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Plugging and Abandonment Report for Alluvial Wells WCO-3 and WCO-1 and Completion Report for Replacement Alluvial Wells WCO-3r and WCO-1r

Prepared by the Environmental Programs Directorate

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Acronyms and Abbreviations

amsl	above mean sea level
bgs	below ground surface
Consent Order	Compliance Order on Consent
DO	dissolved oxygen
IA	Information Architecture (project)
NAD	North American Datum
LANL	Los Alamos National Laboratory
NMED	New Mexico Environment Department
NTU	nephelometric turbidity unit
O.D.	outside diameter
ORP	oxidation-reduction potential
P&A	0plug and abandon
PVC	polyvinyl chloride
RPF	Records Processing Facility
TA	technical area
TD	total depth

1.0 INTRODUCTION

This report describes the methods used to plug and abandon alluvial wells WCO-1 and WCO-3 and to drill and install replacement wells WCO-1r and WCO-3r. All activities were performed for the Los Alamos National Laboratory (LANL or the Laboratory) Environmental Programs Directorate. The report is written in accordance with the requirements in section IV.A.3.e.iv of the March 1, 2005 (revised 2008), Compliance Order on Consent (the Consent Order).

The subject wells are located in Water Canyon on Laboratory property within Technical Area 68 (TA-68) (Figure 1.0-1). WCO-1 and WCO-3 were plugged and abandoned because the wells were drilled and installed in 1989 during a period of artificially low recharge while water was being diverted from upper Water Canyon and, as a result, the screened intervals did not intercept alluvial groundwater (NMED 2007, 095025).

WCO-1 and WCO-3 were abandoned in accordance with the requirements and guidelines in sections IV.B.1.b.v and X.D (Well Abandonment) of the Consent Order. Additionally, the plugging and abandonment procedures complied with 19.27.4 New Mexico Administrative Code Rules and Regulations Governing Well Driller Licensing; Construction, Repair and Plugging of Well. All activities were performed following appropriate standard operating procedures and Laboratory-approved health and safety documents.

Replacement wells WCO-1r and WCO-3r were installed to determine if saturated alluvium is present at these locations within Water Canyon and to monitor alluvial groundwater levels and water quality downgradient of potential Laboratory release sites. WCO-1r and WCO-3r were designed in accordance with the Consent Order and the final well designs were approved by New Mexico Environment Department (NMED) before installation.

The work described in this document was performed in accordance with requirements set forth in the "Drilling Work Plan for Alluvial Aquifer Wells WCO-1a and WCO-3a" (LANL 2009, 107425).

2.0 DRILLING AND WELL INSTALLATION

Activities at WCO-1r and WCO-3r included coring, well installation, and surveying. Additionally, WCO-1r was developed and a sampling system was installed; water has not been detected in WCO-3r.

WCO-1r and WCO-3r were drilled and completed from December 19 to 22, 2009. A track-mounted PS-600C sonic drill rig, equipped with an 8¼-in.-outside diameter (O.D.) flush-threaded casing and a 6¼-in.-O.D. core barrel, was used for the project. No fluids were used during sonic coring. The sonic drilling methodology, equipment, and drill-casing size were selected to investigate any potential saturated zones within the alluvium.

2.1 WCO-3r

Following a field management, operations, and verification review that included inspection of heavy equipment, drilling commenced at 1038 h on the morning of December 19. The target depth for WCO-3r was 29 ft below ground surface (bgs), approximately 5 ft below the predicted alluvium-bedrock interface. On December 19, the alluvium-bedrock contact was encountered at 11 ft bgs. The corehole was advanced open hole with the 6 ¼-in. core barrel to a total depth (TD) of 29.5 ft bgs on December 20 at 1005 h. Saturated conditions were not encountered during drilling, but the core was damp from 21.5 ft bgs to TD.

The lithologic log for the WCO-3r corehole is presented in Appendix A. Lithologic descriptions and unit contacts are based on microscopic analysis of core samples. Figure 2.1-1 shows the stratigraphy encountered at WCO-3r.

On December 22, the well was installed with a 0.020-in. slot screen set between 4.7 and 9.7 ft bgs and the bottom of the sump at 10.1 ft bgs (Figure 2.1-2). The lower portion of the borehole was backfilled from 10.6 to 29.5 ft bgs using 4.4 ft^3 of 3/8-in. bentonite chips. The filter pack was installed from 3.0 to 10.6 ft bgs using 2.5 ft^3 of 10/20 silica sand. The upper bentonite seal was installed from 2 to 3 ft bgs using 1.3 ft^3 of 3/8-in. bentonite chips. The annular surface seal (from 0 to 2 ft bgs) and surface pad (2 ft long × 2 ft wide × 0.5 ft deep) were constructed simultaneously using 3 ft^3 of Portland type I/II/V cement. A brass survey marker was installed on top of the pad. Water was not present in the well after completion.

Well development was not performed due to the absence of groundwater. An In-Situ Level Troll 500 transducer was installed in the well to monitor for potential water levels. The water level will be monitored and if sufficient alluvial groundwater is observed, groundwater samples will be collected and analyzed in accordance with the annual Interim Facility-Wide Groundwater Monitoring Plan.

2.2 WCO-1r

The track-mounted PS-600C sonic drill rig and ancillary equipment were mobilized to WCO-1r on December 21, 2009. Drilling commenced at 1148 h the same day using 8¼-in.-O.D. flush-threaded casing and a 6¼-in.-O.D. core barrel.

The target depth for WCO-1r was 29 ft bgs, approximately 5 ft below the predicted alluvium-bedrock interface. On December 21, the alluvium-bedrock contact was encountered at 17 ft bgs, and drilling continued to 26 ft bgs. On the same day at 1310 h, the corehole was advanced open hole with the 6¼-in.-O.D. core barrel to the TD of 30 ft bgs. Saturated conditions were not encountered during drilling, but the core was wet from 10 to 15 ft bgs.

The lithologic log for the WCO-1r corehole is presented in Appendix A. Lithologic descriptions and unit contacts are based on microscopic analysis of core samples. Figure 2.2-1 shows the stratigraphy encountered at WCO-1r.

On December 22, 2009, the alluvial monitoring well was installed with a 0.020-in. slot screen set between 6 and 16 ft bgs and the bottom of the sump at 16.4 ft bgs (Figure 2.2-2). The lower portion of the borehole was backfilled from 16.5 to 30 ft bgs using 4.5 ft^3 of 3/8-in. bentonite chips. The filter pack was installed from 3.7 to 16.5 ft bgs using 3.5 ft^3 of 10/20 silica sand. The upper bentonite seal was installed from 3 to 3.7 ft bgs using 0.3 ft^3 of 3/8-in. bentonite chips. The annular surface seal (from 0 to 3 ft bgs) and surface pad (2 ft × 2 ft × 0.5 ft deep) were constructed simultaneously using 3.5 ft^3 of Portland type I/II/V cement. A brass survey marker was installed on top of the pad. Water was not present in the completed well immediately after well installation.

Well Development and Sampling System Installation

Initially, well development was not performed after well installation due to the absence of groundwater in the well. However, on July 10, 2010, water was measured at 9.7 ft bgs (indicating approximately 6.7 ft of standing water was present in the well). On August 23, 2010, the depth to water had dropped to 10.7 ft bgs.

Swabbing and bailing began on the same afternoon. The well was swabbed with a 1¾-in.-O.D. stainless-steel bailer. The bailer was drawn repeatedly across the screened interval, which caused a surging action across the screen and filter pack. After swabbing, a ¼-in. nylon tube was inserted into the well and a peristaltic pump at the surface was used for well development.

On August 26, 2010, the tubing was removed and swabbing continued with a 3.5-in.-O.D. flush-threaded polyvinyl chloride (PVC) tube. After swabbing, the ¼-in. nylon tube was reinstalled in the well and development continued with the peristaltic pump.

During pumping, turbidity, temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductance were measured. Approximately 60.3 gal. of groundwater were removed during pumping. The final parameters at the end of pumping were pH of 6.43, temperature of 13.53ºC, specific conductance of 218 µS/cm, and turbidity of 0.1 nephelometric turbidity unit (NTU). Table 2.2-1 lists the purge volumes and field parameters measured during development. The water level at the end of development was approximately 10.6 ft bgs.

On November 11, 2010, the depth to water had dropped to 15.7 ft bgs. A Well Wizard pneumatic bladder pump was installed in the well with the intake set from 15.7 to 15.8 ft bgs and an In-Situ Level Troll 500 transducer was installed to monitor water levels. Figure 2.2-2 shows the configuration of the sampling system in WCO-1r. When groundwater is present, sampling will be performed at WCO-1r as part of the annual Interim Facility-Wide Groundwater Monitoring Plan.

3.0 PLUGGING AND ABANDONMENT OF WCO-3 AND WCO-1

Plugging and abandonment activities at WCO-3 and WCO-1 included over-drilling, removing the well casing and annular fill, and pressure-grouting. WCO-3 and WCO-1 were plugged and abandoned on December 20 and 21, 2009, respectively, with the same track-mounted PS-600C sonic drill rig used for drilling WCO-1r and WCO-3r.

3.1 WCO-3

On December 20, 2009, WCO-3 (with 2-in. well casing set to 12.4 ft bgs) was over-drilled with the 8¼-in.-O.D. casing to a TD of 15 ft bgs. The 8¼-in.-O.D. casing was repeatedly advanced and retracted from the corehole, removing the annular fill materials and PVC well casing. The corehole was sealed with 10.7 ft^3 of neat cement grout the same afternoon.

3.2 WCO-1

On December 21, 2009, WCO-1 (with 2-in. well casing set to 34.4 ft bgs) was over-drilled with the 8¼-in.-O.D. casing to a TD of 38 ft bgs. The 8¼-in.-O.D. casing was repeatedly advanced and retracted from the corehole, removing the annular fill materials and PVC well casing. The corehole was sealed with 21.4 ft^3 of neat cement grout the same afternoon.

4.0 WASTE MANAGEMENT

Waste generated during drilling and abandonment activities included drill cuttings, annular fill materials, well casing, decontamination water, and contact waste. All waste streams were sampled in accordance with “Waste Characterization Strategy Form for the R-38, R-41, R-44, R-45, and R-46 Regional Groundwater Well Installation and Corehole Drilling” (LANL 2008, 103916).

Cuttings produced during drilling were land-applied per the waste characterization strategy form and ENV-RCRA QA-011, Land Application of Drill Cuttings. Decontamination fluid used for cleaning equipment is containerized. The fluid waste was sampled and will be disposed of at an authorized facility. Characterization of contact waste will be based upon acceptable knowledge and analyses of the waste samples collected from the cuttings, annular fill waste, and decontamination fluid.

5.0 GEODETIC SURVEY

A New Mexico licensed professional land surveyor conducted a geodetic survey on March 12, 2010 (Table 5.0-1). The survey data collected conform to Laboratory Information Architecture (IA) project standards IA-CB02, GIS Horizontal Spatial Reference System, and IA-D802, Geospatial Positioning Accuracy Standard for A/E/C and Facility Management. All coordinates are expressed relative to the New Mexico State Plane Coordinate System Central Zone (North American Datum [NAD] 83); elevations are expressed in feet above mean sea level (amsl) using the National Geodetic Vertical Datum of 1929.

6.0 REFERENCES AND MAP DATA SOURCES

6.1 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 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.

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), October 2009. "Drilling Work Plan for Alluvial Aquifer Wells WCO-1a and WCO-3a," Los Alamos National Laboratory document LA-UR-09-6733, Los Alamos, New Mexico. (LANL 2009, 107425)

NMED (New Mexico Environment Department), February 19, 2007. "Notice of Disapproval, South Canyons Investigation Work Plan," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2007, 095025)

6.2 Map Data Sources

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; January 6, 2004; as published May 28, 2009.

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

LANL Area Boundary; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Division; August 16, 2010.

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; January 6, 2004; as published May 28, 2009.

Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2009-0283; April 12, 2010.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; January 6, 2004; as published May 28, 2009.

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

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Division; December 4, 2008.

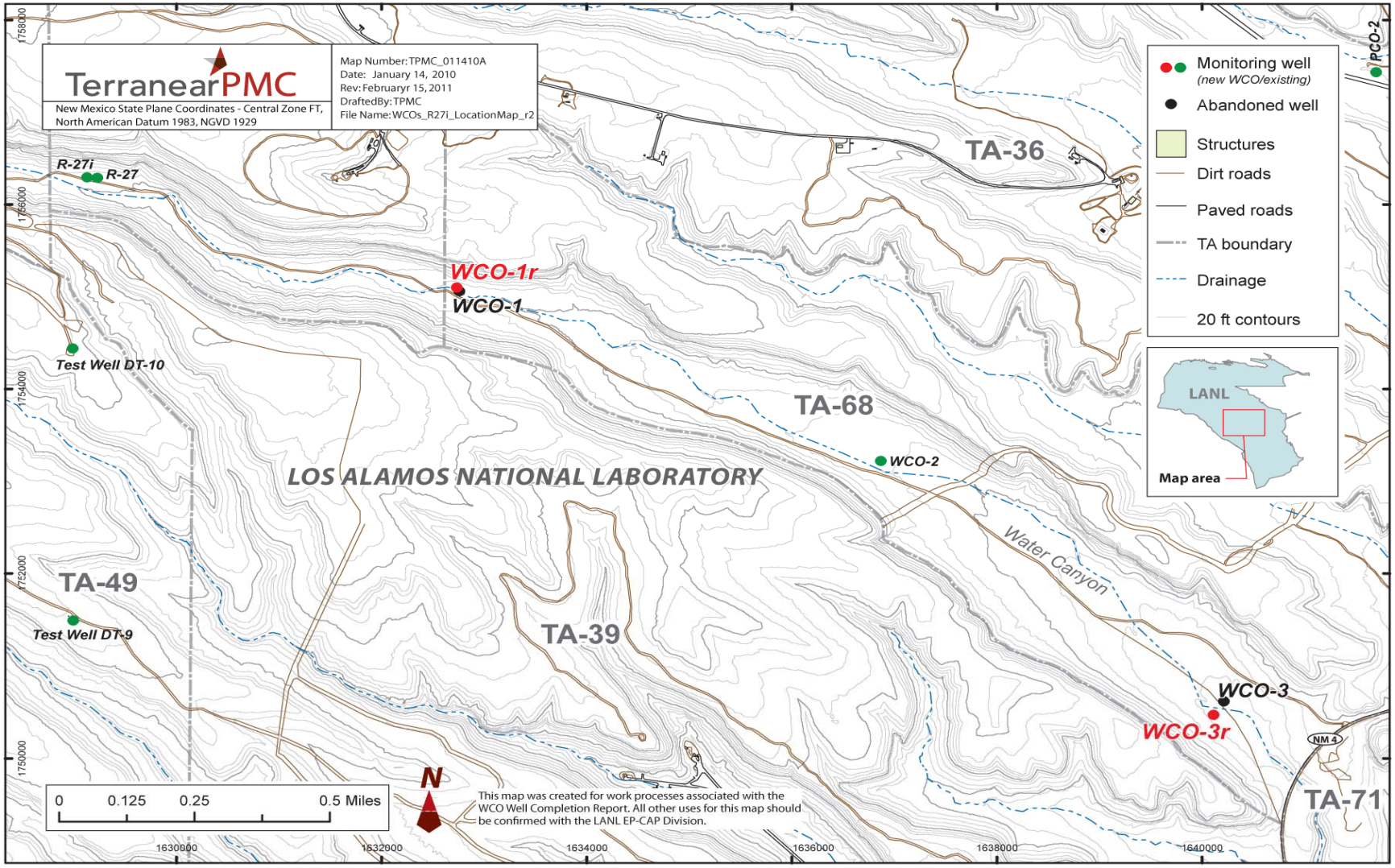

Figure 1.0-1 Location map for WCO wells

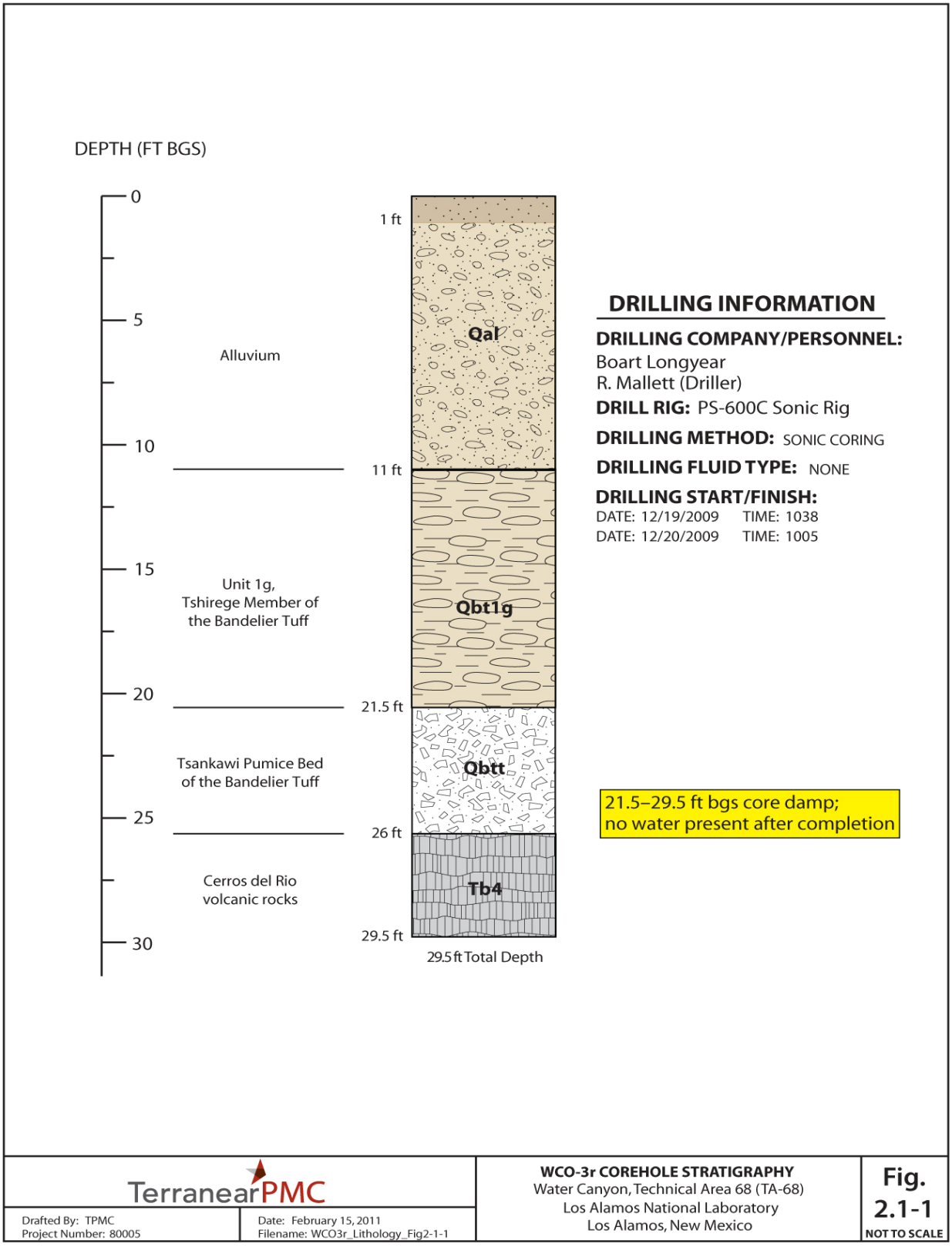

Figure 2.1-1 WCO-3r stratigraphy

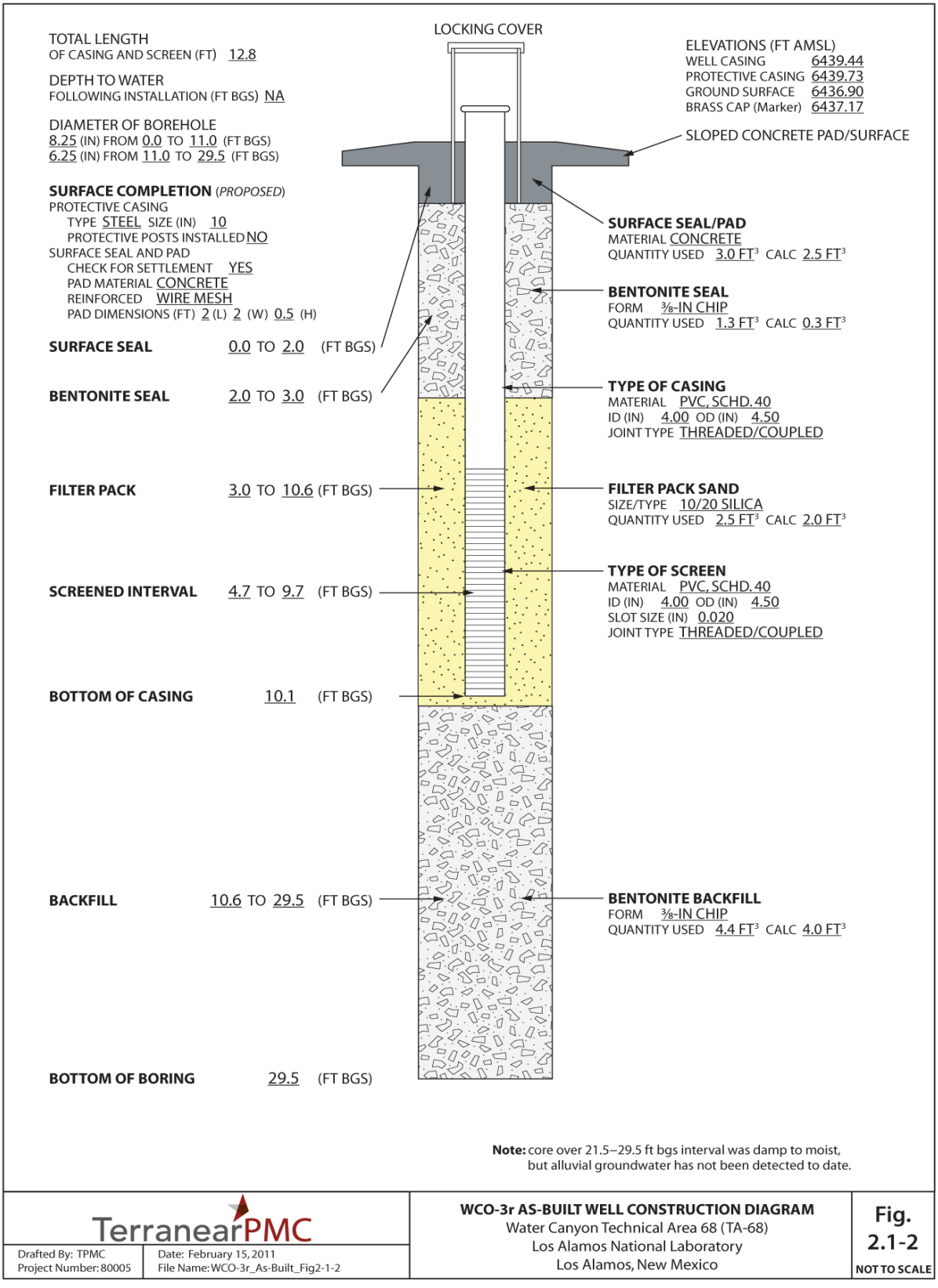

Figure 2.1-2 WCO-3r as-built well construction diagram

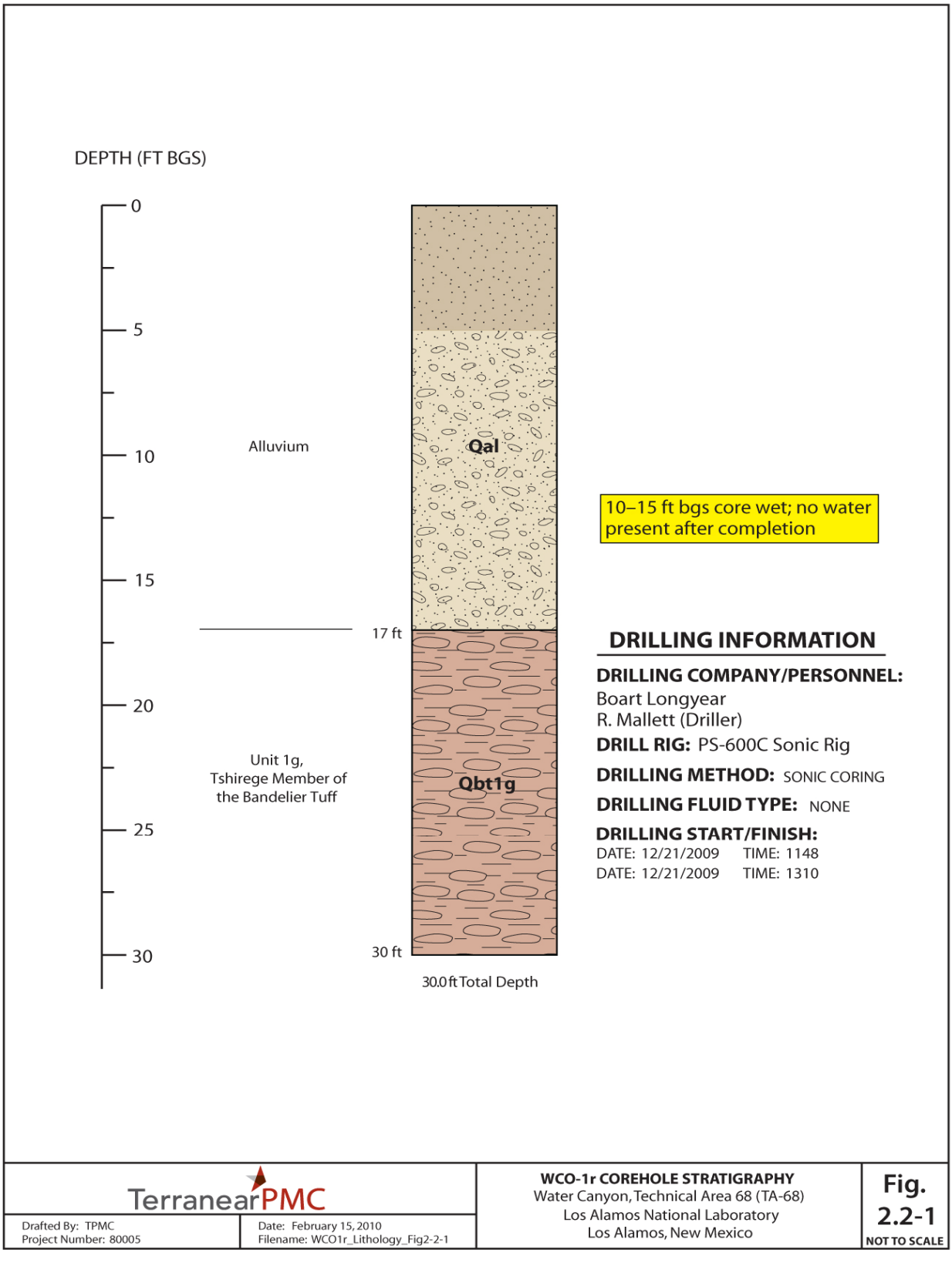

Figure 2.2-1 WCO-1r stratigraphy

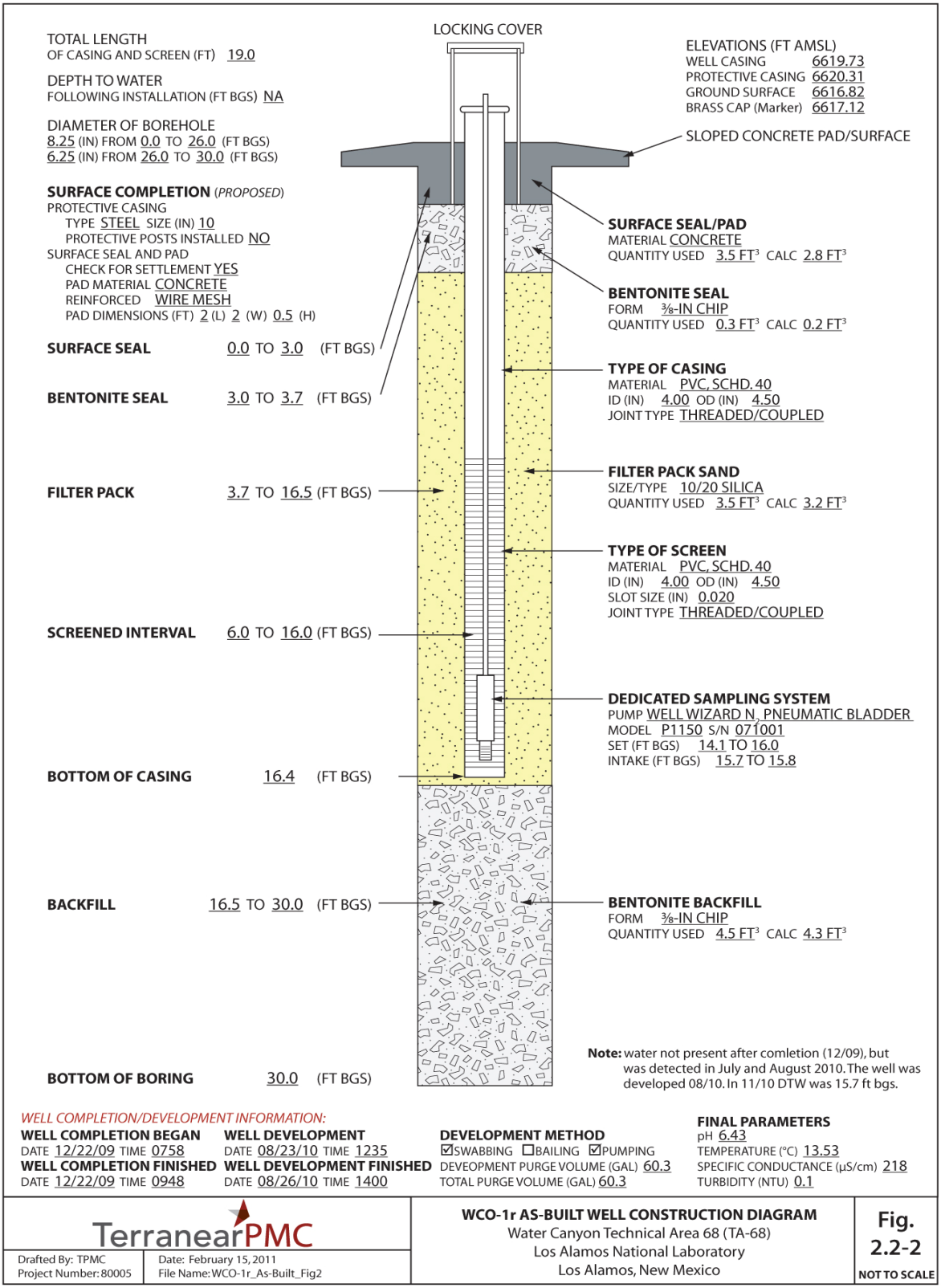

Figure 2.2-2 WCO-1r as-built well construction diagram

Table 2.2-1
Purge Volumes and Water Quality Parameters during
WCO-1r Well Development

Date	pH	Temp (°C)	DO (mg/L)	ORP (mV)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Purge Volume between Samples (gal.)	Cumulative Purge Volume (gal.)
Well Development								
08/23/10	6.37	12.97	4.67	191.3	220	2.0	19.2	19.2
	6.40	12.79	4.64	192.2	220	1.1	3.9	23.1
	6.41	12.81	4.67	194.4	221	0.9	5.2	28.3
08/26/10	6.35	14.10	5.88	137.4	225	93.3	2.1	30.4
	6.41	13.38	5.43	154.8	220	22.1	2.6	33.0
	6.42	13.52	5.43	169.8	219	4.8	3.9	36.9
	6.44	13.60	4.79	183.7	220	3.1	7.8	44.7
	6.44	13.62	4.77	192.5	221	0.3	7.8	52.5
	6.43	13.53	5.09	190.3	218	0.1	7.8	60.3

Table 5.0-1
Survey Coordinates

Identification	Northing	Easting	Elevation
WCO-1 abandoned location	1755067.16	1632765.30	6615.56
WCO-1r brass cap embedded in pad	1755106.26	1632736.78	6617.12
WCO-1r ground surface near pad	1755106.56	1632735.52	6616.82
WCO-1r top of 10-in. protective casing	1755105.06	1632736.63	6620.31
WCO-1r top of PVC well casing	1755105.25	1632736.80	6619.73
WCO-3 abandoned location	1750620.06	1640215.86	6434.95
WCO-3r brass cap embedded in pad	1750476.65	1640114.87	6437.17
WCO-3r ground surface near pad	1750476.61	1640113.74	6436.90
WCO-3r top of 10-in. protective casing	1750476.12	1640114.54	6439.73
WCO-3r top of PVC well casing	1750475.96	1640114.80	6439.44

Note: All coordinates are expressed as New Mexico State Plane Coordinate System Central Zone (NAD 83); elevations are expressed in feet above mean sea level using the National Geodetic Vertical Datum of 1929.

Appendix A

Lithologic Logs for
Water Canyon Alluvial Wells WCO-3r and WCO-1r

Corehole Identification (ID): WCO-3r	**Technical Area (TA):** 68	**Page:** 1 of 1
Drilling Company: Boart Longyear Company	**Start Date/Time:** 12/19/2009 1038	**End Date/Time:** 12/20/2009 1005
Drilling Method: Sonic	**Machine:** PS-600C	**Sampling Method:** Grab
Ground Elevation: 6436.90 ft amsl		**Total Depth:** 29.5 ft
Driller: R. Mallett	**SITE GEOLOGISTS:** R. McGuill, S. Muggleton	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
0–1	**ALLUVIUM**: Soil—Very dark brown (7.5YR 2.5/2), silt to very fine sand, organic-rich material, including root segments and bark. Soil is slightly moist.	Qal	Note: Descriptive analysis is from continuous core collected from ground surface to 29.5 ft bgs. Alluvial sediments were encountered from ground surface to 11 ft bgs.
1–11	Tuffaceous sediments—Brown (7.5 YR 5/2), unconsolidated, poorly sorted, silt to pebble detrital clasts of subangular to subrounded gray porphyritic dacite and minor indurated ash-flow tuff with abundant fine to coarse sand grains of quartz and sanidine crystals and dacite clasts.	Qal	
11–21.5	**UNIT 1g OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** Variable color from dark reddish gray (5 YR 4/2) to white (7.5 YR 8/1), poorly indurated gray porphyritic dacite, pumice fragments, and indurated ash-flow tuff fragments with abundant fine to coarse grains of quartz and sanidine crystals, dacite clasts, and pumice fragments.	Qbt 1g	Unit 1g of the Tshirege Member of the Bandelier Tuff (Qbt 1g) was encountered from 11 to 21.5 ft bgs.
21.5–26	**TSANKAWI PUMICE BED OF THE BANDELIER TUFF:** Variable color from reddish yellow (7.5 YR 6/6) to white (7.5 YR 8/1), strongly weathered, ash-rich tuff with abundant quartz and sanidine crystals, pumice fragments, and dacite clasts.	Qbtt	Tsankawi Pumice Bed was encountered from 21.5 to 26 ft bgs. Core interval was damp.
26–27.5	**CERROS DEL RIO VOLCANIC ROCKS:** Paleosol (?)—Strong brown (7.5YR 4/6) to very dark gray (7.5YR 3/1). Clay-rich weathered basalt with minor silt-sized quartz grains and some basalt fragments up to 5 mm in diameter.	Tb 4	Basalt was encountered from 26 ft bgs to TD at 29.5 ft bgs. Core interval was damp.
27.5–29.5	Basalt—Gray (7.5YR 6/1). Pulverized.	Tb 4	Bottom of corehole at 29.5 ft bgs.

Corehole Identification (ID): WCO-1r	**Technical Area (TA):** 68	**Page:** 1 of 1
Drilling Company: Boart Longyear Company	**Start Date/Time:** 12/19/2009 1038	**End Date/Time:** 12/20/2009 1005
Drilling Method: Sonic	**Machine:** PS-600C	**Sampling Method:** Grab
Ground Elevation: 6436.90 ft amsl		**Total Depth:** 29.5 ft
Driller: R. Mallett	**SITE GEOLOGISTS:** R. McGuill, S. Muggleton	

Depth (ft bgs)	Lithologic Description	Lithologic Symbol	Notes
0–5	**ALLUVIUM:** Soil—Very dark brown (7.5YR 2.5/2), silt to very fine sand, organic-rich material, including root segments and bark. Soil is slightly moist.	Qal	Note: Descriptive analysis is from continuous core collected from ground surface to 30 ft bgs. Alluvial sediments were encountered from surface to 17 ft bgs.
5–10	Tuffaceous sediments—Brown (7.5 YR 5/2), unconsolidated, poorly sorted, silt to pebble detrital clasts of subangular to subrounded gray porphyritic dacite with abundant fine to coarse grains of quartz and sanidine crystals and dacite clasts.	Qal	
10–15	Tuffaceous sediments—Brown (7.5 YR 4/3), unconsolidated, poorly sorted, clay to cobble detrital clasts of subangular to subrounded gray porphyritic dacite with abundant fine to coarse grains of quartz and sanidine crystals and dacite and red rhyolite clasts.	Qal	Core interval was wet.
15–17	Pumiceous sediments—Brown (10YR 4/3), unconsolidated, silt to pebble detrital clasts of subangular to subrounded gray porphyritic dacite, weathered indurated ash-flow tuff and fibrous pumice fragments up to 20 mm in diameter. Abundant fine to coarse grains of quartz and sanidine crystals, pumice fragments, and dacite clasts.	Qal	
17–30	**UNIT 1g OF THE TSHIREGE MEMBER OF THE BANDELIER TUFF:** Ash-flow tuff—Pinkish gray (7.5YR 6/2), poorly to nonwelded, vitric, lithic-bearing, pumiceous with abundant quartz and sanidine phenocrysts.	Qbt 1g	Unit 1g of the Tshirege Member of the Bandelier Tuff (Qbt 1g) was encountered from 17 to 30 ft bgs. Bottom of corehole at 30 ft bgs.

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.

amsl = above mean sea level

bgs = below ground surface

Qal = Quaternary alluvium

Qbt 1g = Unit 1g of the Tshirege Member of the Bandelier Tuff

Qbtt = Tsankawi Pumice Bed of the Bandelier Tuff

Tb 4 = Cerros del Rio volcanic rocks

1 mm = 0.039 in.

1 in. = 25.4 mm