containment pit and along the perimeter of the work area.

3.0 DRILLING ACTIVITIES

This section describes the drilling strategy and approach and provides a chronological summary of field activities conducted at both the CdV-37-1i monitoring well and CdV-37-1i corehole.

3.1 Drilling Approach

The drilling method and selection of equipment and drill-casing sizes for the CdV-37-1i monitoring well were designed to retain the ability to investigate and case off potential perched groundwater above the target perched water zone. 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 5.56-in.-outside diameter (O.D.) well.

Dual-rotary air-drilling methods using a Foremost DR-24HD drill rig were used to drill the CdV-37-1i borehole. Dual-rotary drilling has the advantage of simultaneously advancing and casing the borehole. The drill rig was equipped with conventional drilling rods, tricone bits, downhole hammer bits, a deck-mounted 900 ft^3/min air compressor, and general drilling equipment. Auxiliary equipment included two 1150 ft^3/min trailer-mounted air compressors. Three sizes of A53 grade B flush-welded mild carbon-steel casing (18-in., 16-in., and 12-in.-inside diameter [I.D.]) were used for the CdV-37-1i monitoring well borehole. The dual-rotary technique at CdV-37-1i 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 municipal water and a mixture of municipal water with Baroid AQF-2 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 490.0 ft bgs per the drilling work plan (LANL 2009, 106689). No additives, other than municipal water, were used to drill below this depth (490.0 ft bgs). Total amounts of drilling fluids introduced into the borehole and those recovered are recorded and presented in Table 3.1-1.

For the CdV-37-1i corehole, a track-mounted PS-600C sonic drilling rig equipped with both 6.0- and 4.25-in.-O.D. core barrels and 7.0-in. casing was selected to meet the depth and sampling requirements of this portion of the CdV-37-1i project. No fluids were used during sonic drilling/coring, and subsequent abandonment practices and materials met NMED requirements.

3.2 Chronological Drilling Activities for the CdV-37-1i Well

Mobilization of drilling equipment and supplies to the CdV-37-1i drill site occurred from October 7 to 9. Decontamination of the equipment and tooling was performed before mobilization to the site. Following on-site equipment inspections, the monitoring well borehole drilling began on the morning of October 9 (at 0440 h) using dual-rotary methods with 18-in. drill casing and a 17-in. (16.75-in.) tricone bit. Drilling and advancing 18-in. casing proceeded rapidly through canyon bottom alluvium and into unit 1g of the Tshirege Member of the Bandelier Tuff to a depth of 90.1 ft bgs where the 18-in. casing was landed. The 18-in. casing was used because of concerns of potential alluvial perched groundwater in the upper 75 ft of the borehole. If water had been detected in the upper portion of the hole, the 18-in. casing would have been used to seal it off before the borehole was advanced. No perched water was detected as 18-in. casing was advanced to 90.1 ft bgs.

After changing over to 16-in. drill casing and a 15.75-in. tricone bit, drilling recommenced on October 12 at 0420 h. On October 14, groundwater was encountered in a gravel zone at approximately 207 to 210 ft bgs in the upper portion of Cerro Toledo interval. This zone initially produced water (with air-only circulation) at an estimated 35 gpm that rapidly diminished to 3 gpm and eventually to dry in about 1 h; a water sample was collected and drilling continued. Additional water samples were collected at 250 and 270 ft bgs on October 16. Drilling continued until high rotational torque on the casing necessitated landing the 16-in. casing at 395.0 ft bgs the next evening. The 16-in. casing shoe was then cut off at 388.7 ft bgs on October 18, and 12-in. drill casing was started into the borehole.

Drilling resumed on the evening of October 21 using an 11.625-in. downhole hammer bit and 12-in. casing. Slight indications of groundwater were noted at approximately 500, 537, 580, and 620 ft bgs while drilling. Each of these zones was investigated by lifting the casing string slightly, followed by air-only circulation. Only the 620-ft-bgs zone produced enough water to sample; it had an apparent water level of approximately 618 ft bgs after drilling activity had been suspended for 2.5 h on the morning of October 24. Drilling continued to a depth of 640 ft bgs. Early the next evening, before drilling ahead, water levels in the borehole had stabilized at 627.8 ft bgs, and a water sample was collected. The borehole was then advanced to 692.7 ft bgs into basalt, and no indications of groundwater were noted. A decision was made to terminate casing advance and switch to open-hole drilling; the 12-in. casing was landed at 691.4 ft bgs.

Open-hole drilling started with the same 12-in. hammer bit, with an added stabilizer on the evening of October 25. By early morning (0022 h) the next day, the borehole had been advanced through the basalt and into the lower Puye Formation gravels to the TD 803.0 ft bgs. No indications of groundwater were noted while the open-hole interval was drilled.

To evaluate earlier, but uncertain, indications of perched groundwater, the 12-in. casing was lifted approximately 10 ft (to 680 ft bgs) on the morning of October 27 (0450 h) to allow water inflow. After lifting the casing, Laboratory personnel ran a video log to 790 ft bgs in the evening of October 27. The video showed no evidence of water entering the borehole over the 740- to 790-ft-bgs interval in the lower Puye Formation interval, and only a slight trickle of water came from outside the 12-in. casing shoe at 680 ft bgs. No natural gamma ray log was recorded because of instrument problems; an induction survey was not run at this time because of the lack of water in the borehole.

The dual-rotary drill rig was used to begin backfilling the borehole and partially retract the 12-in. casing. Bentonite chips (3/8-in.) were added and hydrated to bring the borehole depth up to 740.0 ft bgs by midnight on October 29. After the partial backfill, an attempt to lift the 12-in. drill casing for further evaluation of groundwater inflow failed. As a result, the 12-in. casing was cut just above the drive shoe. The casing was successfully cut at 675.0 ft bgs, and a total of 95.8 ft of 12-in. casing retracted, bringing the bottom of the 12-in. casing up to 598.1 ft bgs. The dual-rotary drill rig was used to backfill the borehole to 660.7 ft bgs with bentonite chips and retract the entire string of 18-in. casing before the rig was demobilized from the site on November 4.

During drilling, field crews worked a single 12-h night shift each calendar day, 7 d/wk. All associated daily activities proceeded normally without incident or delay.

3.3 Chronological Drilling and Abandonment Activities for the CdV-37-1i Corehole

As was the case for the monitoring well, all activities took place exclusively on night shift in to avoid safety/access conflicts with nearby active Laboratory sites.

After the dual-rotary rig was moved off-site, a track-mounted PS-600C sonic drilling rig and ancillary equipment were mobilized to the CdV-37-1i corehole site, which was collocated on the CdV-37-1i monitoring well drilling pad, on December 10. All casing and downhole tools were decontaminated on-site the next day.

Continuous coring commenced using 7-in. flush threaded casing and a 6.0-in. rotosonic coring head/barrel early (0048 h) in the morning of December 12. Casing advance was suspended at 217 ft bgs at 0129 h on December 14, and open-hole coring with the 6-in. coring assembly continued to 300 ft bgs. A smaller 4.75-in. coring head/barrel was used to reach a TD of 305 ft bgs at 2140 h on December 14 within the Otowi Member of the Bandelier Tuff. In accordance with the core sampling plan, two 0.5-ft × 6.0-in. O.D. Lexan-cased and capped core samples were collected from each of the prescribed intervals (10.5, 20, 30, 40, 50, 60, 80, 100, 140, 180, 220, 260, and 300 ft bgs).

The corehole was abandoned with 3/8-in. bentonite chips (hydrated) backfill from TD to 50.1 ft bgs (62.0 ft^3 bentonite [dry]). Neat (100%) Portland cement grout (57.4 ft^3 grout) was then placed above the bentonite backfill to ground surface. Backfill materials were added as the 7-in. casing was retracted. From December 14 to 16, the corehole was abandoned. The site was cleaned up and the rig moved off-site on December 16.

During corehole drilling, field crews worked a single 12-h night shift each calendar day. All associated daily activities proceeded normally without incident or delay.

4.0 SAMPLING ACTIVITIES

This section describes the cuttings and groundwater sampling activities for monitoring well CdV-37-1i and core sampling for the CdV-37-1i corehole. All sampling activities were conducted in accordance with applicable quality procedures.

4.1 Cuttings Sampling

Cuttings samples were collected from the CdV-37-1i monitoring well borehole at 5-ft intervals from ground surface to the TD of 803.0 ft bgs. At each interval, approximately 500 mL of bulk cuttings was collected by the site geologist from the drilling discharge cyclone, placed in resealable plastic bags, labeled, and archived in core boxes. Sieved fractions (>#10 and >#35 mesh) were also collected from ground surface to TD and placed in chip trays along with unsieved (whole rock) cuttings. Cuttings samples were recovered over 100% of the CdV-37-1i monitoring well borehole. Radiation control technicians screened cuttings before the cuttings were removed from the drill site. All screening measurements were within the range of background values. The core boxes and chip trays were delivered to the Laboratory’s archive at the conclusion of drilling activities.

The borehole stratigraphy for CdV-37-1i is described in section 5.1, and the lithology is detailed in Appendix A.

4.2 Water Sampling

Groundwater-screening samples were collected from the drilling discharge hose from 210 to 640 ft bgs to evaluate potential perched groundwater zones. Typically, once the bottom of a 20-ft run of casing is reached, the driller stops water circulation (if injecting water) and circulate air. As the discharge cleared, a water sample was collected directly from the discharge cyclone. Table 4.2-1 presents a summary of screening samples collected during the CdV-37-1i monitoring well installation project. Groundwater chemistry and field water-quality parameters are discussed in Appendix B.

Five groundwater screening samples, from depths of 210, 250, 270, 620, and 640 ft bgs, were collected from the monitoring well borehole during drilling operations by air-lifting water samples. These screening samples were analyzed for cations, anions, perchlorate, metals, high explosives (HE), low-level tritium (LH3), and volatile organic compounds (VOCs).

Two groundwater-screening samples were collected during well development from the development pump’s discharge line. Development screening samples were analyzed only for total organic carbon (TOC). Additionally, four groundwater-screening samples were collected during aquifer testing from the pump’s discharge line and analyzed only for TOC.

No groundwater was detected during coring; therefore, no groundwater samples were collected during the drilling of the corehole.

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 the full suite of constituents, including radioactive elements; anions/cations; general inorganic chemicals; VOCs and semivolatile organic compounds; and stable isotopes of hydrogen, nitrogen, and oxygen. The analytical results will be included in the appropriate periodic monitoring report issued by the Laboratory. After the first year, the analytical suite and sample frequency at CdV-37-1i will be evaluated and presented in the annual interim facility-wide groundwater monitoring plan prepared by the Laboratory.

4.3 Core Sampling

Core recovery from the CdV-37-1i corehole was 100%. In accordance with the drilling plan (LANL 2009, 106689), 26 samples were collected for pore water analysis from the following 13 intervals (two 6-in. samples per interval): 10.5 to11.5, 20.0 to 1.0, 30.0 to 31.0, 40.0 to 41.0, 50.0 to 51.0, 60.0 to 61.0, 80.0 to 81.0, 100.0 to 101.0, 140.0 to 141.0, 180.0 to 181.0, 220.0 to 221.0, 260.0 to 261.0, and 300.0 to 301.0 ft bgs. All core samples were collected from Lexan sleeves inside the core barrel; the Lexan sleeves with core samples were sealed and capped. Details of the core sampling are presented in Table 4.3-1; Appendix A includes a corehole lithologic log. Radiation control technicians screened core samples before the samples were removed from the drill site. As with the cuttings samples, all radiation-screening measurements were within the range of background values.

5.0 GEOLOGY AND HYDROGEOLOGY

Brief descriptions of the geologic and hydrogeologic features encountered at CdV-37-1i are presented below. The Laboratory's geology task leader and project site geologists examined cuttings, core samples and geophysical logs to determine geologic contacts and hydrogeologic conditions. Drilling observations, video logging, water-level measurements, and geophysical logs were used to characterize groundwater occurrences encountered at CdV-37-1i.

5.1 Stratigraphy

Stratigraphic units for the CdV-37-1i deep rotary borehole (TD of 803.0 ft bgs) and adjacent shallow cored borehole (TD of 305.0 ft bgs) are presented in order of occurrence, from younger to older units. Lithologic descriptions are based on microscopic examination and analysis of drill cuttings samples collected from the discharge hose. Cuttings and borehole geophysical logs were used to identify the unit contacts. Figure 5.1-1 illustrates the stratigraphy at CdV-37-1i. A detailed lithologic log is present in Appendix A.

Quaternary Alluvium, Qal (0–40 ft bgs)

Quaternary alluvium consisting of unconsolidated, poorly sorted sand and gravelly sand composed of tuffaceous and volcanic detritus was encountered from 0 ft to approximately 40 ft bgs in the deep CdV-37-1i borehole. The alluvium/bedrock contact was intersected at 29 ft bgs in the adjacent shallow corehole. No evidence of alluvial groundwater was observed in either borehole.

Unit 1g of the Tshirege Member of the Bandelier Tuff, Qbt 1g (40–200 ft bgs)

Unit 1g of the Tshirege Member of the Bandelier Tuff was encountered from 40 to 200 ft bgs in the deep rotary CdV-37-1i borehole, as interpreted from the natural gamma log curve. Examination of the core collected from the adjacent corehole places the lower Qbt 1g contact at 201 ft bgs. As discussed below, there is some uncertainty associated with the depth of the basal unit 1g contact.

Unit 1g is a poorly welded rhyolitic ash-flow tuff that is strongly pumiceous, crystal-bearing, and lithic-poor. Unit 1g cuttings locally exhibit abundant ash matrix. Fragments of indurated tuff are rarely preserved in cuttings, suggesting poor welding. Pumice lapilli are generally glassy with a lustrous appearance and are quartz- and sanidine-phyric. Volcanic lithic fragments, predominantly dacitic, occur in minor abundances.

Cerro Toledo Interval, Qct (200–275 ft bgs)

The Cerro Toledo interval, a layer of poorly consolidated volcaniclastic sediments that occurs stratigraphically between the Tshirege and Otowi Members of the Bandelier Tuff, was interpreted to be present from 200 to 275 ft bgs. Locally, these sediments consist of poorly sorted pebble gravels with silty fine to coarse sands consisting of volcanic (predominantly dacitic) and tuffaceous (abundant detrital pumices and free quartz and sanidine crystals) debris.

Placement of the upper and lower contacts for the Cerro Toledo interval was strongly influenced by the signature of the natural gamma log curve. However, the depths of the upper and lower contacts of the Qct are somewhat uncertain on the basis of core recovery. A pumice-rich tuff, interpreted to be the Tsankawi Pumice Bed that occurs above the Cerro Toledo interval, was observed in the core from 198 to 200 ft bgs and seems to confirm Qbt 1g/Qct contact in the vicinity of 200 ft bgs. However, a clay-rich core interval from 179 to 180 ft bgs may represent mudstone that might be interpreted to mark the upper contact of the Qct, but the clay-rich interval lacked distinct bedding features that would be consistent with Cerro Toledo stratigraphy.

Otowi Member of the Bandelier Tuff, Qbo (275–520 ft bgs)

The Otowi Member of the Bandelier Tuff was present from 275 to 520 ft bgs in CdV-37-1i. The upper contact was chosen on the basis of the natural gamma log signature. As discussed above, there is some uncertainty as to the accurate placement of the Cerro Toledo interval/Otowi Member contact. The Otowi Member is a poorly welded rhyolite ash-flow tuff (i.e., ignimbrite) that is pumiceous, crystal-bearing, and locally lithic-rich. Abundant pale orange to white pumice lapilli noted in cuttings are typically glassy with quartz and sanidine phenocrysts. Locally abundant volcanic lithics occur in cuttings as subangular to subrounded fragments of intermediate composition, including porphyritic dacites and andesite. Cuttings locally exhibit abundant fine volcanic ash and numerous quartz and sanidine crystals.

Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff, Qbog (520–537 ft bgs)

The Guaje Pumice Bed occurred from 520 to 537 ft bgs. This air-fall tephra deposit forms the base of the Otowi Member. The unit contained abundant (up to 97% by volume) rounded, lustrous, vitric, phenocryst-poor pumice lapilli with minor occurrences of small volcanic lithic fragments and quartz and sanidine crystals.

Puye Formation (Upper), Tpf (537–689 ft bgs)

An upper tongue of Puye Formation volcaniclastic sediments was encountered from 537 to 689 ft bgs. These moderately cemented sediments typically range from fine to coarse gravels with a silty sand matrix to moderately well sorted sandstones with variable gravel content. Fine to coarse detritus is comprised of diverse volcanic rocks, predominantly dacites and other rocks of intermediate volcanic composition.

Cerros del Rio Basalt, Tb 4 (689–740 ft bgs)

The Cerros del Rio basalt, encountered in CdV-37-1i from 689 to 740 ft bgs, locally forms a sequence of lavas, cinders, breccias, and agglomerate of basaltic composition. The Cerros del Rio section is approximately 51 ft thick. Its upper part, from 689 to 710 ft bgs, includes a thin olivine- and clinopyroxene-phyric basalt flow and overlying layer of clay-rich volcanic breccia. The lower Tb 4 section, from 710 to 740 ft bgs, contains cinder deposits and agglomerate.

Puye Formation (Lower), Tpf (740–803 ft bgs)

Lower Puye Formation volcaniclastic sediments (Tpf), intersected from 740 ft to the bottom of the CdV-37-1i borehole at 803 ft bgs, are locally a minimum of 63 ft thick. These fine to coarse gravels with silty sand are generally weakly to moderately cemented. The majority of the Puye section is comprised of volcanic detritus, predominantly of gray biotite- and/or hornblende-phyric dacites with less abundant lithologies ranging from andesite to rhyolite. Fine-grained Precambrian (quartzite, granitic rocks, microcline, etc.) detritus occurs in trace amounts throughout the lower Puye Formation section in CdV-37-1i.

5.2 Groundwater

Perched groundwater was first encountered in well CdV-37-1i at approximately 207 to 210 ft bgs in the upper part of the Cerro Toledo interval on October 15. This zone initially produced water (with air-only circulation) at an estimated 35 gpm that rapidly diminished to 3 gpm and eventually was dry in about 1 h; a water sample was collected and drilling continued. Additional samples were collected at 250 and 270 ft bgs on October 16.

As the borehole progressed, slight indications of groundwater were noted at approximately 500, 537, 580, and 620 ft bgs during drilling. Each of these zones was investigated by lifting the casing string slightly, followed by air-only circulation. Of these intervals, only the 620-ft-bgs zone was found to have sustainable recharge. It had an apparent fluid level of approximately 618 ft bgs after activities were suspended for 2.5 h, and the water was sampled on October 24. Drilling then continued to a depth of 640 ft bgs. Early the next evening, before drilling ahead, the water level in the borehole had stabilized at 627.8 ft bgs, and a water sample was collected.

No indications of groundwater were noted while the open-hole interval was drilled from 691 ft bgs to borehole TD at 803.0 ft bgs. A video survey run to 790 ft bgs confirmed the lack of groundwater but showed a small amount of water entering from behind the 12-in. casing shoe at 680 ft bgs. The 12-in. casing string had been raised from its initial landing point roughly 10 ft to allow water inflow.

No groundwater was observed during coring operations to the TD of 305.0 ft bgs in the CdV-37-1i corehole. An effort was made to locate the thin water-bearing zone the rotary drilling operation had identified at around 207 to 210 ft bgs. First, the hole was cored open hole to 208 ft bgs while the 7-in. casing was left at 177 ft bgs, and then the hole was cored open hole to 220 ft bgs after advancing the 7-in. casing to 197 ft bgs. No standing water was observed in the corehole after each of these open-hole intervals was allowed to equilibrate for approximately 1 h. Returned core at 180 ft bgs was noted as being damp, and at 199 ft bgs it was noted as wet. Returned core below 199 ft bgs was described as dry.

6.0 BOREHOLE LOGGING

A video log, a gamma ray log, and two induction logs were collected during the CdV-37-1i drilling project using Laboratory-owned equipment. A summary of video and geophysical logging runs is presented in Table 6.0-1. No logging was conducted in the CdV-37-1i corehole.

6.1 Video Logging

A single video logging run to 790 ft bgs was made by Laboratory personnel (using Laboratory equipment) in the CdV-37-1i monitoring well on October 27. The video showed no evidence of water entering the borehole from 740 to 790 ft bgs in the lower Puye Formation interval, and only a trickle was seen entering from outside the casing shoe at 680 ft bgs. The video log is presented on a DVD in Appendix D of this report.

6.2 Geophysical Logging

A natural gamma-ray survey was run in the borehole on October 27 by Laboratory personnel. However, the gamma ray tool malfunctioned and experienced depth-determination problems that rendered it unreliable. No induction log was run at that time because of a lack of water in the borehole. Two open-hole intervals (611 to 660 ft bgs and 695 to 719 ft bgs) were logged with the Laboratory induction tool on November 1. A successful natural gamma ray survey was obtained from 0 to 650 ft bgs on November 6 after the borehole was backfilled to 661.7 ft bgs and before the monitoring well was installed. Logging data are presented on the CD as part of Appendix E, and Table 6.0-1 summarizes the individual geophysical logging runs.

7.0 WELL INSTALLATION

The CdV-37-1i well was installed between November 6 and December 2.

7.1 Well Design

The CdV-37-1i well was designed in accordance with the Consent Order and approved by NMED before it was installed. The well was designed with a single screened interval between 632.0 and 652.0 to monitor perched groundwater quality and water levels in the upper Puye Formation.

7.2 Well Construction

The CdV-37-1i monitoring well was constructed of 5.0-in.-I.D./5.56-in.-O.D. type A304 passivated stainless-steel threaded 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 0.020-in. wire-wrapped well screen. Compatible external stainless-steel couplers (also type A304 passivated stainless steel fabricated to ASTM A312 standards) were used to join all individual casing and screened sections. The coupled unions between threaded sections were approximately 0.7 ft long. The screen and all casing were steam- and pressure-washed on-site before installation. During well construction, 2 in.-I.D. steel threaded/coupled tremie pipe string (decontaminated before use) was used to deliver backfill and annular fill materials. The placement of annular and backfill materials was accomplished by installing the materials, retracting the drill casing, and raising the tremie pipe. As each section of drill casing was cut off the string, it was picked up and laid down. During this part of the process, the well casing was hung on a wireline while the drill casing was supported by a ring and slips on casing jacks. As Figure 7.2-1 shows, short lengths of 12-in.-diameter casing/shoe (3.0 ft long) and 16-in. (6.3 ft long) remain in the borehole. The 12-in. casing stub was entombed in bentonite backfill, while the 16-in. casing stub was set in the Portland cement surface seal.

The nominal 20-ft-long screened interval was set from 632.0 to 652.5 ft bgs. A 5.3-ft-long stainless-steel sump was placed below the bottom of the well screen. Stainless-steel centralizers (two sets of four) were welded to the well casing approximately 2.0 ft above and below the screen. Figure 7.2-1 presents an as-built schematic showing construction details for the completed well.

While monitoring water levels in the borehole and moving the drill rig off the borehole, the stainless-steel well casing and screen were decontaminated on-site. Additional backfill, also 3/8-in. bentonite chips, was emplaced in the borehole, bringing TD to 660.7 ft bgs. On November 5, a Semco work-over rig replaced the dual-rotary rig for well-construction activities when the backfilling was completed. Before the well casing was installed, Laboratory personnel ran a natural gamma ray log in the borehole from 661 ft bgs to surface. The stainless-steel well casing and screen were started in the borehole after the geophysical logging concluded and were hung in the hole with the bottom at 657.8 ft bgs on November 8. Bentonite (3/8-in. chips) was then emplaced in the borehole to bring the backfill level up to the bottom of the well casing to 657.8 ft bgs. In total, 121.4 ft^3 of bentonite was added to the borehole as backfill.

The filter pack for the screened interval was then placed from 657.8 to 625.9 ft bgs using a total of 34.5 ft^3 of 10/20 silica sand; the filter pack was surged twice ensuring proper compaction. The volume of 10/20 sand required exceeded the calculated volume for the interval by approximately 48%, most likely because of borehole washout across the water-bearing zone. A 2-ft-thick fine sand transition collar (625.9 to 624.0 ft bgs) was added on top of the filter pack on November 10 using 1.5 ft^3 of 20/40 silica sand.

A hydrated bentonite seal was added on top of the transition sand from 624.0 to 457.9 ft bgs from November 11 to 18. Initially, 8.0 ft^3 of ¼-in. bentonite pellets was placed, followed by 93.7 ft^3 of 3/8-in. chips, for a total of 101.7 ft^3 of bentonite (dry volume). The cement seal began to be added on November 18. A total of 795.5 ft^3 of neat (100%) Portland cement grout was added between 457.9 and 3 ft bgs, ending on December 2, which marked the end of well construction. The cement volume in the surface seal was approximately 36% greater than the calculated volume for the interval and is probably the result of hydrostatic pressures within the cement column, forcing the cement into the formation. Table 7.2-1 itemizes the volumes of all materials used during well construction.

Overall, well construction proceeded smoothly 12 h/d, 7 d/wk (night time only) from November 6 (well casing installation) to December 2. Progress slowed slightly during emplacement of the bentonite seal because of standing water in the annular space, which required more careful addition of material to avoid plugging the tremie pipe.

8.0 POSTINSTALLATION ACTIVITIES

Following well installation at CdV-37-1i, the well was developed. The wellhead and surface pad were constructed, a dedicated sampling system was installed, and a geodetic survey was performed. Site-restoration activities will be completed following the final disposition of contained drill cuttings and groundwater, per the NMED-approved waste-disposal decision trees.

8.1 Well Development

Well development occurred from December 3 to 7. Initially, the screened interval was bailed and swabbed to remove formation fines in the filter pack and sump. Bailing and swabbing continued until water clarity visibly improved. Final development was accomplished using a submersible pump. Approximately 4682 gal. of groundwater was purged at CdV-37-1i during the 4 d of well development activities. Another 4965 gal. was purged during aquifer testing, and an additional 980 gal. was purged after the conclusion of aquifer testing. Total groundwater purged during postinstallation activities was 10,627 gal.

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 in both directions across the screened interval, causing a surging action across the screen/filter pack. After bailing and swabbing were completed, a 4-in. 5-hp Grundfos submersible pump was installed in the well for the final stage of well development.

During the pumping stage of well development, turbidity, temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductance parameters were measured. In addition, two water samples were collected for TOC analysis. The required values for TOC and turbidity to determine adequate well development are less than 2.0 ppm and less than 5 nephelometric turbidity units (NTUs), respectively. The target values for both parameters were achieved at CdV-37-1i.

8.1.1 Well Development Field Parameters

Field parameters were measured at well CdV-37-1i by collecting aliquots of groundwater from the discharge pipe without the use of a flow-through cell. Several attempts were made to use a flow-through cell during both development and aquifer testing, but the flexible tubing feeding the cell continually froze. A further discussion of well development field parameters and TOC measurements from water purged during development is presented in Appendix B.

As Table B-1.3-1 shows, measurements of pH varied from 7.59 to 8.25, and temperature varied from 14.59°C to 16.04°C. Dissolved oxygen varied from 6.98 to 8.80 mg/L and oxidation-reduction potential (Eh) values (corrected from ORP measurements) varied from 317.5 to 160.2 millivolts (mV). Specific conductance ranged from 123 to 183 microsiemens per centimeter (μS/cm). Values of turbidity measured at CdV-37-1i ranged from 11.0 to 0.1 NTUs for the nonfiltered groundwater samples.

The final field parameters measured at the end of development at CdV-37-1i were pH of 7.62, temperature of 15.87ºC, specific conductance of 140 μS/cm, and turbidity of 0.1 NTU.

8.2 Aquifer Testing

An aquifer pumping test was conducted at CdV-37-1i from December 10 to 14. Several short-duration pumping tests were performed initially. A 24-h constant rate test, followed by a 24-h recovery period, completed the testing. A 5-hp Grundfos submersible pump was used during testing. Approximately 4965 gal. of groundwater was purged at CdV-37-1i during aquifer testing activities.

Turbidity, temperature, pH, DO, ORP, and specific conductance parameters were measured during the 24-h test. In addition, water samples were collected for TOC analysis.

A discussion of water removed during well development, field water-quality parameters, and analytical results for samples collected during development is summarized below in section 8.2.1 and detailed in Table B-1.2-1 of Appendix B. Results of the CdV-37-1i aquifer test are presented in Appendix C.

8.3 Dedicated Sampling System Installation

The dedicated sampling system for CdV-37-1i was installed on January 16, 2010. The sampling system uses a single 4-in.-O.D., 1.5-hp environmentally retrofitted Grundfos submersible pump set in the bottom half of the screened interval. Because of the lack of available water above the screen, the pump was set within the screened interval in a stainless-steel pump shroud; the bottom of the shroud is at 647.3 ft bgs. The pump riser pipe consists of threaded and coupled 1-in.-I.D. pickled and passivated schedule 40 stainless steel. Two 1-in.-diameter polyvinyl chloride (PVC) tubes were installed with and were banded to the pump riser pipe. One tube is to be used for the dedicated pressure transducer and the other for manual water-level measurements. Both tubes are 1.0-in.-I.D. flush-threaded schedule 80 PVC pipe; each tube has a 6-in.-long 0.010-in. screen-slot interval at the bottom of the tube. An In-Situ Level Troll 500 30 psig vented transducer has been installed in one of the PVC tubes to monitor the water level in the well's screened interval.

Details of the construction and sampling-system component installation for CdV-37-1i are presented in Figure 8.3-1a. Figure 8.3-1b presents technical notes for the well.

8.4 Wellhead Completion

A reinforced concrete surface pad, 10 ft × 10 ft × 6 in. thick, was installed at the CdV-37-1i (monitoring well) wellhead. The concrete pad was slightly elevated above the ground surface and crowned to promote runoff. The pad will provide long-term structural integrity for the well. A brass survey pin was embedded in the northwest corner of the pad. A 10-in.-I.D. steel protective casing with a locking lid was installed around the stainless-steel well riser. A total of four bollards, painted yellow for visibility, are set at the outside edges of the pad to protect the well from traffic. All four bollards are designed for easy removal to allow access to the well. Details of the wellhead completion are presented in Figure 8.3-1a.

8.5 Geodetic Survey

A New Mexico licensed professional land surveyor conducted a geodetic survey on March 12, 2010 (Tables 8.5-1 and 8.5-2). The survey data collected conforms 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 as New Mexico State Plane Coordinate System Central Zone (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 brass pin in the concrete pad, the top of the well casing, the top of the protective casing for the CdV-37-1i monitoring well, and the location and ground-level elevation of the abandoned CdV-37-1i corehole.

8.6 Waste Management and Site Restoration

Waste generated from the CdV-37-1i project includes drilling fluids, purged groundwater, drill cuttings, decontamination water, and contact waste. A summary of the waste characterization samples collected during drilling, construction, and development of the CdV-37-1i well is presented in Table 8.6-1.

All waste streams produced during drilling and development activities were sampled in accordance with waste characterization strategy form for CdV-37-1i (LANL 2008, 103916).

Fluids produced during drilling and well development are expected to be land-applied after a review of associated analytical results per the waste characterization strategy form (WCSF) and the Standard Operating Procedure (SOP) 010.0, Land Application of Groundwater. If it is determined that drilling fluids are nonhazardous but do not meet the criteria for land application, the drilling fluids will be evaluated for treatment and disposal at one of the Laboratory's six wastewater treatment facilities. If analytical data indicate that the drilling fluids are hazardous/nonradioactive or mixed low-level waste, the drilling fluids will be disposed of at an authorized facility.

Cuttings produced during drilling are anticipated to be land-applied after a review of associated analytical results per the WCSF and ENV-RCRA SOP-011.0, Land Application of Drill Cuttings. If the drill cuttings do not meet the criterion for land application, they will be disposed of at an authorized facility. Decontamination fluid used for cleaning the drill rig and equipment is containerized onsite. The fluid waste was sampled and will be disposed of at an authorized facility. Characterization of contact waste will be based upon acceptable knowledge (AK), pending analyses of the waste samples collected from the drill cuttings, purge water, and decontamination fluid.

Site-restoration activities will include removing drilling fluids and cuttings from the pit and managing the fluids and cuttings in accordance with applicable SOPs, removing the polyethylene liner, removing the containment area berms, and backfilling and regrading the containment area, as appropriate.

9.0 DEVIATIONS FROM PLANNED ACTIVITIES

All aspects of drilling, sampling, well construction, and aquifer testing at the CdV-37-1i monitoring well and the CdV-37-1i corehole were performed as specified in “Drilling Plan for Intermediate Well CdV-37-1i and CdV-37-1i Corehole” (TerranearPMC 2009, 106980).

10.0 ACKNOWLEDGMENTS

Boart Longyear drilled and installed the CdV-37-1i monitoring well and drilled and abandoned the CdV-37-1i corehole.

Patrick Longmire wrote Appendix B, Groundwater Analytical Results.

David Schafer wrote Appendix C, Aquifer Testing Report.

Los Alamos National Laboratory personnel ran downhole video and geophysical logging equipment.

Terranear PMC provided oversight on all preparatory and field-related activities.

11.0 REFERENCES AND MAP DATA SOURCES

11.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the EP Directorate’s RPF and are used to locate the document at the RPF and, where applicable, in the master reference set.

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

LANL (Los Alamos National Laboratory), March 2006. “Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan,” Los Alamos National Laboratory document LA-UR-06-1840, Los Alamos, New Mexico. (LANL 2006, 092600)

LANL (Los Alamos National Laboratory), October 4, 2007. “Integrated Work Document for Regional and Intermediate Aquifer Well Drilling (Mobilization, Site Preparation and Setup Stages),” Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2007, 100972)

LANL (Los Alamos National Laboratory), October 2008. “Waste Characterization Strategy Form for the R-38, R-41, R-44, R-45, and R-46 Regional Groundwater Well Installation and Corehole Drilling,” Los Alamos, New Mexico. (LANL 2008, 103916)

LANL (Los Alamos National Laboratory), July 2009. "Drilling Work Plan for Perched-Intermediate Aquifer Well CdV-37-1i," Los Alamos National Laboratory document LA-UR-09-4726, Los Alamos, New Mexico. (LANL 2009, 106689)

LANL (Los Alamos National Laboratory), September 9, 2009. "Waste Characterization Strategy Form for South Canyon Wells CdV-37-1i and R-27i Intermediate Aquifer Well Installation and Corehole Drilling," Los Alamos, New Mexico. (LANL 2009, 106895)

TerranearPMC, September 2009. "Drilling Plan for Intermediate Well CdV-37-1i and CdV-37-1i Corehole," plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (TerranearPMC 2009, 106980)

11.2 Map Data Sources for CdV-37-1i Completion Report Location Map

Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2009-0283; June 4, 2009.

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; January 6, 2004; as published January 4, 2008.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; January 6, 2004; as published January 4, 2008.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; January 6, 2004; as published January 4, 2008.

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

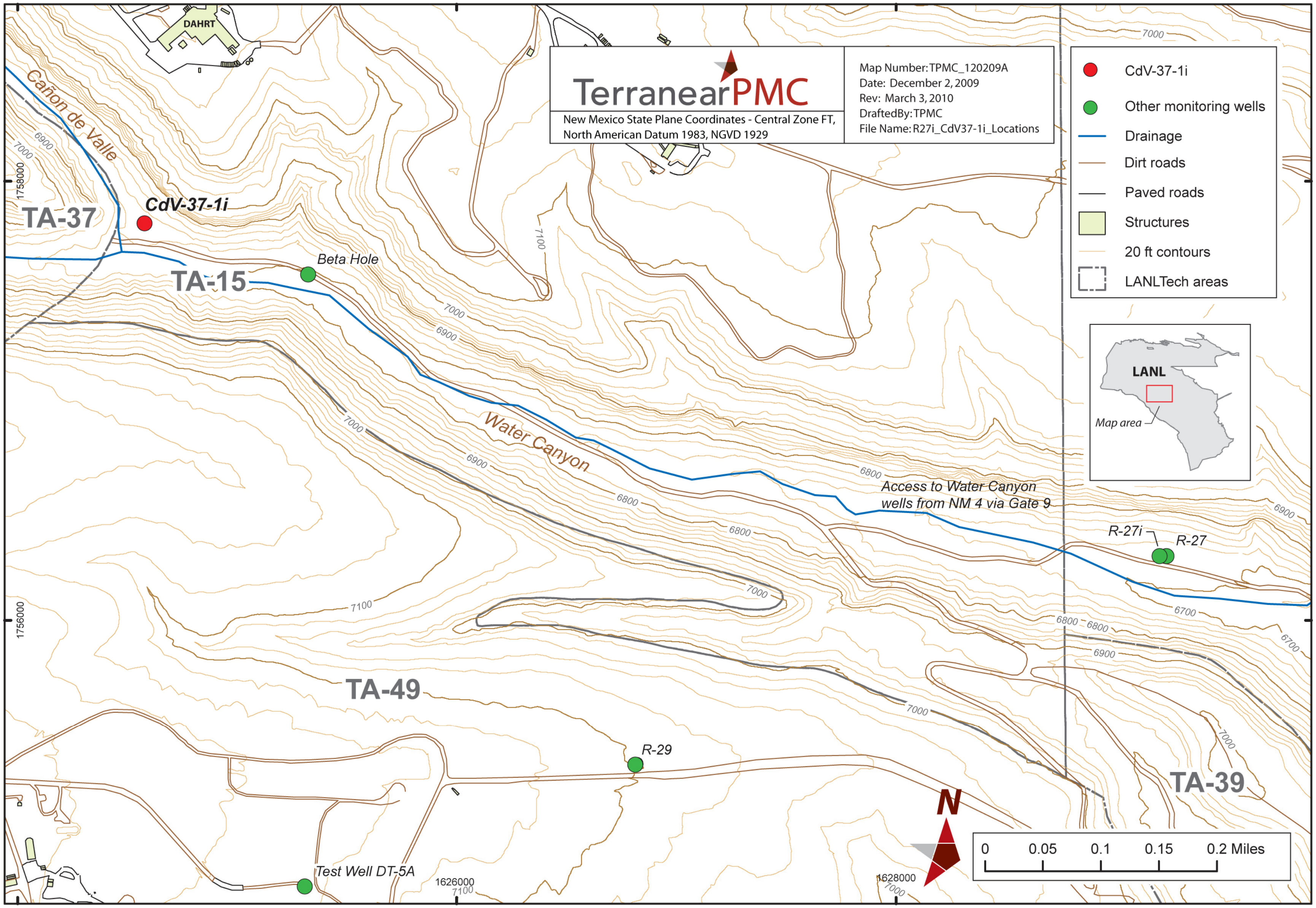

Figure 1.0-1 Locations of monitoring well CdV-37-1i and associated corehole

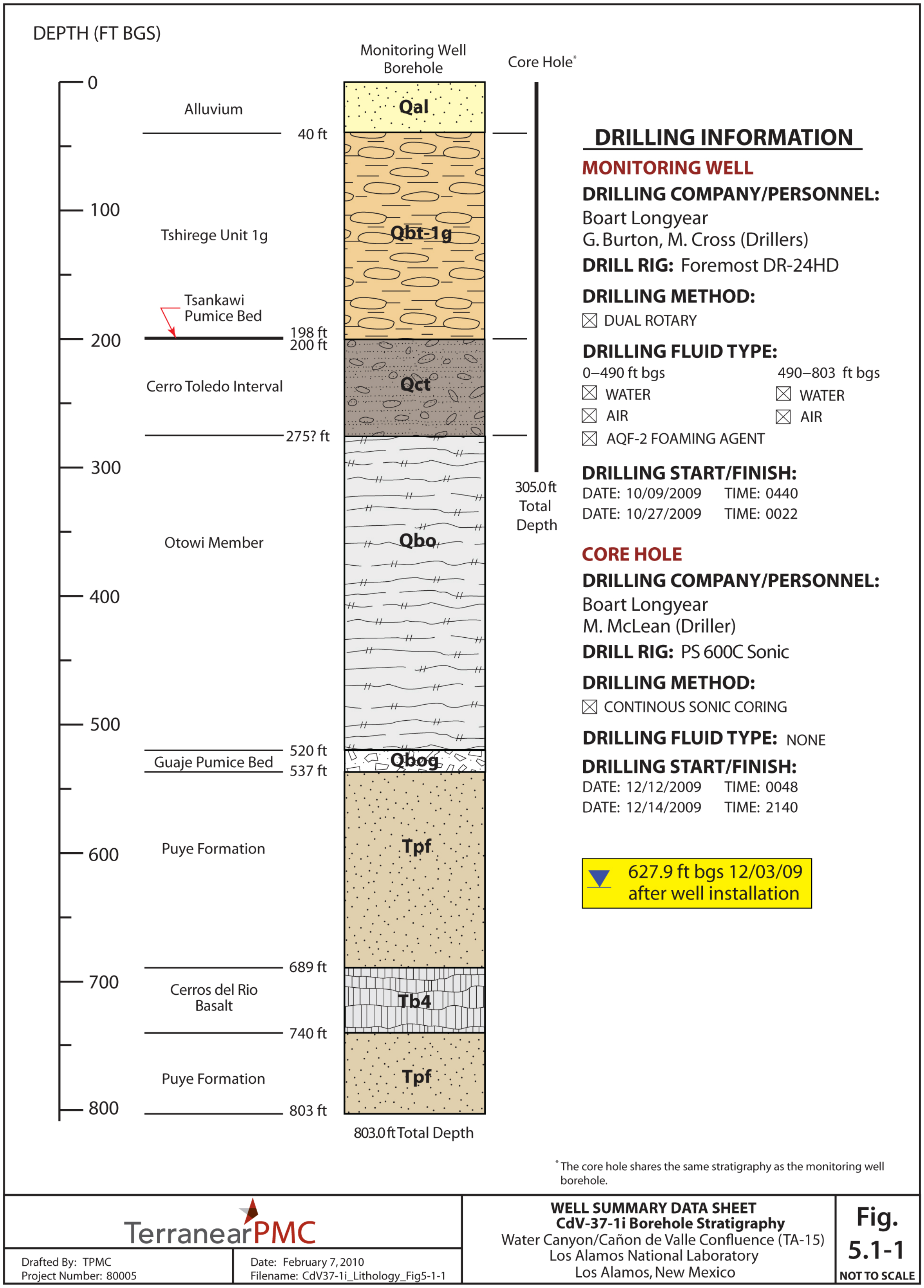

Figure 5.1-1 Monitoring well CdV-37-1i borehole stratigraphy

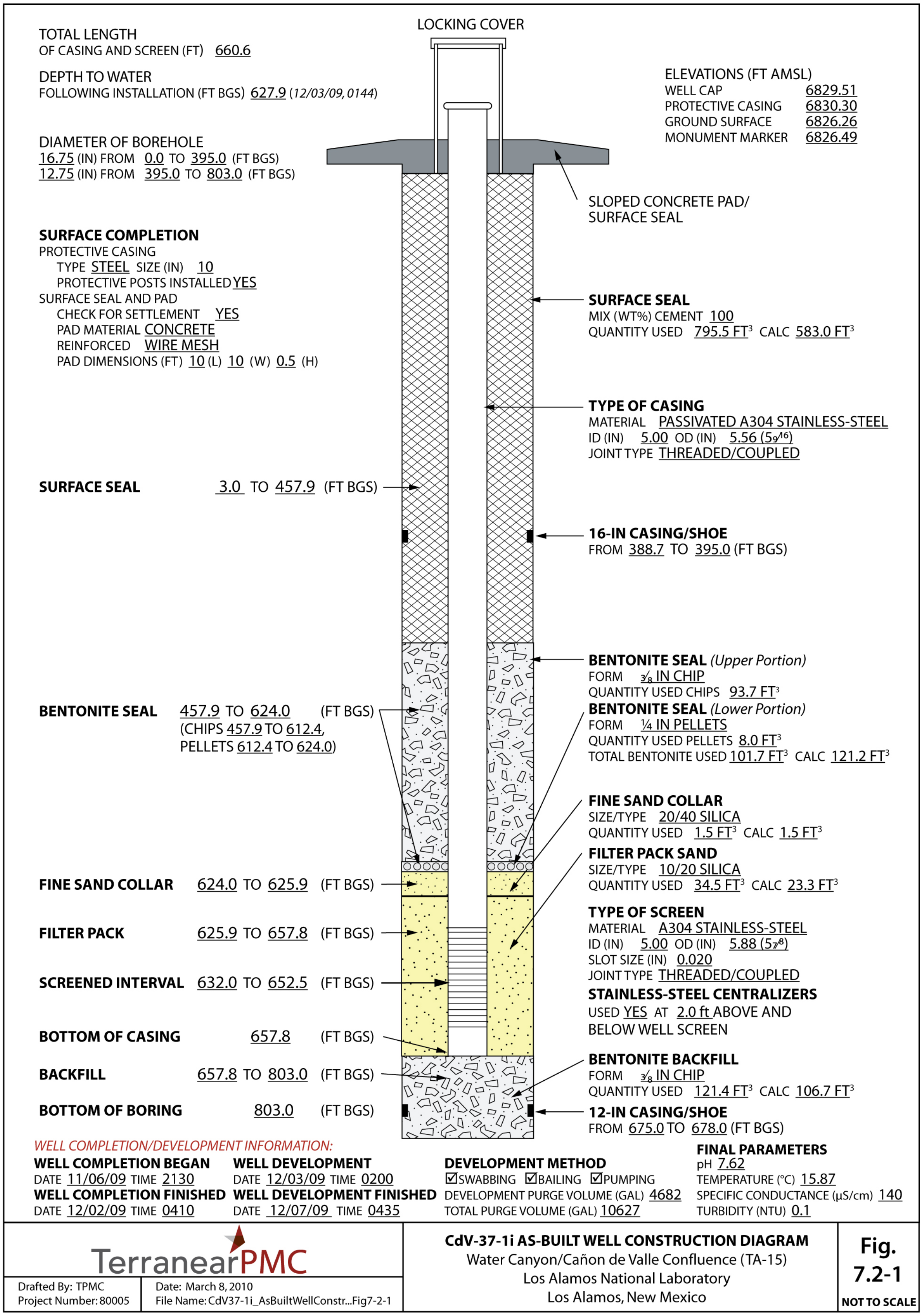

Figure 7.2-1 Monitoring well CdV-37-1i as-built well construction diagram

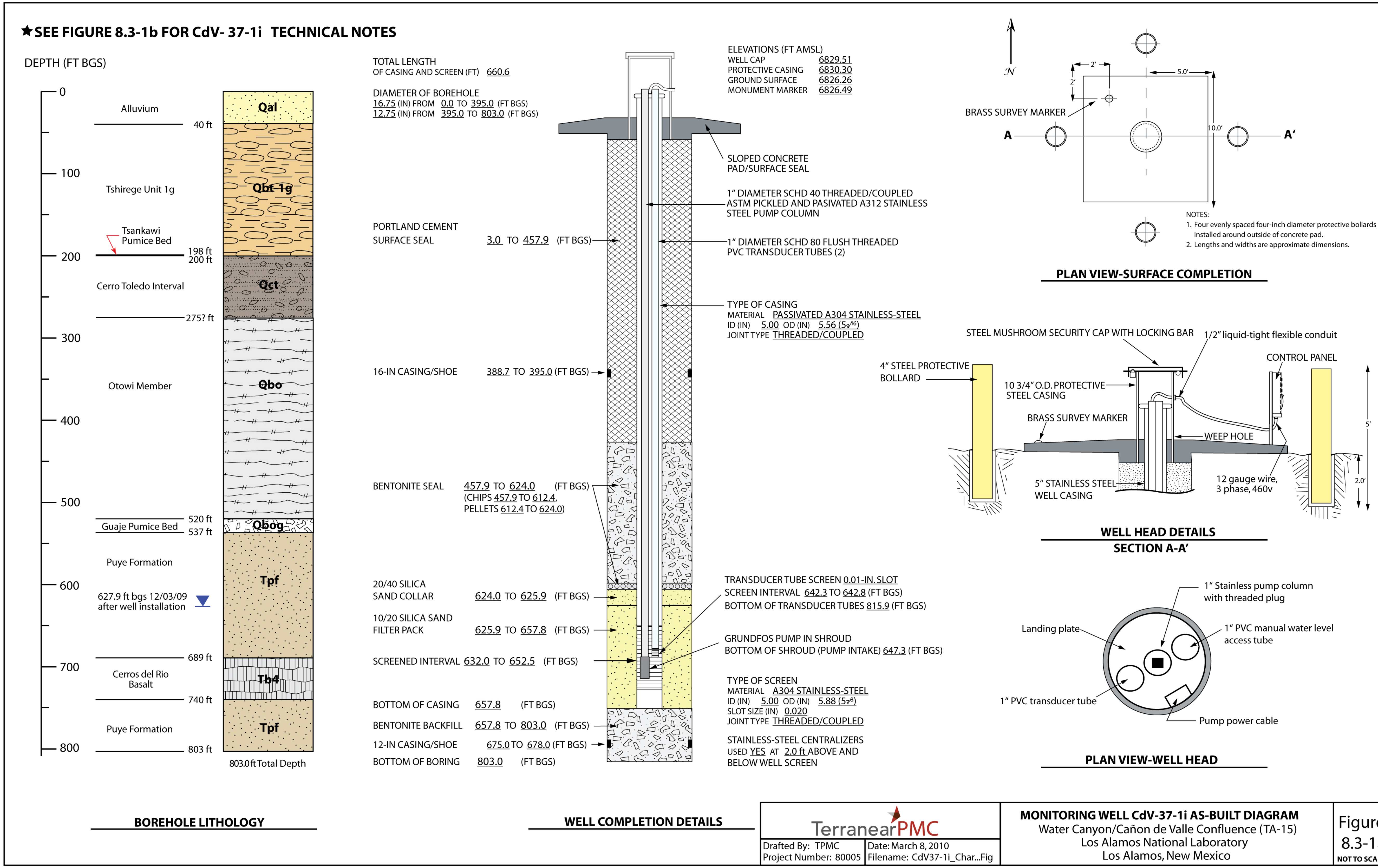

Figure 8.3-1a As-built schematic for intermediate perched water monitoring well CdV-37-1i

CdV-37-1i TECHNICAL NOTES:

SURVEY INFORMATION*

Brass Marker
Northing: 1757798.61 ft
Easting: 1624592.30 ft
Elevation: 6826.49 ft AMSL

Well Casing (top of stainless steel)
Northing: 1757793.07 ft
Easting: 1624593.69 ft
Elevation: 6829.51 ft AMSL

BOREHOLE GEOPHYSICAL LOGS

LANL: Video, Natural Gamma Ray

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

MILESTONE DATES

Drilling
Start: 10/09/2009
Finished: 10/27/2009

Well Completion
Start: 11/06/2009
Finished: 12/02/2009

Well Development
Start: 12/03/2009
Finished: 12/07/2009

WELL DEVELOPMENT

Development Methods
Performed swabbing, bailing, and pumping
Volume Purged: 4,682 gallons
Total Volume Purged: 10,627 gallons

Parameter Measurments (Final)
pH: 7.62
Temperature: 15.87°C
Specific Conductance: 140 μS/cm
Turbidity: 0.1 NTU

AQUIFER TESTING

Constant Rate Pumping Test
Water Purged: 4,965 gallons
Average Flow Rate: 2.76 gpm
Performed on: 12/11–14/2009

DEDICATED SAMPLING SYSTEM

Pump (Shrouded)
Make: Grundfos
Model: B08110031-P10729286
Capacity: 5 U.S. gpm, Shroud at 647.3 ft bgs
Environmental Retrofit

Motor
Type: Franklin Electric 1.5 hp
Model: 2345249403
1.5 HP, 3-phase

Pump Column
1-in. threaded/coupled schd. 40, ASTM pickled and passivated A312stainless-steel tubing

Transducer Tubes
2 × 1-in. flush threaded schd. 80 PVC tubing
0.01-in. slot screen at 642.3–642.8 ft bgs

Transducer
Make: In-Situ, Inc.
Model: Level TROLL 500
30 psig range (vented)
S/N: 156563

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

TerranearPMC		**CdV-37-1i TECHNICAL NOTES** Water Canyon/Cañon de Valle Confluence (TA-15) Los Alamos National Laboratory Los Alamos, New Mexico	Figure 8.3-1b **NOT TO SCALE**
Drafted By: TPMC Project Number: 80005	Date: March 8, 2010 Filename: CdV37-1i_TechnicalNotes_Fig8-3-1b		

Figure 8.3-1b As-built technical notes for monitoring well CdV-37-1i

Table 3.1-1
Fluid Quantities Used during Drilling and Construction of CdV-37-1i Monitoring Well

Date	Water (gal.)	Cumulative Water (gal.)	AQF-2 Foam (gal.)	Cumulative AQF-2 Foam (gal.)
Drilling				
10/09/09	50	50	0.5	0.5
10/10/09	700	750	10	10.5
10/11/09	500	1250	10	20.5
10/12/09	200	1450	2	22.5
10/13/09	600	2050	8	30.5
10/15/09	500	2550	5	35.5
10/16/09	1000	3550	6	41.5
10/17/09	1600	5150	5	46.5
10/18/09	300	5450	2	48.5
10/19/09	50	5500	0	48.5
10/22/09	900	6400	5	53.5
10/23/09	400	6800	0	53.5
10/24/09	400	7200	0	53.5
10/25/09	1000	8200	0	53.5
10/26/09	1700	9900	0	53.5
10/27/09	1500	11400	0	53.5
Well Construction				
10/28/09	700	12100	n/a*	n/a
10/29/09	500	12600	n/a	n/a
10/30/09	250	12850	n/a	n/a
11/03/09	700	13550	n/a	n/a
11/04/09	1500	15050	n/a	n/a
11/09/09	200	15250	n/a	n/a
11/10/09	1200	16450	n/a	n/a
11/11/09	600	17050	n/a	n/a
11/12/09	700	17750	n/a	n/a
11/13/09	1700	19450	n/a	n/a
11/14/09	2400	21850	n/a	n/a
11/15/09	1200	23050	n/a	n/a
11/16/09	2800	25850	n/a	n/a
11/17/09	2500	28350	n/a	n/a
11/19/09	100	28450	n/a	n/a
11/21/09	700	29150	n/a	n/a
11/22/09	500	29650	n/a	n/a

Table 3.1-1 (continued)

Date	Water (gal.)	Cumulative Water (gal.)	AQF-2 Foam (gal.)	Cumulative AQF-2 Foam (gal.)
11/23/09	800	30450	n/a	n/a
12/01/09	1000	31450	n/a	n/a
12/02/09	500	31950	n/a	n/a
Total Water Volume (gal.)				
CdV-37-1i	**31,950**			

*n/a = Not applicable. Foam use discontinued during drilling at 490 ft bgs.

Table 4.2-1
Summary of Groundwater-Screening Samples Collected during Drilling, Well Development, and Aquifer Testing of Monitoring Well CdV-37-1i

Location ID	Sample ID	Date Collected	Collection Depth (ft bgs)	Sample Type	Analysis
Drilling					
CdV-37-1i	GW37_1(i)-09-13128	10/15/09	210	Groundwater, airlifted	Anions, cations, LH3, HE, VOCs, perchlorate
CdV-37-1i	GW37_1(i)-09-13129	10/16/09	250	Groundwater, airlifted	Anions, cations, LH3, HE, VOCs, perchlorate
CdV-37-1i	GW37_1(i)-09-13130	10/16/09	270	Groundwater, airlifted	Anions, cations, LH3, HE, VOCs, perchlorate
CdV-37-1i	GW37_1(i)-09-13131	10/24/09	620	Groundwater, airlifted	Anions, cations, LH3, HE, VOCs, perchlorate
CdV-37-1i	GW37_1(i)-09-13132	10/24/09	640	Groundwater, airlifted	Anions, cations, LH3, HE, VOCs, perchlorate
Development					
CdV-37-1i	GW37_1(i)-09-13138	12/06/09	632.0–652.5	Groundwater, pumped	TOC
CdV-37-1i	GW37_1(i)-09-13139	12/07/09	632.0–652.5	Groundwater, pumped	TOC
Aquifer Testing					
CdV-37-1i	GW37_1(i)-09-13140	12/11/09	632.0–652.5	Groundwater, pumped	TOC
CdV-37-1i	GW37_1(i)-09-13141	12/11/09	632.0–652.5	Groundwater, pumped	TOC
CdV-37-1i	GW37_1(i)-09-13142	12/12/09	632.0–652.5	Groundwater, pumped	TOC
CdV-37-1i	GW37_1(i)-09-13143	12/12/09	632.0–652.5	Groundwater, pumped	TOC

Table 4.3-1
Summary of Core Samples Collected
for Analysis during Drilling of CdV-37-1i Corehole

Sample ID	Date Collection	Collection Depth (ft bgs)	Geologic Zone	Analyses
GW37_1(i)-10-7780	12/12/09	10.5–11.0	Qal	Anions and metals
GW37_1(i)-10-7798	12/12/09	11.0–11.5	Qal	Anions, metals, NMEDE*
GW37_1(i)-10-7781	12/12/09	20.0–20.5	Qal	Anions and metals
GW37_1(i)-10-7799	12/12/09	20.5–21.0	Qal	Anions, metals, NMEDE
GW37_1(i)-10-7782	12/12/09	30.0–30.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7800	12/12/09	30.5–31.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7783	12/12/09	40.0–40.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7801	12/12/09	40.5–41.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7784	12/12/09	50.0–50.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7802	12/12/09	50.5–51.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7785	12/12/09	60.0–60.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7803	12/12/09	60.5–61.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7786	12/12/09	80.0–80.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7804	12/12/09	80.5–81.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7787	12/13/09	100.0–100.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7805	12/13/09	100.5–101.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7788	12/13/09	140.0–140.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7806	12/13/09	140.5–141.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7789	12/13/09	180.0–180.5	Qbt 1g	Anions and metals
GW37_1(i)-10-7807	12/13/09	180.5–181.0	Qbt 1g	Anions, metals, NMEDE
GW37_1(i)-10-7790	12/14/09	220.0–220.5	Qct	Anions and metals
GW37_1(i)-10-7808	12/14/09	220.5–221.0	Qct	Anions, metals, NMEDE
GW37_1(i)-10-7791	12/14/09	260.0–260.5	Qct	Anions and metals
GW37_1(i)-10-7809	12/14/09	260.5–261.0	Qct	Anions, metals, NMEDE
GW37_1(i)-10-7792	12/14/09	300.0–300.5	Qbo	Anions and metals
GW37_1(i)-10-7810	12/14/09	300.5–301.0	Qbo	Anions, metals, NMEDE

*NMEDE = NMED explosives suite.

Table 6.0-1
CdV-37-1i Monitoring Well Video and Geophysical Logging Runs

Date	Depth (ft bgs)	Description
10/27/09	680–790	Ran LANL video and natural gamma ray tools. Video shows no evidence of water entering the borehole from 740–790 ft bgs in the lower Puye Fm. Interval and only a slight trickle entering from outside the casing shoe at 680 ft bgs. The gamma ray log experienced data problems and is deemed unreliable. No induction log was run due to the lack of water in the borehole.
11/02/09	611–660 and 695–719	Ran LANL induction tool prior to backfilling bottom portion of borehole.
11/06/09	Surface–650	Ran LANL natural gamma ray log after backfilling the borehole to 661.7 ft bgs with bentonite and before installing well screen and casing in the borehole.

Table 7.2-1
CdV-37-1i Monitoring Well Annular Fill Materials

Material	Volume (ft^3)
Surface seal: cement slurry	795.5
Upper seal: bentonite chips	93.7
Upper seal: bentonite pellets	8.0
Fine sand collar: 20/40 silica sand	1.5
Filter pack: 10/20 silica sand	34.5
Backfill: bentonite chips	121.4

Table 8.5-1
CdV-37-1i Monitoring Well Survey Coordinates

Identification	Northing	Easting	Elevation
CdV-37-1i brass pin embedded in pad	1757798.61	1624592.30	6826.49
CdV-37-1i ground surface near pad	1757797.29	1624589.45	6826.26
CdV-37-1i top of 10-in. protective casing	1757792.82	1624593.68	6830.30
CdV-37-1i top of stainless-steel well casing	1757793.07	1624593.69	6829.51

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

Table 8.5-2
CdV-37-1i Corehole Survey Coordinates

Identification	Northing	Easting	Elevation
CdV-37-1i (abandoned) corehole location	1757749.63	1624551.27	6825.18

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

Table 8.6-1
Summary of Waste Samples Collected during Drilling and Development of CdV-37-1i Monitoring Well and Corehole

Location ID	Sample ID	Date Collected	Description	Sample Type
CdV-37-1i	n/a*	n/a	Contact waste, use AK from drill cuttings	Solid
CdV-37-1i	WST15-10-1890	10/28/09	Drilling fluid (filtered)	Liquid
CdV-37-1i	WST15-10-1891	10/28/09	Drilling fluid (unfiltered)	Liquid
CdV-37-1i	WST15-10-1892	10/28/09	Drilling fluid (unfiltered, duplicate)	Liquid
CdV-37-1i	WST16-10-1888	11/06/09	Drill cuttings	Solid
CdV-37-1i	WST15-10-1910	12/21/09	Development water (filtered)	Liquid
CdV-37-1i	WST15-10-1911	12/21/09	Development water (unfiltered)	Liquid
CdV-37-1i	WST15-10-1912	12/21/09	Development water (unfiltered, duplicate)	Liquid
CdV-37-1i	WST15-10-1894	12/21/09	Decon fluid, tools (filtered)	Liquid
CdV-37-1i	WST15-10-1899	12/21/09	Decon fluid, tools (unfiltered)	Liquid
CdV-37-1i	WST15-10-1903	12/21/09	Decon fluid, tools (unfiltered, duplicate)	Liquid
CdV-37-1i	WST15-10-1898	01/18/10	Decon fluid, pump (filtered)	Liquid
CdV-37-1i	WST15-10-1895	01/18/10	Decon fluid, pump (unfiltered)	Liquid
CdV-37-1i	WST15-10-1902	01/18/10	Decon fluid, pump (unfiltered, duplicate)	Liquid

*n/a = Not applicable.

Appendix A

CdV-37-1i Borehole Lithologic Log
(Descriptive Analysis of Drill Cuttings) and
CdV-37-1i Corehole Lithologic Log
(Descriptive Analysis of Core)

Los Alamos National Laboratory
Regional Hydrogeologic Characterization Project
Borehole Lithologic Log

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 1 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
0–5	**FILL:** Construction fill—gravelly sand containing sub-rounded quartzite pebbles; used as base coarse for drill pad	Fill	Note: Drill cuttings for microscopic and descriptive analysis were collected at 5-ft intervals from 0 ft to borehole TD at 803 ft bgs. Alluvial sediments, encountered from 0 ft to40 ft, are approximately 40ft thick.
5–15	**ALLUVIUM:** Tuffaceous sediments—light olive gray(5 YR 6/1) 5'–15' +10F: 75-85% angular/broken welded crystal-tuff fragments; 15-25% dacitic lithic-fragments and minor pumice.	Qal	Note: Large boulder of welded tuff encountered 5'-15'.
15–35	Tuffaceous sediments—pinkish gray (5 YR 8/1) to white (N9), unconsolidated silty fine to coarse sand with pebble gravel; Constituents generally derived from weathered tuff. 15'-35' WR: abundant white silt. +10F: 95-97% angular to subangular pebble-size volcanic lithic clasts (predominantly dacitic); 3-5% rounded pumices and quartz crystals. +35F: 80-90% quartz and sanidine crystals, 5-15% volcanic lithic grains, and 1-3% pumice fragments. 15'–20': Minor fragments of welded crystal-tuff present.	Qal	
35–40	Tuffaceous sediments—very light gray (N8), unconsolidated silty fine to coarse sand with pebble gravel; Constituents generally derived from weathered tuff 35'–40' +10F: 70-80% subrounded clasts and fragments representing varieties of pumice: weathered and white; black and glassy, and gray vitric pumice with black (obsidian) streaks.	Qal	The Qal–Qbt 1g contact occurs within the 35' to 40' cuttings interval; the contact is placed at 40 ft bgs, based on microscopic examination and analysis of drill cuttings.

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 2 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
0–50	**UNIT 1g OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** Tuff—light gray (N6), poorly welded, strongly pumiceous, crystal-rich and lithic-bearing. 40'–50' WR: 10% volcanic ash. +10F: 90% glassy to weathered-vitric pumice fragments (≤5 mm) that are quartz- and sanidine-phyric, +/- pyroxene and clinopyroxene, with streaks of black obsidian common; 3-5% light gray porphyritic dacite lithic fragments that are hornblende-phyric; 2-3% quartz and sanidine crystals. +35F: 80% quartz and sanidine crystals and 15-20% weathered and glassy pumice fragments.	Qbt 1g	Unit 1g of the Tshirege Member of the Bandelier Tuff (Qbt 1g), encountered from 40 ft to 200 ft bgs, is estimated to be 160 ft thick
50–60	Tuff—light gray (N6), poorly welded, strongly pumiceous, crystal-rich and lithic-bearing. 50'–60' +10F: 97-98% white, generally glassy (with streaks of obsidian) pumice fragments, locally weathered, and 3-2% small (≤5 mm) gray dacite lithics. +35F: 75% quartz and sanidine crystals, 25% white to black glassy pumice fragments.	Qbt 1g	
60–75	Tuff—light gray (N6) to white (N9), poorly welded, strongly pumiceous, crystal-rich and lithic-poor. 60'–75' +10F: white, with black streaks, quartz and sanidine phyric, vitric pumices up to 15 mm; 1% light gray dacite lithic fragments; up to 1% free quartz. +35F: 60-50% quartz and sanidine crystals; 50-40% white, gray and black vitric pumice fragments.	Qbt 1g	
75–90	Tuff—light gray (N6) to white (N9), poorly welded, strongly pumiceous, crystal-rich and lithic-poor. 75'–90' +10F: 98-99% white, glassy, quartz and sanidine-phyric, subrounded (milled?) pumice fragments up to 25 mm; 1-2% light gray, porphyritic, dacitic lithic fragments up to 7 mm.+35F: 50-60% white, glassy and locally black, vitric pumice fragments; 40-50% quartz and sanidine crystals.	Qbt 1g	
90–100	Tuff—white (N9), poorly welded, pumiceous, crystal-rich and lithic-poor. 90'–100' +10F: 99% white, vitric, quartz and sanidine-phyric pumice fragments, up to 9 mm; up to 1%dacite lithic fragments. +35F: 50-60% quartz and sanidine crystals, 40-50% pumice fragments and 3% lithics fragments.	Qbt 1g	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 3 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
100–110	Tuff—white (N9), poorly welded, pumiceous, crystal-rich and lithic-poor. 100'–110' +10F: 97-98% white, vitric pumice fragments, 2-3% dacitic lithic fragments (up to 7 mm).	Qbt 1g	
110–125	Tuff—light gray (N7), poorly welded, weakly indurated, pumiceous, crystal-bearing, lithic-bearing. 110'–125' +10F: 85-90% generally vitric pumices, partly weathered, subangular to subrounded; 10-15% broken fragments of gray and pink dacite and quartz-phyric rhyodacite. +35: 30-40% quartz and sanidine crystals; 20-30% white pumice grains and 10-20% volcanic lithics.	Qbt 1g	
125–140	Tuff—very light gray (N8) to white (N9), pumiceous, poorly welded, weakly indurated, pumiceous, crystal-bearing, lithic-poor. 125'–140' +10F: 99% white, quartz- and sanidine-phyric, vitric to weathered pumice fragments (up to 12 mm); 1% dacite lithic fragments. +35F: 75% pumice grains/fragments with minor limonite staining; 20-25% quartz and sanidine crystals; 2-3% lithic grains.	Qbt 1g	
140–150	Tuff—very light gray (N8) to white (N9), poorly welded, weakly indurated, pumiceous, crystal-bearing, lithic-poor. 140'–150' +10F: 90-95% vitric pumice lapilli/fragments with minor limonite staining: 10-5% volcanic lithics. +35F: 40-50% pumice grains; 30-40% quartz and sanidine crystals; 15-20% dacitic lithic grains.	Qbt 1g	
150–175	Tuff— very pale gray (N8) to gray (5YR 8/1), poorly welded, pumiceous, crystal-bearing, lithic-poor. 150'–175' +10F: 99-100% subrounded, vitric, quartz- and sanidine-phyric pumice fragments with weak yellow-brown limonite staining; up to 1% dacitic lithic clasts (<5mm). +35F: 40-50% pumice grains; 40-50% quartz and sanidine crystals and 2-3% volcanic grains.	Qbt 1g	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 4 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
175–200	Tuff—white (N9), poorly welded, weakly indurated, pumiceous, crystal-bearing, lithic-poor. 175'–200' +10F: 80-90% subrounded to subangular fragments/lapilli (up to 12 mm) of white vitric, quartz- and sanidine-phyric pumice; 15-20% subrounded to broken lithic fragments dacite, rhyodacite and andesite. +35F: 50-60% white pumice fragments; 40-50% quartz and sanidine crystals, 10-15% volcanic fragments.	Qbt 1g	The Qbt 1g–Qct contact, estimated to be at 200 ft bgs, is based primarily on natural gamma log interpretation.
200–210	**CERRO TOLEDO INTERVAL:** Tuffaceous sediments—pale gray (5Y 8/1) to very pale orange (10YR 8/2), subrounded pebble gravel and fine to coarse sand; mixed volcanic detritus of dacite and andesite with less frequent pumice clasts. 200'–210' +10F: 40-50% white to pale orange, subrounded quartz and sanidine-phyric, vitric pumices; 50-40% broken and subrounded pebbles (up to 20 mm) of hornblende-dacite and minor andesite. +35F: 40-50% quartz and sanidine crystals; 20-30% vitric pumice grains; 15-20% volcanic grains.	Qct	The Cerro Toledo interval (Qct), encountered from 200 ft to approximately 275' bgs, is estimated to be 75 ft thick. Note: Sharp increase in occurrence of volcanic detritus (predominantly dacitic) and reduced frequency of pumice in the interval 200'–210'.
210–225	Tuffaceous sediments—pale gray (5Y 8/1) to very pale orange (10YR 8/2), subrounded pebble gravel and fine to coarse sand; mixed volcanic detritus of dacite and andesite with less abundant detrital pumice. 210'–225' +10F: 85-90% small pebbles (up to 15 mm) of subrounded to rounded volcanic lithics (dacite, andesite and rhyodacite). +35F: 50-60% volcanic grains; 30-40% quartz and sanidine crystal grains and 10-15% pumice grains.	Qct	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 5 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
225–235	Tuffaceous sediments—pale gray (5Y 8/1) to very pale orange (10YR 8/2), fine to medium gravel with fine to coarse sand. Mixed detritus of volcanic lithologies (dacite, andesite) and pumice clasts in varying proportions. 225'–230' +10F: 99% subrounded (up to 17 mm) volcanic detritus; 1% pumice clasts. +35F: 50-60% pumice grains; 50-40% volcanic grains; and 5-10% quartz and sanidine crystals. 230'–235' +10F: 98% white, vitric, quartz- and sanidine-phyric pumice fragments (up to 15 mm); 2% lithic fragments. +35F: 80% pumice fragments; 15% volcanic lithics; 5% quartz and sanidine crystals.	Qct	
235–265	Tuffaceous sediments —pinkish gray (5YR 8/1), fine to medium gravel with fine to coarse sand. Mixed detritus of volcanic lithologies (predominantly dacite) and pumice clasts in varying proportions. 235'–245' +10F: 70% angular to broken volcanic lithic fragments of predominantly dacitic compositions; 30% vitric pumice fragments. +35F: 40-50% volcanic lithics; 30-40% pumices; 15-20% quartz and sanidine crystals. 245'–255' +10F: 60-80% vitric pumice clasts; 20-40% volcanic lithic fragments (up to 17 mm). +35F: 30-40% volcanic lithics; 40-50% pumice fragments; 10-20% quartz and sanidine crystals. 255'–265'+10F: 15-25% vitric, white, quartz and sanidine-phyric pumices. 75-85% angular to broken, and subrounded volcanic lithic (dacite, andesite) clasts. +35F: 25-35% quartz and sanidine crystals; 25-35% volcanic lithics; 25-35% pumice fragments.	Qct	
265–275	Tuffaceous sediments —pinkish gray (5YR 8/1), fine to medium sands with minor pebble gravels. Mixed detritus of volcanic lithologies (predominantly dacite) and pumice clasts in varying proportions. 265'–275' +10F: 30-40% volcanic lithic clasts (dacite, and dacite vitrophyre); 60-70% white vitric pumice fragments.	Qct	The Qct–Qbo contact, at 275 ft bgs, is based on an abrupt increase seen on the natural gamma ray log at that depth and a zone of oxidation from 265–275 ft bgs. However, the contact is uncertain and will require further study to characterize it.

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 6 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
275–290	**OTOWI MEMBER OF THE BANDELIER TUFF:** Tuff—pinkish gray (5YR 8/1), poorly welded, pumiceous, crystal and lithic-bearing. 275'–290' +10F: 80-90% white to pale orange, vitric, quartz and sanidine-phyric with weakly limonite stained pumice fragments (≤20 mm in diameter); 10-20% volcanic lithic fragments. +35F: 40-50% pumice fragments; 30-25% quartz and sanidine crystals; 20-30% volcanic lithic fragments.	Qbo	The Otowi Member of the Bandelier Tuff (Qbo) was intersected from approximately 275 ft to 520 ft bgs and is estimated to be 245 ft thick.
290–300	Tuff—pale pinkish gray (5YR 8/1), poorly welded, pumiceous, lithic-rich and crystal-poor. 290'–300' +10F: 40-50% white, glassy, quartz and sanidine-phyric pumice fragments; 50-60% angular volcanic lithic fragments of various composition (dacite. andesite), up to 15 mm in diameter. +35F: 50-60% pumice fragments; 30-40% volcanic lithics; 10-15% quartz and sanidine crystals.	Qbo	
300–310	Tuff—pale pinkish gray (5YR 8/1), poorly welded, pumiceous, lithic-rich and crystal-poor. 300'–310' +10F: 50-60% angular, andesite and dacite lithic fragments (≤12 mm); and 40-50% white to locally pale orange (i.e. limonite), vitric pumice fragments. +35F: 40-50% pumice fragments; 30-40% volcanic lithics; 10-20% quartz and sanidine crystals.	Qbo	
310–315	Tuff—very pale pinkish gray (5YR 8/1), poorly welded, strongly pumiceous, lithic-bearing and crystal-poor. 310'–315' +10F: 98% white, vitric, subrounded, quartz and sanidine-phyric pumice fragments, ≤20 mm in diameter; 1-2% volcanic lithic fragments.	Qbo	
315–330	Tuff—very pale pinkish gray (5YR 8/1), poorly welded, strongly pumiceous, lithic-bearing and crystal-poor. 315'–330' +10F: 75-85% white, vitric, quartz and sanidine-phyric pumice fragments; 15-25% angular volcanic lithic fragments, predominantly dacite, up to ≤12 mm. +35F: 75-85% vitric pumice fragments; 15-25% volcanic lithic fragments: 2-3% quartz and sanidine crystals.	Qbo	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 7 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
330–340	Tuff—very pale pinkish gray (5YR 8/1) to medium light gray (N6), poorly welded, pumiceous, lithic-rich and crystal-poor. 330'–340'+10F: 70-80% angular, volcanic lithic fragments of pink and gray dacites and rhyodacites; 20-30% white, glassy, quartz and sanidine-phyric pumice. +35F: 40-50% volcanic lithic fragments; 40-50% vitric pumice fragments; 3-5% quartz and sanidine crystals.	Qbo	Note: More abundant volcanic lithics in the 330'-350' interval
340–350	Tuff—very pale pinkish gray (5YR 8/1) to medium light gray (N6), poorly welded, pumiceous, lithic-rich and crystal-poor. 340'–350'+10F: 60-70% white, vitric, quartz and sanidine-phyric pumice fragments; 30-40% angular volcanic lithic fragments of variable composition (i.e. dacite, flow-banded rhyodacite and andesite).	Qbo	.
350–360	Tuff—pale pinkish gray (5YR 8/1) to medium light gray (N6), poorly welded, pumice-rich, lithic-bearing to lithic-poor, and crystal-poor. 350'–360' +10F: 85-95% white, vitric, quartz and sanidine-phyric pumice fragments; 5-15% volcanic lithic fragments of dacite and rhyodacite. +35F: 85-90% quartz and sanidine crystals; 10-15% volcanic lithics; 2-3% quartz and sanidine crystals.	Qbo	
360–380	Tuff—pale pinkish gray (5YR 8/1) to medium light gray (N6), poorly welded, pumice-rich, lithic-bearing to lithic-poor, and crystal-poor. 360'–380' +10F: 70-80% white to locally pinkish orange (i.e. limonite stained), quartz- and sanidine-phyric pumice fragments; 20-30% angular volcanic (dacite, andesite, flow-banded rhyodacite) lithic fragments. +35F: 40-50% glassy pumices; 15-20% quartz and sanidine crystals; 30-40% volcanic (dacite, andesite, obsidian) lithic fragments.	Qbo	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 8 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
380–395	Tuff—pale pinkish gray (5YR 8/1) to medium light gray (N6), poorly welded, pumice-rich, lithic-bearing to lithic-poor, and crystal-poor. 380'–395' +10F: 98-95% white, glassy, quartz- and sanidine-phyric pumice fragments (5-10 mm); 2-5% volcanic lithic fragments. +35F: 95-90% pumice fragments; 5-10% volcanic lithics; 2-3% quartz and sanidine crystals.	Qbo	
395–400	Tuff—moderate orange brown (10YR 7/4), poorly welded, pumiceous, lithic-bearing, and crystal-poor. 395'–400' +10F: 10-15% angular, volcanic lithics, $\leq$ 5 mm; 85-90% strongly iron-oxide stained (i.e., limonite) vitric pumices.	Qbo	
400–410	Tuff—moderate orange brown (10YR 7/4), poorly welded, pumiceous, lithic-bearing, and crystal-poor. 400'–410' +10F: 40-60% angular volcanic (dacite, andesite, flow banded rhyolite) lithic fragments; 40-60% limonite-stained fragments of vitric pumice. +35F: 85-90% limonitic pumice fragments; 5-10% volcanic lithic fragments' 5-50% quartz and sanidine crystals.	Qbo	
410–415	Tuff—pale grayish orange (10YR 7/4), poorly welded, pumiceous, lithic-rich, and crystal-rich. 410'–415' +10F: 95% angular fragments of flow-banded rhyolite and dacite, $\leq$15 mm in diameter; 5% vitric pumice fragments. +35F: 50-60% quartz and sanidine crystals; 15-20% pumices; 20-30% volcanic lithic fragments.	Qbo	
415–420	Tuff—pale pinkish gray (5YR 8/1), poorly welded, pumiceous, lithic-bearing, and crystal-rich. 415'–420' +10F: 70% angular ($\leq$10 mm) volcanic (rhyolite and dacite) lithic fragments; 30% white, vitric, quartz- and sanidine-phyric pumices.	Qbo	
420–435	Tuff—pale pinkish gray (5YR 8/1), poorly welded, pumiceous, lithic-bearing, and crystal-rich. 420'–435' +10F: 20-40% angular volcanic (andesite, dacite, flow-banded rhyolite) lithic fragments up to 5mm in diameter; 60-80% white, vitric, quartz- and sanidine-phyric pumice fragments. +35F: 30-40% quartz and sanidine-phyric crystals, 40-30% pumice; 10-20% volcanic lithics.	Qbo	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 9 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
435–450	Tuff—pale pinkish gray (5YR 8/1), poorly welded, pumiceous, lithic-bearing, and crystal-rich. 435'–450' +10F: 30-40% angular to subrounded volcanic (flow-banded rhyolite, dacite, and andesite) lithic fragments; 60-70% white, glassy, quartz and sanidine-phyric, pumice fragments. +35F: 20-30% quartz- and sanidine-phyric; 30-40% volcanic lithics; 30-40% glassy pumices.	Qbo	
450–475	Tuff—pale pinkish gray (5YR 8/1), poorly welded, pumiceous, lithic-bearing, and crystal-poor. 450'–475' +10F: 30-40% angular to subangular volcanic (i.e. flow-banded rhyolite, black porphyritic vitrophyre, hornblende-dacite andesite) lithic fragments up to 12 mm in diameter; 60-70% white, vitric, quartz and sanidine-phyric pumice fragments. +35F: 40-60% glassy pumices; 10-20% quartz and sanidine crystals; 20-30% volcanic lithics.	Qbo	
475–490	Tuff—pale pinkish gray (5YR 8/1), poorly welded, pumiceous, lithic-bearing, and crystal-poor. 475'–490' +10F: 50-70% angular to subangular volcanic (i.e. andesite and dacite) lithic fragments up to 13 mm in diameter; 30-50% white, vitric, quartz and sanidine pumice. +35F: 50-60% white, glassy pumices; 10-20% quartz and sanidine crystals; 30-40% volcanic lithic fragments.	Qbo	Note: The interval of 475'–490' has more abundant volcanic lithics.
490–505	Tuff—moderate orange to pink (5YR 8/4) and light/medium gray (N6), poorly welded to non-welded, pumiceous, lithic-bearing to lithic-rich, and crystal-bearing. 490'–505' WR: abundant, weakly iron-stained ash. +10F:60-70% angular, broken and subrounded volcanic (i.e. andesite, dacite and rhyolite) lithic fragments up to 15 mm in diameter; 30-40% white, vitric pumice fragments. +35F: 30-50% vitric pumices; 10-20% quartz and sanidine crystals; 30-40% volcanic lithics.	Qbo	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 10 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
505–515	Tuff—very pale orange (10YR 8/2), poorly welded to non-welded, pumiceous, lithic-bearing, and crystal-poor. 505'–515' +10F: 75-85% white, vitric, quartz and sanidine-phyric pumices; 15-25% volcanic lithic fragments up to 7 mm in diameter.	Qbo	
515–520	Tuff–moderate orange pink (5YR 8/4) to very pale orange (10YR 8/2),), poorly welded to non-welded, pumiceous, lithic-bearing, and crystal-poor. 515'–520' +10F: 40-50% vitric pumices; 5-3% subrounded quartz and sanidine grains; 40-50% angular to subangular volcanic lithics.	Qbo	The Qbo-Qbog contact, estimated to be at 520 ft bgs, is based on the natural gamma ray response, microscopic examination and descriptive analysis of cuttings.
520–537	**GUAJE PUMICE BED OF THE OTOWI MEMBER OF THE BANDELIER TUFF:** Air-fall tuff –moderate orange pink (5YR 8/4) to very pale orange (10YR 8/2), poorly welded to non-welded, pumice-rich, crystal-poor, lithic-poor. 520'–537' +10F: 95-97% white vitric pumice detrital lapillis/fragments; 3-5% subangular to subrounded volcanic (i.e. dacite and andesite) lithics.	Qbog	The Guaje Pumice Bed (Qbog), intersected from 520 ft to 537 ft bgs, is estimated to be 17 ft thick. The Qbog-Tpf contact, estimated to be at 537 ft bgs, is based on the natural gamma ray log, microscopic examination and descriptive analysis of cuttings.
537–545	**PUYE FORMATION:** Volcaniclastic sediments – very pale orange (10YR 8/2), silty pebble gravel with fine to coarse sand. 537'–545' WR: silty matrix. +10F: 10-20% white pumices; 80-90% broken and subrounded pebble clasts ($\leq$22 mm) of diverse volcanic composition (i.e. andesite, dacite and vitrophyre); minor fragments of volcaniclastic silty sandstone (i.e. matrix residue),	Tpf	The upper section of Puye Fm. (Tpf) volcaniclastic sediments, intersected from 537 ft to 689 ft bgs, is estimated to be 152 ft thick. Note: degree of rounding of volcanic lithic clasts increases significantly in the interval 540'–545'.
545–560	Volcaniclastic sediments – pale yellowish brown (10YR 6/2) to light medium gray (N6), fine pebble gravel with fine to coarse sand. 545'–560' +10F: 99% angular, broken and subrounded clasts of dacite and andesite; $\leq$1% fragments of volcanic sandstone with silty matrix.	Tpf	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 11 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
560–585	Volcaniclastic sediments – pale yellowish brown (10YR 6/2), silty fine to medium gravels with fine to coarse sand. Detritus of intermediate volcanic composition. 560'–585' WR: silty matrix. +10F: 100% broken and subrounded clasts (<u><</u>25mm in diameter) predominantly gray porphyritic dacite in composition, with minor white aphanitic rhyolite.	Tpf	
585–600	Volcaniclastic sediments – light brownish gray (5YR 6/1), medium to coarse gravels with medium to coarse sand and silt. Detritus is predominantly dacitic in composition. 585'–600' +10F: 100% broken and subangular to subrounded clasts (≤ 20 mm) of predominantly gray, biotite and hornblende- dacite.	Tpf	
600–610	Volcaniclastic sediments – pale yellowish brown (10YR 6/2), medium gravel with medium to coarse sand and silt. 600'–610' +10F: 100% broken and subrounded volcanic clasts predominantly of gray porphyritic dacite with minor white hornblende-dacite.	Tpf	
610–625	Volcaniclastic sediments – pale yellowish brown (10YR 6/2) to light brownish gray (5YR 6/1), fine to medium gravels with fine to coarse sand and silt. 610'–625' +10F: 90% broken and subrounded volcanic clasts predominantly dacite; 10% fragments of silty volcanic sandstone.	Tpf	
625–650	Volcaniclastic sediments – pale yellowish brown (10YR 6/2), silty fine to medium gravels with fine to coarse sand. 625'–650' +10F: 100% broken and subrounded volcanic clasts (≤ 22 mm) predominantly dacitic in composition, with minor dark gray basaltic andesite. +35F: 75-90% broken and subangular to subrounded volcanic lithic grains, dacitic in composition; 10-25% fragments of fine to medium grains of indurated volcanic sandstone.	Tpf	

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15	**Page:** 12 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440	**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD	**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl		**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
650–665	Volcaniclastic sediments – light brownish gray (5YR 6/1), medium to coarse gravels with fine to coarse sand and silt, predominantly dacitic detritus. 650’–665’ WR: moderately abundant silt matrix. +10F: 98-95% angular to subangular, silt coated, volcanic lithic fragments to clasts, of gray hornblende dacite; 3-5% fragments of indurated volcanic sandstone; minor pumice fragments. +35F: 60-80% volcanic lithic fragments /grains; 20-40% fragments of volcanic sandstone.	Tpf	
665–689	Volcaniclastic sediments – grayish orange (10YR 7/4), silty gravel with fine to medium sand, detritus is predominantly dacitic in composition. 665’–689’ +10F: angular/broken chips and subrounded, silt coated volcanic lithic clasts, up to 20 mm, predominantly gray and pinkish dacite. +35F: 90-80% dacitic fragments and grains; 20-20% fragments of indurated silty volcanic sandstone.	Tpf	The Tpf-Tb4 contact, estimated to be at 689 ft bgs, is based on natural gamma ray response and microscopic and descriptive analysis.
689–691	**CERROS DEL RIO BASALT:** Basaltic cinder deposit—grayish orange pink (5YR 7/1), clay-rich stratified cinder deposits. 681’–691’ WR: 30-50% clay matrix. +10F:80-90% clay-coated, angular to subangular scoriaceous basalt cinders; 10-20% fragments of pink to light gray clay. +35F: 90-95% fine fragments of basalt cinders with amygdaloidal clay; 5-10% clay fragments.	Tb4	The Cerros del Rio basalt (Tb4) section, including lavas, cinder deposits and agglomerates, was intersected from 689 ft to 740 ft bgs. The Tb4 section is estimated to be 51 ft thick. Note: The interval 689’–691’ is a stratified, clay-rich layer at the top of basalt cinder deposits, as noted in LANL video camera survey on 10/27/09.
691–710	Basalt lava—medium dark gray (N4), scoriaceous to strongly vesicular, olivine-phyric basalt. 691’–710’ +10F: 100% angular chips of slightly porphyritic, scoriaceous to strongly vesicular basalt. Phenocrysts include: $\leq$1% of olivine, trace amounts of clinopyroxene and plagioclase in an aphanitic groundmass.	Tb4	Note: A massive basalt flow, in the interval 691’–710’, was identified in LANL video survey on 10/27/09.

Borehole Lithologic Log (continued)

Borehole Identification (ID): CdV-37-1i	**Technical Area (TA):** 15		**Page:** 13 of 13
Drilling Company: Boart Longyear Company	**Start Date/Time:** 10/9/09:0440		**End Date/Time:**10/27/09: 0022
Drilling Method: Dual Rotary	**Machine:** Foremost DR24 HD		**Sampling Method:** Grab
Ground Elevation: 6826.26 ft amsl			**Total Depth:** 803.0 ft
Drillers: G. Burton, M. Cross	**Site Geologists:** E. Huggins , C. Pigman, J. R. Lawrence,		

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes
710–719	Basalt lava—medium dark gray (N4), scoriaceous to strongly vesicular, olivine-phyric basalt. 710'–719' +10F: 100% angular chips, vesicular becoming more massive depth. Phenocrysts include: $\leq$1% olivine ($\leq$1 mm in diameter), commonly iddingsitized; trace amounts of clinopyroxene and plagioclase in an aphanitic groundmass.	Tb4	
719–740	Basalt cinders and agglomerate—medium gray (N5) to light grayish brown (5YR 6/1), cinders and blocks as identified in video survey of10/27/09. 719'–740' +10F: 90-95% angular to subangular, clay coated fragments ($\leq$17 mm in diameter) of vesicular, gray to locally reddish (i.e. oxidized) basalt. Basalt is plagioclase- and olivine-phyric. 5-10% fragments of light tan siltstone and very fine grained sandstone.	Tb4	Note: The interval 719'–740' contains basalt cinders and blocks as identified in the video survey on 10/27/09. The estimated Tb4-Tpf contact, estimated to be at 740 ft bgs, is based on based on microscopic examination and descriptive analysis of cuttings.
740–765	**PUYE FORMATION:** Volcaniclastic sediments –grayish orange (10YR 7/4), very coarse sand with pebble gravel, subrounded detritus of diverse volcanic lithologies. 740'–765' +10F: 90-95% subangular to well rounded granules and small pebbles ($\leq$12 mm) of variable volcanic composition including gray porphyritic dacite, olivine-basalt, black vitrophyre, andesite, and white rhyolite; 5-10% fragments of indurated silty fine-grained volcanic sandstone. +35F: Commonly well-rounded grains of volcanic lithologies similar to the +10F, but with more abundant basalt; trace quartzite and microcline grains.	Tpf	The lower section of Puye Fm. (Tpf) volcaniclastic sediments, intersected from 740 ft to the bottom of the R-37-1i borehole at 803 ft bgs, is a minimum of 63 ft thick. Note: Stratified sediments with subrounded pebbles and cobbles were identified in video survey on 10/27/09 in the interval 740'–765'.
765–803	Volcaniclastic sediments –light brownish gray (5YR 6/1), medium to coarse gravels with fine to course sand, subrounded detritus of diverse volcanic lithologies, with minor quartzite. 765'–803' +10F: 95-99% angular/broken fragments and subrounded pebbles ($\leq$15 mm in diameter) composed of variable volcanic lithologies (i.e. gray and pink porphyritic dacite, white dacite with abundant fine hornblende phenocrysts, glassy rhyolite black and reddish porphyritic vitrophyre; 1-5% fragments of volcanic sandstone. +35F: trace quartzite grains present.	Tpf	Note: Higher frequency of subrounded cobbles and boulders identified in video survey (10/27/09) in the interval 776'–790' bgs. Drilling of CdV-37-1i borehole concluded at 803.0 ft bgs.

Borehole Lithologic Log (continued)

ABBREVIATIONS

5YR 8/4 = 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 per cent by volume of a given sample constituent
amsl = above mean sea level
bgs = below ground surface
ft = feet.

Qal = Quaternary Alluvium.
Qbo = Quaternary Otowi Member of Bandelier Tuff
Qbog = Quaternary Guaje Pumice Bed
Qbt = Quaternary Tshirege Member of the Bandelier Tuff
Qct = Quaternary Cerro Toledo interval
Tpf = Tertiary Puye Formation
Tb4= Tertiary Cerros del Rio basalt

+10F = ≥ No. 10 sieve sample fraction

+35F = ≥ No. 35 sieve sample fraction

WR = whole rock (unsieved sample)

1mm = 0.039 in

1 in = 25.4 mm

Los Alamos National Laboratory
Regional Hydrogeologic Characterization Project
Corehole Lithologic Log

Corehole Identification (ID): CdV-37-1i COREHOLE	**Technical Area (TA):** 15	**Page:** 1 of 5
Drilling Company: Boart Longyear Company	**Start Date/Time:** 12/12/09:0048	**End Date/Time:** 12/14/09:2140
Drilling Method: Sonic	**Machine:** PS-600C sonic	**Sampling Method:** Core
Ground Elevation: 6825.18 ft amsl	**Core Recovery:** 100%	**Total Depth:** 305.0 ft
Drillers: M. McLean	**Site Geologists:** R. McGuill, S. Muggleton	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes and Sample ID
0–2	Construction fill—Very dark gray (7.5YR 3/1), unconsolidated, clay-rich pebble gravel with very fine to coarse sand, detritus of mixed volcanic and quartzite and granite (indicating drill pad base-coarse gravel). Some organic material (root segments and bark) present.	Fill	Note: Samples for descriptive analysis were collected in 5-ft intervals as continuous core from 0 ft to borehole TD at 305 ft bgs with 100% recovery.
2–8	**ALLUVIUM:** Tuffaceous sediments—Brown (7.5 YR 4/2), unconsolidated, silty pebble gravel. Predominantly subangular to subrounded detrital clasts of gray porphyritic dacite and minor pale red rhyolite. Abundant sand grains of quartz and sanidine crystals up to 50 mm in diameter.	Qal	Alluvial sediments, encountered from 2–29 ft, are approximately 27 ft thick.
8–9	Tuffaceous sediments—Light Gray (7.5 YR 7/1), unconsolidated, silty to coarse sand. Abundant sand grains of quartz and sanidine crystals up to 50 mm in diameter in an ashy matrix.	Qal	
9–10	Tuffaceous sediments—Brown (7.5 YR 4/2), unconsolidated, silty pebble gravel. Predominantly subangular to subrounded detrital clasts of gray porphyritic dacite and minor pale red rhyolite. Abundant sand grains of quartz and sanidine crystals up to 10 mm in diameter.	Qal	
10–15	Tuffaceous sediments	Qal	GW37_1(i)-10-7780 GW37_1(i)-10-7798 Sample interval from 10.5–11.5 ft
15–20	Tuffaceous sediments—Reddish Brown (5 YR 5/2), slightly cemented, subangular to subrounded detrital clasts of silt to coarse grains of quartz, sanidine and dacite lithics.	Qal	
20–25	Tuffaceous sediments	Qal	GW37_1(i)-10-7781 GW37_1(i)-10-7799 Sample interval from 20.0–21.0 ft
25–29	Weathered Tuff— Yellowish Brown (10 YR 5/4), silt to coarse grains of quartz, sanidine with minor dacite clasts in a clay rich matrix	Qal	The Qal–Qbt 1g contact, estimated to be at 29 ft bgs, based on descriptive analysis

Corehole Lithologic Log (continued)

Corehole Identification (ID): CdV-37-1i COREHOLE	**Technical Area (TA):** 15	**Page:** 2 of 5
Drilling Company: Boart Longyear Company	**Start Date/Time:** 12/12/09:0048	**End Date/Time:** 12/14/09:2140
Drilling Method: Sonic	**Machine:** PS-600C sonic	**Sampling Method:** Core
Ground Elevation: 6825.18 ft amsl	**Core Recovery:** 100%	**Total Depth:** 305.0 ft
Drillers: M. McLean	**Site Geologists:** R. McGuill, S. Muggleton	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes and Sample ID
29–30	**UNIT 1g OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** Tuff—Grayish Brown (10YR 5/2), poorly to nonwelded, lithic-bearing, pumiceous and crystal-rich.20% weathered pumice fragments, 10% dark gray dacitic lithics and 70% crystals of quartz and sanidine,	Qbt 1g	Unit 1g of the Tshirege Member of the Bandelier Tuff (Qbt 1g), encountered from 29–201 ft bgs, is estimated to be 172 ft thick
30–35	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7782 GW37_1(i)-10-7800 Sample interval from 30.0–31.0 ft
35–40	Tuff—Grayish Brown (10YR 5/2), poorly to nonwelded, pumice and crystal-rich, lithic-poor.50% glassy, fibrous pumice fragments up to 20 mm in diameter, and 50% crystals of quartz and sanidine, with minor lithics.	Qbt 1g	
40–45	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7783 GW37_1(i)-10-7801 Sample interval from 40.0–41.0 ft
45–50	Tuff—Dark Grayish Brown (10YR 4/2), SAA.	Qbt 1g	
50–55	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7784 GW37_1(i)-10-7802 Sample interval from 50.0–51.0 ft
55–60	Tuff—Dark Grayish Brown (10YR 4/2), SAA.	Qbt 1g	
60–65	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7785 GW37_1(i)-10-7803 Sample interval from 60.0–61.0 ft
65–74	Tuff—Dark Grayish Brown (10YR 4/2), SAA except pumice fragments are yellowish brown (10YR 5/4) and more weathered than above.	Qbt 1g	
74–80	Tuff—Grayish Brown (10YR 5/2), poorly to nonwelded, pumice and crystal-rich, lithic-bearing. Glassy, fibrous pumice fragments and dacitic clasts up to 20 mm in diameter.	Qbt 1g	

Corehole Lithologic Log (continued)

Corehole Identification (ID): CdV-37-1i COREHOLE	**Technical Area (TA):** 15	**Page:** 3 of 5
Drilling Company: Boart Longyear Company	**Start Date/Time:**12/12/09:0048	**End Date/Time:** 12/14/09:2140
Drilling Method: Sonic	**Machine:** PS-600C sonic	**Sampling Method:** Core
Ground Elevation: 6825.18 ft amsl	**Core Recovery:** 100%	**Total Depth:** 305.0 ft
Drillers: M. McLean	**Site Geologists:** R. McGuill, S. Muggleton	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes and Sample ID
80–85	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7786 GW37_1(i)-10-7804 Sample interval from 80.0–81.0 ft
85–92	Tuff—Grayish Brown (10YR 5/2), SAA	Qbt 1g	
92–100	Tuff—Grayish Brown (10YR 5/2), poorly to nonwelded, crystal rich, pumice and lithic-poor. Pumice fragments present are 2 to 5 mm in diameter.	Qbt 1g	
100–105	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7787 GW37_1(i)-10-7805 Sample interval from 100.0–101.0 ft
100–115	Tuff—Grayish Brown (10YR 5/2), poorly to nonwelded, crystal rich, pumice and lithic-poor. Pumice fragments are broken and 2 to 5 mm in diameter.	Qbt 1g	
115–122	Tuff—Brown (10YR 5/3), poorly to nonwelded, quartz crystal rich, pumice and lithic-bearing. Pumice fragments are broken and 2 to 5 mm in diameter. Lithics primarily subangular dacitic clasts up to 30 mm in diameter.	Qbt 1g	.
122–130	Tuff—Brown (10YR 5/3), poorly to nonwelded, quartz crystal rich, pumice and lithic-bearing in an ash matrix. Lithics primarily porphyritic and reddish gray dacitic clasts.	Qbt 1g	
130–140	Tuff—Brown (10YR 5/3), poorly to nonwelded, quartz crystal rich, pumice and lithic-bearing in an ash matrix. Lithics primarily porphyritic and reddish gray dacitic clasts.	Qbt 1g	
140–145	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7788 GW37_1(i)-10-7806 Sample interval from 140.0–141.0 ft
145–179	Tuff—SAA except more pumices present than above.	Qbt 1g	
179–180	Tuff—Brown (10YR 5/3) poorly to nonwelded clay and ash-rich. Pumice bearing.	Qbt 1g	Core is damp.

Corehole Lithologic Log (continued)

Corehole Identification (ID): CdV-37-1i COREHOLE	**Technical Area (TA):** 15	**Page:** 4 of 5
Drilling Company: Boart Longyear Company	**Start Date/Time:** 12/12/09:0048	**End Date/Time:** 12/14/09:2140
Drilling Method: Sonic	**Machine:** PS-600C sonic	**Sampling Method:** Core
Ground Elevation: 6825.18 ft amsl	**Core Recovery:** 100%	**Total Depth:** 305.0 ft
Drillers: M. McLean	**Site Geologists:** R. McGuill, S. Muggleton	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes and Sample ID
180–185	Ash Flow Tuff	Qbt 1g	GW37_1(i)-10-7789 GW37_1(i)-10-7807 Sample interval from 180.0–181.0 ft
185–195	Tuff—Brown (10YR 5/3), poorly to nonwelded, quartz crystal rich, pumice and lithic-bearing in an ash matrix. Lithics primarily porphyritic and reddish gray dacitic clasts.	Qbt 1g	
195–198	Tuff—SAA with ash/ clay component increasing down section.	Qbt 1g	The Qbt 1g–QTt contact, is estimated to be at 198 ft bgs, based on descriptive analysis of core samples.
198–200	**TSANKAWI PUMICE BED:** Tuff—Brown (10YR 5/3), poorly to nonwelded, pumice and lithic-bearing, in an ash and clay matrix.	Qbtt	Core is wet at 199' bgs. NOTE: A pumice-rich tuff interpreted to be the Tsankawi Pumice Bed was noted from 198–200 ft bgs.
200–215	**CERRO TOLEDO INTERVAL:** Tuffaceous sediments—Brown (10YR 5/3), unconsolidated, clay and silt-rich, pebble conglomerate. Detritus primarily subangular to subrounded dacite clasts and slightly indurated, weathered ash-flow tuff fragments, up to 30 mm in diameter.	Qct	The Cerro Toledo Interval (Qct), encountered from 200–270' bgs, is estimated to be 70 ft thick.
215–220	Tuffaceous sediments —SAA	Qct	
220–225	Tuffaceous sediments	Qct	GW37_1(i)-10-7790 GW37_1(i)-10-7808 Sample interval from 220.0–221.0 ft
225–260	Tuffaceous sediments —SAA	Qct	
260–265	Tuffaceous sediments	Qct	GW37_1(i)-10-7791 GW37_1(i)-10-7809 Sample interval from 260.0–261.0 ft
265–270	Tuffaceous sediments —SAA	Qct	The Qct–Qbo contact, estimated to be at 270 ft bgs, is based on based on descriptive analysis of core samples.

Corehole Lithologic Log (continued)

Corehole Identification (ID): CdV-37-1i COREHOLE	**Technical Area (TA):** 15	**Page: 5** of 5
Drilling Company: Boart Longyear Company	**Start Date/Time:**12/12/09:0048	**End Date/Time:** 12/14/09:2140
Drilling Method: Sonic	**Machine:** PS-600C sonic	**Sampling Method:** Core
Ground Elevation: 6825.18 ft amsl	**Core Recovery:** 100%	**Total Depth:** 305.0 ft
Drillers: M. McLean	**Site Geologists:** R. McGuill, S. Muggleton	

Depth (ft bgs)	Lithology	Lithologic Symbol	Notes and Sample ID
270–271	**OTOWI MEMBER OF THE BANDELIER TUFF:** Tuff—Pinkish gray (5YR 8/1), poorly welded, lithic-rich, pumiceous, crystal-bearing in a clay and ash-rich matrix. No indurated tuff fragments present.	Qbo	The Otowi Member of the Bandelier Tuff (Qbo) is intersected from 270 ft to TD at 305 ft bgs.
271–300	Tuff—Brown (7.5YR 5/2), poorly welded, lithic-rich, pumiceous, crystal-bearing. No indurated tuff fragments present.	Qbo	
300–305	Ash Flow Tuff	Qbo	GW37_1(i)-10-7792 GW37_1(i)-10-7810 Sample interval from 300.0–301.0 ft

Corehole Lithologic Log (continued)

ABBREVIATIONS

5YR 8/4 = 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 per cent by volume of a given sample constituent
amsl = above mean sea level
bgs = below ground surface
ft = feet.
SAA – same as above

Qal = Quaternary Alluvium.
Qbo = Quaternary Otowi Member of Bandelier Tuff
Qbt 1g= Quaternary Unit 1g of the Tshirege Member of the Bandelier Tuff
Qct = Quaternary Cerro Toledo interval
Qbtt = Quaternary Tsankawi Pumice Bed of the Bandelier Tuff

1mm = 0.039 in

1 in = 25.4 mm

Appendix B

Groundwater Analytical Results

B-1.0 SAMPLING AND ANALYSIS OF GROUNDWATER AT CdV-37-1i

A total of 11 groundwater-screening samples were collected during drilling, development, and aquifer-performance testing at well CdV-37-1i. Five groundwater-screening samples were collected from perched intermediate saturation encountered during drilling at depths ranging between 210 and 640 ft below ground surface (bgs). Aliquots from five borehole samples were submitted to an external analytical laboratory for analyses of volatile organic compounds (VOCs), low-level tritium (LH3), and high explosive (HE) compounds. Additionally, groundwater-screening samples collected from CdV-37-1i during drilling were filtered and analyzed for cations, anions, perchlorate, and metals at Los Alamos National Laboratory's (LANL's or the Laboratory's) Earth and Environmental Sciences Group 14 (EES-14).

Two groundwater-screening samples were collected from well CdV-37-1i during development from the screened interval from 632.0 to 652.5 ft bgs in the completed well. Four groundwater-screening samples were collected during aquifer performance testing at well CdV-37-1i. Groundwater samples collected during well development and aquifer testing were only analyzed for total organic carbon (TOC) in nonfiltered samples.

B-1.1 Analytical Techniques

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

Groundwater samples were analyzed using techniques specified by the U.S. Environmental Protection Agency (EPA) methods for water analyses. Ion chromatography (EPA Method 300, Rev. 2.1) was the analytical method for bromide, chloride, fluoride, nitrate, nitrite, oxalate, perchlorate, phosphate, and sulfate. The instrument detection limits for perchlorate were 0.002 and 0.005 ppm (EPA Method 314.0, Rev. 1) for the water samples collected from CdV-37-1i. Inductively coupled (argon) plasma optical emission spectroscopy (ICPOES) (EPA Method 200.7, Rev. 4.4) was used to analyze dissolved aluminum, barium, boron, calcium, iron, lithium, magnesium, manganese, potassium, silica, sodium, strontium, titanium, and zinc. Dissolved antimony, arsenic, beryllium, cadmium, cesium, chromium, cobalt, copper, lead, lithium, mercury, molybdenum, nickel, rubidium, selenium, silver, thallium, thorium, tin, vanadium, uranium, and zinc were analyzed by inductively coupled (argon) plasma mass spectrometry (ICPMS) (EPA Method 200.8, Rev. 5.4). The precision limits (analytical error) for major ions and trace elements were generally less than ±7% using ICPOES and ICPMS. Total carbonate alkalinity (EPA Method 310.1) was measured using standard titration techniques. No groundwater samples were collected for TOC analyses at CdV-37-1i before well development and aquifer testing because of the complex sampling matrix that consisted of disaggregated aquifer material, groundwater, municipal water, and drilling fluid used in the unsaturated zone. Analyses of TOC were performed on groundwater-screening samples collected during development following EPA Method 415.1. Charge-balance errors for total cations and anions ranged between +/- 10% the inorganic chemicals. Sample CdV37-1(i)-09-13130 had a charge balance of 20% and contained anomalously high concentrations of aluminum, iron, and silica. The negative cation-anion charge-balance values indicate excess anions for the filtered samples.

B-1.2 Field Parameters

Field water-quality parameters were measured from groundwater that was purged during well development using a YSI multimeter. Results of field parameters, consisting of pH, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance, and turbidity measured during well development and aquifer testing at CdV-37-1i, are provided in Table B-1.2-1.

B-1.2.1 Well Development

Seventeen measurements of pH and temperature varied from 7.59 to 8.25 and from 14.59 to 16.04°C, respectively, in groundwater pumped from well CdV-37-1i during development. Concentrations of DO ranged from 7.23 mg/L to 8.80 mg/L during development. Corrected oxidation-reduction potential (Eh) values determined from field ORP measurements decreased from 317.5 millivolts (mV) at the beginning of development to 160.2 mV at the end (Table B-1.2-1). A temperature-dependent correction factor for calculating Eh values from field ORP measurements at well CdV-37-1i was based on an Ag/AgCl, KCl-saturated filling solution contained in the ORP electrode. The correction factor was 208.9 mV at 15.0ºC. Several negative and uncorrected ORP readings were recorded during development at well CdV-37-1i most likely resulting from instrument drift. Corrected Eh values and measurable DO concentrations are considered to be reliable and representative of the known relatively oxidizing conditions characteristic of perched-intermediate zones beneath the Pajarito Plateau. Specific conductance varied from 123 microsiemens per centimeter (µS/cm) to 183, µS/cm and turbidity ranged from 0.1 to 11.0 nephelometric turbidity units (NTU) during development of well CdV-37-1i (Table B-1.2-1). With the exception of one sample with 11 NTU, the remaining turbidity values recorded during development were less than 4 NTU.

B-1.3 Analytical Results for Groundwater-Screening Samples

B-1.3.1 Analytical Results for VOCs, Tritium, and HE Compounds

The following VOCs were detected in one or more of the three borehole water samples [GW37-1(i)-09-13128 (210 ft bgs), GW37-1(i)-09-13129 (250 ft bgs), and GW37-1(i)-09-13130 (270 ft bgs)] collected at CdV-37-1i during drilling (Table B-1.3-1):

- GW37-1(i)-09-13128 (210 ft bgs) and GW37-1(i)-09-13129 (250 ft bgs): N-butyl alcohol (1-butanol) was detected at concentrations of 99.7 µg/L and 108 µg/L in these two samples, respectively. It is very likely this organic compound was derived from drilling foam (AQF-2) used at CdV-37-1i.
- GW37-1(i)-09-13130 (270 ft bgs): 4-methyl-2-pentanone was detected (J value) at a concentration of 1.31 µg/L; naphthalene and chloromethane were reported at estimated concentrations of 0.29 µg/L and 0.36 µg/L, respectively.
- GW37-1(i)-09-13131 (620 ft bgs): 4-methyl-2-pentanone and naphthalene were reported at estimated concentrations of 2.03 µg/L and 0.39 µg/L, respectively.
- GW37-1(i)-09-13132 (640 ft bgs): Acetone and naphthalene were reported at estimated concentrations of 5.69 µg/L and 0.37 µg/L, respectively.

Tritium was detected in all five samples collected during drilling at CdV-37-1i at concentrations between 0.48 and 1.05 tritium units (TU) or 1.55 pCi/L and 3.38 pCi/L (Table B-1.3-1).

HE compounds were not detected in the three groundwater screening samples collected from CdV-37-1i during drilling (Table B-1.3-1).

B-1.3.2 Analytical Results for Metals, Cations, Anions, TOC, and Perchlorate

Analytical results for groundwater screening samples collected at well CdV-37-1i during drilling are provided in Table B-1.3-2. The filtered borehole groundwater samples [GW37-1(i)-09-13128 (210 ft bgs), GW37-1(i)-09-13129 (250 ft bgs), GW37-1(i)-09-13130 (270 ft bgs), GW37-1(i)-09-13131 (620 ft bgs), and GW37-1(i)-09-13132 (640 ft bgs)] consisted of disaggregated colloidal aquifer material, drilling fluid, municipal water used during drilling, and native groundwater.

Concentrations of sodium ranged from 18.22 to 43.40 ppm in the five borehole water samples. Detectable concentrations of oxalate ($C_2O_4^{2-}$) ranged from 0.38 to 1.10 ppm in the samples collected at 210, 250, and 270 ft bgs, suggesting the presence of AQF-2 drilling foam used during drilling was diluted by groundwater and municipal water. Oxalate was not reported (detection limit of 0.01 ppm) in the last two borehole water samples collected during drilling from 620 ft and 640 ft bgs, respectively, at CdV-37-1i. Concentrations of other inorganic analytes, including chloride, fluoride, and sulfate, were slightly elevated and may indicate residual effects of drilling fluids used during drilling of CdV-37-1i. Perchlorate was not reported in any of the borehole samples at detection limits of 0.002 and 0.005 ppm.

Analytical results for the five borehole water samples show elevated concentrations of molybdenum ranging from 0.045 ppm to 0.138 ppm, probably derived from the pipe lubricant used during drilling. Detectable concentrations of mercury ranged from 0.0031 ppm to 0.0073 ppm, or 3.1 µg/L to 7.3 µg/L, in the three borehole water samples collected from 210 to 270 ft bgs; it was reported at 0.00007 ppm and undetected in the two samples from 620 and 640 ft bgs, respectively. Similarly, chromium was reported at concentrations of 0.0031 ppm to 0.0084 ppm, or 3.1 µg/L to 8.4 µg/L in the three samples collected in the 200-ft interval of the borehole; it was reported at 0.00007 ppm at 620 ft bgs and was not detected at 640 ft bgs.

Sample CdV37-1(i)-09-13130 (270 ft bgs) contained anomalously high concentrations of aluminum (9.15 ppm), iron (11 ppm), mercury (0.0073 ppm), chromium (0.0084 ppm), lead (0.0236 ppm), and silica (150 ppm), suggesting the presence of naturally occurring colloidal material, possibly consisting of ferric (oxy)hydroxide and clay. Nitrite(N) was also measured in this sample at 2.0 ppm.

Analytical results for TOC measured in six groundwater-screening samples collected during development and aquifer testing of well CdV-37-1i are provided in Table B-1.3-3. Concentrations of TOC decreased from 0.50 mgC/L to 0.20 mgC/L over the course of well development and aquifer testing, suggesting any potential residual drilling fluid (AQF-2) used during drilling was successfully removed during development and aquifer testing at well CdV-37-1i.

In summary, groundwater at well CdV-37-1i is relatively oxidizing, based on corrected Eh values and measurable concentrations of DO during development and aquifer testing. Presence of residual drilling fluid effects are not likely in the screened perched-water zone at well CdV-37-1i based on concentrations of measurable TOC of 0.5 mgC/L or less. Tritium was detected in the five borehole screening samples at concentrations between 1.55 pCi/L and 3.38 pCi/L. HE compounds were not detected in the screening samples. Five VOCs were sporadically reported in the five borehole screening samples.

Table B-1.2-1
Field Parameters Measured at Well CdV-37-1i during Development and Aquifer Testing

Date	pH	Temp (°C)	DO (mg/L)	ORP, Eh[a] (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
Well Development								
12/03/09	n/r[b]; bailing						200	200
12/04/09	n/r, bailing						100	300
12/05/09	8.25	15.58	8.80	108.6, 317.5	133	3.5	1093	1393
12/06/09	8.15	15.86	8.44	108.5, 317.4	132	3.0	130	1523
	8.06	15.87	8.72	107.2, 316.1	130	1.8	220	1743
	8.00	16.04	8.63	106.5, 315.4	130	1.1	111	1854
	7.97	15.84	8.71	97.7, 306.6	128	1.1	274	2128
	7.93	16.00	8.70	101.0, 309.9	127	0.2	241	2369
	7.87	15.23	8.40	96.2, 305.1	123	0.8	232	2601
12/06/09	7.94	14.59	6.98	43.9, 252.8	183	11.0	273	2874
	7.95	15.10	7.47	-9.2, 199.7	154	2.4	148	3022
	7.78	15.33	7.23	-16.6, 192.3	149	0.5	253	3275
	7.73	15.13	7.50	-25.4, 183.5	146	0.4	243	3518
12/07/09	7.70	15.80	7.74	-37.5, 171.4	144	0.4	262	3780
	7.59	15.64	7.36	-34.9, 174.0	140	0.3	208	3988
	7.66	15.59	7.50	-37.4, 171.5	142	0.7	210	4198
	7.64	15.97	7.66	-46.1, 162.8	141	0.1	220	4418
	7.63	15.97	7.68	-48.3, 160.6	141	0.1	110	4528
	7.62	15.87	7.69	-48.7, 160.2	140	0.1	122	4650
	n/r						32	4682
Aquifer Testing								
12/10/09	n/r, pumping, mini-test						994	5676[c]
12/11/09	7.99	13.97	6.40	61.2, 270.1	119	12.3	195	5871
	7.74	16.08	6.56	-37.6, 171.3	135	0.2	172	6043
	7.69	14.95	6.78	-39.7, 169.2	126	0.1	1084	7127
	7.59	14.96	6.66	-28.4, 180.5	130	0.1	179	7306
	7.58	15.52	6.64	-33.8, 175.1	133	0.1	164	7470
	7.54	14.72	6.52	1.8, 210.7	127	0.1	164	7634
12/12/09	7.58	15.55	6.65	-44.2, 164.7	129	0.1	165	7799
	7.55	15.30	6.78	-24.2, 185.6	128	0.1	165	7964
	7.52	15.55	6.66	-22.6, 186.3	130	0.1	165	8129
	7.58	15.10	6.79	31.4, 240.3	133	0.1	1352	9481
	7.53	16.12	6.59	-36.8, 172.1	129	0.1	166	9647
Post Aquifer Testing Purging								
12/14/09	n/r						980	10,627

[a] Eh (mV) is calculated from a Ag/AgCl saturated KCl electrode filling solution at 15.0ºC by adding temperature-sensitive correction factors of 208.9 mV, respectively. See text for discussion.

[b] n/r = Not recorded.

[c] Cumulative purge volumes for aquifer testing use average pump discharge rates during the 24-h pumping tests.

Table B-1.3-1
Off-Site Analytical Data

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13128	ANION	Bromide	0.02	mg/L	NQ
GW37_1(i)-09-13128	ANION	Chloride	8.3300	mg/L	NQ
GW37_1(i)-09-13128	ANION	Perchlorate	0.0050	mg/L	U
GW37_1(i)-09-13128	ANION	Fluoride	1.0700	mg/L	NQ
GW37_1(i)-09-13128	ANION	Nitrate	0.2281	mg/L	NQ
GW37_1(i)-09-13128	ANION	Nitrite	0.0030	mg/L	U
GW37_1(i)-09-13128	ANION	Oxalate	1.1000	mg/L	NQ
GW37_1(i)-09-13128	ANION	Phosphorus, Orthophosphate (Expressed as PO_4)	0.0100	mg/L	U
GW37_1(i)-09-13128	ANION	Sulfate	12.7900	mg/L	NQ
GW37_1(i)-09-13128	LH3	Low-level Tritium	1.0500	TU	NQ
GW37_1(i)-09-13128	HEXP	2,4-Diamino-6-nitrotoluene	13.0000	µg/L	U
GW37_1(i)-09-13128	HEXP	2,6-Diamino-4-nitrotoluene	13.0000	µg/L	U
GW37_1(i)-09-13128	HEXP	3,5-Dinitroaniline	13.0000	µg/L	U
GW37_1(i)-09-13128	HEXP	Amino-2,6-dinitrotoluene[4-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Amino-4,6-dinitrotoluene[2-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Dinitrobenzene[1,3-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Dinitrotoluene[2,4-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Dinitrotoluene[2,6-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	HMX[b]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Nitrobenzene	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Nitrotoluene[2-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Nitrotoluene[3-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Nitrotoluene[4-]	6.4900	µg/L	U
GW37_1(i)-09-13128	HEXP	PETN[c]	13.0000	µg/L	U
GW37_1(i)-09-13128	HEXP	RDX[d]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	TATB[e]	13.0000	µg/L	U
GW37_1(i)-09-13128	HEXP	Tetryl	6.4900	µg/L	UJ
GW37_1(i)-09-13128	HEXP	Trinitrobenzene[1,3,5-]	3.2500	µg/L	UJ
GW37_1(i)-09-13128	HEXP	Trinitrotoluene[2,4,6-]	3.2500	µg/L	U
GW37_1(i)-09-13128	HEXP	Tris (o-cresyl) phosphate	13.0000	µg/L	U
GW37_1(i)-09-13128	METALS	Aluminum	0.3724	mg/L	NQ
GW37_1(i)-09-13128	METALS	Antimony	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Arsenic	0.0005	mg/L	NQ
GW37_1(i)-09-13128	METALS	Barium	0.0097	mg/L	NQ
GW37_1(i)-09-13128	METALS	Beryllium	0.0010	mg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13128	METALS	Boron	0.0253	mg/L	NQ
GW37_1(i)-09-13128	METALS	Cadmium	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Calcium	11.1630	mg/L	NQ
GW37_1(i)-09-13128	METALS	Cesium	0.0017	mg/L	NQ
GW37_1(i)-09-13128	METALS	Chromium	0.0031	mg/L	NQ
GW37_1(i)-09-13128	METALS	Cobalt	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Copper	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Iron	0.2781	mg/L	NQ
GW37_1(i)-09-13128	METALS	Lead	0.0004	mg/L	NQ
GW37_1(i)-09-13128	METALS	Lithium	0.0266	mg/L	NQ
GW37_1(i)-09-13128	METALS	Magnesium	4.2569	mg/L	NQ
GW37_1(i)-09-13128	METALS	Manganese	0.3244	mg/L	NQ
GW37_1(i)-09-13128	METALS	Mercury	0.0031	mg/L	NQ
GW37_1(i)-09-13128	METALS	Molybdenum	0.0550	mg/L	NQ
GW37_1(i)-09-13128	METALS	Nickel	0.0022	mg/L	NQ
GW37_1(i)-09-13128	METALS	Potassium	9.9770	mg/L	NQ
GW37_1(i)-09-13128	METALS	Selenium	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Silicon Dioxide	35.5862	mg/L	NQ
GW37_1(i)-09-13128	METALS	Silver	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Sodium	26.6387	mg/L	NQ
GW37_1(i)-09-13128	METALS	Strontium	0.0707	mg/L	NQ
GW37_1(i)-09-13128	METALS	Thallium	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Tin	0.0010	mg/L	U
GW37_1(i)-09-13128	METALS	Titanium	0.0165	mg/L	NQ
GW37_1(i)-09-13128	METALS	Uranium	0.0048	mg/L	NQ
GW37_1(i)-09-13128	METALS	Vanadium	0.0011	mg/L	NQ
GW37_1(i)-09-13128	METALS	Zinc	0.0103	mg/L	NQ
GW37_1(i)-09-13128	VOC	Acetone	10.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Acetonitrile	25.0000	µg/L	R
GW37_1(i)-09-13128	VOC	Acrolein	5.0000	µg/L	R
GW37_1(i)-09-13128	VOC	Acrylonitrile	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Benzene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Bromobenzene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Bromochloromethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Bromodichloromethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Bromoform	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Bromomethane	1.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13128	VOC	Butanol[1-]	99.7000	µg/L	NQ
GW37_1(i)-09-13128	VOC	Butanone[2-]	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Butylbenzene[n-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Butylbenzene[sec-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Butylbenzene[tert-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Carbon Disulfide	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chloro-1,3-butadiene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chloro-1-propene[3-]	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chlorobenzene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chlorodibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chloroethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chloroform	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chloromethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chlorotoluene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Chlorotoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dibromo-3-Chloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dibromoethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichlorobenzene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichlorobenzene[1,4-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichlorodifluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloroethane[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloroethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloroethene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloroethene[cis-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloroethene[trans-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloropropane[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloropropane[2,2-]	1.0000	µg/L	UJ
GW37_1(i)-09-13128	VOC	Dichloropropene[cis-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Dichloropropene[trans-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Diethyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Ethyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Ethylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Hexachlorobutadiene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Iodomethane	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Isobutyl alcohol	50.0000	µg/L	R

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13128	VOC	Isopropylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Methacrylonitrile	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Methyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Methyl tert-Butyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Methyl-2-pentanone[4-]	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Methylene Chloride	10.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Naphthalene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Propionitrile	5.0000	µg/L	R
GW37_1(i)-09-13128	VOC	Propylbenzene[1-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Styrene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Tetrachloroethane[1,1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Tetrachloroethane[1,1,2,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Tetrachloroethene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Toluene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichlorobenzene[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichlorobenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichloroethane[1,1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichloroethane[1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichloroethene	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichlorofluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trichloropropane[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trimethylbenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Trimethylbenzene[1,3,5-]	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Vinyl acetate	5.0000	µg/L	UJ
GW37_1(i)-09-13128	VOC	Vinyl Chloride	1.0000	µg/L	U
GW37_1(i)-09-13128	VOC	Xylene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13128	WET_CHEM	Alkalinity-CO_3	0.8000	mg/L	U
GW37_1(i)-09-13128	WET_CHEM	Alkalinity-CO_3+HCO_3	98.2000	mg/L	NQ
GW37_1(i)-09-13128	WET_CHEM	pH	7.9450	SU[f]	NQ
GW37_1(i)-09-13129	ANION	Bromide	0.0100	mg/L	U
GW37_1(i)-09-13129	ANION	Chloride	6.6700	mg/L	NQ
GW37_1(i)-09-13129	ANION	Fluoride	0.3700	mg/L	NQ
GW37_1(i)-09-13129	ANION	Nitrate	0.5194	mg/L	NQ
GW37_1(i)-09-13129	ANION	Nitrite	0.0030	mg/L	U
GW37_1(i)-09-13129	ANION	Oxalate	0.7300	mg/L	NQ
GW37_1(i)-09-13129	ANION	Perchlorate	0.0050	mg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13129	ANION	Phosphorus, Orthophosphate (Expressed as PO_4)	0.0100	mg/L	U
GW37_1(i)-09-13129	ANION	Sulfate	5.3500	mg/L	NQ
GW37_1(i)-09-13129	LH3	Low-level Tritium	0.8100	TU	NQ
GW37_1(i)-09-13129	HEXP	2,4-Diamino-6-nitrotoluene	130.0000	µg/L	U
GW37_1(i)-09-13129	HEXP	2,6-Diamino-4-nitrotoluene	130.0000	µg/L	U
GW37_1(i)-09-13129	HEXP	3,5-Dinitroaniline	130.0000	µg/L	U
GW37_1(i)-09-13129	HEXP	Amino-2,6-dinitrotoluene[4-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Amino-4,6-dinitrotoluene[2-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Dinitrobenzene[1,3-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Dinitrotoluene[2,4-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Dinitrotoluene[2,6-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	HMX	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Nitrobenzene	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Nitrotoluene[2-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Nitrotoluene[3-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Nitrotoluene[4-]	64.9000	µg/L	U
GW37_1(i)-09-13129	HEXP	PETN	130.0000	µg/L	U
GW37_1(i)-09-13129	HEXP	RDX	32.5000	µg/L	UJ
GW37_1(i)-09-13129	HEXP	TATB	130.0000	µg/L	U
GW37_1(i)-09-13129	HEXP	Tetryl	64.9000	µg/L	UJ
GW37_1(i)-09-13129	HEXP	Trinitrobenzene[1,3,5-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Trinitrotoluene[2,4,6-]	32.5000	µg/L	U
GW37_1(i)-09-13129	HEXP	Tris (o-cresyl) phosphate	130.0000	µg/L	U
GW37_1(i)-09-13129	METALS	Aluminum	0.8262	mg/L	NQ
GW37_1(i)-09-13129	METALS	Antimony	0.0018	mg/L	NQ
GW37_1(i)-09-13129	METALS	Arsenic	0.0004	mg/L	NQ
GW37_1(i)-09-13129	METALS	Barium	0.0059	mg/L	NQ
GW37_1(i)-09-13129	METALS	Beryllium	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Boron	0.0263	mg/L	NQ
GW37_1(i)-09-13129	METALS	Cadmium	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Calcium	11.2495	mg/L	NQ
GW37_1(i)-09-13129	METALS	Cesium	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Chromium	0.0056	mg/L	NQ
GW37_1(i)-09-13129	METALS	Cobalt	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Copper	0.0028	mg/L	NQ
GW37_1(i)-09-13129	METALS	Iron	2.4815	mg/L	NQ
GW37_1(i)-09-13129	METALS	Lead	0.0016	mg/L	NQ

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13129	METALS	Lithium	0.0349	mg/L	NQ
GW37_1(i)-09-13129	METALS	Magnesium	3.1040	mg/L	NQ
GW37_1(i)-09-13129	METALS	Manganese	0.1236	mg/L	NQ
GW37_1(i)-09-13129	METALS	Mercury	0.0037	mg/L	NQ
GW37_1(i)-09-13129	METALS	Molybdenum	0.0462	mg/L	NQ
GW37_1(i)-09-13129	METALS	Nickel	0.0031	mg/L	NQ
GW37_1(i)-09-13129	METALS	Potassium	6.6099	mg/L	NQ
GW37_1(i)-09-13129	METALS	Selenium	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Silicon Dioxide	47.7245	mg/L	NQ
GW37_1(i)-09-13129	METALS	Silver	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Sodium	21.9533	mg/L	NQ
GW37_1(i)-09-13129	METALS	Strontium	0.0722	mg/L	NQ
GW37_1(i)-09-13129	METALS	Thallium	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Tin	0.0010	mg/L	U
GW37_1(i)-09-13129	METALS	Titanium	0.0415	mg/L	NQ
GW37_1(i)-09-13129	METALS	Uranium	0.0006	mg/L	NQ
GW37_1(i)-09-13129	METALS	Vanadium	0.0019	mg/L	NQ
GW37_1(i)-09-13129	METALS	Zinc	0.0176	mg/L	NQ
GW37_1(i)-09-13129	VOC	Acetone	10.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Acetonitrile	25.0000	µg/L	R
GW37_1(i)-09-13129	VOC	Acrolein	5.0000	µg/L	UJ
GW37_1(i)-09-13129	VOC	Acrylonitrile	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Benzene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Bromobenzene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Bromochloromethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Bromodichloromethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Bromoform	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Bromomethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Butanol[1-]	108.0000	µg/L	NQ
GW37_1(i)-09-13129	VOC	Butanone[2-]	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Butylbenzene[n-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Butylbenzene[sec-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Butylbenzene[tert-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Carbon Disulfide	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Carbon Tetrachloride	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chloro-1,3-butadiene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chloro-1-propene[3-]	5.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13129	VOC	Chlorobenzene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chlorodibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chloroethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chloroform	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chloromethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chlorotoluene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Chlorotoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dibromo-3-Chloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dibromoethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichlorobenzene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichlorobenzene[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichlorobenzene[1,4-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichlorodifluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloroethane[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloroethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloroethene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloroethene[cis-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloroethene[trans-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloropropane[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloropropane[2,2-]	1.0000	µg/L	UJ
GW37_1(i)-09-13129	VOC	Dichloropropene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloropropene[cis-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Dichloropropene[trans-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Diethyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Ethyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Hexachlorobutadiene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Hexanone[2-]	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Iodomethane	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Isobutyl alcohol	50.0000	µg/L	R
GW37_1(i)-09-13129	VOC	Isopropylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Isopropyltoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Methacrylonitrile	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Methyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Methyl tert-Butyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Methyl-2-pentanone[4-]	5.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13129	VOC	Methylene Chloride	10.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Naphthalene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Propionitrile	5.0000	µg/L	R
GW37_1(i)-09-13129	VOC	Styrene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Tetrachloroethane[1,1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Tetrachloroethane[1,1,2,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Tetrachloroethene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Toluene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichlorobenzene[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichlorobenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichloroethane[1,1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichloroethane[1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichloroethene	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichlorofluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trichloropropane[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trimethylbenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Trimethylbenzene[1,3,5-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Vinyl acetate	5.0000	µg/L	UJ
GW37_1(i)-09-13129	VOC	Vinyl Chloride	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Xylene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13129	VOC	Xylene[1,3-]+Xylene[1,4-]	2.0000	µg/L	U
GW37_1(i)-09-13129	WET_CHEM	Alkalinity-CO_3	0.8000	mg/L	U
GW37_1(i)-09-13129	WET_CHEM	Alkalinity-CO_3+HCO_3	88.7500	mg/L	NQ
GW37_1(i)-09-13129	WET_CHEM	pH	7.8640	SU	NQ
GW37_1(i)-09-13130	ANION	Bromide	0.0100	mg/L	U
GW37_1(i)-09-13130	ANION	Chloride	6.1000	mg/L	NQ
GW37_1(i)-09-13130	ANION	Fluoride	0.6000	mg/L	NQ
GW37_1(i)-09-13130	ANION	Nitrate	0.8535	mg/L	NQ
GW37_1(i)-09-13130	ANION	Nitrite	1.9996	mg/L	NQ
GW37_1(i)-09-13130	ANION	Oxalate	0.3800	mg/L	NQ
GW37_1(i)-09-13130	ANION	Perchlorate	0.0050	mg/L	U
GW37_1(i)-09-13130	ANION	Phosphorus, Orthophosphate (Expressed as PO_4)	0.0100	mg/L	U
GW37_1(i)-09-13130	ANION	Sulfate	8.3700	mg/L	NQ
GW37_1(i)-09-13130	LH3	Low-level Tritium	0.4800	TU	NQ
GW37_1(i)-09-13130	HEXP	2,4-Diamino-6-nitrotoluene	13.0000	µg/L	U
GW37_1(i)-09-13130	HEXP	2,6-Diamino-4-nitrotoluene	13.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13130	HEXP	3,5-Dinitroaniline	13.0000	µg/L	U
GW37_1(i)-09-13130	HEXP	Amino-2,6-dinitrotoluene[4-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Amino-4,6-dinitrotoluene[2-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Dinitrobenzene[1,3-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Dinitrotoluene[2,4-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Dinitrotoluene[2,6-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	HMX	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Nitrobenzene	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Nitrotoluene[2-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Nitrotoluene[3-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Nitrotoluene[4-]	6.4900	µg/L	U
GW37_1(i)-09-13130	HEXP	PETN	13.0000	µg/L	U
GW37_1(i)-09-13130	HEXP	RDX	3.2500	µg/L	UJ
GW37_1(i)-09-13130	HEXP	TATB	13.0000	µg/L	U
GW37_1(i)-09-13130	HEXP	Tetryl	6.4900	µg/L	UJ
GW37_1(i)-09-13130	HEXP	Trinitrobenzene[1,3,5-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Trinitrotoluene[2,4,6-]	3.2500	µg/L	U
GW37_1(i)-09-13130	HEXP	Tris (o-cresyl) phosphate	13.0000	µg/L	U
GW37_1(i)-09-13130	METALS	Aluminum	9.1519	mg/L	NQ
GW37_1(i)-09-13130	METALS	Antimony	0.0089	mg/L	NQ
GW37_1(i)-09-13130	METALS	Arsenic	0.0020	mg/L	NQ
GW37_1(i)-09-13130	METALS	Barium	0.0123	mg/L	NQ
GW37_1(i)-09-13130	METALS	Beryllium	0.0010	mg/L	U
GW37_1(i)-09-13130	METALS	Boron	0.0388	mg/L	NQ
GW37_1(i)-09-13130	METALS	Cadmium	0.0010	mg/L	U
GW37_1(i)-09-13130	METALS	Calcium	10.5258	mg/L	NQ
GW37_1(i)-09-13130	METALS	Cesium	0.0010	mg/L	U
GW37_1(i)-09-13130	METALS	Chromium	0.0084	mg/L	NQ
GW37_1(i)-09-13130	METALS	Cobalt	0.0010	mg/L	U
GW37_1(i)-09-13130	METALS	Copper	0.0010	mg/L	U
GW37_1(i)-09-13130	METALS	Iron	11.0238	mg/L	NQ
GW37_1(i)-09-13130	METALS	Lead	0.0002	mg/L	U
GW37_1(i)-09-13130	METALS	Lithium	0.1401	mg/L	NQ
GW37_1(i)-09-13130	METALS	Magnesium	8.2082	mg/L	NQ
GW37_1(i)-09-13130	METALS	Manganese	0.5032	mg/L	NQ
GW37_1(i)-09-13130	METALS	Mercury	0.0073	mg/L	NQ
GW37_1(i)-09-13130	METALS	Molybdenum	0.0445	mg/L	NQ

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13130	METALS	Nickel	0.0036	mg/L	NQ
GW37_1(i)-09-13130	METALS	Potassium	10.1053	mg/L	NQ
GW37_1(i)-09-13130	METALS	Selenium	0.0018	mg/L	NQ
GW37_1(i)-09-13130	METALS	Silicon Dioxide	150.3586	mg/L	NQ
GW37_1(i)-09-13130	METALS	Silver	0.0010	mg/L	U
GW37_1(i)-09-13130	METALS	Sodium	43.4045	mg/L	NQ
GW37_1(i)-09-13130	METALS	Strontium	0.0811	mg/L	NQ
GW37_1(i)-09-13130	METALS	Thallium	0.0010	mg/L	U
GW37_1(i)-09-13130	METALS	Tin	0.0078	mg/L	NQ
GW37_1(i)-09-13130	METALS	Titanium	0.0646	mg/L	NQ
GW37_1(i)-09-13130	METALS	Uranium	0.0022	mg/L	NQ
GW37_1(i)-09-13130	METALS	Vanadium	0.0040	mg/L	NQ
GW37_1(i)-09-13130	METALS	Zinc	0.0493	mg/L	NQ
GW37_1(i)-09-13130	VOC	Acetone	10.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Acetonitrile	25.0000	µg/L	R
GW37_1(i)-09-13130	VOC	Acrolein	5.0000	µg/L	UJ
GW37_1(i)-09-13130	VOC	Acrylonitrile	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Benzene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Bromobenzene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Bromochloromethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Bromodichloromethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Bromoform	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Bromomethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Butanol[1-]	50.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Butanone[2-]	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Butylbenzene[n-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Butylbenzene[sec-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Butylbenzene[tert-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Carbon Disulfide	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Carbon Tetrachloride	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chloro-1,3-butadiene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chloro-1-propene[3-]	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chlorobenzene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chlorodibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chloroethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chloroform	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chloromethane	0.3600	µg/L	J

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13130	VOC	Chlorotoluene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Chlorotoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dibromo-3-Chloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dibromoethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichlorobenzene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichlorobenzene[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichlorobenzene[1,4-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichlorodifluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloroethane[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloroethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloroethene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloroethene[cis-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloroethene[trans-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloropropane[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloropropane[2,2-]	1.0000	µg/L	UJ
GW37_1(i)-09-13130	VOC	Dichloropropene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloropropene[cis-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Dichloropropene[trans-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Diethyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Ethyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Ethylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Hexachlorobutadiene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Hexanone[2-]	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Iodomethane	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Isobutyl alcohol	50.0000	µg/L	R
GW37_1(i)-09-13130	VOC	Isopropylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Isopropyltoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Methacrylonitrile	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Methyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Methyl tert-Butyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Methyl-2-pentanone[4-]	1.3100	µg/L	J
GW37_1(i)-09-13130	VOC	Methylene Chloride	10.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Naphthalene	0.2900	µg/L	J
GW37_1(i)-09-13130	VOC	Propionitrile	5.0000	µg/L	R
GW37_1(i)-09-13130	VOC	Propylbenzene[1-]	1.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13130	VOC	Styrene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Tetrachloroethane[1,1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Tetrachloroethane[1,1,2,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Tetrachloroethene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Toluene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichlorobenzene[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichlorobenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichloroethane[1,1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichloroethane[1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichloroethene	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichlorofluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trichloropropane[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trimethylbenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Trimethylbenzene[1,3,5-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Vinyl acetate	5.0000	µg/L	UJ
GW37_1(i)-09-13130	VOC	Vinyl Chloride	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Xylene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13130	VOC	Xylene[1,3-]+Xylene[1,4-]	2.0000	µg/L	U
GW37_1(i)-09-13130	WET_CHEM	Alkalinity-CO_3	0.8000	mg/L	U
GW37_1(i)-09-13130	WET_CHEM	Alkalinity-CO_3+HCO_3	98.6000	mg/L	NQ
GW37_1(i)-09-13130	WET_CHEM	pH	7.9510	SU	NQ
GW37_1(i)-09-13131	ANION	Bromide	0.0100	mg/L	U
GW37_1(i)-09-13131	ANION	Chloride	9.0656	mg/L	NQ
GW37_1(i)-09-13131	ANION	Fluoride	0.5077	mg/L	NQ
GW37_1(i)-09-13131	ANION	Nitrate	0.2458	mg/L	NQ
GW37_1(i)-09-13131	ANION	Nitrite	0.0030	mg/L	U
GW37_1(i)-09-13131	ANION	Oxalate	0.0100	mg/L	U
GW37_1(i)-09-13131	ANION	Perchlorate	0.0050	mg/L	U
GW37_1(i)-09-13131	ANION	Phosphorus, Orthophosphate (Expressed as PO_4)	0.0100	mg/L	U
GW37_1(i)-09-13131	ANION	Sulfate	6.0511	mg/L	NQ
GW37_1(i)-09-13131	LH3	Low-level Tritium	0.7500	TU	NQ
GW37_1(i)-09-13131	HEXP	2,4-Diamino-6-nitrotoluene	13.0000	µg/L	UJ
GW37_1(i)-09-13131	HEXP	2,6-Diamino-4-nitrotoluene	13.0000	µg/L	U
GW37_1(i)-09-13131	HEXP	3,5-Dinitroaniline	13.0000	µg/L	U
GW37_1(i)-09-13131	HEXP	Amino-2,6-dinitrotoluene[4-]	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Amino-4,6-dinitrotoluene[2-]	3.2500	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13131	HEXP	Dinitrobenzene[1,3-]	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Dinitrotoluene[2,4-]	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Dinitrotoluene[2,6-]	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	HMX	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Nitrobenzene	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Nitrotoluene[2-]	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Nitrotoluene[3-]	3.2500	µg/L	UJ
GW37_1(i)-09-13131	HEXP	Nitrotoluene[4-]	6.4900	µg/L	U
GW37_1(i)-09-13131	HEXP	PETN	13.0000	µg/L	U
GW37_1(i)-09-13131	HEXP	RDX	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	TATB	13.0000	µg/L	U
GW37_1(i)-09-13131	HEXP	Tetryl	6.4900	µg/L	U
GW37_1(i)-09-13131	HEXP	Trinitrobenzene[1,3,5-]	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Trinitrotoluene[2,4,6-]	3.2500	µg/L	U
GW37_1(i)-09-13131	HEXP	Tris (o-cresyl) phosphate	13.0000	µg/L	U
GW37_1(i)-09-13131	METALS	Aluminum	0.1244	mg/L	NQ
GW37_1(i)-09-13131	METALS	Antimony	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Arsenic	0.0002	mg/L	NQ
GW37_1(i)-09-13131	METALS	Barium	0.0059	mg/L	NQ
GW37_1(i)-09-13131	METALS	Beryllium	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Boron	0.0280	mg/L	NQ
GW37_1(i)-09-13131	METALS	Cadmium	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Calcium	6.5838	mg/L	NQ
GW37_1(i)-09-13131	METALS	Cesium	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Chromium	0.0020	mg/L	NQ
GW37_1(i)-09-13131	METALS	Cobalt	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Copper	0.0010	mg/L	NQ
GW37_1(i)-09-13131	METALS	Iron	0.0436	mg/L	NQ
GW37_1(i)-09-13131	METALS	Lead	0.0003	mg/L	NQ
GW37_1(i)-09-13131	METALS	Lithium	0.0402	mg/L	NQ
GW37_1(i)-09-13131	METALS	Magnesium	1.7650	mg/L	NQ
GW37_1(i)-09-13131	METALS	Manganese	0.0584	mg/L	NQ
GW37_1(i)-09-13131	METALS	Mercury	0.000069	mg/L	NQ
GW37_1(i)-09-13131	METALS	Molybdenum	0.1384	mg/L	NQ
GW37_1(i)-09-13131	METALS	Nickel	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Potassium	3.2136	mg/L	NQ
GW37_1(i)-09-13131	METALS	Selenium	0.0010	mg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13131	METALS	Silicon Dioxide	13.1145	mg/L	NQ
GW37_1(i)-09-13131	METALS	Silver	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Sodium	25.8901	mg/L	NQ
GW37_1(i)-09-13131	METALS	Strontium	0.0291	mg/L	NQ
GW37_1(i)-09-13131	METALS	Thallium	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Tin	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Titanium	0.0042	mg/L	NQ
GW37_1(i)-09-13131	METALS	Uranium	0.0006	mg/L	NQ
GW37_1(i)-09-13131	METALS	Vanadium	0.0010	mg/L	U
GW37_1(i)-09-13131	METALS	Zinc	0.0063	mg/L	NQ
GW37_1(i)-09-13131	VOC	Acetone	10.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Acetonitrile	25.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Acrolein	5.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Acrylonitrile	5.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Benzene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Bromobenzene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Bromochloromethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Bromodichloromethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Bromoform	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Bromomethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Butanol[1-]	50.0000	µg/L	R
GW37_1(i)-09-13131	VOC	Butanone[2-]	5.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Butylbenzene[n-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Butylbenzene[sec-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Butylbenzene[tert-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Carbon Disulfide	5.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Carbon Tetrachloride	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Chloro-1,3-butadiene[2-]	1.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Chloro-1-propene[3-]	5.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Chlorobenzene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Chlorodibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Chloroethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Chloroform	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Chloromethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Chlorotoluene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Chlorotoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dibromo-3-Chloropropane[1,2-]	1.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13131	VOC	Dibromoethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichlorobenzene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichlorobenzene[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichlorobenzene[1,4-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichlorodifluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloroethane[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloroethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloroethene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloroethene[cis-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloroethene[trans-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloropropane[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloropropane[2,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloropropene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloropropene[cis-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Dichloropropene[trans-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Diethyl Ether	1.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Ethyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Ethylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Hexachlorobutadiene	1.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Hexanone[2-]	5.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Iodomethane	5.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Isobutyl alcohol	50.0000	µg/L	R
GW37_1(i)-09-13131	VOC	Isopropylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Isopropyltoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Methacrylonitrile	5.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Methyl Methacrylate	5.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Methyl tert-Butyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Methyl-2-pentanone[4-]	2.0300	µg/L	J
GW37_1(i)-09-13131	VOC	Methylene Chloride	10.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Naphthalene	0.3930	µg/L	J
GW37_1(i)-09-13131	VOC	Propionitrile	5.0000	µg/L	UJ
GW37_1(i)-09-13131	VOC	Propylbenzene[1-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Styrene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Tetrachloroethane[1,1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Tetrachloroethane[1,1,2,2-]	1.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13131	VOC	Tetrachloroethene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Toluene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichlorobenzene[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichlorobenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichloroethane[1,1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichloroethane[1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichloroethene	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichlorofluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trichloropropane[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trimethylbenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Trimethylbenzene[1,3,5-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Vinyl acetate	5.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Vinyl Chloride	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Xylene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13131	VOC	Xylene[1,3-]+Xylene[1,4-]	2.0000	µg/L	U
GW37_1(i)-09-13131	WET_CHEM	Alkalinity-CO_3	0.8000	mg/L	U
GW37_1(i)-09-13131	WET_CHEM	Alkalinity-CO_3+HCO_3	93.1000	mg/L	NQ
GW37_1(i)-09-13131	WET_CHEM	pH	7.3350	SU	NQ
GW37_1(i)-09-13132	ANION	Bromide	0.0100	mg/L	U
GW37_1(i)-09-13132	ANION	Chloride	5.7492	mg/L	NQ
GW37_1(i)-09-13132	ANION	Fluoride	0.2507	mg/L	NQ
GW37_1(i)-09-13132	ANION	Nitrate	0.0416	mg/L	NQ
GW37_1(i)-09-13132	ANION	Nitrite	0.1210	mg/L	NQ
GW37_1(i)-09-13132	ANION	Oxalate	0.0100	mg/L	U
GW37_1(i)-09-13132	ANION	Perchlorate	0.0020	mg/L	U
GW37_1(i)-09-13132	ANION	Phosphorus, Orthophosphate (Expressed as PO_4)	0.0100	mg/L	U
GW37_1(i)-09-13132	ANION	Sulfate	3.6453	mg/L	NQ
GW37_1(i)-09-13132	LH3	Low-level Tritium	0.9700	TU	NQ
GW37_1(i)-09-13132	HEXP	2,4-Diamino-6-nitrotoluene	13.0000	µg/L	UJ
GW37_1(i)-09-13132	HEXP	2,6-Diamino-4-nitrotoluene	13.0000	µg/L	U
GW37_1(i)-09-13132	HEXP	3,5-Dinitroaniline	13.0000	µg/L	U
GW37_1(i)-09-13132	HEXP	Amino-2,6-dinitrotoluene[4-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Amino-4,6-dinitrotoluene[2-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Dinitrobenzene[1,3-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Dinitrotoluene[2,4-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Dinitrotoluene[2,6-]	3.2500	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13132	HEXP	HMX	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Nitrobenzene	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Nitrotoluene[2-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Nitrotoluene[3-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Nitrotoluene[4-]	6.4900	µg/L	U
GW37_1(i)-09-13132	HEXP	PETN	13.0000	µg/L	U
GW37_1(i)-09-13132	HEXP	RDX	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	TATB	13.0000	µg/L	U
GW37_1(i)-09-13132	HEXP	Tetryl	6.4900	µg/L	U
GW37_1(i)-09-13132	HEXP	Trinitrobenzene[1,3,5-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Trinitrotoluene[2,4,6-]	3.2500	µg/L	U
GW37_1(i)-09-13132	HEXP	Tris (o-cresyl) phosphate	13.0000	µg/L	U
GW37_1(i)-09-13132	METALS	Aluminum	0.0543	mg/L	NQ
GW37_1(i)-09-13132	METALS	Antimony	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Arsenic	0.0002	mg/L	U
GW37_1(i)-09-13132	METALS	Barium	0.0057	mg/L	NQ
GW37_1(i)-09-13132	METALS	Beryllium	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Boron	0.0151	mg/L	NQ
GW37_1(i)-09-13132	METALS	Cadmium	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Calcium	6.9211	mg/L	NQ
GW37_1(i)-09-13132	METALS	Cesium	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Chromium	0.0018	mg/L	NQ
GW37_1(i)-09-13132	METALS	Cobalt	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Copper	0.0010	mg/L	NQ
GW37_1(i)-09-13132	METALS	Iron	0.0341	mg/L	NQ
GW37_1(i)-09-13132	METALS	Lead	0.0002	mg/L	NQ
GW37_1(i)-09-13132	METALS	Lithium	0.0260	mg/L	NQ
GW37_1(i)-09-13132	METALS	Magnesium	1.9079	mg/L	NQ
GW37_1(i)-09-13132	METALS	Manganese	0.1439	mg/L	NQ
GW37_1(i)-09-13132	METALS	Mercury	0.0001	mg/L	U
GW37_1(i)-09-13132	METALS	Molybdenum	0.0451	mg/L	NQ
GW37_1(i)-09-13132	METALS	Nickel	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Potassium	2.0106	mg/L	NQ
GW37_1(i)-09-13132	METALS	Selenium	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Silicon Dioxide	15.8339	mg/L	NQ
GW37_1(i)-09-13132	METALS	Silver	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Sodium	18.2249	mg/L	NQ

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13132	METALS	Strontium	0.0285	mg/L	NQ
GW37_1(i)-09-13132	METALS	Thallium	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Tin	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Titanium	0.0024	mg/L	NQ
GW37_1(i)-09-13132	METALS	Uranium	0.0004	mg/L	NQ
GW37_1(i)-09-13132	METALS	Vanadium	0.0010	mg/L	U
GW37_1(i)-09-13132	METALS	Zinc	0.0045	mg/L	NQ
GW37_1(i)-09-13132	VOC	Acetone	5.6900	µg/L	J
GW37_1(i)-09-13132	VOC	Acetonitrile	25.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Acrolein	5.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Acrylonitrile	5.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Benzene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Bromobenzene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Bromochloromethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Bromodichloromethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Bromoform	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Bromomethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Butanol[1-]	50.0000	µg/L	R
GW37_1(i)-09-13132	VOC	Butanone[2-]	5.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Butylbenzene[n-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Butylbenzene[sec-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Butylbenzene[tert-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Carbon Disulfide	5.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Carbon Tetrachloride	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Chloro-1,3-butadiene[2-]	1.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Chloro-1-propene[3-]	5.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Chlorobenzene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Chlorodibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Chloroethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Chloroform	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Chloromethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Chlorotoluene[2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Chlorotoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dibromo-3-Chloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dibromoethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dibromomethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichlorobenzene[1,2-]	1.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13132	VOC	Dichlorobenzene[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichlorobenzene[1,4-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichlorodifluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloroethane[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloroethane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloroethene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloroethene[cis-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloroethene[trans-1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloropropane[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloropropane[1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloropropane[2,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloropropene[1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloropropene[cis-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Dichloropropene[trans-1,3-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Diethyl Ether	1.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Ethyl Methacrylate	5.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Ethylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Hexachlorobutadiene	1.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Hexanone[2-]	5.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Iodomethane	5.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Isobutyl alcohol	50.0000	µg/L	R
GW37_1(i)-09-13132	VOC	Isopropylbenzene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Isopropyltoluene[4-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Methacrylonitrile	5.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Methyl Methacrylate	5.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Methyl tert-Butyl Ether	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Methyl-2-pentanone[4-]	5.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Methylene Chloride	10.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Naphthalene	0.3690	µg/L	J
GW37_1(i)-09-13132	VOC	Propionitrile	5.0000	µg/L	UJ
GW37_1(i)-09-13132	VOC	Propylbenzene[1-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Styrene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Tetrachloroethane[1,1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Tetrachloroethane[1,1,2,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Tetrachloroethene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Toluene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5.0000	µg/L	U

Table B-1.3-1 (continued)

Sample Name	Analytical Suite Code	Analyte Description	Lab Result	Units	Validation Qualifier Code[a]
GW37_1(i)-09-13132	VOC	Trichlorobenzene[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trichlorobenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trichloroethane[1,1,1-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trichloroethane[1,1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trichloroethene	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trichlorofluoromethane	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trichloropropane[1,2,3-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trimethylbenzene[1,2,4-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Trimethylbenzene[1,3,5-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Vinyl acetate	5.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Vinyl Chloride	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Xylene[1,2-]	1.0000	µg/L	U
GW37_1(i)-09-13132	VOC	Xylene[1,3-]+Xylene[1,4-]	2.0000	µg/L	U
GW37_1(i)-09-13132	WET_CHEM	Alkalinity-CO_3	0.8000	mg/L	U
GW37_1(i)-09-13132	WET_CHEM	Alkalinity-CO_3+HCO_3	79.2150	mg/L	NQ
GW37_1(i)-09-13132	WET_CHEM	pH	7.5570	SU	NQ
GW37_1(i)-09-13138	WET_CHEM	Total Organic Carbon	0.3685	mg/L	NQ
GW37_1(i)-09-13139	WET_CHEM	Total Organic Carbon	0.4980	mg/L	NQ

[a] J = Estimated value. NQ = No qualifiers were applied during validation; data are useable. R = Data are rejected. U = Undetected. UJ = Undetected, but estimated value.

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

[c] PETN = Pentaerythritol tetranitrate.

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

[e] TATB = Triaminotrinitrobenzene.

[f] SU = Standard unit.

Table B-1.3-2
Analytical Results for Groundwater Screening Samples Collected at CdV-37-1i

Sample ID	Date Received	ER/RRES-WQH	Sample Type	Depth (ft)	Ag rslt (ppm)	stdev (Ag)	Al rslt (ppm)	stdev (Al)	As rslt (ppm)	stdev (As)	B rslt (ppm)	stdev (B)	Ba rslt (ppm)	stdev (Ba)	Be rslt (ppm)	stdev (Be)	Br(-) ppm	Br(-) (U)	TOC rslt (ppm)	Ca rslt (ppm)	stdev (Ca)	Cd rslt (ppm)	stdev (Cd)	Cl(-) ppm	ClO4(-) ppm	ClO4(-) (U)	Co rslt (ppm)	stdev (Co)
GW37-1(i)-09-13128	10/15/2009	10-135	Borehole	203	0.001	U	0.37	0.00	0.0005	0.0000	0.025	0.000	0.010	0.000	0.001	U	0.02	AD	Not applicable	11.16	0.03	0.001	U	8.33	0.005	U	0.001	U
GW37-1(i)-09-13129	10/16/2009	10-153	Borehole	250	0.001	U	0.83	0.01	0.0004	0.0001	0.026	0.000	0.006	0.000	0.001	U	0.01	U	Not applicable	11.25	0.03	0.001	U	6.67	0.005	U	0.001	U
GW37-1(i)-09-13130	10/16/2009	10-153	Borehole	270	0.001	U	9.15	0.03	0.0020	0.0003	0.039	0.000	0.012	0.001	0.001	U	0.01	U	Not applicable	10.53	0.05	0.001	U	6.10	0.005	U	0.001	U
GW37-1(i)-09-13131	10/26/2009	10-249	Borehole	620	0.001	U	0.12	0.00	0.0002	0.0001	0.028	0.000	0.006	0.000	0.001	U	0.01	U	Not applicable	6.58	0.04	0.001	U	9.07	0.005	U	0.001	U
GW37-1(i)-09-13132	10/26/2009	10-249	Borehole	640	0.001	U	0.05	0.00	0.0002	U	0.015	0.000	0.006	0.000	0.001	U	0.01	U	Not applicable	6.92	0.04	0.001	U	5.75	0.002	U	0.001	U

Note. U = Not detected, AD = above analytical detection.

Table B-1.3-2
Analytical Results for Groundwater Screening Samples Collected at CdV-37-1i

Sample ID	Date Received	ER/RRES-WQH	Sample Type	Alk-CO3 rslt (ppm)	ALK-CO3 (U)	Cr rslt (ppm)	stdev (Cr)	Cs rslt (ppm)	stdev (Cs)	Cu rslt (ppm)	stdev (Cu)	F(-) ppm	Fe rslt (ppm)	stdev (Fe)	Alk-CO3+HCO3 rslt (ppm)	Hg rslt (ppm)	stdev (Hg)	K rslt (ppm)	stdev (K)	Li rslt (ppm)	stdev (Li)	Mg rslt (ppm)	stdev (Mg)	Mn rslt (ppm)	stdev (Mn)	Mo rslt (ppm)
GW37-1(i)-09-13128	10/15/2009	10-135	Borehole	0.8	U	0.003	0.000	0.002	0.000	0.001	0.000	1.07	0.28	0.00	98.2	0.0031	0.0000	9.98	0.03	0.027	0.000	4.26	0.01	0.324	0.002	0.055
GW37-1(i)-09-13129	10/16/2009	10-153	Borehole	0.8	U	0.006	0.001	0.001	U	0.003	0.000	0.37	2.48	0.01	88.8	0.0037	0.0001	6.61	0.02	0.035	0.000	3.10	0.02	0.124	0.001	0.046
GW37-1(i)-09-13130	10/16/2009	10-153	Borehole	0.8	U	0.004	0.000	0.001	U	0.007	0.000	0.60	11.0	0.1	98.6	0.0073	0.0003	10.11	0.22	0.059	0.002	8.21	0.60	0.503	0.116	0.045
GW37-1(i)-09-13131	10/26/2009	10-249	Borehole	0.8	U	0.002	0.000	0.001	U	0.001	U	0.51	0.04	0.00	93.1	0.00007	0.00000	3.21	0.02	0.040	0.000	1.76	0.01	0.058	0.002	0.138
GW37-1(i)-09-13132	10/26/2009	10-249	Borehole	0.8	U	0.002	0.000	0.001	U	0.001	0.000	0.25	0.03	0.00	79.2	0.00005	U	2.01	0.00	0.026	0.000	1.91	0.01	0.144	0.005	0.045

Note. U = Not detected, AD = above analytical detection.

Table B-1.3-2
Analytical Results for Groundwater Screening Samples Collected at CdV-37-1i

Sample ID	Date Received	ER/RRES-WQH	Sample Type	stdev (Mo)	Na rslt (ppm)	stdev (Na)	Ni rslt (ppm)	stdev (Ni)	NO2 (ppm)	NO2-N rslt	NO2-N (U)	NO3 ppm	NO3-N rslt	C2O4 rslt (ppm)	C2O4 (U)	Pb rslt (ppm)	stdev (Pb)	pH	PO4(-3) rslt (ppm)	PO4(-3) (U)	Rb rslt (ppm)	stdev (Rb)	Sb rslt (ppm)	stdev (Sb)	Se rslt (ppm)	stdev (Se)
GW37-1(i)-09-13128	10/15/2009	10-135	Borehole	0.001	26.64	0.28	0.002	0.000	0.01	0.003	U	1.01	0.23	1.10	AD	0.0004	0.0000	7.95	0.01	U	0.061	0.005	0.001	U	0.001	U
GW37-1(i)-09-13129	10/16/2009	10-153	Borehole	0.000	21.95	0.17	0.003	0.000	0.01	0.003	U	2.30	0.52	0.73	AD	0.0016	0.0000	7.86	0.01	U	0.062	0.002	0.002	0.000	0.001	U
GW37-1(i)-09-13130	10/16/2009	10-153	Borehole	0.001	43.40	0.10	0.004	0.001	6.57	2.000	AD	3.78	0.85	0.38	AD	0.0236	0.0005	7.95	0.01	U	0.025	0.002	0.009	0.000	0.002	0.000
GW37-1(i)-09-13131	10/26/2009	10-249	Borehole	0.000	25.89	0.26	0.001	U	0.01	0.003	U	1.09	0.25	0.01	U	0.0003	0.0000	7.34	0.01	U	0.003	0.000	0.001	U	0.001	U
GW37-1(i)-09-13132	10/26/2009	10-249	Borehole	0.000	18.22	0.13	0.001	U	0.40	0.121	AD	0.18	0.04	0.01	U	0.0002	0.0000	7.56	0.01	U	0.002	0.000	0.001	U	0.001	U

Note. U = Not detected, AD = above analytical detection.

Table B-1.3-2
Analytical Results for Groundwater Screening Samples Collected at CdV-37-1i

Sample ID	Date Received	ER/RRES-WQH	Sample Type	Si rslt (ppm)	stdev (Si)	SiO2 rslt (ppm)	stdev (SiO2)	Sn rslt (ppm)	stdev (Sn)	SO4(-2) rslt (ppm)	Sr rslt (ppm)	stdev (Sr)	Th rslt (ppm)	stdev (Th)	Ti rslt (ppm)	stdev (Ti)	Tl rslt (ppm)	stdev (Tl)	U rslt (ppm)	stdev (U)	V rslt (ppm)	stdev (V)	Zn rslt (ppm)	stdev (Zn)	TDS (ppm)	Cations	Anions	Balance
GW37-1(i)-09-13128	10/15/2009	10-135	Borehole	16.63	0.11	35.59	0.25	0.001	U	12.79	0.071	0.000	0.001	U	0.016	0.000	0.001	U	0.0048	0.0002	0.001	0.000	0.010	0.001	212	2.34	2.23	0.02
GW37-1(i)-09-13129	10/16/2009	10-153	Borehole	22.30	0.15	47.72	0.33	0.001	U	5.35	0.072	0.001	0.001	U	0.041	0.000	0.001	U	0.0006	0.0000	0.002	0.000	0.018	0.000	207	1.95	1.99	-0.01
GW37-1(i)-09-13130	10/16/2009	10-153	Borehole	70.26	1.00	150.36	2.15	0.008	0.000	8.37	0.081	0.001	0.008	0.000	0.065	0.004	0.001	U	0.0022	0.0001	0.004	0.002	0.049	0.002	359	3.38	2.23	0.20
GW37-1(i)-09-13131	10/26/2009	10-249	Borehole	6.13	0.04	13.11	0.09	0.001	U	6.05	0.029	0.001	0.001	U	0.004	0.000	0.001	U	0.0006	0.0000	0.001	U	0.006	0.001	162	1.69	1.98	-0.08
GW37-1(i)-09-13132	10/26/2009	10-249	Borehole	7.40	0.09	15.83	0.20	0.001	U	3.65	0.028	0.000	0.001	U	0.002	0.000	0.001	U	0.0004	0.0000	0.001	U	0.004	0.001	135	1.36	1.59	-0.08

Note. U = Not detected, AD = above analytical detection.

Table B-1.3-3
TOC Results for Groundwater Screening Samples Collected at CdV-37-1i

Sample ID	Sample Type	Analyte Suite	TOC (mgC/L)	Data Qualifier
GW37-1(i)-09-13138	Development	TOC	0.37	AD
GW37-1(i)-09-13139	Development	TOC	0.50	AD
GW37-1(i)-09-13140	Aquifer Testing	TOC	0.20	U
GW37-1(i)-09-13141	Aquifer Testing	TOC	0.22	AD
GW37-1(i)-09-13142	Aquifer Testing	TOC	0.20	U
GW37-1(i)-09-13143	Aquifer Testing	TOC	0.20	U

Note: U means not detected and AD means above analytical detection.

Appendix C

Aquifer Testing Report

C-1.0 INTRODUCTION

This appendix describes the hydraulic analysis of pumping tests conducted at CdV-37-1i, an intermediate-zone well located at the confluence of Cañon de Valle and Water Canyon. The tests on CdV-37-1i were conducted to evaluate the hydraulic properties of the saturated perched zone in which the well is completed.

Testing consisted of brief trial pumping of CdV-37-1i at multiple discharge rates, background water-level data collection, and a 24-h constant-rate pumping test. In most of the regional (R-) well pumping tests conducted on the plateau an inflatable packer system is used in an attempt to eliminate storage effects on the test data. However, a packer system was not used in the CdV-37-1i tests because the filter pack and transition sand collar extended above the static water level, so that dewatering of the annular sand backfill materials was inevitable during testing. Thus, storage effects would have occurred regardless of whether or not a packer was employed.

C-1.1 Conceptual Hydrogeology

Well CdV-37-1i extends into the top of the Puye Formation. The well was completed with 20.58 ft of 5-in. stainless steel well screen from 631.95 to 652.53 ft below ground surface (bgs). The static water level measured on December 9, 2009, before aquifer testing was above the top of the well screen, at 628.17 ft bgs. Based on an estimated land surface elevation of 6828 ft above mean sea level (amsl), this put the perched water table at an elevation of approximately 6200 ft amsl.

The perching layer was believed to fall between 640 and 660 ft bgs, because water production during drilling ceased somewhere within this interval. A layer of basalt was encountered between 689 and 740 ft, so the top of this zone was viewed as a possible perching surface. Nevertheless, the loss of water production between 640 and 660 ft during drilling suggested that tight sediments within the Puye Formation supported the perched water. For the purposes of analytical calculation in this report, the saturated zone was assumed to be unconfined, extending from the static water level of 628.17 ft bgs to the bottom of the well screen at 652.53 ft bgs—a thickness of 24.36 ft. As described below, indirect evidence suggests that the base of the permeable water-bearing zone might be shallower than this.

C-1.2 CdV-37-1i Testing

Well CdV-37-1i was tested from December 10 to 14, 2009. After the drop pipe was filled during the early morning of December 10, testing consisted of brief trial pumping later that evening, a 24-h test that was begun on December 11, and background/recovery data collection through December 14.

Trial testing consisted of pumping CdV-37-1i at four different rates for 40 min each from 7:40 to 10:20 p.m. on December 10. The well was pumped sequentially at 8.65, 6.90, 4.55, and 3.10 gpm. Following pump shutoff, recovery data were recorded for 940 min until 2:00 p.m. on December 11.

At 2:00 p.m. on December 11, the 24-h pumping test was begun at a rate of 2.76 gpm. Pumping continued until 2:00 p.m. on December 12. Following shutdown, recovery/background measurements were recorded for 3222 min until 7:42 p.m. on December 14.

C-2.0 BACKGROUND DATA

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

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

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

Subsequent pumping tests, including the one at CdV-37-1i, have used nonvented transducers. These devices simply record the total pressure on the transducer, that is, the sum of the water height plus the barometric pressure. This results in an attenuated “apparent” hydrograph in a barometrically efficient well. Take as an example a 90% barometrically efficient well. When monitored with 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, with 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 Waste and Environmental Services Division–Environmental Data and Analysis group (WES-EDA). The TA-54 measurement location is at an elevation of 6548 ft amsl, whereas the wellhead elevation is approximately 6828 ft amsl. The static water level in CdV-37-1i was 628.17 ft below land surface, making the calculated water-table elevation roughly 6200 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 CdV-37-1i.

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

$$P_{WT} = P_{TA54} \exp\left[-\frac{g}{3.281R}\left(\frac{E_{CdV-37-1i} - E_{TA54}}{T_{TA54}} + \frac{E_{WT} - E_{CdV-37-1i}}{T_{WELL}}\right)\right], \qquad \textbf{Equation C-1}$$

where P_{WT} = barometric pressure at the water table inside CdV-37-1i,

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

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

R = gas constant, in J/kg/ K (287.04 J/kg/ K),

$E_{CdV\text{-}37\text{-}1i}$ = land-surface elevation at CdV-37-1i site, in feet (estimated 6828 ft),

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

E_{WT} = elevation of the water level in CdV-37-1i, in feet (approximately 6200 ft),

T_{TA54} = air temperature near TA-54, in degrees Kelvin (assigned a value of 22.9 F, or 268.1 K), and

T_{WELL} = air temperature inside CdV-37-1i, in degrees Kelvin (assigned a value of 56.6 F, or 286.8 K).

This formula is an adaptation of an equation WES-EDA provided. It can be derived from the ideal gas law and standard physics principles. Inherent assumptions in the derivation of the equation are that (1) the air temperature between TA-54 and the well is temporally and spatially constant and (2) the temperature of the air column in the well is similarly constant.

The corrected barometric pressure data reflecting pressure conditions at the water table were compared with the water-level hydrograph to discern the correlation between the two.

C-3.0 IMPORTANCE OF EARLY DATA

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

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

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

Equation C-2

where t_c = duration of casing-storage effect, in minutes,

D = inside diameter of well casing, in inches,

d = outside diameter of column pipe, in inches,

Q = discharge rate, in gallons per minute, and

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, there can be an additional storage contribution from the filter pack around the screen. The following equation provides an estimate of the storage duration accounting for both casing and filter-pack storage.

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

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

D_B = diameter of borehole, in inches, and

D_C = outside diameter of well casing, in inches.

This equation was derived from Equation C-2 on a proportional basis, specifically an increase in the computed time in direct proportion to the additional volume of water expected to drain from the filter pack. (As proof, 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. While this option has been implemented for the R-well testing program in general, it was not applied to the CdV-37-1i pumping test because inevitable dewatering of the filter pack would have negated the effects of the inflatable packer.

In estimating storage effects, a short-term drainable porosity of the filter materials of 0.20 was arbitrarily used. The borehole diameter, D_B, was assigned a value of 0.71 ft. The nominal drilled diameter was 0.51 ft, but excess filter-pack usage during backfilling showed the effective average borehole diameter to be greater because of washouts and hole enlargement.

C-4.0 TIME-DRAWDOWN METHODS

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

$$s = \frac{114.6Q}{T} W(u) ,$$ **Equation C-4**

where

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

and

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

and where s = drawdown, in feet,

Q = discharge rate, in gallons per minute,

T = transmissivity, in gallons per day per foot,

S = storage coefficient (dimensionless),

t = pumping time, in days, and

r = distance from center of pumpage, in feet.

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

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

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

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

S = storage coefficient,

Q = discharge rate, in gallons per minute,

$W(u)$ = match-point value,

s = match-point value, in feet,

u = match-point value, and

t = match-point value, in minutes.

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

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

The Cooper-Jacob equation is a simplified approximation of the Theis equation and is valid whenever the u-value is less than about 0.05. For small radius values (e.g., corresponding to borehole radii), u is less than 0.05 at very early pumping times and therefore is less than 0.05 for most or all measured drawdown values. Thus, for the pumped well, the Cooper-Jacob equation usually can be considered a valid approximation of the Theis equation.

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

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

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

Q = discharge rate, in gallons per minute, and

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

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

Equation C-11

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

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

b = aquifer thickness,

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

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

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

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

K_z = vertical hydraulic conductivity, and

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

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

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

C-5.0 RECOVERY METHODS

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

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

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

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

C-6.0 UNCONFINED AQUIFER DRAWDOWN CORRECTION

For unconfined aquifers, the saturated aquifer thickness is reduced below the original thickness during testing. This results in drawdown values that deviate from theoretical predictions, because well hydraulics formulas are based on 100% aquifer saturation. Before analysis, the actual drawdown values must be corrected for dewatering effects with the following formula (Kruseman et al. 1991, 106681):

$$s_c = s_a - \frac{s_a^2}{2b} \quad , \qquad \textbf{Equation C-14}$$

where s_c = corrected drawdown, in ft,

S_a = observed drawdown, in ft, and

b = saturated aquifer thickness, in ft.

Assumptions required for validity of Equation C-14 are (1) homogeneous hydraulic conductivity, (2) full penetration of the producing zone by the well screen, and (3) no head loss associated with vertical flow. This last assumption is satisfied by one of two extremes—either zero permeability in the vertical direction so that there is no flow (and therefore no head loss) vertically, or infinite vertical permeability. Failure to meet any of these three assumptions leads to modest errors in application of the drawdown correction equation.

C-7.0 SPECIFIC CAPACITY METHOD

The specific capacity of the pumped well can be used to obtain a lower-bound value of hydraulic conductivity. The hydraulic conductivity is computed using formulas that are based on the assumption that the pumped well is 100% efficient. The resulting hydraulic conductivity is the value required to sustain the observed specific capacity. If the actual well is less than 100% efficient, it follows that the actual hydraulic conductivity would have to be greater than calculated to compensate for well inefficiency. Thus, because the efficiency is unknown, the computed hydraulic-conductivity value represents a lower bound. The actual conductivity is known to be greater than or equal to the computed value.

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

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

$$s_P = \frac{1-\frac{L}{b}}{\frac{L}{b}}\left[\ln\frac{b}{r_w} - 2.948 + 7.363\frac{L}{b} - 11.447\left(\frac{L}{b}\right)^2 + 4.675\left(\frac{L}{b}\right)^3\right]. \quad \textbf{Equation C-15}$$

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

$$K = \frac{264Q}{sb}\left(\log\frac{0.3Tt}{r_w^2 S} + \frac{2s_P}{\ln 10}\right). \quad \textbf{Equation C-16}$$

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. Unconfined conditions were assumed for CdV-37-1i. Storage-coefficient values for unconfined conditions can be expected to range from about 0.01 to 0.25 (Driscoll 1986, 104226). Values of 0.01 and 0.10 were used for the CdV-37-1i calculations. The calculation result is not particularly sensitive to the choice of storage-coefficient value, so a rough estimate of the storage coefficient is generally adequate to support the calculations.

For partially penetrating systems, the analysis also requires assigning a value for the saturated aquifer thickness, b. For the purposes of this exercise, however, because the pumping water level was pulled down into or very near the screen, the problem was solved as a fully penetrating case with a correction for dewatering.

C-8.0 BACKGROUND DATA ANALYSIS

Background aquifer pressure data collected during the CdV-37-1i tests were plotted along with barometric pressure to determine the barometric effect on water levels.

Figure C-8.0-1 shows aquifer pressure data from CdV-37-1i 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 CdV-37-1i data are referred to in the figure as the “apparent hydrograph” because the measurements reflect the sum of water pressure and barometric pressure, having been recorded using a nonvented pressure transducer. The times of the pumping periods for the CdV-37-1i pumping tests are included on the figure for reference.

There was little change in barometric pressure during the test except for December 13, when the pressure dropped steeply and then rebounded rapidly. The apparent hydrograph showed that the total aquifer pressure remained essentially unchanged in response to these swings in barometric pressure, indicating a barometric efficiency of near 100%.

C-9.0 WELL CdV-37-1i DATA ANALYSIS

This section presents the data obtained from the CdV-37-1i pumping tests and the results of the analytical interpretations. Data are presented for drawdown and recovery from the trial test as well as the 24-h constant-rate pumping test.

C-9.1 Well CdV-37-1i Trial Test

Figure C-9.1-1 shows a semilog plot of the drawdown data collected from the trial test. As indicated on the graph, the discharge rate was varied from 8.65 to 3.10 gpm in four 40-min steps. The casing-storage duration estimated for CdV-37-1i was about the same as the step length used in the test, precluding conventional analysis of the drawdown data.

The final drawdown recorded for each pumping step was corrected for dewatering effects, and the corrected specific capacity values were computed as shown in Table C-9.1-1. Calculations were made for the assumed nominal saturated thickness of 24.36 ft. The calculations showed a declining corrected specific capacity with increasing discharge rate. Assuming laminar-flow conditions (likely), the corrected specific capacity values should not have declined with increasing pumping rate. If anything, values for the greater discharge rates should have exceeded those corresponding to the lower rates because of the progressively longer pumping duration at the successively lower rates. Thus, the calculations showed the inverse of what was expected.

There are three explanations for the inverse correlation shown by the calculations. First, turbulent flow may have degraded pumping performance at the higher pumping rates. However, because none of the discharge rates were excessive, this explanation seems unlikely. Second, the hydraulic conductivity along the length of the well screen may have been nonuniform, such that preferentially higher-permeability sediments were dewatered at the higher pumping rates. A final explanation is that the base of the permeable formation may be shallower than the bottom of the well screen, i.e., the top of the perching horizon may fall within the screened interval.

To illustrate this last hypothesis, the corrected specific capacity values were recalculated for a variety of other assumed aquifer thickness values, both above and below the nominal value of 24.36 ft, and the results were examined. The greatest similarity among the computed values was obtained for an assumed aquifer thickness of 20.5 ft. The results obtained for this assumption are shown in Table C-9.1-2.

The hypothesized saturated thickness was adjusted further to deliberately skew the corrected specific capacity values in such a way as to make the values corresponding to shorter pumping times greater than those corresponding to longer pumping times. The thickness value was adjusted until the percentage spread among the corrected specific capacity values was about what would be estimated from the difference in total cumulative pumping time associated with each discharge rate. An appropriate spread of corrected values was obtained for an assumed saturated thickness of 15.5 ft. The results obtained for this assumption are shown in Table C-9.1-3. For uniform hydraulic conductivity and negligible turbulent flow, this scenario is likely to be reasonably representative of actual conditions. This would place the computed base of the permeable section at 628.17 + 15.5 = 643.67 ft bgs. The implication is that the bottom 9 ft or so of well screen may be placed opposite relatively nonproductive sediments.

Figure C-9.1-2 shows the recovery data collected following shutdown of the trial 1 pumping test. The casing and filter-pack storage times are shown on the graph for reference.

The late recovery data were expected to respond according to the overall average discharge rate of 6.2 gpm. As shown on the graph, the late-time slope produced a transmissivity value of 2170 gpd/ft.

Curiously, the data trace showed a concave downward shape after cessation of storage effects. Recovery data following a high-to-low pumping-rate regime should exhibit a flat to slightly concave upward trace. The actual response may have been an artifact of hysteretic effects (Bevan et al. 2005, 105186) in which the effective storage coefficient immediately following pump shutoff is small, gradually increasing over time. This response causes a gradual flattening of the recovery curve (concave downward shape) and can lead to overestimating the transmissivity because of the flat late-time data trace. This suggested that the computed transmissivity value of 2170 gpd/ft may represent an upper bound of the actual value.

C-9.2 Well CdV-37-1i 24-h Constant-Rate Pumping Test

Figure C-9.2-1 shows a semilog plot of the drawdown data collected during the 24-h pumping test performed at 2.76 gpm. The casing-storage times are shown on the graph for reference.

The corrected data curve on Figure C-9.2-1 shows the data corrected for dewatering effects for the nominal saturated thickness of 24.36 ft. The transmissivity calculated from the line of fit through the data points was 1740 gpd/ft. This produced a computed hydraulic conductivity value of 71.4 gpd/ft^2, or 9.5 ft/d.

As discussed above, however, the corrected specific capacity data from the trial test implied the likelihood of a thinner permeable zone, perhaps around 15.5 ft thick. The data were corrected for dewatering effects for this assumed saturated thickness as shown on Figure C-9.2-2. The transmissivity value computed from the line of fit was 1890 gpd/ft. This value is probably more representative of actual conditions. The hydraulic conductivity computed from this combination of transmissivity and saturated thickness was 122 gpd/ft^2, or 16.3 ft/d.

Figure C-9.2-3 shows the recovery data collected following shutdown of the 24-h pumping test. The times corresponding to casing and filter-pack storage duration are shown on the graph for reference. The recovery data trace showed the same subtle concave downward shape seen in the trial recovery data, suggesting possible hysteretic effects associated with a reduced storage coefficient during early recovery followed by a gradually increasing storage coefficient at late recovery time.

The transmissivity computed from the line of fit on the graph was 2130 gpd/ft. This was greater than values obtained from the drawdown data, further reinforcing the idea of hysteresis in the test data. This value probably represents a slight overestimate of the actual transmissivity.

C-9.3 Well CdV-37-1i Specific Capacity Data

Late-time specific capacity data were used along with well geometry to estimate a lower-bound transmissivity value for the permeable zone penetrated by CdV-37-1i. This was done to provide a frame of reference for evaluating the foregoing analyses.

During the 24-h pumping test, the discharge rate of 2.76 gpm was maintained for 1440 min. The measured drawdown at this rate was 3.21 ft, yielding an actual specific capacity of 0.86 gpm/ft. The observed drawdown was corrected for dewatering effects using Equation C-14 and assuming the likely effective saturated thickness of 15.5 ft. This yielded a corrected drawdown of 2.88 ft and a corrected specific capacity of 0.96 gpm/ft. In addition to specific capacity and pumping time, other input values used in the calculations included storage-coefficient values of 0.01 and 0.10 and a borehole radius of 0.71 ft.

Applying the Brons and Marting method to these inputs for fully penetrating conditions yielded lower-bound transmissivity values of 1230 and 950 gpd/ft for storage coefficient values of 0.01 and 0.10, respectively. These values were consistent with that obtained from the pumping test analyses (1890 gpd/ft), supporting the analytical results and implying a reasonable well efficiency in the range of about 50% to 65%.

C-10.0 SUMMARY

Step-drawdown and constant-rate pumping tests were conducted on CdV-37-1i. The tests were performed to gain an understanding of the hydraulic characteristics of the saturated perched zone penetrated by the CdV-37-1i well screen. Numerous observations and conclusions were drawn for the tests as summarized below.

A comparison of barometric pressure and CdV-37-1i water-level data suggested a barometric efficiency near 100%, typical of most wells on the plateau.

The filter sand and fine sand collar extended above the static water level. This meant that dewatering of the filter pack was inevitable during testing and that storage effects would occur whether or not an inflatable packer was used. Therefore, implementation of an inflatable packer to eliminate storage effects would have been futile and was not pursued.

Step-drawdown data provided indirect evidence of a saturated thickness on the order of 15.5 ft as opposed to the apparent value of 24.36 ft between the static water level and the bottom of the well screen. This suggested that the bottom 9 ft or so of well screen was placed opposite nonproductive sediments.

The transmissivity value computed from the drawdown data was 1890 gpd/ft. Based on the extrapolated saturated thickness of 15.5 ft, the average hydraulic conductivity computed to 122 gpd/ft^2, or 16.3 ft/d.

The recovery data traces showed late-time curvature and overestimated the transmissivity, suggesting hysteretic effects associated with a reduced storage coefficient during early recovery followed by a gradually increasing storage coefficient at late recovery time.

CdV-37-1i produced 2.76 gpm with 3.21 ft of drawdown after 1440 min of pumping, resulting in a specific capacity of 0.86 gpm/ft and a corrected specific capacity of 0.96 gpm/ft. The corresponding computed lower-bound transmissivity value ranged from 950 to 1230 gpd/ft—consistent with the pumping test values. This helped to corroborate the analytical results and suggested a moderate well efficiency.

The drawdown and recovery data showed no significant boundary effects within the area of influence of pumping.

C-11.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

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

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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)

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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., N.A. de Ridder, and J.M. Verweij, 1991. Excerpted page from *Analysis and Evaluation of Pumping Test Data*, International Institute for Land Reclamation and Improvement, Netherlands. (Kruseman et al. 1991, 106681)

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)

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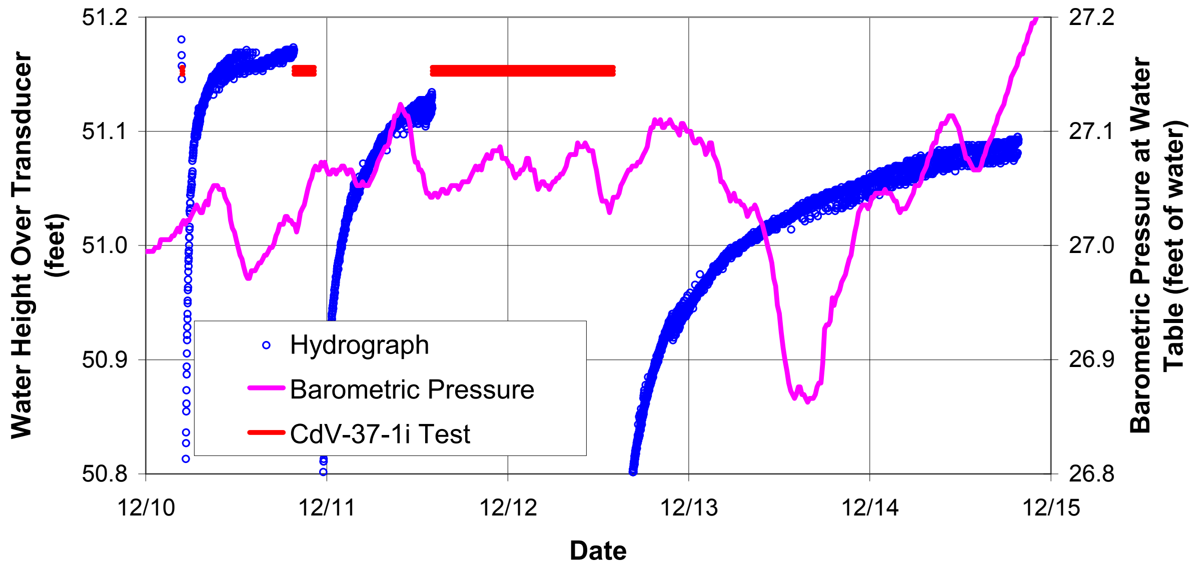


Figure C-8.0-1 Well CdV-37-1i apparent hydrograph

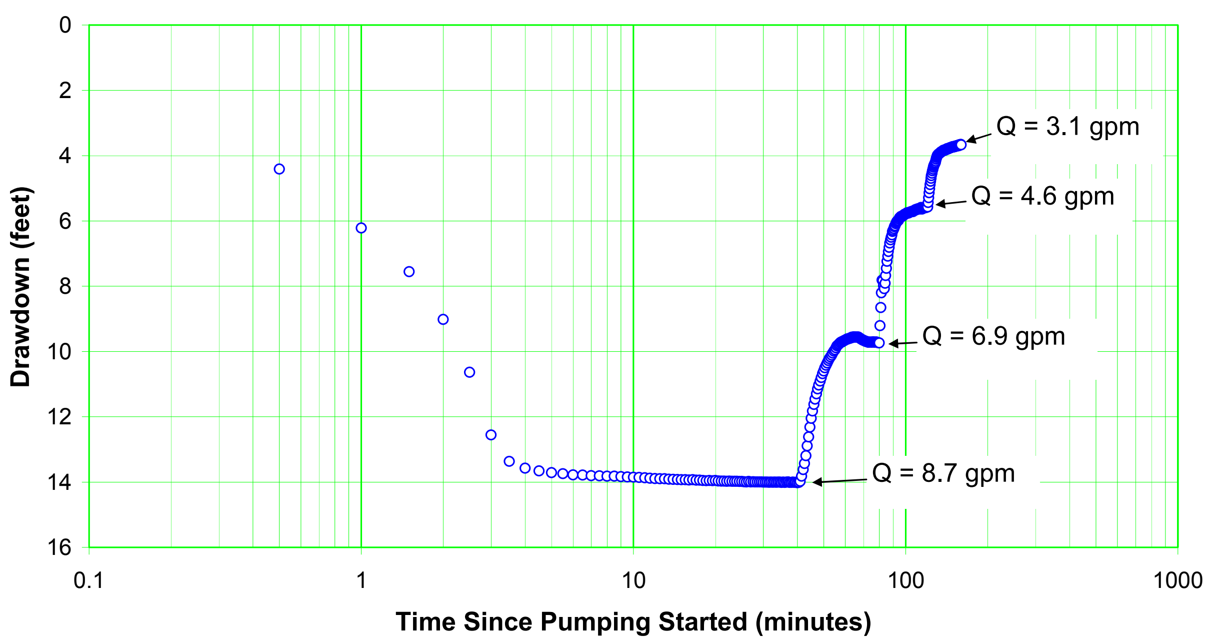


Figure C-9.1-1 Well CdV-37-1i trial drawdown

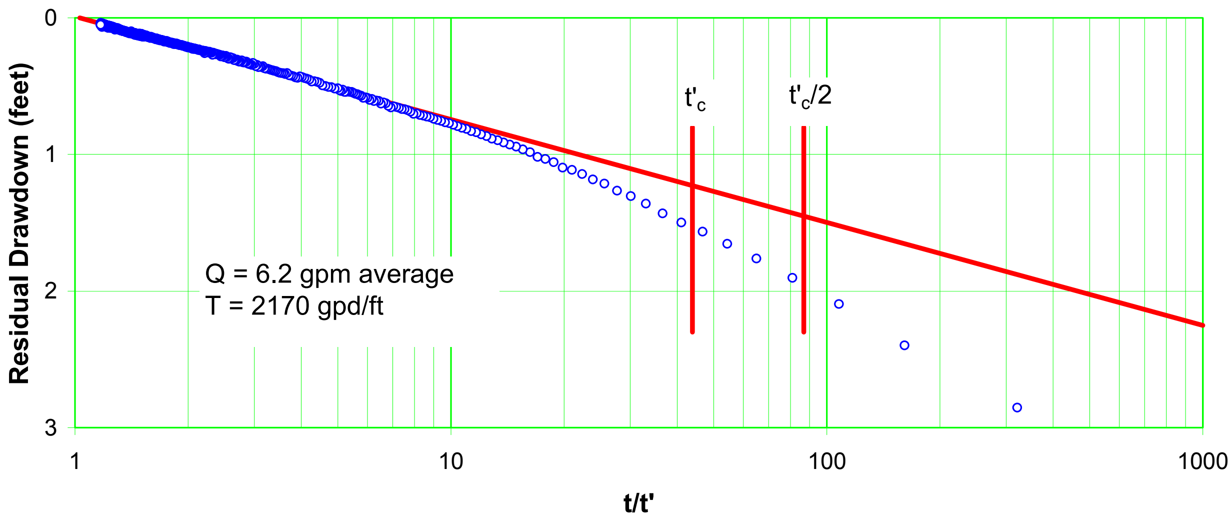


Figure C-9.1-2 Well CdV-37-1i trial recovery

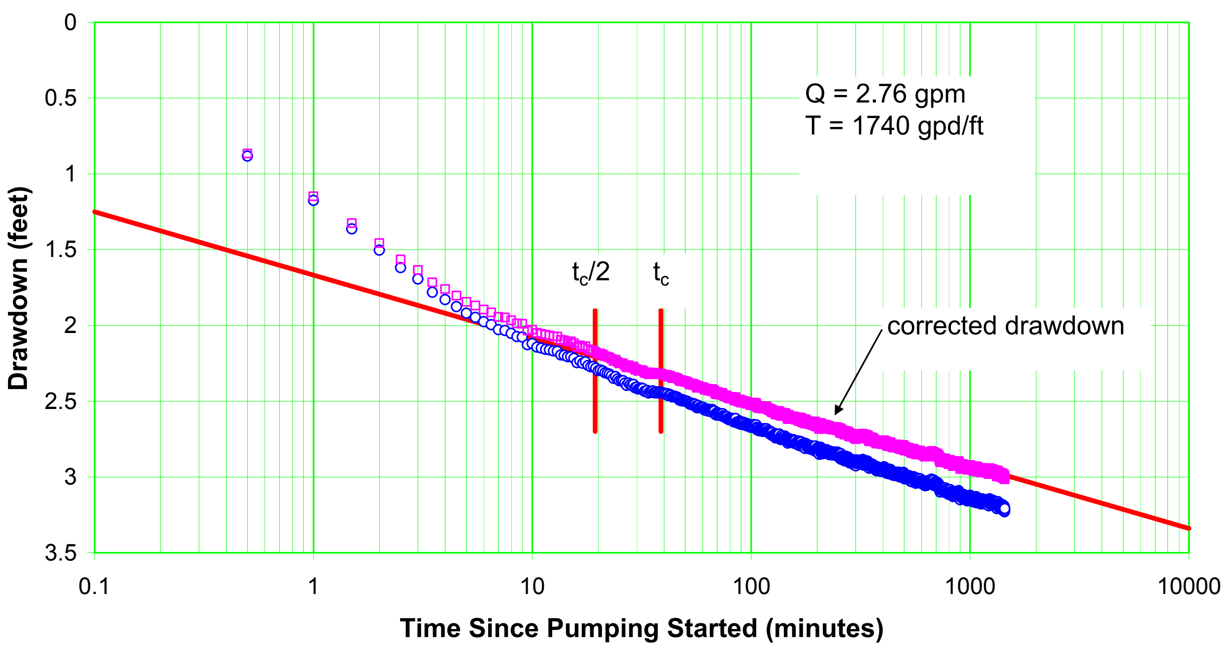


Figure C-9.2-1 Well CdV-37-1i drawdown

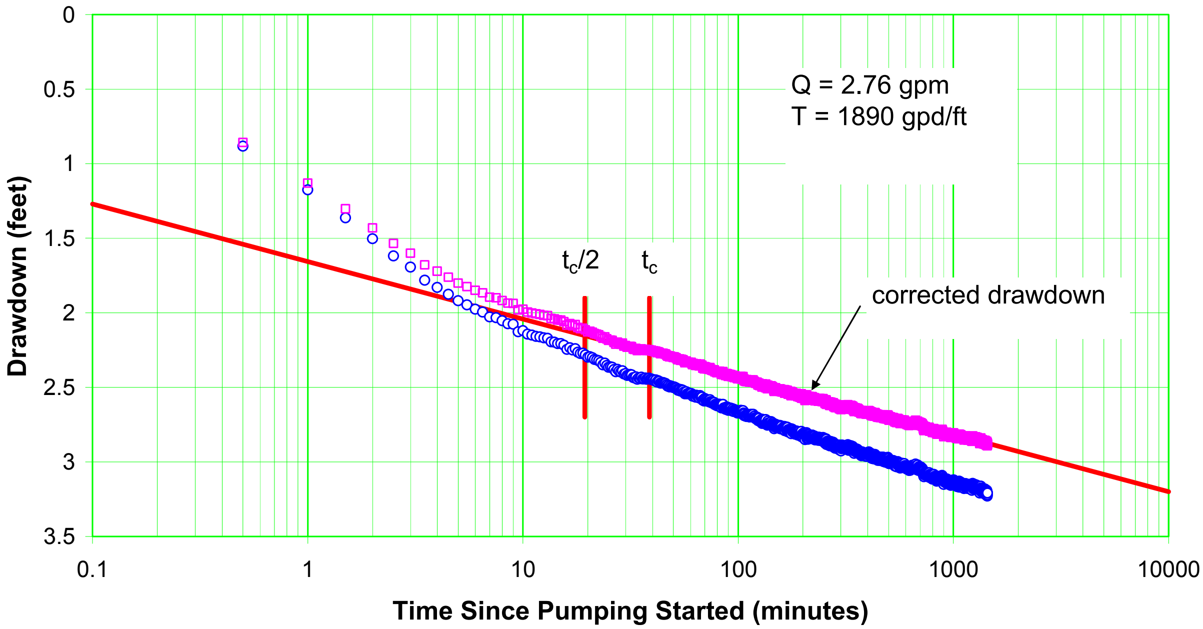


Figure C-9.2-2 Well CdV-37-1i drawdown corrected for a saturated thickness of 15.5 ft

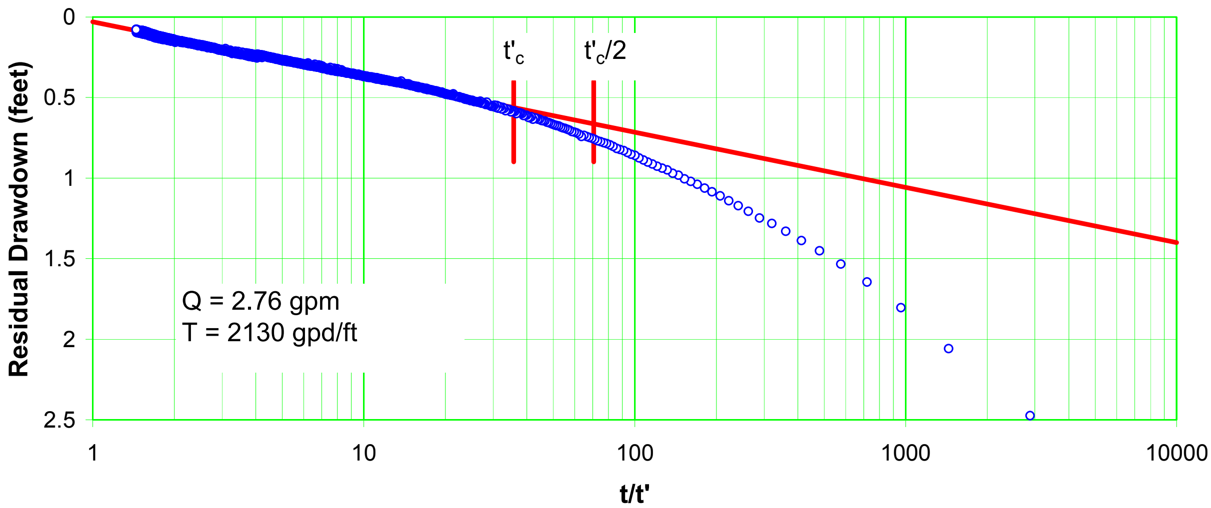


Figure C-9.2-3 Well CdV-37-1i recovery

Table C-9.1-1
Specific Capacity Values for a Saturated Thickness of 24.36 ft

Q (gpm)	s (ft)	Corrected s (ft)	Corrected Q/s (gpm/ft)
8.65	14.00	9.98	0.87
6.90	9.74	7.79	0.89
4.55	5.58	4.94	0.92
3.10	3.66	3.39	0.92

Table C-9.1-2
Specific Capacity Values for a Saturated Thickness of 20.5 ft

Q (gpm)	s (ft)	Corrected s (ft)	Corrected Q/s (gpm/ft)
8.65	14.00	9.22	0.94
6.90	9.74	7.43	0.93
4.55	5.58	4.82	0.94
3.10	3.66	3.33	0.93

Table C-9.1-3
Specific Capacity Values for a Saturated Thickness of 15.5 ft

Q (gpm)	s (ft)	Corrected s (ft)	Corrected Q/s (gpm/ft)
8.65	14.00	7.68	1.13
6.90	9.74	6.68	1.03
4.55	5.58	4.58	0.99
3.10	3.66	3.23	0.96

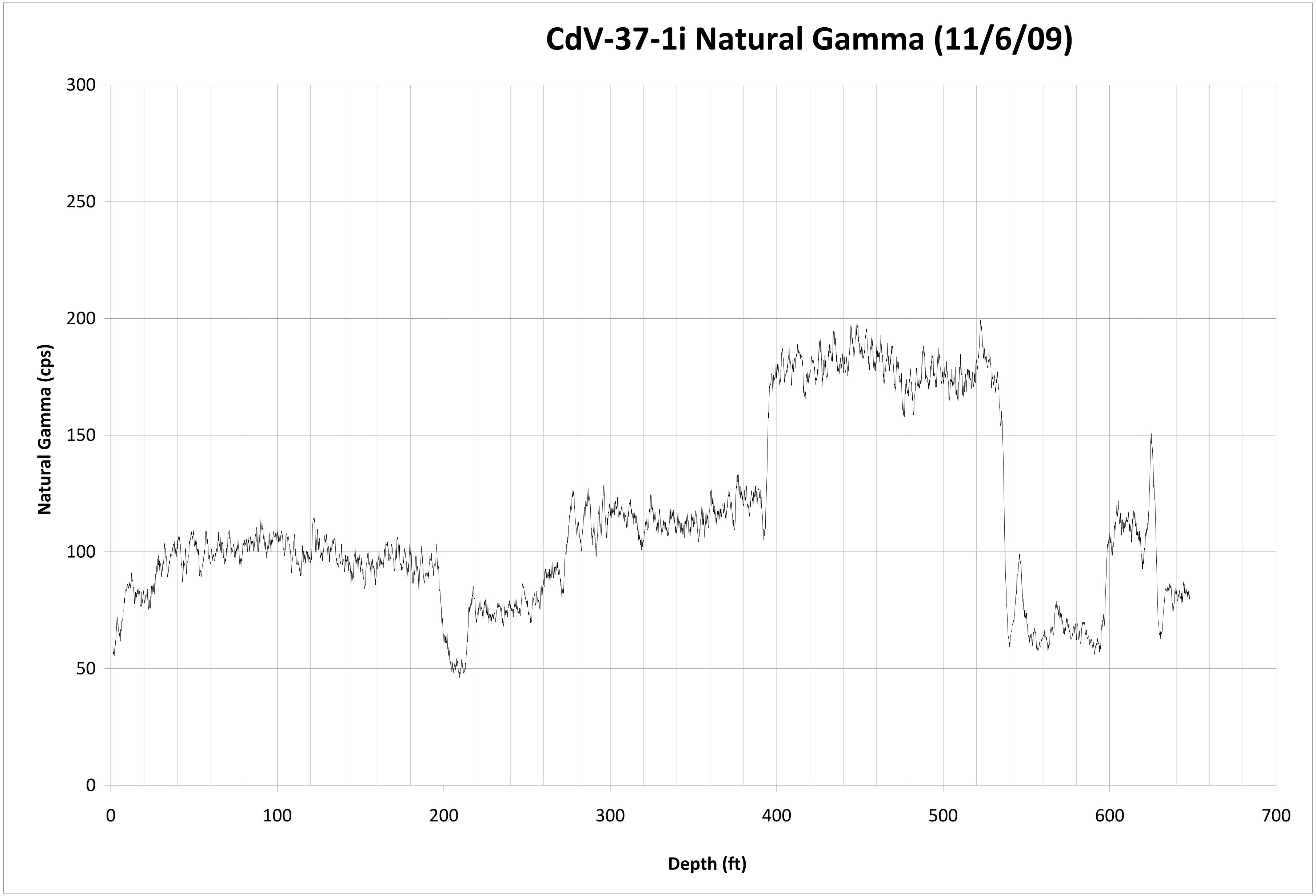
Appendix D

Borehole Video Logging
(on DVD included with this document)

TO VIEW THE VIDEO THAT ACCOMPANIES THIS DOCUMENT, PLEASE CALL THE HAZARDOUS WASTE BUREAU AT 505-476-6000 TO MAKE AN APPOINTMENT

Appendix E

Geophysical Logs
(on CD included with this document)



CdV-37-1i Natural Gamma (11/6/09)
Natural Gamma (cps)
Depth (ft)
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700

```
~VERSION INFORMATION
VERS    .2.0              :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP    .NO               :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT    .FT      649.902 :START DEPTH
STOP    .FT      -1.1811 :STOP DEPTH
STEP    .FT     -0.16404 :STEP
NULL    .        -999.25 :NULL VALUE
COMP    .                :COMPANY
WELL    .                :WELL
FLD     .                :FIELD
LOC     .      Water Can :LOCATION
PROV    .      N/A       :PROVINCE
SRVC    .      N/A       :SERVICE COMPANY
DATE    .                :DATE
UWI     .      N/A       :UNIQUE WELL ID
~CURVE INFORMATION
DEPT    .FT              :DEPTH
GAMM    .CPS             :Gamma
~PARAMETER INFORMATION
ELEV    .                :ELEVATION
STE     .                :STE
DENS    .                :DENSITY
CASI    .                :CASING TO1
OPER    .                :OPERATING RIG TIME
WGT1    .                :WGT1
CASI    .                :CASING SIZE1
CASI    .                :CASING TO2
WGT2    .                :WGT2
CASI    .                :CASING SIZE2
WELL    .      CdV 37-1i :WELL ID
CASI    .                :CASING TO3
K.B.    .                :K.B.
WGT3    .                :WGT3
TYPE    .                :TYPE LOG
CASI    .                :CASING SIZE3
CASI    .                :CASING TO4
SALI    .                :SALINITY
TITL    .                :TITLE
WGT4    .                :WGT4
TOP     .                :TOP LOGGED INTERVAL
CASI    .                :CASING SIZE4
WITN    .      Rick  Lasr :WITNESSED BY
CASI    .                :CASING TO5
DRIL    .                :DRILLING MEAS. FROM
WGT5    .                :WGT5
CASI    .                :CASING SIZE5
CTY     .                :CTY
WGT6    .                :WGT6
CASI    .                :CASING SIZE6
MAX.    .                :MAX. REC. TEMP.
D.F.    .                :D.F.
CASI    .                :CASING TO6
OTHE    .                :OTHER SERVICES
BIT1    .                :BIT1
DEPT    .      Top of Ber :DEPTH-DRILLER
BIT2    .                :BIT2
RUN     .                :RUN No
RUN1    .                :RUN1
BIT3    .                :BIT3
RUN2    .                :RUN2
PERM    .                :PERMANENT DATUM
TWP     .                :TWP
BIT4    .                :BIT4
LOG     .                :LOG MEAS. FROM
BIT     .                :BIT FROM1
RUN3    .                :RUN3
BIT5    .                :BIT5
CASI    .      16" to 395 :CASING FROM1
TYPE    .                :TYPE FLUID IN HOLE
RUN4    .                :RUN4
FLD     .                :FLD
BIT6    .                :BIT6
BIT     .                :BIT TO1
CASI    .      12" to 598 :CASING FROM2
BIT     .                :BIT FROM2
CO      .                :CO
RGE     .                :RGE
BIT     .                :BIT TO2
DEPT    .                :DEPTH-LOGGER
CASI    .                :CASING FROM3
BIT     .                :BIT FROM3
RUN5    .                :RUN5
SEC     .                :SEC
BIT     .                :BIT TO3
G.L.    .                :G.L.
CASI    .                :CASING FROM4
BIT     .                :BIT FROM4
RUN6    .                :RUN6
BIT     .                :BIT TO4
BTM     .                :BTM LOGGED INTERVAL
CASI    .                :CASING FROM5
BIT     .                :BIT FROM5
STAT    .                :STATE
BIT     .                :BIT TO5
LEVE    .                :LEVEL
CASI    .                :CASING FROM6
BIT     .                :BIT FROM6
COUN    .                :COUNTRY
RECO    .      M Gard &  :RECORDED BY
FILI    .                :FILING No
BIT     .                :BIT TO6
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  649.738  96.6328
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  649.245  95.2578
  649.081  81.5195
  648.917  73.1289
  648.753  91.3945
  648.589   69.043
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  647.769   91.582
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  645.472  95.5586
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  630.709  54.0039
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   629.56  77.4375
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  629.068  86.0664
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  626.608  147.344
  626.444  116.586
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  625.951  164.031
  625.787  159.531
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[illegible]
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576.411	64.7617
576.247	61.1152
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575.919	61.627
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575.591	77.0352
575.427	70.4453
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574.934	71.6211
574.77	56.2559
574.606	91.1719
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572.802	61.9082
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571.49	61.5293
571.325	73.1836
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570.833	67.3398
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564.436	61.5488
564.272	54.8145
564.108	65.7813
563.944	53.834
563.78	60.0508
563.615	59.5898
563.451	44.1758
563.287	76.8516
563.123	52.8457
562.959	52.3672
562.795	61.8262
562.631	77.3164
562.467	71.7656
562.303	67.3984
562.139	67.2109
561.975	65.7383
561.811	48.6152
561.647	55.0488
561.483	79.457
561.319	57.3164
561.155	67.5547
560.991	74.707
560.827	61.5684
560.663	48.1094
560.499	84.4375
560.335	61.6289
560.171	65.9375
560.007	51.6738
559.843	44.4277
559.678	70.9023
559.514	59.7461
559.35	66.1719
559.186	65.4492
559.022	67.7773
558.858	51.0059
558.694	52.8164
558.53	58.8359
558.366	62.752
558.202	51.9512
558.038	67.5898
557.874	67.6133
557.71	48.2578
557.546	61.875
557.382	51.1387
557.218	69.4961
557.054	42.6895
556.89	65.4492
556.726	50.0684
556.562	72.8867
556.398	64.0195
556.234	61.4434
556.07	58.4492
555.906	76.707
555.741	78.7656
555.577	80.2969
555.413	66.0859
555.249	50.2559
555.085	74.3516
554.921	57.1641
554.757	57.2012
554.593	58.8672
554.429	56.5313
554.265	64.9727
554.101	54.3594
553.937	65.5078
553.773	50.2559
553.609	78.2852
553.445	70.7578
553.281	64.4414
553.117	71.4961
552.953	73.957
552.789	63.0723
552.625	50.7305
552.461	57.6953
552.297	45.7031
552.133	83.75
551.969	36.1504
551.804	56.5254
551.64	83.332
551.476	84.3516
551.312	70.1133
551.148	69.5391

489.14	187.477
488.976	191.859
488.812	220.156
488.648	181.852
488.484	201
488.32	178.828
488.156	186.258
487.992	143.695
487.828	169.82
487.664	188.109
487.5	163.109
487.336	156.063
487.172	200.563
487.008	160.781
486.844	152.352
486.68	207.398
486.516	178.578
486.352	171.609
486.188	157.883
486.024	178.297
485.86	144.742
485.696	166.188
485.532	172.719
485.367	199.398
485.203	150.531
485.039	182.063
484.875	174.078
484.711	188.852
484.547	167.938
484.383	193.531
484.219	188.734
484.055	181.414
483.891	153.43
483.727	154.273
483.563	151.258
483.399	159.555
483.235	147
483.071	169.945
482.907	166.68
482.743	171.109
482.579	173.773
482.415	136.477
482.251	160.656
482.087	162.5
481.923	190.391
481.759	194
481.594	141.281
481.43	182.797
481.266	176.633
481.102	165.703
480.938	215.516
480.774	166.328
480.61	167.648
480.446	171.375
480.282	192.25
480.118	158.375
479.954	157.07
479.79	160.82
479.626	173.945
479.462	148.68
479.298	161.102
479.134	178.875
478.97	189.734
478.806	171.805
478.642	153.734
478.478	194.047
478.314	172.82
478.15	176.891
477.986	190.797
477.822	128.32
477.657	156.156
477.493	177.75
477.329	133.563
477.165	193.055
477.001	129.563
476.837	118.117
476.673	158.063
476.509	208.992
476.345	159.414
476.181	180.773
476.017	160.102
475.853	181.063
475.689	147.016
475.525	166.219
475.361	205.594
475.197	146.188
475.033	176.391
474.869	209.313
474.705	171.961
474.541	171.43
474.377	165.68
474.213	162.078
474.049	175.492
473.885	149.289
473.72	193.758
473.556	201.859
473.392	180.414
473.228	213.047
473.064	177.547
472.9	180.172
472.736	169.703
472.572	169.867
472.408	185.992
472.244	176.586
472.08	170.281
471.916	151.75
471.752	164.992
471.588	139.414
471.424	183.172
471.26	183.734
471.096	160.766
470.932	188.914
470.768	184.852
470.604	183.047
470.44	219.258
470.276	190.445
470.112	181.297
469.948	174.148
469.783	210.164
469.619	193.078
469.455	176.969
469.291	149.492
469.127	185.766
468.963	167.203
468.799	221.633
468.635	167.602
468.471	155.609
468.307	203.672
468.143	196.828
467.979	151.172
467.815	177.102
467.651	206.734
467.487	159.711
467.323	217.414
467.159	164.703
466.995	179.773
466.831	199.289
466.667	227.578
466.503	156.25
466.339	179.141
466.175	142.875
466.01	167.297
465.846	205.398
465.682	172.242
465.518	181.148
465.354	139.336
465.19	183.078
465.026	213.617
464.862	164.617
464.698	159.695
464.534	160.492
464.37	149.305
464.206	210.422
464.042	191.219
463.878	229.945
463.714	192.508
463.55	172.43
463.386	180.039
463.222	216.648
463.058	178.781
462.894	186.875
462.73	175.188
462.566	186.758
462.402	174.922
462.238	176.695
462.073	186.602
461.909	157.961
461.745	200.852
461.581	200.438
461.417	190.641
461.253	198.102
461.089	169.25
460.925	184.797
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460.433	206.773
460.269	172.805
460.105	199.625
459.941	160.688
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459.449	155.063
459.285	202.414
459.121	177.477
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458.136	171.68
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457.808	202.25
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457.152	174.664
456.988	188.289
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456.332	177.297
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456.004	165.477
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455.676	203.969
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455.184	193.531
455.02	172.133
454.856	194.43
454.692	208.586
454.528	196.547
454.364	185.656
454.199	222.258
454.035	182.016
453.871	189.117
453.707	213.625
453.543	170.18
453.379	171.75
453.215	185.195
453.051	152.813
452.887	166.031
452.723	199.242
452.559	196.82
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452.067	189.484
451.903	202.273
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451.411	159.891
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450.755	159.555
450.591	197.945
450.426	196.172
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449.934	220.914
449.77	181.563
449.606	176.82
449.442	151.125
449.278	233.766
449.114	198.141
448.95	207.969
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448.622	185.555
448.458	200.742
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447.966	155.875
447.802	205.57
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447.146	206.141
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446.325	181.273
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445.669	188.227
445.505	202.406
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445.177	213.414
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444.849	213.719
444.685	173.469
444.521	199.219
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444.193	172.906
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443.701	169.352
443.537	177.977
443.373	189.867
443.209	184.344
443.045	170.555
442.881	197.117
442.717	151.922
442.552	185.484
442.388	178
442.224	194.383
442.06	191.836
441.896	195.766
441.732	180.711
441.568	188.883
441.404	166.305
441.24	167.188
441.076	193.891
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440.748	171.477
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440.092	155.93
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439.764	175.648
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439.108	167.953
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438.451	179.828
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438.123	164.602
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437.303	180.344
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436.647	186.188
436.483	156.43
436.319	199.211
436.155	208.602
435.991	152.461
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435.663	167.813
435.499	158.953
435.335	189.508
435.171	177.852
435.007	187.711
434.842	198.07
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434.514	212.742
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434.186	188.188
434.022	192.367
433.858	145.641
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433.366	217.672
433.202	176.945
433.038	187.5
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432.71	211.758
432.546	210.766
432.382	180.758
432.218	187.25
432.054	170.938
431.89	173.109
431.726	168.883
431.562	180.438
431.398	178
431.234	164.703
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430.905	177.742
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430.577	177.367
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429.921	164.734
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429.593	165.656
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428.937	164.172
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428.117	161.156
427.953	250.789
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427.625	167.602
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427.297	177.609
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426.969	194.898
426.804	178.297
426.64	224.258
426.476	173.797
426.312	145.414
426.148	204.563
425.984	180.609
425.82	193.844
425.656	179.156
425.492	149.758
425.328	226.891
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425	184.164
424.836	162.078
424.672	164.57
424.508	166.977
424.344	170.156
424.18	176.242
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423.852	184.555
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423.524	193.164
423.36	179.188
423.196	176.328
423.032	173.328
422.867	190.516
422.703	189.82
422.539	157.336
422.375	204.453
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422.047	197.398
421.883	165.336
421.719	174.57
421.555	192.148
421.391	176.617
421.227	160.531
421.063	224.203
420.899	177.148
420.735	160.203
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420.407	176.055
420.243	199.531
420.079	149.094
419.915	187.016
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419.587	165.883
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416.306	211.234
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415.157	180.859
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414.173	159.813
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413.025	177.625
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412.205	171.211
412.041	191.445
411.877	192.719
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411.549	174.898
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411.056	162.273
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410.728	207.961
410.564	183.688
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[illegible]	[illegible]

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398.589	166.539
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398.097	166.148
397.933	167.148
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397.277	212.063
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396.949	173.352
396.785	147.383
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396.293	162.25
396.129	175.727
395.965	176.203
395.801	168.18
395.636	174.188
395.472	156.906
395.308	126.605
395.144	121.039
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394.816	114.977
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394.488	114.313
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393.996	117.727
393.832	129.555
393.668	122.555
393.504	99.9609
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391.535	141.406
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390.715	148.953
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389.567	126.32
389.403	139.008
389.239	120.246
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388.911	149.57
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386.286	128.133
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384.482	108.98
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378.576	139.164
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374.311	153.945
374.147	105.238
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372.999	127.082
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371.358	118.973
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369.554	106.238
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369.226	115.27
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368.241	121.766
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367.913	121.098
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362.336	109.691
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358.891	110.195
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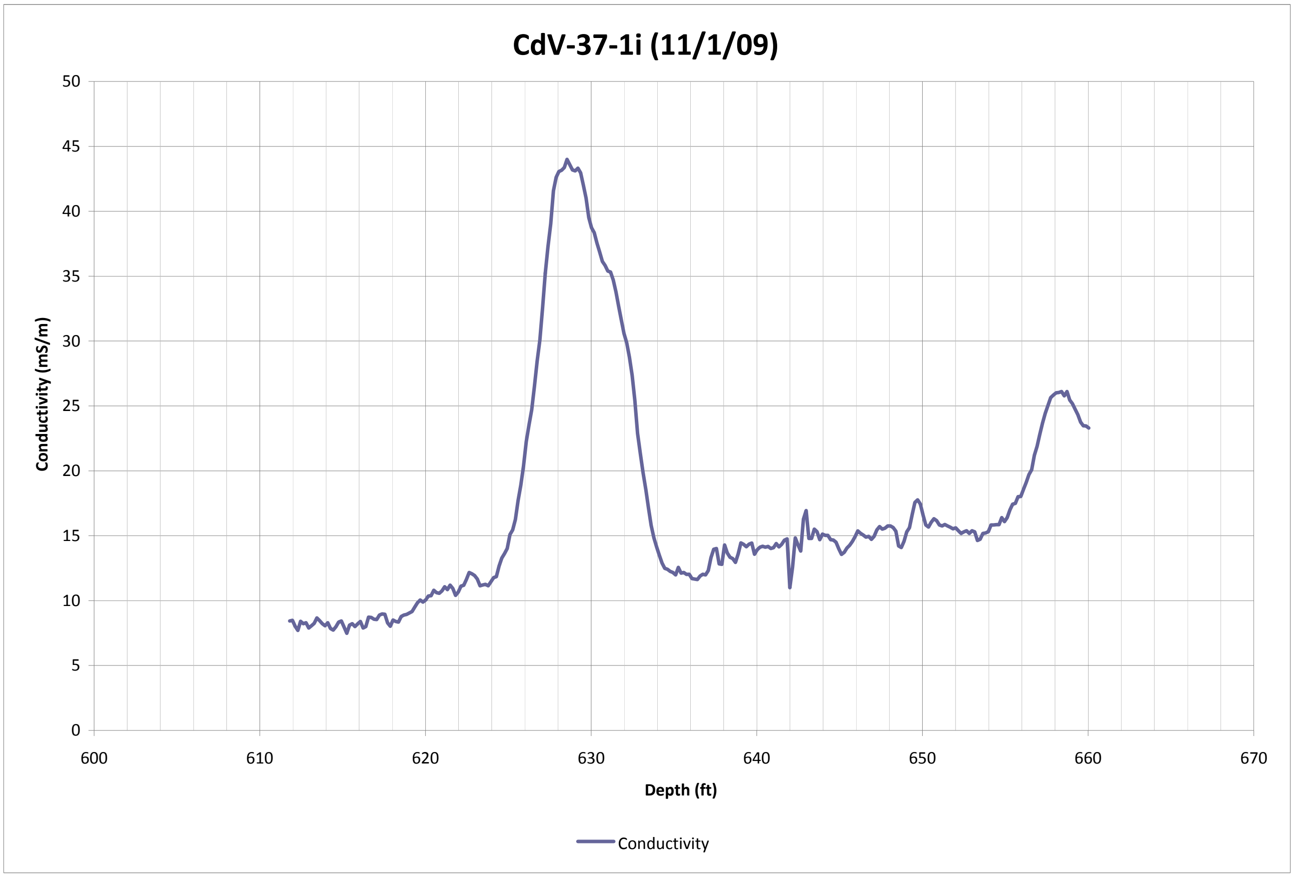
0.295276	56.7461
0.131234	46.5137
-0.03281	68.4531
-0.19685	41.7988
-0.36089	33
-0.52493	37.3711
-0.68898	24.0977
-0.85302	15.4653
-1.01706	17.7061
-1.1811	20.0146



CdV-37-1i (11/1/09)
Conductivity (mS/m)
Depth (ft)
Conductivity
0
5
10
15
20
25
30
35
40
45
50
600
610
620
630
640
650
660
670

CDH ST-3 Induction Log 11-01-09
~VERSION INFORMATION
VERS. 2.0 :CWLS LOG ASCII STANDARD VERSION 2.0
WRAP. NO :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT .FT 660.039 :START DEPTH
STOP .FT 611.811 :STOP DEPTH
STEP .FT -0.164042 :STEP
NULL. -999.25 :NULL VALUE
COMP. :COMPANY
WELL. :WELL
FLD . :FIELD
LOC . :LOCATION
PROV. N/A :PROVINCE
SRVC. N/A :SERVICE COMPANY
DATE. :DATE
UWI . N/A :UNIQUE WELL ID
~CURVE INFORMATION
DEPT .FT :DEPTH
COND .MS :Cond.
I_R .OHM-M :I. Res.
~PARAMETER INFORMATION
ELEV . :ELEVATION
STS . :STS
DENS . :DENSITY
CASI . :CASING TO3
OPER . :OPERATING RIG TIME
MST1 . :MST1
CASI . :CASING SIZE1
CASI . :CASING TO2
MST2 . :MST2
CASI . :CASING SIZE2
WELL . :WELL ID
CASI . :CASING TO1
K.B . :K.B.
MST3 . :MST3
TYPE . :TYPE LOG
CASI . :CASING SIZE3
CASI . :CASING TO4
SALI . :SALINITY
TITL . :TITLE
MST4 . :MST4
TOP . :TOP LOGGED INTERVAL
CASI . :CASING SIZE4
WITN . :WITNESSED BY
CASI . :CASING TO5
DRIL . :DRILLING MEAS. FROM
MST5 . :MST5
CASI . :CASING SIZE5
CITY . :CITY
MST6 . :MST6
CASI . :CASING SIZE6
MAX. . :MAX. REC. TEMP.
D.F . :D.F.
CASI . :CASING TO6
OTHE . :OTHER SERVICES
BIT1 . :BIT1
DEPT . :DEPTH DRILLER
BIT2 . :BIT2
RUN . :RUN No
RUN1 . :RUN1
BIT3 . :BIT3
RUN2 . :RUN2
PERM . :PERMANENT DATUM
TMP . :TMP
BIT4 . :BIT4
LOG . :LOG MEAS. FROM
BIT . :BIT FROM1
RUN3 . :RUN3
BIT5 . :BIT5
CASI . :CASING FROM1
TYPE . :TYPE FLUID IN HOLE
RUN4 . :RUN4
FLD . :FLD
BIT6 . :BIT6
BIT . :BIT TO1
CASI . :CASING FROM2
BIT . :BIT FROM2
CO . :CO
RGE . :RGE
BIT . :BIT TO2
DEPT . :DEPTH LOGGER
CASI . :CASING FROM3
BIT . :BIT FROM3
RUN5 . :RUN5
SEC . :SEC
BIT . :BIT TO3
G.L . :G.L.
CASI . :CASING FROM4
BIT . :BIT FROM4
RUN6 . :RUN6
BIT . :BIT TO4
BTM . :BTM LOGGED INTERVAL
CASI . :CASING FROM5
BIT . :BIT FROM5
STAT . :STATE
BIT . :BIT TO5
LEVE . :LEVEL
CASI . :CASING FROM6
BIT . :BIT FROM6
COUN . :COUNTRY
RECO . :RECORDED BY
FILI . :FILING No
BIT . :BIT TO6
~OTHER
~A

	Conductivity	
660.039	23.2959	42.9261
659.875	23.4607	42.6244
659.711	23.4704	42.6068
659.547	23.7517	42.1023
659.383	24.3239	41.1118
659.219	24.741	40.4188
659.055	25.1677	39.7335
658.891	25.4587	39.2794
658.727	26.1085	38.3017
658.563	25.7787	38.7917
658.399	26.1085	38.3017
658.235	26.0406	38.4016
658.071	26.0115	38.4445
657.907	25.8369	38.7043
657.743	25.6429	38.9971
657.579	25.0416	39.9335
657.415	24.4306	40.9323
657.251	23.6838	42.223
657.087	22.8206	43.82
656.923	21.8895	45.6839
656.759	21.2009	47.1677
656.594	20.0759	49.811
656.43	19.717	50.7176
656.266	19.106	52.3395
656.102	18.5726	53.8428
655.938	18.0198	55.4946
655.774	18.0101	55.5245
655.61	17.496	57.1558
655.446	17.4281	57.3785
655.282	16.9917	58.8523
655.118	16.4001	60.9753
654.954	16.0897	62.1515
654.79	16.4001	60.9753
654.626	15.8473	63.1024
654.462	15.857	63.0638
654.298	15.8279	63.1798
654.134	15.8279	63.1798
653.97	15.3138	65.3005
653.806	15.2168	65.7167
653.642	15.178	65.8847
653.478	14.7319	67.8799
653.314	14.6349	68.3297
653.15	15.3041	65.3419
652.986	15.3817	65.0123
652.821	15.178	65.8847
652.657	15.3817	65.0123
652.493	15.3041	65.3419
652.329	15.178	65.8847
652.165	15.3817	65.0123
652.001	15.6048	64.0829
651.837	15.5369	64.3629
651.673	15.6533	63.8844
651.509	15.76	63.4519
651.345	15.8666	63.0253
651.181	15.76	63.4519
651.017	15.8279	63.1798
650.853	16.1576	61.8903
650.689	16.3031	61.3381
650.525	16.0412	62.3394
650.361	15.6727	63.8053
650.197	15.8279	63.1798
650.033	16.5941	60.2626
649.869	17.4378	57.3466
649.705	17.7676	56.2822
649.541	17.5639	56.9349
649.377	16.6328	60.122
649.213	15.6242	64.0034
649.049	15.3041	65.3419
648.884	14.567	68.6482
648.72	14.0918	70.9633
648.556	14.2179	70.334
648.392	15.3429	65.1766
648.228	15.6339	63.9636
648.064	15.7503	63.491
647.9	15.76	63.4519
647.736	15.5757	64.2026
647.572	15.5078	64.4837
647.408	15.7018	63.6871
[illegible]	[illegible]	[illegible]
628.051	43.0618	23.2224
627.887	42.6157	23.4656
627.723	41.5779	24.0512
627.559	39.0271	25.6232
627.395	37.2911	26.8161
627.231	35.235	28.3809
627.067	32.5484	30.7235
626.903	30.0655	33.2607
626.739	28.4362	35.1665
626.575	26.4867	37.7548
626.411	24.6925	40.4982
626.247	23.5189	42.519
626.083	22.2484	44.9471
625.919	20.3765	49.076
625.755	18.8926	52.9307
625.591	17.7191	56.4363
625.426	16.2449	61.5578
625.262	15.4496	64.7266
625.098	15.0908	66.2657
624.934	14.0142	71.3562
624.77	13.6262	73.3878
624.606	13.2771	75.3177
624.442	12.6564	79.0115
624.278	11.8514	84.3783
624.114	11.7738	84.9344
623.95	11.4537	87.3077
623.786	11.1434	89.7394
623.622	11.2501	88.8884
623.458	11.2113	89.1959
623.294	11.1434	89.7394
623.13	11.6671	85.711
622.966	11.929	83.8295
622.802	12.0648	82.886
622.638	12.1617	82.225
622.474	11.638	85.9253
622.31	11.1822	89.428
622.146	11.1143	89.9743
621.982	10.6584	93.8223
621.818	10.4063	96.0958
621.654	10.93	91.4912
621.489	11.1919	89.3505
621.325	10.8524	92.1453
621.161	11.0658	90.3686
620.997	10.7554	92.9763
620.833	10.5615	94.6839
620.669	10.61	94.2511
620.505	10.7942	92.6421
620.341	10.3772	96.3652
620.177	10.3578	96.5457
620.013	10.0474	99.5279
619.849	9.89225	101.089
619.685	10.0474	99.5279
619.521	9.83406	101.687
619.357	9.5043	105.216
619.193	9.16485	109.113
619.029	9.04846	110.516
618.865	8.93208	111.956
618.701	8.89328	112.444
618.537	8.7769	113.935
618.373	8.34046	119.897
618.209	8.38895	119.204
618.045	8.50534	117.573
617.881	8.0301	124.531
617.717	8.28227	120.74
617.552	8.95148	111.713
617.388	8.97087	111.472
617.224	8.89328	112.444
617.06	8.54413	117.039
616.896	8.56353	116.774
616.732	8.69931	114.952
616.568	8.72841	114.568
616.404	8.001	124.984
616.24	7.89432	126.673
616.076	8.38895	119.204
615.912	8.21438	121.738
615.748	8.001	124.984
615.584	8.22407	121.594
615.42	8.11739	123.192
615.256	7.48697	133.565
615.092	7.96221	125.593
614.928	8.43745	118.519
614.764	8.34046	119.897
614.6	7.9913	125.136
614.436	7.72944	129.375
614.272	7.85552	127.299
614.108	8.29196	120.599
613.944	8.0592	124.082
613.78	8.22407	121.594
613.615	8.45684	118.247
613.451	8.66052	115.467
613.287	8.25317	121.166
613.123	8.0592	124.082
612.959	7.89432	126.673
612.795	8.29196	120.599
612.631	8.22407	121.594
612.467	8.40835	118.929
612.303	7.70034	129.864
612.139	8.0204	124.682
611.975	8.47624	117.977
611.811	8.43745	118.519