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Sandia National Laboratories

Sandia National Laboratories/New Mexico Environmental Restoration Operations

GROUNDWATER MONITORING WELL INSTALLATION REPORT

FOR

SWMU 8 (OPEN DUMP, COYOTE CANYON BLAST AREA) / SWMU 58 (COYOTE CANYON BLAST AREA)

AND

SWMU 68 (OLD BURN SITE)

Installation of SWMU 8 / 58 Groundwater Monitoring Wells CCBA-MW1 and CCBA-MW2

Installation of SWMU 68 Groundwater Monitoring Wells OBS-MW1, OBS-MW2, and OBS-MW3

November 2011

United States Department of Energy
Sandia Site Office

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
ARCH	Air rotary casing hammer
bgs	below ground surface
CAC	Corrective Action Complete
CCBA	Coyote Canyon Blast Area
CSS	Colorado Silica Sand
DOE	U.S. Department of Energy
DVD	digital video disc
ER	Environmental Restoration
FOP	Field Operating Procedure
gpm	gallon(s) per minute
ID	inside diameter
KAFB	Kirtland Air Force Base
MW	monitoring well
NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
NTU	nephelometric turbidity unit(s)
OBS	Old Burn Site
OD	outside diameter
PVC	polyvinyl chloride
Sandia	Sandia Corporation
SC	specific conductivity
SNL/NM	Sandia National Laboratories, New Mexico
SWMU	Solid Waste Management Unit
TD	total depth
WDC	WDC Exploration and Wells Inc.

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1.0 INTRODUCTION

This report documents the August and September 2011 field activities performed during the installation of five groundwater monitoring wells at two Sandia National Laboratories, New Mexico (SNL/NM) sites. SNL/NM is managed and operated by Sandia Corporation (Sandia), a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy (DOE), National Nuclear Security Administration. Two monitoring wells (MWs) (CCBA-MW1 and CCBA-MW2) were installed within the boundaries of Solid Waste Management Units (SWMUs) 8 (Open Dump, Coyote Canyon Blast Area) / 58 (Coyote Canyon Blast Area [CCBA]). Three monitoring wells (OBS-MW1, OBS-MW2, and OBS-MW3) were installed at SWMU 68, the Old Burn Site (OBS).

Table 1-1 summarizes the groundwater monitoring wells that are discussed in this report.

Table 1-1
Summary of Wells Installed at SWMUs 8 / 58 and 68 in August and September 2011

Well	SWMU	Monitoring Zone	Screened Interval (ft bgs)
CCBA-MW1	8	Quaternary Alluvium and possibly Bedrock Aquifer	60 - 80
CCBA-MW2	58	Bedrock Aquifer	98 - 118
OBS-MW1	68	Bedrock Aquifer	135 - 155
OBS-MW2	68	Bedrock Aquifer	234 - 254
OBS-MW3	68	Bedrock Aquifer	190 - 210

bgs = Below ground surface.
CCBA = Coyote Canyon Blast Area.
ft = Foot (feet).
MW = Monitoring well.
OBS = Old Burn Site.
SWMU = Solid Waste Management Unit.

The field activities were performed by staff from SNL/NM Environmental Restoration (ER) Operations and Environmental Programs and Assurance Department and crews from WDC Exploration and Wells Inc. (WDC).

1.1 SWMUs 8 / 58

1.1.1 SWMUs 8 / 58 Regulatory Action

On January 7, 2008, the DOE and Sandia (hereinafter referred to as DOE/Sandia) submitted a letter to the New Mexico Environment Department (NMED) requesting a Corrective Action Complete (CAC) status determination for SWMUs 8 / 58 (DOE/NNSA January 2008). On April 8, 2010, the NMED responded to the DOE/Sandia January 2008 CAC request and stated that SWMUs 8 / 58 required additional site characterization work. The NMED specified that two groundwater monitoring wells needed to be installed within the boundaries of SWMUs 8 / 58 and required submittal of a well installation work plan (NMED April 2010).

On September 23, 2010, DOE/Sandia responded to the NMED letter of April 8, 2010, and submitted a groundwater characterization work plan for the installation of the two SWMU 8 / 58 monitoring wells (DOE/NNSA September 2010). The NMED responded to the DOE/Sandia September 2010 submittal on January 28, 2011, and approved the SWMU 8 / 58 work plan (NMED January 2011).

1.1.2 SWMUs 8 / 58 Site Description and History

The following site description and historical information is excerpted from the summary poster for SWMUs 8 / 58 presented at a public meeting (SNL/NM January 2008). This public meeting was held on January 29, 2008, in Albuquerque, New Mexico, as part of the CAC request process.

SWMUs 8 / 58 are located within the U.S. Forest Service Withdrawn Area on the eastern side of Kirtland Air Force Base (KAFB). SWMU 58 covers approximately 288 acres, and the boundary is defined as a 4,000-foot-diameter circle, selected to encompass the probable area of fragment dispersal from outdoor explosives testing. SWMU 8, defined as a distinct debris area, covers approximately 30 acres and is contained within the SWMU 58 boundary (Figure 1-1).

The ground surface elevation at SWMUs 8 / 58 ranges from approximately 5,880 to 6,280 feet above mean sea level (amsl). SWMU 8 and the central portion of SWMU 58 are generally flat with a slight slope to the south-southwest (SNL/NM April 2005). The Lurance Canyon arroyo trends east to west along the southern boundary of SWMU 58 and roughly parallels Coyote Springs Road (Figure 1-1). A smaller arroyo trends from north to south across the western portion of SWMU 8. Surface water occasionally flows through the arroyos in response to heavy precipitation events.

SNL/NM personnel conducted more than 100 research tests from 1950 to the late 1960s at the two SWMUs. Tests at SWMU 58 included ground surface, aboveground, and ground penetration tests. Primary materials dispersed at the site included partially combusted high explosives, metals, and radionuclides. Debris from the SWMU 58 tests and possibly debris transported from other sites were disposed of at SWMU 8. Wood shipping crates, scrap metal from tests, and concrete rubble comprised most of the solid waste at SWMU 8.

SWMUs 8 / 58 were initially identified in the mid-1980s, as part of the Comprehensive Environmental Assessment and Response Program. Numerous surveys were conducted throughout SWMUs 8 / 58 from 1993 through 2004 to identify areas and locations at the sites that contained radiologically contaminated materials, unexploded ordnance, and other miscellaneous types of wastes. The surveys identified 60 individual locations (designated as “Features” and shown on Figure 1-1) within the SWMU 58 site boundary that contained potentially contaminated soil and debris requiring additional characterization.

Several remediation projects starting in the mid-1980s and continuing until 2000 have been conducted at the SWMU 8 / 58 Features. Approximately 1,390 cubic yards of various types of solid waste, such as metal shrapnel, jet-assisted take off motors, concrete rubble, and wood scrap, have been removed.

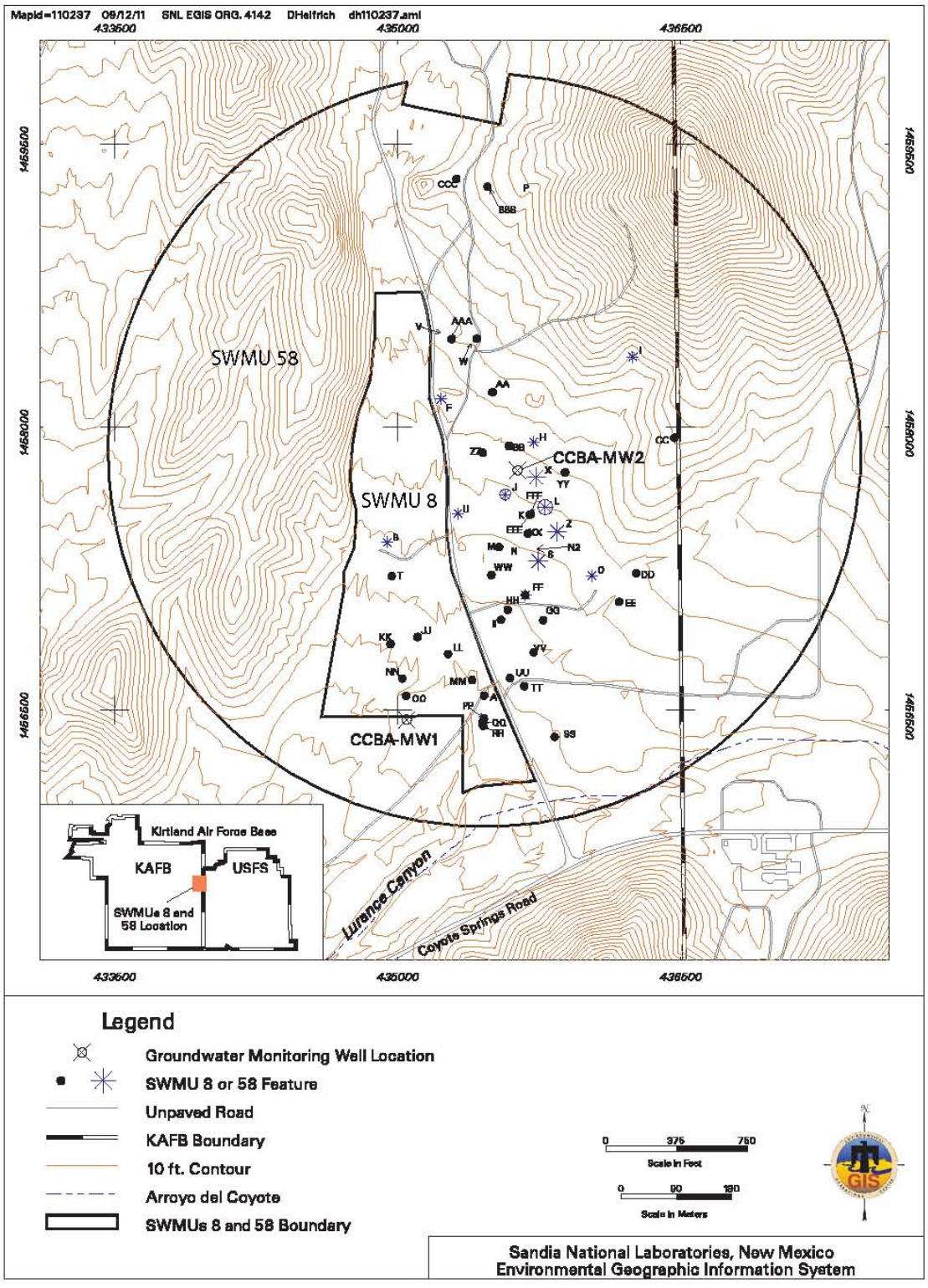

Figure 1-1
Location Map of SWMUs 8 / 58 and the
New Monitoring Wells CCBA-MW1 and CCBA-MW2

A total of 1,395 confirmatory soil sample analyses were used as a basis for the final risk assessment for SWMUs 8 / 58. These samples were collected from 1995 to 2006 to characterize existing surface or subsurface soil at numerous locations at the site or soil that remained after remediation activities were completed at several of the SWMU 8 / 58 Features. Surface samples were collected with hand-held equipment, and subsurface samples were collected with drill rigs to a maximum depth of 100 feet below ground surface (bgs).

1.1.3 SWMUs 8 / 58 Geologic and Hydrogeologic Setting

Alluvium derived from the surrounding Precambrian quartzite, greenstone, metarhyolite, and granite and Paleozoic limestone and sandstone covers the central, flatter portion of SWMUs 8 / 58. A thin veneer of weathered bedrock (colluvium) covers the steeper slopes that surround the western and northern portions of the SWMUs. Geologic mapping completed in the SWMU 8 / 58 area in the mid-1990s determined that the subsurface bedrock beneath the central and southern portion of the site consists of Precambrian quartzite. Precambrian granite underlies the northern portion of the site (SNL/NM December 1995).

Drilling conducted in 2006 to a depth of 100 feet bgs near Feature YY penetrated unconsolidated alluvium but did not reach bedrock. Another borehole drilled near Feature OO in the southern portion of SWMU 58 encountered bedrock at a depth of approximately 70 feet bgs (Figure 1-1). Groundwater was not encountered in any of the 2006 boreholes.

The following discussion incorporates findings from the 2011 drilling activities that are presented in greater detail in Sections 2.0 and 3.0. In the CCBA-MW1 borehole, unconsolidated alluvium and possibly weathered quartzite bedrock were encountered; the total depth (TD) of the borehole was 90 feet bgs. Saturated alluvium starting at approximately 62 feet bgs was encountered, and the well screen was set at 60 to 80 feet bgs. At the CCBA-MW2 location, unconsolidated alluvium was encountered from the surface to 30 feet bgs. From 30 feet to the borehole TD of 123 feet bgs, Precambrian granite and granitic gneiss was penetrated. Water-producing fractures were encountered in the borehole, and the well screen was set at 98 to 118 feet bgs. Following well development, the groundwater elevations at CCBA-MW1 and CCBA-MW2 were 5,854.61 and 5,867.91 feet amsl, respectively, on September 13, 2011. The potentiometric surfaces represented by the groundwater elevations measured in both wells is above the top of each screen. This indicates that the groundwater at both wells is under semiconfined conditions.

1.2 SWMU 68

1.2.1 SWMU 68 Regulatory Action

On March 1, 2006, DOE/Sandia submitted a letter to the NMED requesting a CAC status determination for SWMU 68 (DOE/NNSA March 2006).

On April 8, 2010, the NMED responded to the DOE/Sandia CAC request of March 2006, stating that SWMU 68 required additional site characterization work, including the installation of three groundwater monitoring wells near the previous location of the burn pan and associated ditch/surface impoundment. The NMED also required the submittal of a well installation work plan (NMED April 2010).

On September 23, 2010, DOE/Sandia responded to the NMED letter of April 8, 2010, by submitting a groundwater characterization work plan for the installation of three monitoring wells at SWMU 68 (DOE/NNSA September 2010). The NMED responded to the DOE/Sandia September 2010 submittal on January 28, 2011, and approved the SWMU 68 well installation work plan (NMED January 2011).

1.2.2 SWMU 68 Site Description and History

The following site description and history information is summarized from the SWMU 68 summary poster that was presented at a public meeting (SNL/NM March 2006). This public meeting was held on March 22, 2006, in Albuquerque, New Mexico, as part of the CAC request process.

SWMU 68 is located in the Coyote Test Field, approximately 0.8 miles north of the southern boundary of KAFB and approximately 0.6 miles to the west of the U.S. Forest Service Withdrawn Area (Figure 1-2). SWMU 68 encompasses approximately 6.5 acres of generally flat and gently westerly sloping terrain at an average elevation of approximately 5,860 feet amsl.

From 1965 to 1978, pool fire tests were conducted at SWMU 68 to study the effects of fire on weapons components and to determine the potential for release of radioactive material in case of a transportation (air, truck, and rail) accident. The primary fuel used for the pool fire tests was jet fuel (typically kerosene-based jet propellant JP-4). Prior to investigative and remedial activities that were completed in 2004, SWMU 68 consisted of an aboveground, approximately 3-foot-deep, steel burn pool; a drainage ditch; an overflow basin; a rectangular burn pit that was once lined with plastic; three debris piles; and two irregularly shaped borrow pits (Figure 1-2).

From 1995 to 2004, multiple surveys and remediation projects were conducted at SWMU 68 to identify and remove nonhazardous and hazardous materials from the site. Wastes removed from SWMU 68 included soil contaminated with radionuclides and metals (primarily lead) and assorted metal fragments, scrap metal, concrete, wire, scrap wood, cardboard, plastic fencing, and burn debris. All testing materials and features were removed. As a final measure, the disturbed areas were graded and reseeded in 2004.

A total of 499 confirmatory soil samples were collected at SWMU 68 from 1996 to 2004, and these sample analyses were used in the final risk assessment for SWMU 68. Soil samples were collected from the plastic-lined pit, the overflow basin, the drainage ditch running from the burn pan to the overflow basin, the soil underneath the burn pan, and other remediated areas of the site.

1.2.3 SWMU 68 Geologic and Hydrogeologic Setting

Most of SWMU 68 is covered with a thin veneer of unconsolidated proximal to mid-fan alluvial sediments that vary in thickness across the site. Paleozoic limestone outcrops at the northwest portion of the site. Of the three drilling locations discussed in this report, the greatest thickness of unconsolidated sediments was 3 feet at monitoring well OBS-MW1.

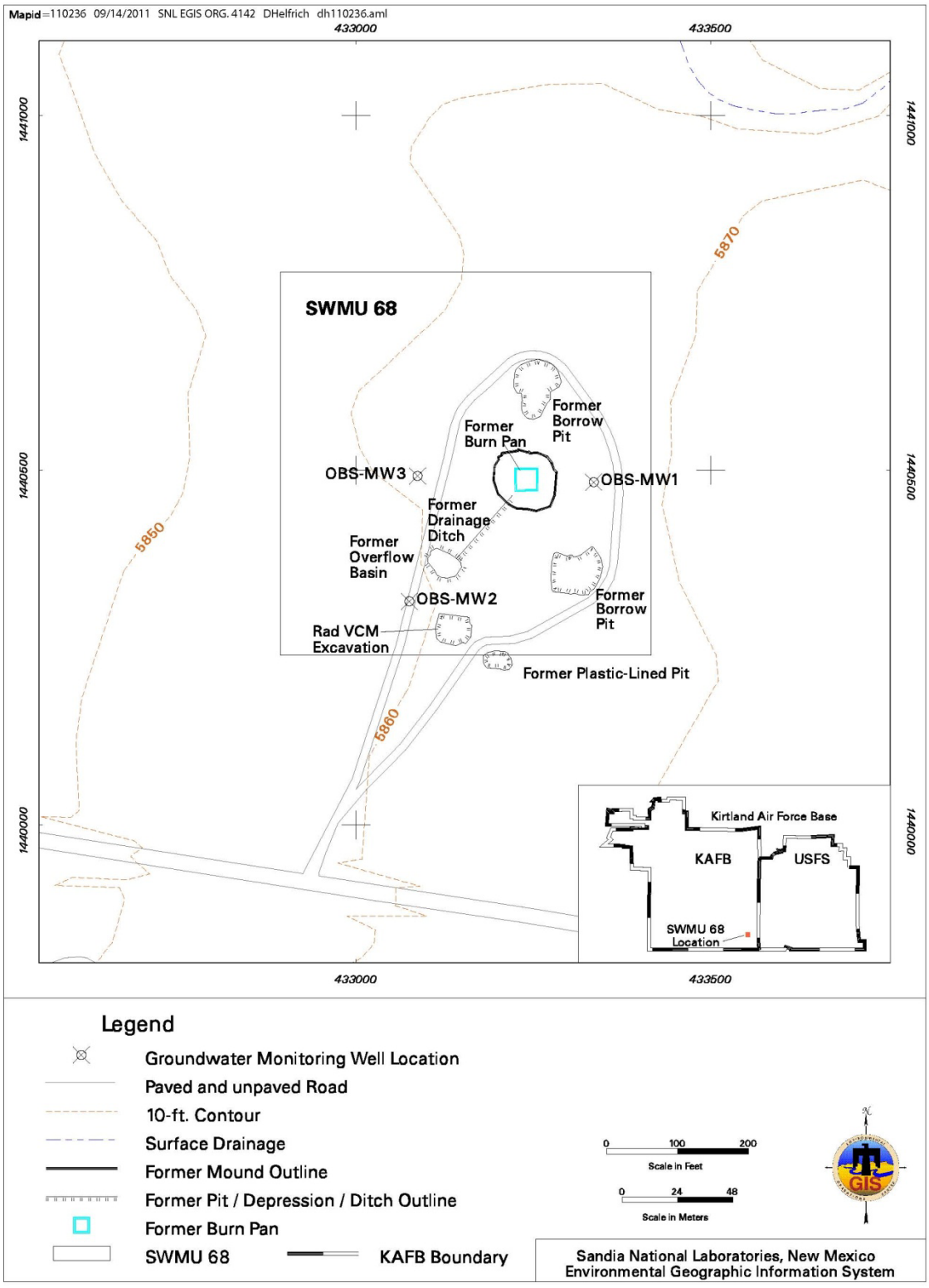

Figure 1-2
Location Map of SWMU 68 and New Monitoring Wells OBS-MW1, OBS-MW2, and OBS-MW3

SWMU 68 appears to straddle the north-south–trending Coyote Fault zone based on the types of lithology encountered during drilling of the three boreholes at the site. The Coyote Fault is located along the base of the Manzanita Mountains in the southeastern part of KAFB, and exhibits down-to-the-west composite displacement of approximately 1,300 feet (SNL/NM December 1995).

Lithologic cuttings generated during this drilling project indicate that all three of the wells are located within the Coyote Fault zone. As described in Section 2.0, Paleozoic Madera Group limestone and Sandia Formation (sandstone, claystone, and conglomerate) were encountered in all three boreholes. Precambrian granite and granitic gneiss were also penetrated at each drilling location. Figure 1-3 presents a close-up photograph of the limestone outcrop located at the northwestern corner of SWMU 68.

At the OBS-MW1 location (Figure 1-2), significant groundwater was first encountered in fractured Precambrian granite at a depth of 135 feet bgs, and the well screen was set at 135 to 155 feet bgs in this well. At the OBS-MW2 location, a high-volume of water flowing in fractures was first encountered at approximately 240 feet bgs, and the well screen was set at 234 to 254 feet bgs. The rock type in which the OBW-MW2 screen was placed is not conclusively known because no drill cuttings were returned from approximately 205 to 305 feet bgs. Well OBS-MW2 is interpreted to most likely be screened in an extensively fractured interval of the Sandia Formation near the Coyote Fault. At the OBS-MW3 location, the first indication of significant groundwater was encountered at a depth of approximately 190 feet bgs, and water production gradually increased with borehole depth. The screen for this well was set in fractured Precambrian granite at a depth of 190 to 210 feet bgs.

The following discussion incorporates findings from the 2011 drilling activities that are presented in greater detail in Sections 2.0 and 3.0. Post-well development water levels in the three SWMU 68 wells were measured on September 13, 2011. The groundwater elevations at OBS-MW1 and OBS-MW3 are similar, at 5799.38 and 5796.06 feet amsl, respectively. However, the groundwater elevation at OBS-MW2 is much lower at 5685.12 feet amsl. The horizontal distance between OBS-MW2 and the other two wells is approximately 300 feet. The difference in groundwater elevations of more than 100 feet between OBS-MW2 and the other two nearby wells suggests that a fault, possibly a splay of the Coyote Fault, represents a hydraulic barrier between OBS-MW2 and the other two wells (OBS-MW1 and OBS-MW3). The potentiometric surfaces represented by the groundwater elevations measured in each of the three wells is above the top of each screen. This indicates that the groundwater in the SWMU 68 area is under semiconfined conditions.

1.3 Project Objectives

The objective of this project was to install two groundwater monitoring wells (CCBA-MW1 and CCBA-MW2) at SWMUs 8 / 58 and three groundwater monitoring wells (OBS-MW1, OBS-MW2, and OBS-MW3) at SWMU 68.

Figure 1-3
Outcrop of Paleozoic (Pennsylvanian) Madera Group limestone with calcium carbonate (calcite) veinlets and stringers near the SWMU 68 well OBS-MW3 location. Chert nodules form the higher (more erosion resistant) protrusions. August 9, 2011.

1.4 Report Organization

This report is organized by activity, as follows:

- Chapter 2.0 describes the drilling and installation operations for the new wells.
- Chapter 3.0 describes the well development activities.
- Chapter 4.0 describes the land surveying.
- Chapter 5.0 addresses variances from the groundwater characterization work plans for SWMUs 8, 58, and 68 (DOE/NNSA September 2010).
- Chapter 6.0 lists the references cited in this report.

The following appendices provide supplemental information for the well installation activities:

- Appendix A provides the lithologic logs.
- Appendix B contains the well construction data sheets.
- Appendix C presents the well construction diagrams.
- Appendix D provides the well development forms.

This report satisfies the reporting requirements for both the NMED and New Mexico Office of the State Engineer (NMOSE) as described in the work plan. The Compliance Order on Consent (NMED April 2004) specifies the required elements for reporting the installation of monitoring wells. The NMOSE requirements and guidance are provided in “Rules and Regulations Governing Well Driller Licensing; Construction, Repair, and Plugging of Wells” (NMOSE August 2005).

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2.0 DRILLING AND GROUNDWATER MONITORING WELL INSTALLATION

The drilling and well installation operations were performed by WDC and supervised by SNL/NM ER Operations personnel. The boreholes for four of the five wells were drilled using the air rotary casing hammer (ARCH) and air rotary drilling methods, while the fifth well (CCBA-MW1) was drilled with the ARCH method only. Drilling equipment included a Speedstar 50K-CH drilling rig and an Ingersoll Rand air compressor, which typically supplied downhole air at 1,170 cubic feet per minute and 350 pounds per square inch. The drilling technique was consistent for each of the five wells and included the use of 8.5-inch-diameter drill bits and 9.625-inch outside diameter (OD) drive casing. Removal of cuttings from the drive casing and/or borehole was facilitated by intermittently injecting a mist of clean water down through the drill pipe and up along the inside of the drive casing to the surface.

No petroleum odors, stains, or sheens were observed in the cuttings or air-lifted groundwater from any of the five boreholes. Drilling waste, including vadose-zone and saturated-zone cuttings, was disposed of according to applicable state and federal regulations and as specified in the project-specific waste management plan.

Environmentally sensitive protocols were used to ensure that the monitoring wells would produce representative groundwater samples of the water-bearing zones. For example, Matex Thread Compound ES (a vegetable oil-based material) was used for lubricating the drive-casing joints. The Campbell™Monoflex® well casings and screens were shipped to the drill site in individual “enviro-wrapped” polyethylene bags.

The following sections describe the borehole drilling, lithologic logging, well construction, and groundwater level measurements for each of the five monitoring wells. Additional field documentation that consists of copies of the relevant logbook pages, daily driller reports, safety records, and DVDs [digital video discs] of the downhole video logs are on file at the SNL/NM Customer Funded Records Center.

2.1 SWMU 8 / 58 Groundwater Monitoring Wells

In August 2011, two monitoring wells (CCBA-MW1 and CCBA-MW2) were installed at SWMUs 8 / 58. Monitoring well CCBA-MW1 is located at the southwestern corner of SWMU 8, and monitoring well CCBA-MW2 is located near the center of SWMU 58 (Figure 1-1).

2.1.1 Well CCBA-MW1

Monitoring well CCBA-MW1 is located approximately 0.2 miles north of the ephemeral channel in Lurance Canyon and approximately 0.7 miles east of Coyote Springs. Lurance Canyon is the eastern extension of Arroyo del Coyote.

2.1.1.1 CCBA-MW1 Drilling Operations

Prior to the start of drilling, all equipment (rig, drill bits, drill collars, and drill pipe) was decontaminated with a pressure washer at the ER Operations decontamination pad at Building 9925. The borehole was spudded on August 12, 2011, and advanced with a tricone bit

and drive casing to accommodate drilling through the sand and gravel zones. Saturated cuttings were encountered at 62 feet bgs. Drilling was difficult below a depth of 75 feet bgs due to encountering numerous quartzite cobbles and the sloughing of gravel zones into the borehole. The borehole was advanced to a TD of 92 feet bgs in order to accommodate the required 20-foot-long screen and 5-foot-long sump. The TD of the borehole was reached on August 13, 2011.

2.1.1.2 CCBA-MW1 Lithologic Logging

Lithologic descriptions for monitoring well CCBA-MW1 are based upon drill cuttings collected from the air-discharge hose (Appendix A). From the ground surface to the TD of 92 feet bgs, the cuttings consisted of unconsolidated Quaternary alluvium comprised mostly of poorly sorted sands and gravels. Saturated cuttings indicative of groundwater were first encountered at 62 feet bgs. Difficult drilling from 62 to 92 feet bgs was due to encountering significant amounts of quartzite and granite cobbles. (Such cobbles are scattered across the nearby ground surface.) Drilling through numerous cobbles and sloughing (especially below 75 feet bgs in poorly sorted gravels) made advancement of the drive casing difficult. Returns of drill cuttings were erratic below this depth. A tricone bit was run to TD, which indicates that competent bedrock was not encountered. However, the possibility exists that weathered bedrock was encountered near TD.

Video logging of the borehole was not conducted before the installation of well CCBA-MW1 because the drive casing had to be run to TD in response to the sloughing material that consisted of loose gravel zones and possibly weathered bedrock. On the steep hillside located south of the drilling site, fractured and moderately dipping quartzite bedrock is clearly visible.

2.1.1.3 CCBA-MW1 Well Construction

The well construction activities for CCBA-MW1 began on August 13, 2011, and were completed on August 14, 2011 (Appendices B and C). The well materials were installed through the temporary steel drive casing. Figure 2-1 shows the pulling of the steel drive casing during the well installation. The well was constructed of nominal 5-inch-diameter (inside diameter [ID] of 4.75 inches and OD of 5.5 inches), Schedule 80 polyvinyl chloride (PVC), flush-threaded, blank casing and a 20-foot length of 0.020-inch slot, Schedule 80 PVC slotted screen. The sump consisted of a 5-foot length of nominal 5-inch-diameter, Schedule 80 PVC, flush-threaded, blank casing with a threaded bottom cap. A 6-inch-long PVC solid plug was placed inside the bottom cap to reduce the possibility of damage during subsequent well development and sampling activities. PVC centralizers were placed at the upper and lower ends of the screen.

Monitoring well CCBA-MW1 is screened in Quaternary alluvium and possibly across the contact between alluvium and weathered bedrock. The bottom of the 5-foot-long sump was placed at 85 feet bgs, and the 20-foot screen was placed from 60 to 80 feet bgs (which coincides with the saturated sediment). Carmeuse® Colorado Silica Sand (CSS) #10-20 sand was installed as the primary sand pack in the annulus around the screen and extended approximately 5 feet above the top of the screen to 55 feet bgs. A surge block was used during emplacement of the sand to settle and eliminate possible voids in the primary sand pack. A secondary sand pack using Carmeuse® CSS #60 sand was installed from 50 to 55 feet bgs. An

Figure 2-1
Pulling the drive casing while installing well materials at monitoring well CCBA-MW1, located at the southwestern corner of SWMU 8. View to the northeast, August 13, 2011.

approximately 49-foot-thick, bentonite-chip seal (consisting of 3/8-inch grade PDS Bentonite Plug) was placed from 1 to 50 feet bgs. The chips were hydrated with water at 20-foot intervals during installation. A concrete well pad and 3-foot-high monument (stovepipe) completed the well installation (Section 2.3).

An unusually large volume of sand pack was required for building monitoring well CCBA-MW1 (Figure 2-2). A total of 118 bags of sand were used to fill the annulus from the bottom of the sump to the required height above the screen. A monitoring well of similar design that is installed in alluvium would be expected to typically require approximately 25 bags of sand. The large annular volume for well CCBA-MW1 indicates that a borehole with a much larger than normal diameter was created during the drilling process due to the significant amount of borehole sloughing in the cobble zone.

Figure 2-2
Installing the sand pack for monitoring well CCBA-MW1 at SWMU 8.
View to the northeast, August 13, 2011.

2.1.2 Well CCBA-MW2

Monitoring well CCBA-MW2 is located approximately 0.4 miles north of the ephemeral channel in Lurance Canyon and approximately 1 mile northeast of Coyote Springs (Figure 2-3).

2.1.2.1 CCBA-MW2 Drilling Operations

Prior to the start of drilling operations, all drilling equipment (rig, drill bits, drill collars, and drill pipe) was decontaminated with a pressure washer at the ER Operations decontamination pad at Building 9925. The borehole was spudded on August 14, 2011, and initially advanced with a tricone bit and drive casing to accommodate drilling through unconsolidated near-surface sand and gravel zones. At a depth of 30 feet bgs, the top of the Precambrian granite was encountered and drilling became more difficult. The

Figure 2-3
Drilling activity at the location of monitoring well CCBA-MW2 at SWMU 58.
View to the south, August 14, 2011.

drive casing was set to a depth of 36 feet bgs. Because drilling became much more difficult in the Precambrian granite, switching to a button bit at 41 feet bgs was necessary. Based upon the driller's comments, a slightly increased penetration rate from 90 to 103 feet bgs probably indicates that fractures in the granitic bedrock are present. Saturated cuttings were encountered at 100 feet bgs. At depths of 103 to 115 feet bgs, drilling again became difficult. A slightly increased penetration rate from 115 to 117 feet bgs also probably indicates that fractures in the granitic bedrock are present. The borehole was advanced to a TD of 123 feet bgs to accommodate the required 20-foot-long screen and 5-foot-long sump. The TD was reached on August 15, 2011.

2.1.2.2 CCBA-MW2 Lithologic and Video Logging

Lithologic descriptions are based upon drill cuttings collected from the air-discharge hose (Appendix A). Video logging was conducted on August 15, 2011, using a GeoVision Jr™ downhole video camera (model number GVJRHDMI). The camera was lowered on a steel cable

to a depth of 123 feet bgs. The color video was recorded on videotape and subsequently transferred to a DVD.

Unconsolidated, poorly sorted sands and gravels are present from the ground surface to a depth of 30 feet bgs where the top of chlorite-rich Precambrian granite is encountered. The interval from 30 to 123 feet bgs consists of Precambrian granite and gneiss. Discontinuous, vertical fractures are visible on the video log at several depths; the fractures appear dry and closed.

2.1.2.3 CCBA-MW2 Well Construction

The well construction activities for CCBA-MW2 began on August 15, 2011, and were completed on August 16, 2011 (Appendices B and C). The well materials were installed through the drive casing. The well was constructed of nominal 5-inch-diameter (ID of 4.75 inches and OD of 5.5 inches), Schedule 80 PVC, flush-threaded, blank casing and a 20-foot length of 0.020-inch slot, Schedule 80 PVC slotted screen. The sump consisted of a 5-foot length of nominal 5-inch-diameter, Schedule 80 PVC, flush-threaded, blank casing with a threaded bottom cap. A 6-inch-long PVC solid plug was placed inside the bottom cap to reduce the possibility of damage during subsequent well development and sampling activities. PVC centralizers were placed at the upper and lower ends of the screen.

Monitoring well CCBA-MW2 is screened in Precambrian granite that is moderately fractured. The bottom of the 5-foot-long sump was placed at 123 feet bgs, and the 20-foot screen was placed from 98 to 118 feet bgs. Carmeuse® CSS #10-20 sand was installed as the primary sand pack in the annulus around the screen and extended approximately 5 feet above the top of the screen to 93 feet bgs. A surge block was used during emplacement of the sand to settle and eliminate possible voids in the primary sand pack. A secondary sand pack using Carmeuse® CSS #60 sand was installed from 88 to 93 feet bgs. An approximately 87-foot-thick, bentonite-chip seal (consisting of 3/8-inch grade PDS Bentonite Plug) was placed from 1 to 88 feet bgs. The chips were hydrated with water at 20-foot intervals during installation. A concrete well pad and monument (stovepipe) completed the well installation (Section 2.3).

2.2 SWMU 68 Groundwater Monitoring Wells

2.2.1 Well OBS-MW1

Monitoring well OBS-MW1 is located at SWMU 68 in the Coyote Test Field, approximately 0.6 miles southwest of the Starfire Optical Range. Figure 2-4 shows the flat terrain at the drilling location with the Manzanita Mountains in the background.

Figure 2-4
Drilling activity at the location for monitoring well OBS-MW1 at SWMU 68.
View to the southeast, August 8, 2011.

2.2.1.1 OBS-MW1 Drilling Operations

Prior to the start of drilling operations, all drilling equipment (rig, drill bits, drill collars, and drill pipe) was decontaminated with a pressure washer at the ER Operations decontamination pad at Building 9925. The borehole was spudded on August 8, 2011, and completed that same day. The borehole was initially advanced with a tricone bit and drive casing to accommodate drilling through unconsolidated sand. Drive casing was run to a depth of 13 feet bgs where bedrock (limestone, claystone, and conglomerate) was encountered. More dense bedrock at 15 feet bgs required switching to a button bit. Precambrian granite was encountered at 18 feet bgs. An increase in the drilling rate starting at 130 feet bgs is probably due to fractures in the granite bedrock. Saturated cuttings were encountered at 135 feet bgs. The borehole was advanced to a TD of 165 feet bgs to accommodate the required 20-foot-long screen and 5-foot-long sump.

2.2.1.2 OBS-MW1 Lithologic and Video Logging

Lithologic descriptions are based upon drill cuttings collected from the air-discharge hose (Appendix A). Video logging was conducted on August 9, 2011, to a depth of 161 feet bgs.

Poorly sorted sand extends from the ground surface to a depth of 3 feet bgs. The interval of 3 to 18 feet bgs consists of weathered bedrock comprised of limestone, claystone, and conglomerate. This interval probably corresponds to the Sandia Formation. Precambrian granite is encountered at 18 feet bgs. A vertical set of dry fractures at 58 to 59 feet bgs, and 63 to 65 feet bgs are visible on the video log. An increased drilling rate starting at 130 feet bgs is probably due to fractures that are present in the granite bedrock. Saturated cuttings were encountered at 135 feet bgs. A consistent drilling rate from 130 feet bgs to the TD of 165 feet bgs indicates that the granite is moderately fractured throughout the interval. No significant fractures are visible in this zone on the video log, but the moderately cloudy water limited visibility.

2.2.1.3 OBS-MW1 Well Construction

The well construction activities for OBS-MW1 were conducted on August 9, 2011 (Appendices B and C). The well materials were installed through the drive casing. The well was constructed of nominal 5-inch-diameter (ID of 4.75 inches and OD of 5.5 inches), Schedule 80 PVC, flush-threaded, blank casing and a 20-foot length of 0.020-inch slot, Schedule 80 PVC slotted screen. The sump consisted of a 5-foot length of nominal 5-inch-diameter, Schedule 80 PVC, flush-threaded, blank casing with a threaded bottom cap. A 6-inch-long PVC solid plug was placed inside the bottom cap to reduce the possibility of damage during subsequent well development and sampling activities. PVC centralizers were placed at the upper and lower ends of the screen and at 100-foot intervals along the blank casing.

Monitoring well OBS-MW1 is screened in Precambrian granite that is moderately fractured. The bottom of the 5-foot-long sump was placed at 160 feet bgs, and the 20-foot screen was placed from 135 to 155 feet bgs. Carmeuse® CSS #10-20 sand was installed as the primary sand pack in the annulus around the screen and extended approximately 5 feet above the top of the screen to 130 feet bgs. A surge block was used during emplacement of the sand to settle and eliminate possible voids in the primary sand pack. A secondary sand pack using Carmeuse® CSS #60 sand was installed from 126 to 130 feet bgs, and Carmeuse® CSS #10-20 sand was installed from 124 to 126 feet bgs. An approximately 65-foot-thick, bentonite-chip seal (consisting of 3/8-inch grade PDS Bentonite Plug) was placed from 59 to 124 feet bgs. The chips were hydrated with water at 20-foot intervals during installation. After the final lift of bentonite chips had cured for 1.5 hours, bentonite grout (Quik-Grout® mixed with water in a trough) was pumped into the annulus to fill the remainder of the annulus to the surface. A concrete well pad and monument (stovepipe) completed the well installation (Section 2.3).

2.2.2 Well OBS-MW2

Monitoring well OBS-MW2 is located at SWMU 68 in the Coyote Test Field, approximately 0.6 miles southwest of the Starfire Optical Range. The photograph in Figure 2-5 shows the flat terrain at the drilling location.

Figure 2-5
Drilling activity at monitoring well OBS-MW2 at SWMU 68.
View to the northwest, August 3, 2011.

2.2.2.1 OBS-MW2 Drilling Operations

Prior to the start of drilling operations, all drilling equipment (rig, drill bits, drill collars, and drill pipe) was decontaminated with a pressure washer at the ER Operations decontamination pad at Building 9925. The borehole was spudded on August 3, 2011, and initially advanced with a tricone bit and drive casing to accommodate drilling through unconsolidated sand. Drive casing was set to a depth of 3 feet bgs where limestone of the Madera Formation was encountered. Moderately difficult drilling in limestone continued to 79 feet bgs, where the drilling became harder in more dense limestone. This dense limestone required switching to a button bit at 79 feet bgs. The hard drilling in the sequence of limestone extended to 184 feet bgs, where sandstone (mostly likely of the Sandia Formation) was encountered. The interval from 184 to 190 feet bgs consisted of a medium-grained sandstone. Alternating layers of limestone, sandstone, and claystone were encountered from 190 to 205 feet bgs. No cuttings were returned from 205 to 305 feet bgs; the drilling rate was erratic (not indicative of competent bedrock). Returns of drill cuttings resumed after the drill bit reached 305 feet bgs and consisted of saturated granitic cuttings. The borehole was advanced to a TD of 325 feet bgs in anticipation

of setting the well screen below 305 feet bgs. However, the interpretation of the next day's video log resulted in a different screen interval being selected (Section 2.2.2.2). The TD of 325 feet bgs was reached on August 4, 2011, but borehole sloughing limited video logging to a depth of 254 feet bgs.

2.2.2.2 OBS-MW2 Lithologic and Video Logging

Lithologic descriptions are based upon drill cuttings collected from the air-discharge hose (Appendix A). Video logging was conducted on August 5, 2011, to a depth of 254 feet bgs.

Poorly sorted sand extends from the ground surface to a depth of 3 feet bgs. The interval of 3 to 15 feet bgs consists of weathered limestone. Dense limestone is encountered from 15 to 184 feet bgs. The interval from 184 to 205 feet bgs probably corresponds to the Sandia Formation. The interval from 184 to 190 feet bgs consists of medium-grained sandstone. From 190 to 205 feet bgs, alternating layers of claystone and conglomerate are encountered. The interval of 205 to 305 feet bgs (where no cuttings were recovered) may represent a faulted section of the Sandia Formation. The turbulent water seen in the video log at a depth of 240 to 251 feet bgs is interpreted to most likely represent groundwater flowing through extensive fractures in the Sandia Formation. The top of Precambrian granite is interpreted to be at 305 bgs.

The turbulent groundwater visible in the video log in the borehole for well OBS-MW2 is dark brown to black and suggestive of the strata more typically encountered in the Sandia Formation. This is in contrast to the remarkably pinkish water that was air-lifted and discharged into the hoppers during the drilling for monitoring wells OBS-MW1 and OBS-MW3, where groundwater was encountered in fractured Precambrian granite.

2.2.2.3 OBS-MW2 Well Construction

The well construction activities for OBS-MW2 were conducted on August 5 and August 8, 2011 (Appendices B and C). The well materials were installed through the drive casing. The well was constructed of nominal 5-inch-diameter (ID of 4.75 inches and OD of 5.5 inches), Schedule 80 PVC, flush-threaded, blank casing and a 20-foot length of 0.020-inch slot, Schedule 80 PVC slotted screen. The sump consisted of a 5-foot length of nominal 5-inch-diameter, Schedule 80 PVC, flush-threaded, blank casing with a threaded bottom cap. A 6-inch-long PVC solid plug was placed inside the bottom cap to reduce the possibility of damage during subsequent well development and sampling activities. PVC centralizers were placed at the upper and lower ends of the screen and at 100-foot intervals along the blank casing.

Monitoring well OBS-MW2 is probably screened in a faulted section of the Sandia Formation, which typically consists of claystone and conglomerate. Much borehole sloughing required clearing out the borehole (creating a rat hole) with the drill pipe and bit to a depth of 300 feet bgs and the quick insertion of the PVC well casing before the hole collapsed. The bottom of the 5-foot-long sump was placed at 259 feet bgs, and the 20-foot screen was placed from 234 to 254 feet bgs (which coincides with the turbulent-flow zone at 240 to 251 feet bgs seen on the video log). Carmeuse® CSS #10-20 sand was installed as the primary sand pack in the annulus around the screen and extended approximately 6 feet above the top of the screen to 228 feet bgs. A surge block was used during emplacement of the sand to settle and eliminate possible voids in the primary sand pack. A secondary sand pack using

Carmeuse® CSS #60 sand was installed from 227 to 228 feet bgs. An additional lift of Carmeuse® CSS #10-20 sand was installed from 225 to 227 feet bgs. An approximately 65-foot-thick, bentonite-chip seal (consisting of 3/8-inch grade PDS Bentonite Plug) was placed from 160 to 225 feet bgs. The chips were hydrated with water at 20-foot intervals during installation. After the final lift of bentonite chips had cured for 1 hour, bentonite grout (Quik-Grout® mixed with water in a trough) was pumped into the annulus and used to fill the remainder of the annulus to the surface. A concrete well pad and monument (stovepipe) completed the well installation (Section 2.3).

An unusually large volume of sand pack was required for building monitoring well OBS-MW2. A total of 125 bags of sand were used to fill the annulus from the bottom of the sump to the required height above the screen. A monitoring well of similar design that is installed in competent bedrock would be expected to typically require approximately 20 to 25 bags of sand. The large annular volume for well OBS-MW2 indicates that a borehole with a much larger than normal diameter was created during the drilling process due to the significant amount of borehole sloughing.

2.2.3 Well OBS-MW3

Monitoring well OBS-MW3 is located at SWMU 68 in the Coyote Test Field, approximately 0.6 miles southwest of the Starfire Optical Range. The photograph in Figure 2-6 shows the flat terrain at the drilling location with the Manzanita Mountains in the background.

2.2.3.1 OBS-MW3 Drilling Operations

Prior to the start of drilling operations, all drilling equipment (rig, drill bits, drill collars, and drill pipe) was decontaminated with a pressure washer at the ER Operations decontamination pad at Building 9925. The borehole was spudded on August 9, 2011, and initially advanced with a tricone bit and drive casing to accommodate drilling through unconsolidated sand. Limestone was encountered at a depth of 2 feet bgs and drive casing was set to a depth of 6 feet bgs. Difficult drilling required switching to a button bit at 8 feet bgs. Dense limestone was encountered to a depth of 102 feet bgs. An interval consisting mostly of conglomerate and claystone was encountered from 102 to 114 feet bgs. A decreased penetration rate starting at 114 feet bgs corresponded to the top of harder Precambrian granite. Based upon the driller's comments, an increased penetration rate at 185 feet bgs is probably indicative of fractures present in the granitic bedrock. Saturated cuttings were returned starting at 190 feet bgs. Drilling activities were paused for 2 hours. Air-lifting for 20 minutes produced approximately 80 gallons of groundwater. The borehole was subsequently advanced to a TD of 225 feet bgs to accommodate the required 20-foot-long screen and 5-foot-long sump. The drilling rate was consistent from 185 to 225 feet bgs, indicating that this interval consists of moderately fractured granite. The TD was reached on August 10, 2011.

Figure 2-6
Drilling activity at the location for monitoring well OBS-MW3 at SWMU 68.
Limestone outcrop visible in foreground. View to the southeast, August 9, 2011.

2.2.3.2 OBS-MW3 Lithologic and Video Logging

Lithologic descriptions are based upon drill cuttings collected from the air-discharge hose (Appendix A). Video logging was conducted on August 10, 2011, to a depth of 202 feet bgs.

Poorly sorted sand extends from the ground surface to a depth of 2 feet bgs where limestone of the Madera Formation is encountered. The interval of 2 to 9 feet bgs consists of weathered limestone. From 9 to 102 feet bgs, the strata consist of dense limestone. From 102 to 114 feet bgs, alternating layers of claystone and conglomerate are encountered. This interval probably corresponds to the Sandia Formation and also contains an approximately 1-foot-thick layer composed of either black shale or coal. Precambrian granite is encountered at 114 feet bgs. A vertical set of dry fractures at 136 to 137 feet bgs and a horizontal set of dry fractures at 184 to 185 feet bgs are visible on the video log (Appendix A). Saturated cuttings were encountered at 190 feet bgs. Cloudy water partially obscured the borehole wall, and fractures are not visible in the video log, which was run to a depth of 202 feet bgs. After video logging, the borehole was drilled to a depth of 225 feet bgs. As noted, the consistent and slightly

increased drilling rate from 185 to 225 feet bgs indicates that this interval corresponds to moderately fractured granite.

2.2.3.3 OBS-MW3 Well Construction

The well construction activities for OBS-MW3 were conducted on August 11, 2011 (Appendices B and C). The well materials were installed through the drive casing. The well was constructed of nominal 5-inch-diameter (ID of 4.75 inches and OD of 5.5 inches), Schedule 80 PVC, flush-threaded, blank casing and a 20-foot length of 0.020-inch slot, Schedule 80 PVC slotted screen. The sump consisted of a 5-foot length of nominal 5-inch-diameter, Schedule 80 PVC, flush-threaded, blank casing with a threaded bottom cap. A 6-inch-long PVC solid plug was placed inside the bottom cap to reduce the possibility of damage during subsequent well development and sampling activities. PVC centralizers were placed at the upper and lower ends of the screen and at 100-foot intervals along the blank casing.

Monitoring well OBS-MW3 is screened in Precambrian granite that is moderately fractured. The bottom of the 5-foot-long sump was placed at 215 feet bgs, and the 20-foot screen was placed from 190 to 210 feet bgs. Carmeuse® CSS #10-20 sand was installed as the primary sand pack in the annulus around the screen and extended approximately 5 feet above the top of the screen to 185 feet bgs. A surge block was used during emplacement of the sand to settle and eliminate possible voids in the primary sand pack. A secondary sand pack using Carmeuse® CSS #60 sand was installed from 180 to 185 feet bgs. An approximately 114-foot-thick, bentonite-chip seal (consisting of 3/8-inch grade PDS Bentonite Plug) was placed from 66 to 180 feet bgs. The chips were hydrated with water at 20-foot intervals during installation. After the final lift of bentonite chips had cured for 2 hours, bentonite grout (Quik-Grout® mixed with water in a trough) was used to fill the remainder of the well annulus to the surface. A concrete well pad and monument (stovepipe) completed the well installation (Section 2.3).

2.3 Wellhead Construction

Each of the five wellheads was constructed as aboveground (monument) completions. For each well, the inner well PVC casing was cut to approximately 30 inches above the ground surface, and a 10-foot length of nominal 8.625-inch-diameter steel casing was used as the protective casing at the surface. The protective casing extended 3 feet above the ground and was capped with a Royer Inc. aluminum locking cover. A plastic locking well cap was installed on the top of the PVC casing. Concrete was poured into the annulus from the top of the grout (approximately 1 foot bgs in each borehole) to the surface. A 3- by 3-foot by approximately 6-inch-thick concrete pad, sloped to direct water away from the protective casing, was built around the steel casing. A brass marker stamped with the well identification number was placed on the surface of the concrete pad. Three steel guard posts (bollards) were placed around the pad, and the posts and protective casing were painted yellow.

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3.0 GROUNDWATER MONITORING WELL DEVELOPMENT

From August 29 through September 1, 2011, well development of the five wells (CCBA-MW1, CCBA-MW2, OBS-MW1, OBS-MW2, and OBS-MW3) was performed in accordance with the approved well installation work plans (DOE/NNSA September 2010). The wells were developed using the WDC well development rig. Water produced during well development was disposed of according to applicable state and federal regulations, and as specified in the project-specific waste management plan.

The well development field forms are provided in Appendix D. The following water quality parameters were measured to determine whether representative groundwater was produced from each well at the conclusion of the development process:

- Temperature (degrees Celsius)
- Specific Conductivity (SC) (micromhos/centimeter)
- pH
- Turbidity (measured in nephelometric turbidity units [NTU])

The predevelopment water level readings and the calculated saturated wellbore volumes (defined as the volume of water in the well screen plus the volume of water in the adjacent saturated pore spaces of the annular sand pack [estimated at 30% porosity]) are presented in Table 3-1.

Table 3-1
Calculation for Saturated Wellbore Volumes

Well	Screen Interval (ft bgs)	Initial Water Level (ft bgs)	Saturated Wellbore Volume (gal.)	Target Volume (gal.) (minimum of 5 saturated wellbore volumes)
CCBA-MW1	60 - 80	45	35.5	177.5
CCBA-MW2	98 - 118	68	28.7	143.5
OBS-MW1	135 - 155	68	28.7	143.5
OBS-MW2	234 - 254	169	28.7	143.5
OBS-MW3	190 - 210	69	28.7	143.5

bgs = Below ground surface.
CCBA = Coyote Canyon Blast Area.
ft = Foot (feet).
gal. = Gallon(s).
MW = Monitoring well.
OBS = Old Burn Site

A minimum of five saturated wellbore volumes (also shown in Table 3-1) represents the minimum target volume to be removed from a well where the borehole was drilled without mud or water, as defined in the Field Operating Procedure (FOP) 94-41 (SNL/NM November 1994) and the approved work plans (DOE/NNSA September 2010). The FOP defines the completion of well development at the point where the minimum wellbore volumes have been removed and representative water is obtained. Representative water is indicated when pH, temperature, and

SC measurements are within 10% for three consecutive wellbore volumes, and the water is visibly clear of suspended solids with a target turbidity of less than 5 NTU.

3.1 SWMU 8 / 58 Well Development

3.1.1 CCBA-MW1 Well Development

Well development of CCBA-MW1 began by swabbing the well screen with the surge block on August 31, 2011. A stainless steel bailer/sand pump was initially used to evacuate approximately 50 gallons of water and sediment from the well. The well was then swabbed for approximately 15 minutes, and an additional 175 gallons of water were evacuated with the bailer.

After the initial 225 gallons of water were bailed from the well, an electric submersible pump was installed. The pump intake was positioned at a depth of 80 feet bgs, which was at the bottom of the well screen, and an additional 390 gallons of water were pumped from the well. A total of 615 gallons (17.3 bore volumes) of water were removed from CCBA-MW1 by bailing and pumping on August 31 and September 1, 2011; the pumping rate averaged approximately 4.8 gallons per minute (gpm) during development. Water quality parameters measured during the pumping phase are summarized in Table 3-2. At the conclusion of the CCBA-MW1 development process, water quality parameter stabilization (as previously described) was achieved for temperature, SC, and pH. The final turbidity measurement (4.73 NTU) was also below the target turbidity of 5 NTU (Appendix D).

Table 3-2
Summary of Water Quality Parameters for CCBA-MW1 during Well Development

Date	Time	Total Gallons Bailed and Pumped	Number of Wellbore Volumes	Temperature (°C)	Specific Conductivity (µS/cm)	pH	Turbidity (NTU)
8/31/2011	1512 (start pumping)	240	6.8	18.74	471	7.45	>1,000
	1522	285	8.0	18.87	464	6.87	104
	1545	360	10.1	18.74	465	6.82	12.5
	1600	435	12.2	18.01	465	6.93	42.8
	1611	495	13.9	17.92	464	6.76	21.4
	1618	540	15.2	17.85	467	6.95	64.2
9/1/11	0742	570	16.1	17.41	470	7.02	22.6
	0750 (stop pumping)	615	17.3	17.48	465	6.89	4.73

°C = Degree(s) Celsius.
CCBA = Coyote Canyon Blast Area.
µS/cm = Microsiemen(s)/centimeter (equivalent to micromhos/centimeter).
MW = Monitoring well.
NTU = Nephelometric turbidity unit(s).
pH = Potential of hydrogen.

3.1.2 CCBA-MW2 Well Development

Well development of CCBA-MW2 began by initially bailing water and sediment from the well with a stainless steel bailer/sand pump on August 31, 2011. The well was then swabbed with a surge block for approximately 15 minutes, and more water and sediment were bailed from the well. A total of 180 gallons of water were bailed from CCBA-MW2.

After the initial 180 gallons of water were bailed from the well, an electric submersible pump was installed. The pump intake was positioned at a depth of 117 feet bgs, which was 1 foot above of the bottom of the well screen (118 feet bgs), and an additional 90 gallons of water were pumped from the well. A total of 270 gallons (9.4 bore volumes) of water were removed from CCBA-MW2 by bailing and pumping on August 31, 2011; the pumping rate averaged approximately 3.9 gpm during development. Water quality parameters measured during the pumping phase are summarized in Table 3-3. At the conclusion of the CCBA-MW2 development process, water quality parameter stabilization was achieved for temperature, SC, and pH. The final turbidity measurement (3.45 NTU) was also below the target turbidity of 5 NTU (Appendix D).

Table 3-3
Summary of Water Quality Parameters for CCBA-MW2 during Well Development

Date	Time	Total Gallons Bailed and Pumped	Number of Wellbore Volumes	Temperature (°C)	Specific Conductivity (µS/cm)	pH	Turbidity (NTU)
8/31/11	1346 (start pumping)	195	6.8	20.34	604	8.11	288
	1350	210	7.3	18.90	579	7.59	37.5
	1353	225	7.8	18.89	578	7.57	18.2
	1357	240	8.4	18.93	579	7.74	6.72
	1401	255	8.9	18.84	579	7.67	4.86
	1405 (stop pumping)	270	9.4	18.87	578	7.74	3.45

°C = Degree(s) Celsius.
CCBA = Coyote Canyon Blast Area.
µS/cm = Microsiemen(s)/centimeter (equivalent to micromhos/centimeter).
MW = Monitoring well.
NTU = Nephelometric turbidity unit(s).
pH = Potential of hydrogen.

3.2 SWMU 68 Well Development

3.2.1 OBS-MW1 Well Development

Well development of OBS-MW1 began on August 30, 2011, by bailing 10 gallons of water and sediment from the well with a stainless steel bailer/sand pump. The well was then swabbed with a surge block for approximately 15 minutes, and an additional 170 gallons of water were evacuated with the bailer.

After the initial 180 gallons of water were bailed from the well, an electric submersible pump was installed into the well. The pump intake was positioned at a depth of approximately 150 feet bgs, which was 5 feet above of the bottom of the well screen (155 feet bgs), and an additional 240 gallons of water were pumped from the well on August 30, 2011. On August 31, 2011, an additional 75 gallons of water were pumped from the well. A total of 495 gallons (17.2 bore volumes) of water were removed from OBS-MW1 by bailing and pumping; the pumping rate averaged approximately 3.9 gpm during development. Water quality parameters measured during the pumping phase are summarized in Table 3-4. At the conclusion of the OBS-MW1 development process, water quality parameter stabilization was achieved for temperature, SC, and pH. The final turbidity measurement (1.92 NTU) was also below the target turbidity of 5 NTU (Appendix D).

Table 3-4
Summary of Water Quality Parameters for OBS-MW1 during Well Development

Date	Time	Total Gallons Bailed and Pumped	Number of Wellbore Volumes	Temperature (°C)	Specific Conductivity (µS/cm)	pH	Turbidity (NTU)
8/30/2011	1530 (start pumping)	195	6.8	18.60	498	7.51	>1,000
	1536	225	7.8	18.87	495	7.30	197
	1550	285	9.9	18.76	494	7.42	79.1
	1605	345	12.0	18.76	493	7.34	55.4
	1624	405	14.1	19.23	495	7.31	53.7
8/31/11	0725	435	15.2	17.86	500	7.65	24.8
	0733	465	16.2	18.16	493	7.59	2.54
	0740 (stop pumping)	495	17.2	18.15	492	7.58	1.92

°C = Degree(s) Celsius.
µS/cm = Microsiemen(s)/centimeter (equivalent to micromhos/centimeter).
MW = Monitoring well.
NTU = Nephelometric turbidity unit(s).
OBS = Old Burn Site.
pH = Potential of hydrogen.

3.2.2 OBS-MW2 Well Development

Well development of OBS-MW2 began by bailing 45 gallons of water and sediment from the well with a stainless steel bailer/sand pump on August 29, 2011. The well was then swabbed with a surge block for approximately 15 minutes. Following this, another 45 gallons of water were bailed from the well.

After the initial 90 gallons of water were bailed from the well, an electric submersible pump was installed. The pump intake was positioned at a depth of approximately 258 feet bgs, which was approximately 4 feet below the bottom of the well screen (254 feet bgs), and an additional 295 gallons of water were pumped from the well on August 29, 2011.

On August 30, 2011, the pump intake was raised to a depth of 248 feet bgs, or 6 feet above the bottom of the screen, and an additional 105 gallons of water were pumped from the well by the

end of the day. A total of 490 gallons of water were removed from OBS-MW2 by bailing and pumping; the pumping rate averaged approximately 4.4 gpm during development.

Water quality parameters measured during the pumping phase are summarized in Table 3-5. At the conclusion of the OBS-MW2 development process, water quality parameter stabilization was achieved for temperature, SC, and pH. The final turbidity measurements on August 30, 2011, were fairly stable and ranged from 9.05 to 11.5 NTU, exceeding the target turbidity of 5 NTU (Appendix D). Well development was determined to be adequate and was discontinued after a total of 490 gallons (17.1 bore volumes) of water had been bailed and pumped from the well because, as noted, the parameters for temperature, SC, and pH were stable, and the turbidity measurement had consistently hovered near 10 NTU for the last three well volumes. Because this well was completed in a possible fault zone, additional pumping was not expected to be productive, as discussed in Variance 3 (Section 5.3).

Table 3-5
Summary of Water Quality Parameters for OBS-MW2 during Well Development

Date	Time	Total Gallons Bailed and Pumped	Number of Wellbore Volumes	Temperature (°C)	Specific Conductivity (µS/cm)	pH	Turbidity (NTU)
8/29/2011	1118 (start pumping)	120	4.2	19.74	527	6.82	62.0
	1132	175	6.1	19.99	516	7.17	30.6
	1148	235	8.2	19.97	515	7.24	35.5
	1200	295	10.3	20.07	514	7.27	30.8
	1210	340	11.8	20.01	514	7.25	25.9
8/30/11	0935	400	13.9	18.69	516	7.70	11.5
	0940	430	15	19.55	516	7.40	9.63
	0945	460	16	19.95	510	7.37	9.40
	0950 (stop pumping)	490	17.1	19.89	508	7.37	11.1

°C = Degree(s) Celsius.
µS/cm = Microsiemen(s)/centimeter (equivalent to micromhos/centimeter).
MW = Monitoring well.
NTU = Nephelometric turbidity unit(s).
OBS = Old Burn Site.
pH = Potential of hydrogen.

3.2.3 OBS-MW3 Well Development

Well development of OBS-MW3 began by bailing 35 gallons of water and sediment from the well with a stainless steel bailer/sand pump on August 29, 2011. The well was then swabbed with a surge block for approximately 35 minutes. Following this, another 145 gallons of water were bailed from the well.

After the initial 180 gallons of water were bailed from the well, an electric submersible pump was installed on August 30, 2011. The pump intake was positioned at a depth of 207 feet bgs, or 3 feet above the bottom of the screen (210 feet bgs), and an additional 255 gallons of water were pumped from the well. A total of 435 gallons (15.2 bore volumes) of water were removed from OBS-MW3 by bailing and pumping; the pumping rate averaged approximately 3.6 gpm

during development. Water quality parameters measured during the pumping phase are summarized in Table 3-6. At the conclusion of the OBS-MW3 development process, water quality parameter stabilization was achieved for temperature, SC, and pH. The final turbidity measurement (4.97 NTU) was also below the target turbidity of 5 NTU (Appendix D).

Table 3-6
Summary of Water Quality Parameters for OBS-MW3 during Well Development

Date	Time	Total Gallons Bailed and Pumped	Number of Wellbore Volumes	Temperature (°C)	Specific Conductivity (μS/cm)	pH	Turbidity (NTU)
8/30/2011	1214 (start pumping)	195	6.8	18.40	507	7.37	228
	1228	255	8.9	19.11	503	7.33	60.1
	1242	315	11	19.41	501	7.38	28.1
	1250	345	12	19.58	502	7.43	17.5
	1300	375	13.1	19.56	501	7.46	15.8
	1310	405	14.1	19.64	501	7.47	10.0
	1320 (stop pumping)	435	15.2	19.69	502	7.48	4.97

°C = Degree(s) Celsius.
μS/cm = Microsiemen(s)/centimeter (equivalent to micromhos/centimeter).
MW = Monitoring well.
NTU = Nephelometric turbidity unit(s).
OBS = Old Burn Site.
pH = Potential of hydrogen.

4.0 LAND SURVEYING

On September 15, 2011, land surveying was conducted at the monitoring well locations to determine northing and easting coordinates and precision elevations (accuracy reported to within 0.01 feet). This work was completed by registered professional surveying personnel from Surveying Control, Inc. The northing and easting coordinates are provided in New Mexico Central Zone State Plane coordinates based upon the North American Datum of 1983. The elevations are based upon the North American Vertical Datum of 1988. Well coordinate and elevation data are presented in the well construction diagrams (Appendix C).

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5.0 VARIANCES

The operating procedures cited in the characterization work plans for SWMUs 8 / 58 and SWMU 68 were implemented. Three variances occurred and are described in the following sections.

5.1 Variance 1

Variance 1 consisted of a change of locations for wells CCBA-MW1 and CCBA-MW2 from the proposed locations specified in the approved SWMU 8 / 58 Groundwater Characterization Work Plan (DOE/NNSA September 2010).

The proposed location for CCBA-MW1 (as shown on Figure B-3 of the approved work plan) was later determined to coincide with the northern edge of a designated SNL/NM Cultural Resource Area. Drilling and installing the well at the proposed location would have required driving the drilling equipment across the Cultural Resource Area, which would have damaged the resource. In addition, the proposed CCBA-MW2 location (as shown on Figure B-4 of the approved work plan) was later determined to potentially impact a nearby threatened bird species nesting area.

On April 12, 2011, SNL/NM and NMED personnel inspected the two proposed locations and selected alternate locations as suggested by SNL/NM. The location for well CCBA-MW1 was moved approximately 140 feet south-southeast of the proposed location, and the location for CCBA-MW2 was moved approximately 180 feet west of the proposed location.

On May 10, 2011, DOE/Sandia submitted a letter to the NMED formally requesting approval of the two alternate well locations as agreed to during the field visit on April 12, 2011 (DOE/NNSA May 2011). The NMED responded to the May 2011 letter on June 2, 2011, and formally approved the alternate well locations (NMED June 2011).

5.2 Variance 2

The original deadline specified in the DOE/Sandia response to the NMED letter (DOE/NNSA September 2010) required that the well installation report for SWMUs 8 / 58 and SWMU 68 be submitted by July 29, 2011 (within six months of the NMED approval of the work plans on January 28, 2011). On June 27, 2011, DOE/Sandia submitted a letter to the NMED formally requesting a 120-day extension for the deadline to complete and submit the well installation report to the NMED (DOE/NNSA June 2011). DOE/Sandia requested the deadline extension because of a delay in obtaining the site access approvals from KAFB. On August 3, 2011, the NMED approved extension of the deadline for submitting the well installation report to November 29, 2011 (NMED August 2011).

5.3 Variance 3

As discussed in Section 5.4 of the well installation work plans for SWMUs 8 / 58 and SWMU 68 (DOE/NNSA September 2010), the objective of monitoring well development was to remove a minimum of five wellbore volumes of water from each well and continue the development

process until representative water was obtained, that is, when the groundwater field parameters (pH, SC, and temperature) had stabilized and the water was visibly clear of suspended solids with a target turbidity of less than 5 NTU.

As discussed in Section 3.0, wellbore volumes ranging from 9.4 to 17.3 were bailed and/or pumped from the five wells. Parameter stabilization for temperature, SC, and pH was achieved for each well. However, the target turbidity of less than 5 NTU was attained for only four (CCBA-MW1, CCBA-MW2, OBS-MW1, and OBS-MW3) of the five wells.

After removing 13.9 wellbore volumes and producing visibly clear water, the lowest turbidity value obtained for well OBS-MW2 was 9.4 NTU. From 13.9 to 17.1 wellbore volumes, the turbidity ranged from 9.4 to 11.1 at a pumping rate averaging 4.4 gpm (Table 3-5). Because the well is screened in an extensively fractured interval section of the Sandia Formation (primarily claystone and conglomerate), additional pumping was not expected to be productive. The slightly turbid groundwater observed in this well during development is not anticipated to be detrimental to the collection of representative groundwater samples because the sampling procedure will be conducted at a much lower rate of approximately 1 liter per minute.

6.0 REFERENCES

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New Mexico Environment Department (NMED), April 2010. "Class 3 Permit Modification Requests For Granting Corrective Action Complete Status For 26 SWMUs/AOCs (Request of March 1, 2006), and 5 Other SWMUs/AOCs (Request of January 7, 2008), Sandia National Laboratories, EPA # NM5890110518, HWB-SNL-06-007 and HWB-SNL-08-001," New Mexico Environment Department, Santa Fe, New Mexico. April 8, 2010.

New Mexico Environment Department (NMED), January 2011. "Notice of Approval with Modifications: Groundwater Monitoring Well Installation Workplans for SWMUs 8/58 and 68, September 2010, Sandia National Laboratories, EPA # NM5890110518, HWB-SNL-010-017," New Mexico Environment Department, Santa Fe, New Mexico. January 28, 2011.

New Mexico Environment Department (NMED), June 2011. "Approval: Solid Waste Management Units 8 / 58, Proposed Groundwater Monitoring Well Location Adjustment, May 10, 2011, Sandia National Laboratories, EPA # NM5890110518, HWB-SNL-10-017," New Mexico Environment Department, Santa Fe, New Mexico. June 2, 2011.

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U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA), March 2006. Letter from P. Wagner (U.S. Department of Energy) to J. Bearzi (New Mexico Environment Department), “Notification of a Request for a Class 3 Permit Modification to the Hazardous and Solid Waste Amendments Module of the Resource Conservation and Recovery Act Permit, No Further Action Approved Determinations,” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. March 1, 2006.

U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA), January 2008. Letter from P. Wagner (U.S. Department of Energy) to J. Bearzi (New Mexico Environment Department), “Notification of a Request for a Class 3 Permit Modification to the Hazardous and Solid Waste Amendments Module of the Resource Conservation and Recovery Act Permit, No Further Action Approved Determinations,” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. January 7, 2008.

U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA), September 2010. Letter from P. Wagner (U.S. Department of Energy) to J. Bearzi (New Mexico Environment Department), “SWMU 68 and SWMUs 8/58 Groundwater Characterization Work Plans – U.S. Department of Energy/Sandia Corporation Response to the New Mexico Environment Department letter of April 8, 2010 entitled, *Class 3 Permit Modification Requests for Granting Corrective Action Complete Status for 26 SWMUs/AOCs (Request of March 1, 2006) and 5 Other SWMUs/AOCs (Request of January 7, 2008), Sandia National Laboratories, EPA # NM5890110518, HWB-SNL-06-007 AND HWB-SNL-08-001,*” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. September 23, 2010.

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APPENDIX A
Lithologic Logs for Groundwater Monitoring Wells CCBA-MW1, CCBA-MW2, OBS-MW1, OBS-MW2, and OBS-MW3

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: CCBA-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMUs 8 and 58 (Coyote Canyon Blast Area)	
WELL DEPTH: 85 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/12/11
GROUND ELEVATION: 5899.89 FT AMSL	GWL: 5854.61 FT AMSL (9/13/11)	DATE COMPLETED: 8/13/11
BOREHOLE DEPTH: 90 FT BGS	DTW: 45.28 FT BGS (9/13/11)	WELL COMPLETED: 9/1/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 1 of 2
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
0	0'-20': GW, Poorly sorted gravel, light brown, 10% silt and clay, 30% fine sand to pebbles, 60% gravel to 1-inch diameter, subangular to subrounded, derived from granitic and metamorphic rocks. Dry. Unpaved area.		GW	Not video logged because drive casing was run to total depth in alluvium. Numerous cobbles scattered on nearby ground surface consist of quartzite (whitish grey to light purple), granite (pink), and greenstone (dark green).
20	20'-40': SW, Poorly sorted sand, light brown, 20% silt and clay, 10% fine to medium sand, 50% coarse sand to pebbles, 20% gravel to 0.75-inch diameter, subangular to subrounded, primarily derived from granitic and metamorphic rocks, secondarily limestone. Dry.		SW	
40	40'-50': SW, Poorly sorted sand, light brown, 20% silt and clay, 10% fine to medium sand, 50% coarse sand to pebbles, 20% gravel to 1.5-inch diameter, subangular to subrounded, primarily derived from granitic and metamorphic rocks, secondarily from limestone. Very slightly damp.		SW	
50				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Unconsolidated Alluvium
Borehole Diameter: 9.625 inches from 0-92 ft bgs

Elevation: Ground surface 5899.89 ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1456510.33 Easting: 1575293.87

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: CCBA-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMUs 8 and 58 (Coyote Canyon Blast Area)	
WELL DEPTH: 85 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/12/11
GROUND ELEVATION: 5899.89 FT AMSL	GWL: 5854.61 FT AMSL (9/13/11)	DATE COMPLETED: 8/13/11
BOREHOLE DEPTH: 90 FT BGS	DTW: 45.28 FT BGS (9/13/11)	WELL COMPLETED: 9/1/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 2 of 2
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
50	50'-55': SW, Poorly sorted sand, SW, light brown, 30% silt and clay, 70% fine sand to pebbles up to 0.25-inch diameter, subangular to subrounded, derived from granitic rocks and minor greenstone. No gravel. Damp.		SW	
	55'-62': SW, Same as above.		SW	
60				
	62'-75': SW, Poorly sorted sand, SW, 10% silt and clay, 60% fine sand to pebbles of granite, claystone, and limestone, and 30% cobble fragments up to 2-inch diameter composed of pink granite and quartzite (light grey and purple). Poor amount of returns. First indication of groundwater. Wet cuttings.		SW	
70				
	75'-80': Poorly sorted gravel, GW, 20% silt and clay, 40% fine sand to pebbles composed of granite, claystone, metamorphic, and limestone; 40% gravels up to 1-inch diameter composed of quartzite, red metavolcanics, and greenstone, subangular to angular fragments. Hard drilling probably in cobbles with much sloughing. Erratic returns. Making fair amount of groundwater.		GW	
80				
	80'-92': GW, Same as above except gravels up to 0.75-inch diameter. Hard drilling probably in cobbles with much sloughing. Making fair amount of groundwater.		GW	
90				
	92': GW, Borehole total depth. Same as above. Drilled entire borehole with tricone bit. Possibly encountered weathered quartzite bedrock.			
100				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Unconsolidated Alluvium
Borehole Diameter: 9.625 inches from 0-92 ft bgs

Elevation: Ground surface 5899.89 ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1456510.33 Easting: 1575293.87

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: CCBA-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMUs 8 and 58 (Coyote Canyon Blast Area)	
WELL DEPTH: 123 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/14/11
GROUND ELEVATION: 5936.95 FT AMSL	GWL: 5867.91 FT AMSL	DATE COMPLETED: 8/15/11
BOREHOLE DEPTH: 123 FT BGS	DTW: 69.04 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 1 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
0	0'-15': SW, Poorly sorted sand, SW, light brown, 30% silt and clay, 50% fine sand to pebbles, 20% gravel to 0.5-inch diameter, subangular to subrounded, derived from granitic and metamorphic rocks. Dry. Unpaved area.		SW	Drive Casing
15	15'-22': GW, Poorly sorted gravel, light brown, 20% silt and clay, 30% fine sand to pebbles, 50% gravel to 0.75-inch diameter composed mostly of greenstone and some quartzite. Dry.		GW	
20	22'-30': GW, Poorly sorted gravel, light brown, 20% silt and clay, 30% fine sand to pebbles, 50% gravel to 1.5-inch diameter, subangular to subrounded, derived from granitic and metamorphic rocks. Dry.		GW	
25				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

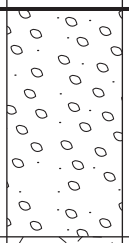
Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite, Granitic Gneiss
Borehole Diameter: 9.625 inches from 0-41 ft bgs
8.5 from 41-123 ft bgs

Elevation: Ground surface 5936.95 ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1457831.88 Easting: 1575881.78

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: CCBA-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMUs 8 and 58 (Coyote Canyon Blast Area)	
WELL DEPTH: 123 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/14/11
GROUND ELEVATION: 5936.95 FT AMSL	GWL: 5867.91 FT AMSL	DATE COMPLETED: 8/15/11
BOREHOLE DEPTH: 123 FT BGS	DTW: 69.04 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 2 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
25				
30	30'-36': Contact pink granite. Granite contains much chlorite, fragments up to 0.25-inch diameter. Hard drilling. Dry.			
35				
	36'-40': Very hard drilling.			Lower end of drive casing. Chlorite-rich pink granite, vertical fractures in granite, dry, 38 to 41 ft.
40	40'-41': Pink granite, fragments up to 0.375-inch diameter, (quartz, microcline and plagioclase feldspars, much chlorite). Dry.			
	41'-49': Very hard drilling requires change from tricone bit to button bit.			Smooth borehole in granite.
45				
	49'-57'			Smooth borehole in granite. Vertical fracture 49 to 54 ft, 55 to 57, dry.
50				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite, Granitic Gneiss
Borehole Diameter: 9.625 inches from 0-41 ft bgs
8.5 from 41-123 ft bgs

Elevation: Ground surface 5936.95 ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1457831.88 Easting: 1575881.78

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: CCBA-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Wells, SWMUs 8 and 58 (Coyote Canyon Blast Area)	
WELL DEPTH: 123 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/14/11
GROUND ELEVATION: 5936.95 FT AMSL	GWL: 5867.91 FT AMSL	DATE COMPLETED: 8/15/11
BOREHOLE DEPTH: 123 FT BGS	DTW: 69.04 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 3 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
50				
55				
	57'-60'			Smooth borehole in granite.
60	60'-61': Pink granite, fragments up to 0.5-inch diameter, (quartz, microcline and plagioclase feldspars, minor chlorite, olivine/pyroxene, biotite/hornblende). Dry.			
	61'-67'			Vertical fracture, iron stained, dry.
65				
	67'-68'			Horizontal series of fractures in granite.
	68'-69'			Smooth borehole in granite
	69'-74'			Slightly cloudy water at 69'. Vertical visibility of 1 to 2 ft. [Water at this depth does not correspond to an adjacent water-bearing zone. This is the depth to which water has risen in the 2 hours since drilling stopped.]
70				
	74'-78'			Smooth borehole in granite
75				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite, Granitic Gneiss
Borehole Diameter: 9.625 inches from 0-41 ft bgs
8.5 from 41-123 ft bgs

Elevation: Ground surface 5936.95 ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1457831.88 Easting: 1575881.78

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: CCBA-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Wells, SWMUs 8 and 58 (Coyote Canyon Blast Area)	
WELL DEPTH: 123 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/14/11
GROUND ELEVATION: 5936.95 FT AMSL	GWL: 5867.91 FT AMSL	DATE COMPLETED: 8/15/11
BOREHOLE DEPTH: 123 FT BGS	DTW: 69.04 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 4 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
75				
	78'-80'			Possible horizontal fracture. Vertical visibility of 1 ft.
80	80'-83'			Start of rough-jagged borehole wall in granite
	83'-85'			Possible vertical fracture 83 to 84 ft
85	85'-86':Pink granite and mottled reddish black gneiss fragments up to 0.375-inch diameter.			
	86'-90'			Vertical fracture 86 to 88 ft
90	90'-93': Easier drilling in granite and gneiss (faster penetration rate). Fragments up to 0.5-inch diameter. Dry.			
	93'-95':			
95	99'-100':			Pause lowering camera. Rock particles dislodged by camera cable settle downward and are not disrupted by flowing water. Vertical visibility of 1 ft.
100				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

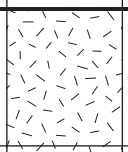
Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite, Granitic Gneiss
Borehole Diameter: 9.625 inches from 0-41 ft bgs
8.5 from 41-123 ft bgs

Elevation: Ground surface 5936.95 ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1457831.88 Easting: 1575881.78

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: CCBA-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Wells, SWMUs 8 and 58 (Coyote Canyon Blast Area)	
WELL DEPTH: 123 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/14/11
GROUND ELEVATION: 5936.95 FT AMSL	GWL: 5867.91 FT AMSL	DATE COMPLETED: 8/15/11
BOREHOLE DEPTH: 123 FT BGS	DTW: 69.04 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 5 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
100	100'-103': Consistent drilling rate in granite and gneiss. First indication of groundwater. Fair amount of groundwater into hopper.			Smooth borehole wall in granite. Vertical visibility about 1 ft.
	103'-105': Hard drilling in granite and gneiss. Fair amount of water into hopper.			
105	105'-106': Granite and gneiss fragments up to 0.5-inch diameter. Fair amount of water into hopper.			Cloudy water.
	106'-110'			Smooth borehole in granite. Visibility poor but no obvious fractures.
110	110'-113'			
	113'-115'			Smooth borehole in granite. Pause lowering camera. Rock particles dislodged by camera cable settle downward and are not disrupted by flowing water. Vertical visibility of 1 ft.
115	115'-117': Easier drilling in granite and gneiss (faster penetration rate). Fair amount of water in to hopper.			Cloudy water.
	117'-122': Hard drilling in granite and gneiss. Fair amount of water in to hopper.			Cloudy water.
120	122'-123': Hard drilling in granite and gneiss. Fair amount of water in to hopper.			Smooth borehole in granite.
	123':Borehole total depth.			Vertical fracture in granite. No slough.
125				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

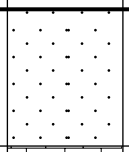
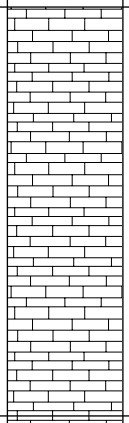
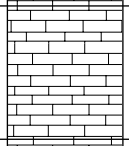
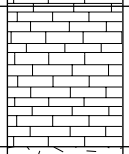
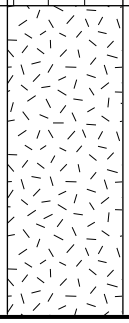
Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite, Granitic Gneiss
Borehole Diameter: 9.625 inches from 0-41 ft bgs
8.5 from 41-123 ft bgs

Elevation: Ground surface 5936.95 ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1457831.88 Easting: 1575881.78

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 160 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/08/11
GROUND ELEVATION: 5869.08 FT AMSL	GWL: 5799.38 FT AMSL (9/13/11)	DATE COMPLETED: 8/09/11
BOREHOLE DEPTH: 165 FT BGS	DTW: 69.7 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 1 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
0	0'-3': SW, Poorly sorted sand, dry, moderately yellowish brown, 10YR 5/4, 20% clay and silt, 70% fine to coarse sand, 10% pebbly sand up to 0.25-inch diameter derived from granitic rocks, occasional limestone gravel. Unpaved area.		SW	Drive casing.
5	3'-12': Top of bedrock. Probable Sandia Formation with mostly limestone fragments and occasional quartz pebbles, dry.			
10				
15	12'-15': Mostly limestone fragments (grey, up to 0.25-inch diameter), minor claystone pieces (yellowish brown, up to 0.25-inch diameter), occasional quartzite pebbles (grayish white, subrounded, up to 0.5-inch diameter). Dry.			Lower end of drive casing. Weathered limestone and conglomerate.
	15'-18': Hard drilling, limestone, dry.			Dense limestone with calcite veins (mostly vertical) from 15 to 18 ft.
20	18'-25': Contact. Pink granite, dry.			Top of pink granite, smooth borehole.
25				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-165 ft bgs

Elevation: Ground Surface 5869.08, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440544.62 Easting: 1573586.47

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 160 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/08/11
GROUND ELEVATION: 5869.08 FT AMSL	GWL: 5799.38 FT AMSL (9/13/11)	DATE COMPLETED: 8/09/11
BOREHOLE DEPTH: 165 FT BGS	DTW: 69.7 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 2 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
25	25'-30': Pink granite, fragments to 0.5-inch diameter (quartz, microcline and plagioclase feldspars, much chlorite), dry.			Granite speckled with chlorite. Smooth borehole.
30	30'-37'			Granite speckled with chlorite.
35				
	37'-40'			Small vertical fractures in granite from 37 to 38 ft.
40	40'-58' Pink granite fragments to 0.125-inch diameter, dry.			
45				
50				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-165 ft bgs

Elevation: Ground Surface 5869.08, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440544.62 Easting: 1573586.47

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 160 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/08/11
GROUND ELEVATION: 5869.08 FT AMSL	GWL: 5799.38 FT AMSL (9/13/11)	DATE COMPLETED: 8/09/11
BOREHOLE DEPTH: 165 FT BGS	DTW: 69.7 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 3 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
50				
55				
	58'-59'			Near vertical fracture, closed, from 58 to 59 ft.
	59'-60'			No fractures, smooth borehole.
60	60'-63': Pink granite fragments to 0.25-inch diameter, dry.			
	63'-65'			Two vertical fractures, closed, from 63 to 65 ft.
65	65'-68'			No fracture
				Scum (from biodegradable oil-downhole hammer) floating on placid water at 68'. [Water at this depth does not correspond to an adjacent water-bearing zone. This is the depth to which water has risen in the 16 hours since drilling stopped.]
	68'-70'			
70	70'-71'			Fairly clear water but scum sticks to camera lens.
	71'-80'			Poor visibility, cloudy water, water not visibly flowing.
75				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-165 ft bgs

Elevation: Ground Surface 5869.08, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440544.62 Easting: 1573586.47

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 160 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/08/11
GROUND ELEVATION: 5869.08 FT AMSL	GWL: 5799.38 FT AMSL (9/13/11)	DATE COMPLETED: 8/09/11
BOREHOLE DEPTH: 165 FT BGS	DTW: 69.7 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 4 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
75				
80	80'-84' Pink granite fragments to 0.25-inch diameter, dry.			
85	84'-100'			Smooth borehole wall in granite, cloudy water with 1 ft visibility, pause to pan and tilt camera lens.
90				
95				
100				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-165 ft bgs

Elevation: Ground Surface 5869.08, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440544.62 Easting: 1573586.47

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 160 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/08/11
GROUND ELEVATION: 5869.08 FT AMSL	GWL: 5799.38 FT AMSL (9/13/11)	DATE COMPLETED: 8/09/11
BOREHOLE DEPTH: 165 FT BGS	DTW: 69.7 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 5 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
100	100'-101':Pink granite fragments to 0.25-inch diameter, dry.			
	101'-125'			Smooth borehole wall in granite, cloudy water. Pause to pan and tilt camera lens; water not visibly flowing.
105				
110				
115				
120				
125				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-165 ft bgs

Elevation: Ground Surface 5869.08, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440544.62 Easting: 1573586.47

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 160 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/08/11
GROUND ELEVATION: 5869.08 FT AMSL	GWL: 5799.38 FT AMSL (9/13/11)	DATE COMPLETED: 8/09/11
BOREHOLE DEPTH: 165 FT BGS	DTW: 69.7 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 6 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
125	125'-130': Pink granite fragments to 0.25-inch diameter, slightly damp.			
130	130'-132': Pink granite fragments to 0.25-inch diameter, wet cuttings. Slight amount of water into hopper. Faster drilling. Pink granite fragments to 0.25-inch diameter, dry.			Smooth borehole wall in granite, poor visibility. Water not visibly flowing.
	132'-135': Pink granite fragments to 0.25-inch diameter, dry.			
135	135'-140': First indication of significant groundwater. Fair amount of water into hopper.			Smooth borehole wall in granite, poor visibility. Water not visibly flowing.
140	140'-145'			Smooth borehole wall in granite, poor visibility. Pause to pan and tilt cameras; water not visibly flowing.
145	145'-155': Good amount of water into hopper. No petroleum odors or sheen.			
150				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-165 ft bgs

Elevation: Ground Surface 5869.08, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440544.62 Easting: 1573586.47

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW1	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 160 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/08/11
GROUND ELEVATION: 5869.08 FT AMSL	GWL: 5799.38 FT AMSL (9/13/11)	DATE COMPLETED: 8/09/11
BOREHOLE DEPTH: 165 FT BGS	DTW: 69.7 FT BGS (9/13/11)	WELL COMPLETED: 8/31/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 7 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
150				
155	155'-160': Pink granite fragments to 0.75-inch diameter, good amount of groundwater into hopper, mostly clear.			
160	160'-161'			Poor visibility. Water not visibly flowing.
	161'-165'			Slough, lower limit of video logging.
165	165': Pink granite fragments to 0.375-inch diameter, good amount of groundwater, mostly clear. Borehole total depth.			
170				
175				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-165 ft bgs

Elevation: Ground Surface 5869.08, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440544.62 Easting: 1573586.47

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 259 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/03/11
GROUND ELEVATION: 5860.75 FT AMSL	GWL: 5685.12 FT AMSL (9/13/11)	DATE COMPLETED: 8/04/11
BOREHOLE DEPTH: 325 FT BGS	DTW: 175.63 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 1 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
0	0'-3': Poorly sorted sand, SW, moderately yellowish brown, 10YR 5/4, 30% clay and silt, 70% fine to coarse sand, derived from granitic rocks. Dry. Unpaved area.		SW	Drive casing.
	3'-10': Contact 3', probable Madera Formation. Bedrock composed of 90% limestone fragments up to 0.5-inch diameter, medium light grey, with approximately 10% rose-colored chert up to 0.25-inch diameter. Dry. Moderately hard drilling.			Lower end of drive casing at 3'. Weathered limestone.
10	10'-15'			Weathered limestone.
	15'-35':			Smooth borehole in limestone, calcite veins nearly vertical.
20				
30				
	35'-41':Limestone fragments up to 0.25-inch diameter, dry.			
40	41'-43'			Fracture zone in limestone, 41 to 42 ft.
	43'-46'			Smooth borehole in limestone.
	46'-51': Limestone fragments up to 0.25-inch diameter, dry.			
50				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

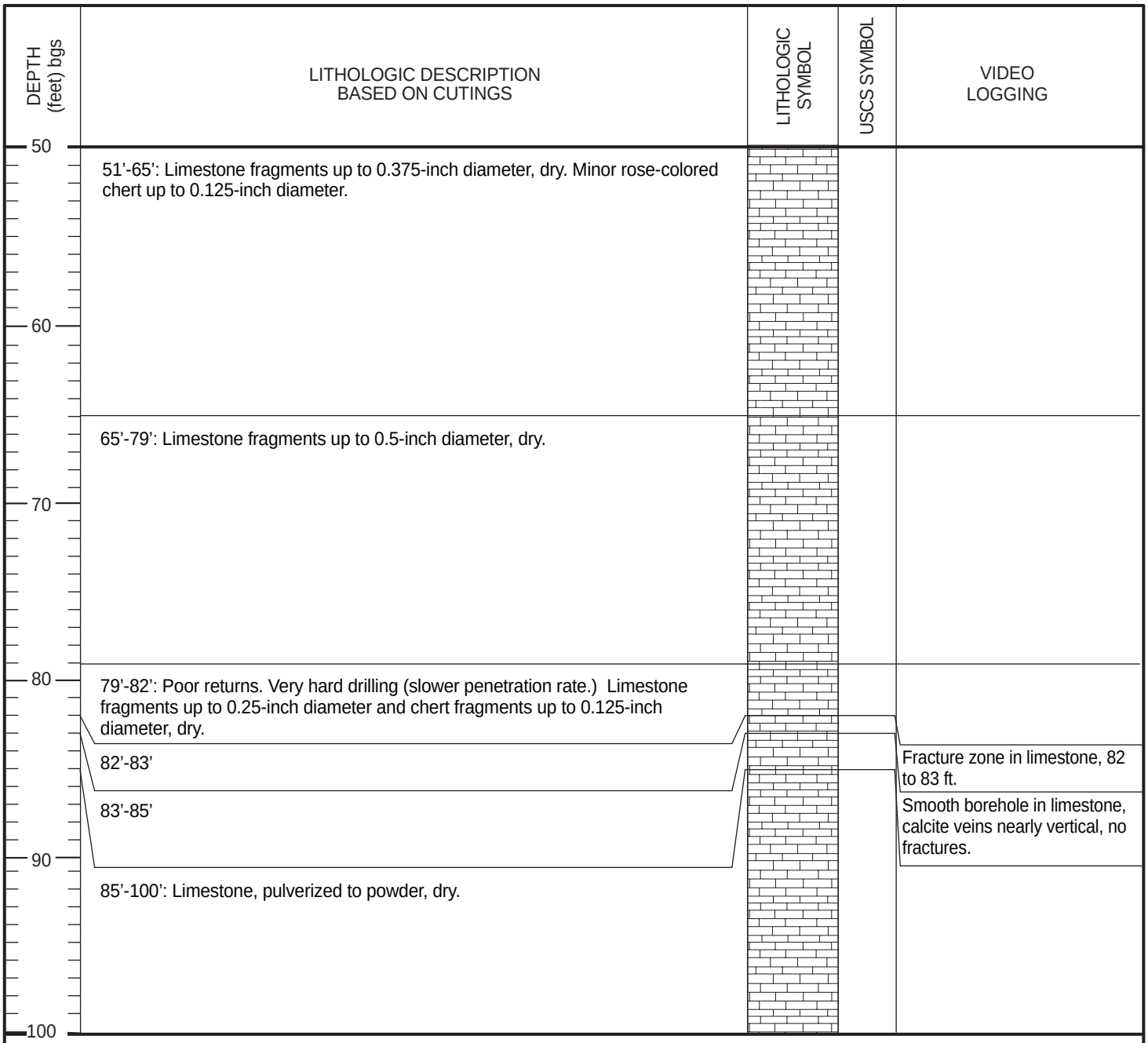
Drilling Contractor: WDC Exploration and Wells
Completion Formation: Sandia Formation
Borehole Diameter: 8.5 inches from 0-325 ft bgs

Elevation: Ground surface 5860.75, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440379.22 Easting: 1573323.37

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 259 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/03/11
GROUND ELEVATION: 5860.75 FT AMSL	GWL: 5685.12 FT AMSL (9/13/11)	DATE COMPLETED: 8/04/11
BOREHOLE DEPTH: 325 FT BGS	DTW: 175.63 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 2 of 7
DRILLING METHOD: Air Rotary Casing Hammer		PAGE: Mike Sanders



NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Sandia Formation
Borehole Diameter: 8.5 inches from 0-325 ft bgs

Elevation: Ground surface 5860.75, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440379.22 Easting: 1573323.37

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 259 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/03/11
GROUND ELEVATION: 5860.75 FT AMSL	GWL: 5685.12 FT AMSL (9/13/11)	DATE COMPLETED: 8/04/11
BOREHOLE DEPTH: 325 FT BGS	DTW: 175.63 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 3 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDIO LOGGING
100	100'-145': Limestone fragments up to 0.5-inch diameter, dry.			
110				
120				
130				
140				
150	145'-165': Limestone fragments up to 0.5-inch diameter, minor chert fragments up to 0.125-inch diameter, dry. No petroleum odors or stains.			

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Sandia Formation
Borehole Diameter: 8.5 inches from 0-325 ft bgs

Elevation: Ground surface 5860.75, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440379.22 Easting: 1573323.37

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 259 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/03/11
GROUND ELEVATION: 5860.75 FT AMSL	GWL: 5685.12 FT AMSL (9/13/11)	DATE COMPLETED: 8/04/11
BOREHOLE DEPTH: 325 FT BGS	DTW: 175.63 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 4 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
150				
160				
	165'-182': Limestone fragments up to 0.5-inch diameter, dry.			
170				
180				
	182'-184'			Water at 182', no fractures. [Water at this depth does not correspond to an adjacent water-bearing zone. This is the depth to which water has risen in the 15 hours since drilling stopped.]
190	184'-190': Contact at 184' (based on video log) with probable Sandia Formation. Silty medium-grained sandstone, medium brown, dry.			
	190'-205': 50% limestone fragments (medium light grey, N6) up to 0.25-inch diameter, 45% medium-grained sandstone (pale yellowish brown, 10 Y/R 6/2), and 5% claystone (dark yellowish orange 10YR 6/6), very slightly damp. Start to lose circulation at 205'.			
200				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Sandia Formation
Borehole Diameter: 8.5 inches from 0-325 ft bgs

Elevation: Ground surface 5860.75, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440379.22 Easting: 1573323.37

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 259 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/03/11
GROUND ELEVATION: 5860.75 FT AMSL	GWL: 5685.12 FT AMSL (9/13/11)	DATE COMPLETED: 8/04/11
BOREHOLE DEPTH: 325 FT BGS	DTW: 175.63 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 5 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
200				
	205'-240': No returns			
210				
220				
230				
240	240'-251'			Cloudy (dark brown) water, flowing vigorously. (240'-251') Pause to pan and tilt camera, borehole wall not visible.
250				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Sandia Formation
Borehole Diameter: 8.5 inches from 0-325 ft bgs

Elevation: Ground surface 5860.75, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440379.22 Easting: 1573323.37

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 259 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/03/11
GROUND ELEVATION: 5860.75 FT AMSL	GWL: 5685.12 FT AMSL (9/13/11)	DATE COMPLETED: 8/04/11
BOREHOLE DEPTH: 325 FT BGS	DTW: 175.63 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 6 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
250				
	251'-254'			Water clearing, possible carbonation bubbles in flowing water
	254'-305': No returns.			Slough, lower limit of video logging at 254'.
260				
270				
280				
290				
300				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Sandia Formation
Borehole Diameter: 8.5 inches from 0-325 ft bgs

Elevation: Ground surface 5860.75, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440379.22 Easting: 1573323.37

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW2	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 259 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/03/11
GROUND ELEVATION: 5860.75 FT AMSL	GWL: 5685.12 FT AMSL (9/13/11)	DATE COMPLETED: 8/04/11
BOREHOLE DEPTH: 325 FT BGS	DTW: 175.63 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 7 of 7
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDIO LOGGING
300				
310	305'-325': Start getting returns of granite. Wet cuttings are first indication of groundwater. Pink granite fragments (quartz, microcline and plagioclase feldspars), up to 0.25-inch diameter. Fair amount of groundwater into hopper.			
320				
330	325': Pink granite fragments up to 0.25-inch diameter and single piece of grey schist (0.25-thick and silver-dollar size). Fair amount of groundwater into hopper, water much less cloudy after filling four hoppers. Borehole total depth.			
340				
350				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Sandia Formation
Borehole Diameter: 8.5 inches from 0-325 ft bgs

Elevation: Ground surface 5860.75, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440379.22 Easting: 1573323.37

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW3	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 215 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/09/11
GROUND ELEVATION: 5863.31 FT AMSL	GWL: 5796.06 FT AMSL (9/13/11)	DATE COMPLETED: 8/10/11
BOREHOLE DEPTH: 225 FT BGS	DTW: 67.25 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 1 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
0	0'-2': Silty gravelly sand, GM, moderately yellowish brown, 10YR 5/4, 30% clay and silt, 50% fine to coarse sand, derived from granitic rocks and 20% limestone gravel up to 0.5-inch diameter. Dry. Unpaved area.		GM	Drive casing.
	2'-10': Contact at 2'. Probable Madera Formation. Limestone fragments up to 1-inch diameter, medium light grey, with approximately 10% rose-colored chert up to 0.25-inch diameter. Dry. Moderately hard drilling.			Lower end of drive casing at 6 ft. Weathered limestone to 9 ft.
10	10'-20': Limestone fragments up to 0.75-inch diameter, dry.			Smooth borehole in limestone, calcite veins nearly vertical.
20	20'-25'			Smooth borehole in limestone, calcite veins, nearly vertical.
30	25'-36': Limestone fragments up to 0.5-inch diameter, dry.			
40	36'-43'			Smooth borehole in limestone, calcite veins, nearly vertical.
	43'-45'			Smooth borehole in limestone, calcite veins, nearly vertical.
50	45'-63': Limestone fragments up to 0.5-inch diameter, dry.			

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-225 ft bgs

Elevation: Ground Surface 5863.31, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440543.54 Easting: 1573352.54

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW3	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 215 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/09/11
GROUND ELEVATION: 5863.31 FT AMSL	GWL: 5796.06 FT AMSL (9/13/11)	DATE COMPLETED: 8/10/11
BOREHOLE DEPTH: 225 FT BGS	DTW: 67.25 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 2 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
50				
60				
	63'-65'			Smooth borehole in limestone, numerous calcite veins, nearly vertical.
	65'-83': Limestone fragments up to 0.5-inch diameter, dry.			
70				
80				
	83'-84'			Smooth borehole in limestone, calcite veins, nearly vertical.
	84'-87'			Vertical, approximately 0.5" wide, open fracture in limestone, dry, 84 to 87 ft.
90	87'-102': Limestone fragments up to 0.25-inch diameter, dry.			Smooth borehole in limestone, calcite veins, nearly vertical.
100				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-225 ft bgs

Elevation: Ground Surface 5863.31, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440543.54 Easting: 1573352.54

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW3	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 215 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/09/11
GROUND ELEVATION: 5863.31 FT AMSL	GWL: 5796.06 FT AMSL (9/13/11)	DATE COMPLETED: 8/10/11
BOREHOLE DEPTH: 225 FT BGS	DTW: 67.25 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 3 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
100				
	102'-105': Contact. Top of conglomerate based on video log.			Top of conglomerate @ 102'.
	105'-110': Probable Sandia Formation. Coarse sandtone derived from granitic rocks and fragments of dark green to yellowish brown claystone, and grey limestone fragments up to 0.5-inch diameter with calcite veins.			
110	110'-114': Fine-grain black material composed of either coal or black shale. Interval possibly about 1 ft thick with claystone.			
	114'-115': Top of limestone at 114'. Very hard drilling. Dry.			Smooth borehole in limestone, calcite veins, nearly vertical
	115'-120':Yellowish claystone fragments up to 0.25-inch diameter and light greenish quartzite pebbles up to 0.25-inch diameter, rounded.			
120	120'-125': Contact. Pink granite.			Pink granite, no fractures
	125'-132': Pink granite fragments up to 0.25-inch diameter, mostly dry powder.			
130	132'-135'			Smooth borehole in granite
	135'-136'			Closed vertical fractures in granite
	136'-140'			Vertical fracture in granite, 136 to 137 ft
140	140'-144': Pink granite fragments up to 0.25-inch, dry.			
	144'-145'			Smooth borehole in granite
	145'-161': Pink granite fragments up to 0.75-inch, dry.			
150				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-225 ft bgs

Elevation: Ground Surface 5863.31, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440543.54 Easting: 1573352.54

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW3	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 215 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/09/11
GROUND ELEVATION: 5863.31 FT AMSL	GWL: 5796.06 FT AMSL (9/13/11)	DATE COMPLETED: 8/10/11
BOREHOLE DEPTH: 225 FT BGS	DTW: 67.25 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 4 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
150				
160	161'-165'			Smooth borehole in granite
	165'-170': Granite, dry, composed of quartz, microcline and plagioclase feldspars, minor mafic minerals.			
170	170'-179'			Closed vertical fracture along smooth borehole wall in granite
180	179'-180'			Horizontal fractures in granite
	180'-184'			Water at 180 ft, slightly cloudy. [Water at this depth does not correspond to an adjacent water-bearing zone. This is the depth to which water has risen in the 3 hours since drilling stopped.]
	184'-185'			Horizontal fractures in granite, 184' to 185'
190	185'-186': Pink granite. Softer granite (faster penetration rate), dry.			
	186'-190'			Water, moderately cloudy
	190'-202': Slightly softer granite (increased penetration rate). Damp cuttings. First indication of groundwater. Stop drilling and pull bit 20 ft off bottom. Wait 1 hour. Produce about 80 gallons of water while air lifting (and clearing hole from 185 to 202 ft) for 20 minutes.			
200				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-225 ft bgs

Elevation: Ground Surface 5863.31, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440543.54 Easting: 1573352.54

Sandia National Laboratories

Visual Classification of Soils

WELL NAME: OBS-MW3	PROJECT NAME: SNL/NM Groundwater Monitoring Well, SWMU 68 (Old Burn Site)	
WELL DEPTH: 215 FT BGS	OWNER NAME: U.S. DOE	DATE STARTED: 8/09/11
GROUND ELEVATION: 5863.31 FT AMSL	GWL: 5796.06 FT AMSL (9/13/11)	DATE COMPLETED: 8/10/11
BOREHOLE DEPTH: 225 FT BGS	DTW: 67.25 FT BGS (9/13/11)	WELL COMPLETED: 8/30/11
LOWEST SAMPLING DEPTH: NA*	GEOLOGIST: John Copland	PAGE: 5 of 5
DRILLING METHOD: Air Rotary Casing Hammer		REVIEWER: Mike Sanders

DEPTH (feet) bgs	LITHOLOGIC DESCRIPTION BASED ON CUTINGS	LITHOLOGIC SYMBOL	USCS SYMBOL	VIDEO LOGGING
200				
	202'-205':			Water, moderately cloudy. Limit of video logging at 202'.
	205'-225': Resumed drilling after video logging. Pink granite (penetration rate same as 190 ft).			
210				
220				
	225': Borehole total depth, granite, making water.			
230				
240				
250				

NOTES: No petroleum odors, stains or sheens observed in cutting or air lifted groundwater.
*No samples submitted for chemical analysis.

Drilling Contractor: WDC Exploration and Wells
Completion Formation: Precambrian Granite
Borehole Diameter: 8.5 inches from 0-225 ft bgs

Elevation: Ground Surface 5863.31, ft amsl, NAVD 88
Coordinate System: SPC NM Central NAD 83
Northing: 1440543.54 Easting: 1573352.54

APPENDIX B
Well Construction Data Sheets for CCBA-MW1, CCBA-MW2, OBS-MW1, OBS-MW2, and OBS-MW3

Well Data for CCBA-MW1
Coyote Canyon Blast Area (SWMUs 8 / 58), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
1. Well name/number	CCBA-MW1
2. Date of well construction	Installation completed on 8/14/2011. Development completed on 9/1/2011.
3. Drilling method	ARCH, one air compressor (350 psi at 1,170 cfm)
4. Drilling contractor and name of driller	WDC Exploration and Wells Inc., John Chaves. GEFCo Speed Star 50K-CH, serial number 907639
5. Borehole diameter and well casing diameter	Borehole: 9.625 inches from 0 to 90 ft bgs
	Well casing: 5.5 inches OD, 4.7 inches ID
6. Well depth	85 ft bgs
7. Casing length	Approximately 87.5 ft total (top of well casing approx. 2.5 ft above ground surface [above-grade well completion])
8. Casing materials	Well casing: Campbell™ Monoflex® Schedule 80 PVC. Centralizers: kwik-ZIP® thermoplastic resin model 155 HT-D. Bow height of 1.1875 inches.
9. Casing and screen joint type	Flush-threaded, 2 threads per inch, o-rings
10. Screened interval(s)	60 to 80 ft bgs
11. Screen materials	Campbell™ Monoflex® Schedule 80 PVC
12. Screen slot size and design	0.020-inch slotted screen
13. Filter pack material and gradation	Primary: Carmeuse® CSS #10-20
	Secondary: Carmeuse® CSS #60
14. Filter pack volume (calculated and actual)[b]	Calculated: 14.5 ft^3
	Actual: 61 ft^3
15. Filter pack placement method	Gravity feed through drive casing
16. Filter pack interval(s)	Primary: 55 to 88 ft bgs
	Secondary: 50 to 55 ft bgs
17. Annular sealant composition	PDS Bentonite Plug (3/8-inch grade bentonite chips)
18. Annular sealant placement method	Gravity feed into annulus and subsequently hydrated with water gravity fed into drive casing.
19. Annular sealant volume (calculated and actual)	Calculated: Chips: 18.6 ft^3
	Actual: Chips: 20.8 ft^3
20. Annular sealant interval(s)	Chips: 1 to 50 ft bgs
21. Surface sealant composition	Quikrete® concrete
22. Surface seal placement method	Gravity fed into annulus
23. Surface sealant volume (calculated and actual)	Calculated: 0.4 ft^3
	Actual: not recorded, poured concrete 0 to 1 ft bgs
24. Surface sealant interval	Ground surface to 1 ft bgs
25. Surface seal and well apron design and construction	3- by 3-ft by 6-inch-thick concrete pad
26. Well development procedure and turbidity measurements	Bail, surge, submersible pump (see Appendix D for turbidity measurements)

Refer to footnotes at end of table.

Well Data for CCBA-MW1 (Concluded)
Coyote Canyon Blast Area (SWMUs 8 / 58), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
27. Well development purge volume(s) and stabilization parameter measurements	Total of 615 gallons (see Appendix D for field parameter measurements)
28. Type and design and construction of protective casing	10-ft length of 8.625-inch-diameter steel casing with hinged cap (7 ft bgs and 3 ft above ground surface)
29. Well cap and lock	Royer Inc. aluminum locking well cap and padlock. Three steel bollards.
30. Ground surface elevation[c]	5899.89 ft amsl
31. Survey reference point elevation on well casing[c]	5902.34 ft amsl
32. Top of monitoring well casing elevation[c]	5902.34 ft amsl
33. Top of protective steel casing elevation[c]	5902.90 ft amsl
34. Name of geologist	John R. Copland
35. Initial water level	45.28 ft bgs/5854.61 ft amsl (post-development water level, 9/13/2011)
36. Final water level	45.28 ft bgs (9/13/ 2011)
37. Date of well development	8/31/2011, 9/1/2011

[a]New Mexico Environment Department, April 2004. "Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act," § 74-4-10, New Mexico Environment Department, Santa Fe, New Mexico.
[b]Filter pack volume defined as the total volume of the primary filter pack sand placed in well, both adjacent to the well casing, screen, and sump and below the sump (if applicable).
[c]Elevations are North American Vertical Datum of 1988, expressed in U.S. feet.
amsl = Above mean sea level.
ARCH = Air-rotary casing hammer.
bgs = Below ground surface.
CCBA = Coyote Canyon Blast Area.
cfm = Cubic feet per minute.
CSS = Colorado Silica Sand (Oglebay Norton Industrial Sands/Carmeuse Industrial Sands Inc.).
ft = Foot (feet).
ft^3 = Cubic foot (feet).
ID = Inside diameter.
MW = Monitoring well.
OD = Outside diameter.
psi = Pound(s) per square inch.
PVC = Polyvinyl chloride.
SWMU = Solid Waste Management Unit.

Well Data for CCBA-MW2
Coyote Canyon Blast Area (SWMUs 8 / 58), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
1. Well name/number	CCBA-MW2
2. Date of well construction	Installation completed on 8/16/2011. Development completed on 8/31/2011.
3. Drilling method	ARCH and air rotary, one air compressor (350 psi at 1,170 cfm)
4. Drilling contractor and name of driller	WDC Exploration and Wells Inc., John Chaves. GEFCo Speed Star 50K-CH, serial number 907639
5. Borehole diameter and well casing diameter	Borehole: 8.5-inch diameter from 0 to 123 ft bgs. (8.5-inch-diameter tricone bit from 0 to 41 ft bgs [9.625 inch-diameter drive casing 0 to 38 ft bgs.] 8.5-inch-diameter button bit from 41 to 123 ft bgs.
	Well casing: 5.5 inches OD, 4.7 inches ID
6. Well depth	118 ft bgs
7. Casing length	Approximately 125.5 ft total (top of well casing approx. 2.5 ft bgs [above-grade well completion])
8. Casing materials	Well casing: Campbell™ Monoflex® Schedule 80 PVC. Centralizers: kwik-ZIP® thermoplastic resin model 155 HT-D. Bow height of 1.1875 inches.
9. Casing and screen joint type	Flush-threaded, 2 threads per inch, o-rings
10. Screened interval(s)	98 to 118 ft bgs
11. Screen materials	Campbell™ Monoflex® Schedule 80 PVC
12. Screen slot size and design	0.020-inch slotted screen
13. Filter pack material and gradation	Primary: Carmeuse® CSS #10-20
	Secondary: Carmeuse® CSS #60
14. Filter pack volume (calculated and actual)[b]	Calculated: 8.0 ft^3
	Actual: 9.5 ft^3
15. Filter pack placement method	Gravity feed through drive casing
16. Filter pack interval(s)	Primary: 93 to 123 ft bgs
	Secondary: 88 to 93 ft bgs
17. Annular sealant composition	PDS Bentonite Plug (3/8-inch grade bentonite chips)
18. Annular sealant placement method	Chips: gravity feed into annulus and subsequently hydrated with water gravity fed into drive casing.
19. Annular sealant volume (calculated and actual)	Calculated: PDS Bentonite Plug: 19.7 ft^3
	Actual: PDS Bentonite Plug: 28.4 ft^3
20. Annular sealant interval(s)	PDS Bentonite Plug: 2 to 88 ft bgs
21. Surface sealant composition	Quikrete® concrete
22. Surface seal placement method	Gravity fed into annulus
23. Surface sealant volume (calculated and actual)	Calculated: 0.5 ft^3
	Actual: not recorded, poured concrete 0 to 2 ft bgs
24. Surface sealant interval	Ground surface to 2 ft bgs

Refer to footnotes at end of table.

Well Data for CCBA-MW2 (Concluded)
Coyote Canyon Blast Area (SWMUs 8 / 58), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
25. Surface seal and well apron design and construction	3- by 3-ft by ~6-inch-deep concrete pad
26. Well development procedure and turbidity measurements	Bail, surge, submersible pump (see Appendix D for turbidity measurements)
27. Well development purge volume(s) and stabilization parameter measurements	Total of 270 gallons (see Appendix D for field parameter measurements)
28. Type and design and construction of protective casing	10-ft length of 8.625-inch-diameter steel casing with hinged cap (7 ft bgs and 3 ft above ground surface)
29. Well cap and lock	Royer Inc. aluminum locking well cap and padlock. Three steel bollards.
30. Ground surface elevation[c]	5936.95 ft amsl
31. Survey reference point elevation on well casing[c]	5939.28 ft amsl
32. Top of monitoring well casing elevation[c]	5939.28 ft amsl
33. Top of protective steel casing elevation[c]	5939.80 ft amsl
34. Name of geologist	John R. Copland
35. Initial water level	69.04 ft bgs/5867.91 ft amsl (post-development water level, 9/13/2011)
36. Final water level	69.04 ft bgs (9/13/2011)
37. Date of well development	8/31/2011

[a]New Mexico Environment Department, April 2004. "Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act," § 74-4-10, New Mexico Environment Department, Santa Fe, New Mexico.
[b]Filter pack volume defined as the total volume of the primary filter pack sand placed in well, both adjacent to the well casing, screen, and sump and below the sump (if applicable).
[c]Elevations are North American Vertical Datum of 1988, expressed in U.S. feet.

amsl = Above mean sea level.
ARCH = Air-rotary casing hammer.
bgs = Below ground surface.
CCBA = Coyote Canyon Blast Area.
cfm = Cubic feet per minute.
CSS = Colorado Silica Sand (Oglebay Norton Industrial Sands/Carmeuse Industrial Sands Inc.).
ft = Foot (feet).
ft^3 = Cubic ft (ft).
ID = Inside diameter.
MW = Monitoring well.
OD = Outside diameter.
psi = Pound(s) per square inch.
PVC = Polyvinyl chloride.
SWMU = Solid Waste Management Unit.

Well Data for OBS-MW1
Old Burn Site (SWMU 68), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
1. Well name/number	OBS-MW1
2. Date of well construction	Installation completed on 8/9/2011. Development completed on 8/31/2011.
3. Drilling method	ARCH and air rotary, one air compressor (350 psi at 1,170 cfm)
4. Drilling contractor and name of driller	WDC Exploration and Wells Inc., John Chaves. GEFCo Speed Star 50K-CH, serial number 907639
5. Borehole diameter and well casing diameter	Borehole: 8.5-inch diameter from 0 to 165 ft bgs. (8.5-inch diameter tricone bit from 0 to 15 ft bgs [9.625 inch diameter drive casing 0 to 12 ft bgs.] 8.5-inch diameter button bit from 15 to 165 ft bgs.)
	Well casing: 5.5 inches OD, 4.7 inches ID
6. Well depth	160 ft bgs
7. Casing length	Approximately 162.5 ft (from bottom of sump to top of well casing approximately 2.5 ft above ground surface). Monument completion.
8. Casing materials	Well casing: Campbell™ Monoflex® Schedule 80 PVC. Centralizers: kwik-ZIP® thermoplastic resin model 155 HT-D. Bow height of 1.1875 inches.
9. Casing and screen joint type	Flush-threaded, 2 threads per inch, o-rings
10. Screened interval(s)	135 to 155 ft bgs (with sump 155 to 160 ft bgs)
11. Screen materials	Campbell™ Monoflex® Schedule 80 PVC
12. Screen slot size and design	0.020-inch slotted screen
13. Filter pack material and gradation	Primary: Carmeuse® CSS # 10-20
	Secondary: Carmeuse® CSS #60
14. Filter pack volume (calculated and actual)[b]	Calculated: 8.5 ft^3
	Actual: 10 ft^3
15. Filter pack placement method	Gravity feed through drive casing and borehole
16. Filter pack interval(s)	Primary: 130 to 161 ft bgs of #10-20 sand. 17 bags
	Secondary: 126 to 130 ft bgs of #60 sand, and 124 to 126 ft bgs of #10-20 sand. 2 bags
17. Annular sealant composition	Baroid Quik-Grout® (bentonite slurry) and PDS Bentonite Plug (3/8-inch grade bentonite chips)
18. Annular sealant placement method	Grout: gravity feed into annulus. Chips: gravity feed into annulus and subsequently hydrated with water gravity fed into drive casing.
19. Annular sealant volume (calculated and actual)	Calculated: grout: 13.3 ft^3 (99 gallons) bentonite chips: 14.9 ft^3
	Actual: grout: 25.7 ft^3 (192 gallons), 8 bags bentonite chips: 12.6 ft^3, 20 bags
20. Annular sealant interval(s)	grout: 1 to 59 ft bgs
	bentonite chips: 59 to 124 ft bgs, 20 bags

Refer to footnotes at end of table.

Well Data for OBS-MW1 (Concluded)
Old Burn Site (SWMU 68), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
21. Surface sealant composition	Quikrete® concrete
22. Surface seal placement method	Gravity fed into borehole
23. Surface sealant volume (calculated and actual)	Calculated: 0.2 ft^3
	Actual: not recorded, poured concrete 0 to 1 ft bgs
24. Surface sealant interval	Ground surface to 1 ft bgs
25. Surface seal and well apron design and construction	3- by 3-ft by ~6-inch-thick concrete pad
26. Well development procedure and turbidity measurements	Bail, surge, submersible pump (see Appendix D for turbidity measurements)
27. Well development purge volume(s) and stabilization parameter measurements	Total of 495 gallons (see Appendix D for field parameter measurements)
28. Type and design and construction of protective casing	10-ft length of 8.625-inch-diameter steel casing with hinged cap (7 ft bgs and 3 ft above ground surface)
29. Well cap and lock	Royer Inc. aluminum locking well cap and padlock. Three steel bollards.
30. Ground surface elevation[c]	5869.08 ft amsl
31. Survey reference point elevation on well casing[c]	5871.42 ft amsl
32. Top of monitoring well casing elevation[c]	5871.42 ft amsl
33. Top of protective steel casing elevation[c]	5871.94 ft amsl
34. Name of geologist	John R. Copland
35. Initial water level	69.70 ft bgs/5799.38 ft amsl (post-development water level, 9/13/2011)
36. Final water level	69.70 ft bgs, 9/13/2011)
37. Date of well development	8/30/2011 and 8/31/2011

[a]New Mexico Environment Department, April 2004. "Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act," § 74-4-10, New Mexico Environment Department, Santa Fe, New Mexico.
[b]Filter pack volume defined as the total volume of the primary filter pack sand placed in well, both adjacent to the well casing, screen, and sump and below the sump (if applicable).
[c]Elevations are North American Vertical Datum of 1988, expressed in U.S. feet.
amsl = Above mean sea level.
ARCH = Air-rotary casing hammer.
bgs = Below ground surface.
cfm = Cubic feet per minute.
CSS = Colorado Silica Sand (Oglebay Norton Industrial Sands / Carmeuse Industrial Sands Inc.).
ft = Foot (feet).
ft^3 = Cubic ft (ft).
ID = Inside diameter.
MW = Monitoring well.
OBS = Old Burn Site.
OD = Outside diameter.
psi = Pounds per square inch.
PVC = Polyvinyl chloride.
SWMU = Solid Waste Management Unit.

Well Data for OBS-MW2
Old Burn Site (SWMU 68), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
1. Well name/number	OBS-MW2
2. Date of well construction	Installation completed on 8/8/2011. Development completed on 8/30/2011.
3. Drilling method	ARCH and air rotary, one air compressor (350 psi at 1,170 cfm)
4. Drilling contractor and name of driller	WDC Exploration and Wells Inc., John Chaves. GEFCo Speed Star 50K-CH, serial number 907639
5. Borehole diameter and well casing diameter	Borehole: 8.5 inches from 0 to 325 ft bgs. (8.5-inch-diameter tricone bit from 0 to 79 ft bgs [9.625-inch-diameter drive casing 0 to 3 ft bgs.] 8.5-inch-diameter button bit from 79 to 325 ft bgs.)
	Well casing: 5.5 inches OD, 4.7 inches ID
6. Well depth	259 ft bgs
7. Casing length	Approximately 261.5 ft total (top of well casing approx. 2.5 ft bgs [above-grade well completion])
8. Casing materials	Well casing: Campbell™ Monoflex® Schedule 80 PVC. Centralizers: kwik-ZIP® thermoplastic resin model 155 HT-D. Bow height of 1.1875 inches.
9. Casing and screen joint type	Flush-threaded, 2 threads per inch, o-rings
10. Screened interval(s)	234 to 254 ft bgs
11. Screen materials	Campbell™ Monoflex® Schedule 80 PVC
12. Screen slot size and design	0.020-inch slotted screen
13. Filter pack material and gradation	Primary: Carmeuse® CSS #10-20
	Secondary: Carmeuse® CSS #60 and Carmeuse® CSS #10-20
14. Filter pack volume (calculated and actual)[b]	Calculated: 7.8 ft^3
	Actual: 62.5 ft^3
15. Filter pack placement method	Gravity feed through drive casing
16. Filter pack interval(s)	Primary: 228 to 259 ft bgs
	Secondary: 225 to 228 ft bgs
17. Annular sealant composition	Baroid Quik-Grout® (bentonite slurry) PDS Bentonite Plug (3/8-inch grade bentonite chips)
18. Annular sealant placement method	Grout: gravity feed into annulus. Chips: gravity feed into annulus and subsequently hydrated with water gravity fed into drive casing.
19. Annular sealant volume (calculated and actual)	Calculated: Baroid Quik-Grout®: 36.7 ft^3 (274 gallons) PDS Bentonite Plug: 14.9 ft^3
	Actual: Baroid Quik-Grout®: 48 ft^3 (360 gallons), 15 bags PDS Bentonite Plug: 18.9 ft^3
20. Annular sealant interval(s)	Baroid Quik-Grout®: 0 to 160 ft bgs
	PDS Bentonite Plug: 160 to 225 ft bgs

Refer to footnotes at end of table.

Well Data for OBS-MW2 (Concluded)
Old Burn Site (SWMU 68), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
21. Surface sealant composition	None
22. Surface seal placement method	NA
23. Surface sealant volume (calculated and actual)	Calculated: None
	Actual: None
24. Surface sealant interval	None
25. Surface seal and well apron design and construction	3- by 3-ft by ~6-inch-thick concrete pad
26. Well development procedure and turbidity measurements	Bail, surge, submersible pump (see Appendix D for turbidity measurements)
27. Well development purge volume(s) and stabilization parameter measurements	Total of 490 gallons (see Appendix D for field parameter measurements)
28. Type and design and construction of protective casing	10-ft length of 8.625-inch-diameter steel casing with hinged cap (7 ft bgs and 3 ft above ground surface)
29. Well cap and lock	Royer Inc. aluminum locking well cap and padlock. Three steel bollards.
30. Ground surface elevation[c]	5860.75 ft amsl
31. Survey reference point elevation on well casing[c]	5863.16 ft amsl
32. Top of monitoring well casing elevation[c]	5863.16 ft amsl
33. Top of protective steel casing elevation[c]	5863.70 ft amsl
34. Name of geologist	John R. Copland
35. Initial water level	175.63 ft bgs/5685.12 ft amsl (post-development water level, 9/13/2011)
36. Final water level	175.63 ft bgs (9/13/2011)
37. Date of well development	8/30/2011

[a]New Mexico Environment Department, April 2004. "Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act," § 74-4-10, New Mexico Environment Department, Santa Fe, New Mexico.
[b]Filter pack volume defined as the total volume of the primary filter pack sand placed in well, both adjacent to the well casing, screen, and sump and below the sump (if applicable).
[c]Elevations are North American Vertical Datum of 1988, expressed in U.S. feet.

amsl = Above mean sea level.
ARCH = Air-rotary casing hammer.
bgs = Below ground surface.
cfm = Cubic feet per minute.
CSS = Colorado Silica Sand (Oglebay Norton Industrial Sands/Carmeuse Industrial Sands Inc.).
ft = Foot (feet).
ft^3 = Cubic ft (ft).
ID = Inside diameter.
MW = Monitoring well.
NA = Not applicable.
OBS = Old Burn Site.
OD = Outside diameter.
psi = Pound(s) per square inch.
PVC = Polyvinyl chloride.
SWMU = Solid Waste Management Unit.

Well Data for OBS-MW3
Old Burn Site (SWMU 68), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
1. Well name/number	OBS-MW3
2. Date of well construction	Installation completed on 8/11/2011. Development completed on 8/30/2011.
3. Drilling method	ARCH and air rotary, one air compressor (350 psi at 1,170 cfm)
4. Drilling contractor and name of driller	WDC Exploration and Wells Inc., John Chaves. GEFCo Speed Star 50K-CH, serial number 907639
5. Borehole diameter and well casing diameter	Borehole: 8.5-inch-diameter tricone bit from 0 to 8 ft bgs. [9.625-inch-diameter drive casing 0 to 6 ft bgs.] 8.5-inch-diameter button bit from 8 to 225 ft bgs.)
	Well casing: 5.5 inches OD, 4.7 inches ID
6. Well depth	215 ft bgs
7. Casing length	Approximately 217.5 ft total (top of well casing approx. 2.5 ft bgs [above-grade well completion])
8. Casing materials	Well casing: Campbell™ Monoflex® Schedule 80 PVC. Centralizers: kwik-ZIP® thermoplastic resin model 155 HT-D. Bow height of 1.1875 inches.
9. Casing and screen joint type	Flush-threaded, 2 threads per inch, o-rings
10. Screened interval(s)	190 to 210 ft bgs
11. Screen materials	Campbell™ Monoflex® Schedule 80 PVC
12. Screen slot size and design	0.020-inch slotted screen
13. Filter pack material and gradation	Primary: Carmeuse® CSS #10-20
	Secondary: Carmeuse® CSS #60
14. Filter pack volume (calculated and actual)[b]	Calculated: 9.6 ft^3
	Actual: 12 ft^3
15. Filter pack placement method	Gravity feed through drive casing
16. Filter pack interval(s)	Primary: 185 to 222 ft bgs
	Secondary: 180 to 185 ft bgs
17. Annular sealant composition	Baroid Quik-Grout® (bentonite slurry) PDS Bentonite Plug (3/8-inch grade bentonite chips)
18. Annular sealant placement method	Grout: gravity feed into annulus. Chips: gravity feed into annulus and subsequently hydrated with water gravity fed into drive casing.
19. Annular sealant volume (calculated and actual)	Calculated: Grout: 14.9 ft^3 (111 gallons) Chips: 26.1 ft^3
	Actual: Grout: 12.8 ft^3 (96 gallons) Chips: 22 ft^3
20. Annular sealant interval(s)	Grout: 1 to 66 ft bgs
	Chips: 66 to 180 ft bgs
21. Surface sealant composition	Quikrete® concrete
22. Surface seal placement method	Gravity fed into annulus

Refer to footnotes at end of table.

Well Data for OBS-MW3 (Concluded)
Old Burn Site (SWMU 68), Sandia National Laboratories/New Mexico

Items Required by the Order[a] Section VIII.D	Comments
23. Surface sealant volume (calculated and actual)	Calculated: 0.2 ft^3
	Actual: not recorded, poured concrete 0 to 1 ft bgs
24. Surface sealant interval	Ground surface to 1 ft bgs
25. Surface seal and well apron design and construction	3- by 3-ft by ~6-inch-thick concrete pad
26. Well development procedure and turbidity measurements	Bail, surge, submersible pump (see Appendix D for turbidity measurements)
Items Required by the Order[a] Section VIII.D	Comments
27. Well development purge volume(s) and stabilization parameter measurements	Total of 435 gallons (see Appendix D for field parameter measurements)
28. Type and design and construction of protective casing	10-ft length of 8.625-inch-diameter steel casing with hinged cap (3 ft bgs and 7 ft above ground surface)
29. Well cap and lock	Royer Inc. aluminum locking well cap and padlock. Three steel bollards.
30. Ground surface elevation[c]	5863.31 ft amsl
31. Survey reference point elevation on well casing[c]	5865.50 ft amsl
32. Top of monitoring well casing elevation[c]	5865.50 ft amsl
33. Top of protective steel casing elevation[c]	5866.00 ft amsl
34. Name of geologist	John R. Copland
35. Initial water level	67.25 ft bgs/5796.06 ft amsl (post-development water level, 9/13/2011)
36. Final water level	67.25 ft bgs (9/13/2011)
37. Date of well development	8/30/2011

[a]New Mexico Environment Department, April 2004. "Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act," § 74-4-10, New Mexico Environment Department, Santa Fe, New Mexico.
[b]Filter pack volume defined as the total volume of the primary filter pack sand placed in well, both adjacent to the well casing, screen, and sump and below the sump (if applicable).
[c]Elevations are North American Vertical Datum of 1988, expressed in U.S. feet.
amsl = Above mean sea level.
ARCH = Air-rotary casing hammer.
bgs = Below ground surface.
cfm = Cubic feet per minute.
CSS = Colorado Silica Sand (Oglebay Norton Industrial Sands/Carmeuse Industrial Sands Inc.).
ft = Foot (feet).
ft^3 = Cubic ft (ft).
ID = Inside diameter.
MW = Monitoring well.
OBS = Old Burn Site.
OD = Outside diameter.
psi = Pound(s) per square inch.
PVC = Polyvinyl chloride.
SWMU = Solid Waste Management Unit.

APPENDIX C
Well Construction Diagrams for CCBA-MW1, CCBA-MW2, OBS-MW1, OBS-MW2, and OBS-MW3

Well Name:	CCBA-MW1	**Drilling Contractor:**	WDC EXPLORATION AND WELLS
Project Name:	ENV. RESTORATION	**Drilling Method:**	AIR ROTARY CASING HAMMER
NMOSE Well File Code:	RG-90065, POINT OF DIVERSION: 117	**Borehole Depth (FBGS):**	90
Owner Name:	SNL/NM	**Casing Depth (FBGS):**	85
Date Drilling Started:	8/12/2011	**Geo Location:**	COYOTE CANYON BLAST AREA
Date Well Dev. Completed:	9/1/2011	**Completion Zone:**	ALLUVIUM-SAND, GRAVEL, COBBLES
		Completion Formation:	& POSSIBLY WEATHERED BEDROCK

Survey Data

Survey Date: 9/15/2011
Surveyed By: SURVEYING CONTROL, INC.

State Plane Coordinates: NAD 83

(X) Easting: 1575293.87
(Y) Northing: 1456510.33

Surveyed Evaluations (FAMSL) NAVD 88

Protective Casing:	5902.90
Top of Inner Well Casing:	5902.34
Concrete Pad:	5900.49
Ground Surface:	5899.9

Calculated Depths and Elevations

Initial Depth to Water (FBGS):	62.00
Date Intiial Depth Measured:	12-AUG-11
Last Measured Water Elevation (FAMSL):	5854.61
Date Last Measured:	9/13/2011

Miscellaneous Information

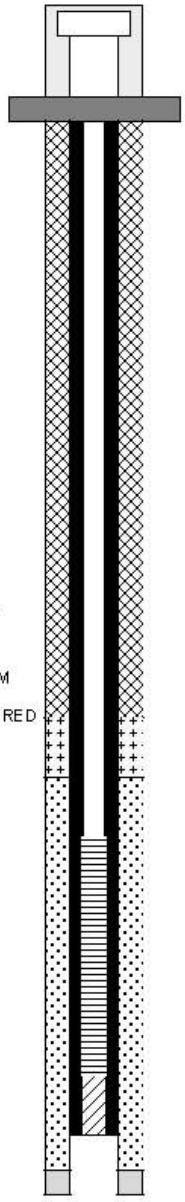
Screen Slot Size (in.): 0.02

Date Updated: 26-OCT-11

Date Printed from EDMS: 10/26/2011 12:40:17 PM

Comments:

WELL INSTALLED IN UNCONSOLIDATED ALLUVIUM (SLOUGHING ZONE OF SAND, GRAVELS, AND COBBLES) AND POSSIBLY UNDERLYING WEATHERED QUARTZITE BEDROCK. SATURATED CUTTINGS ENCOUNTERED AT 62 FEET BGS.



Completion Data Measured Depths (FBGS)

Casing Stickup: 2.5

Interval	Material	Start	Stop	Length	ID/OD(in.)
BOREHOLE		0	90	90	/9.63
CASING	SCHEDULE 80 PVC	0	85	85	4.7 / 5.5
SEAL	BENTONITE CHIPS	0	50	50	
SECONDARY PACK	#60 SAND	50	55	5	
PRIMARY PACK	#10-20 SAND	55	88	33	
SCREEN	SCHEDULE 80 PVC	60	80	20	4.7 / 5.5
SUMP	SCHEDULE 80 PVC	80	85	5	4.7 / 5.5
SLOUGH		88	90	2	

Well Name:	CCBA-MW2	**Drilling Contractor:**	WDC EXPLORATION AND WELLS
Project Name:	ENV. RESTORATION	**Drilling Method:**	ARCH AND AIR ROTARY
NMOSE Well File Code:	RG-90065, POINT OF DIVERSION: 118	**Borehole Depth (FBGS):**	123
Owner Name:	SNL/NM	**Casing Depth (FBGS):**	123
Date Drilling Started:	8/14/2011	**Geo Location:**	COYOTE CANYON BLAST AREA
Date Well Dev. Completed:	8/31/2011	**Completion Zone:**	FRACTURED GRANITE AND GNEISS
		Completion Formation:	PRECAMBRIAN GRANITE

Survey Data

Survey Date: 9/15/2011
Surveyed By: SURVEYING CONTROL, INC.

State Plane Coordinates: NAD 83
(X) Easting: 1575881.78
(Y) Northing: 1457831.88

Surveyed Evaluations (FAMSL) NAVD 88

Protective Casing: 5939.80
Top of Inner Well Casing: 5939.28
Concrete Pad: 5937.54
Ground Surface: 5937.0

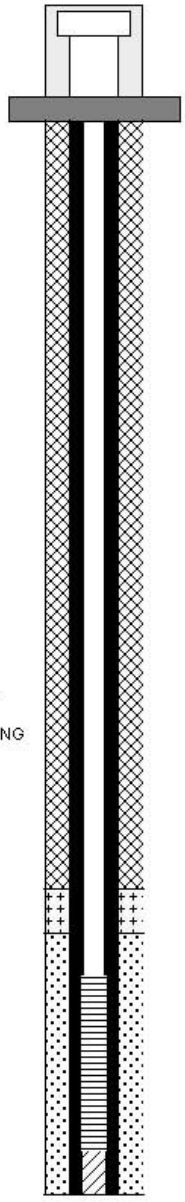
Calculated Depths and Elevations

Initial Depth to Water (FBGS): 100.00
Date Intiial Depth Measured: 15-AUG-11
Last Measured Water Elevation (FAMSL): 5867.95
Date Last Measured: 10/12/2011

Miscellaneous Information

Screen Slot Size (in.): 0.02
Date Updated: 08-NOV-11
Date Printed from EDMS: 11/8/2011 3:59:42 PM

Comments:
GROUNDWATER PRODUCED FROM FRACTURED GRANITE, POSSIBLY FROM 100 TO 103 FEET BGS AND FROM 115 TO 117 FEET BGS. INCREASED DRILLING RATE IN THOSE ZONES. VIDEO LOGGING THROUGH MODERATELY CLOUDY WATER WAS INCONCLUSIVE.



Completion Data Measured Depths (FBGS)

Casing Stickup: 2.3

Interval	Material	Start	Stop	Length	ID/OD(in.)
CASING	SCHEDULE80 PVC	0	123	123	4.7 / 5.5
BOREHOLE		0	123	123	/8.5
SEAL	BENTONITE CHIPS	0	88	88	
SECONDARY PACK	#60 SAND	88	93	5	
PRIMARY PACK	#10-20 SAND	93	123	30	
SCREEN	SCHEDULE80 PVC	98	118	20	4.7 / 5.5
SUMP	SCHEDULE80 PVC	118	123	5	4.7 / 5.5

Well Name:	OBS-MW1	**Drilling Contractor:**	WDC EXPLORATION AND WELLS
Project Name:	ENV. RESTORATION	**Drilling Method:**	ARCH AND AIR ROTARY
NMOSE Well File Code:	RG-90065, POINT OF DIVERSION: 119	**Borehole Depth (FBGS):**	165
Owner Name:	SNL/NM	**Casing Depth (FBGS):**	160
Date Drilling Started:	8/8/2011	**Geo Location:**	OLD BURN SITE (SWMU 68)
Date Well Dev. Completed:	8/31/2011	**Completion Zone:**	FRACTURED GRANITE
		Completion Formation:	PRECAMBRIAN GRANITE

Survey Data

Survey Date: 9/15/2011
Surveyed By: SURVEYING CONTROL, INC.

State Plane Coordinates: NAD 83

(X) Easting: 1573586.47
(Y) Northing: 1440544.62

Surveyed Evaluations (FAMSL) NAVD 88

Protective Casing:	5871.94
Top of Inner Well Casing:	5871.42
Concrete Pad:	5869.78
Ground Surface:	5869.1

Calculated Depths and Elevations

Initial Depth to Water (FBGS):	135.00
Date Intiial Depth Measured:	08-AUG-11
Last Measured Water Elevation (FAMSL):	5799.41
Date Last Measured:	10/5/2011

Miscellaneous Information

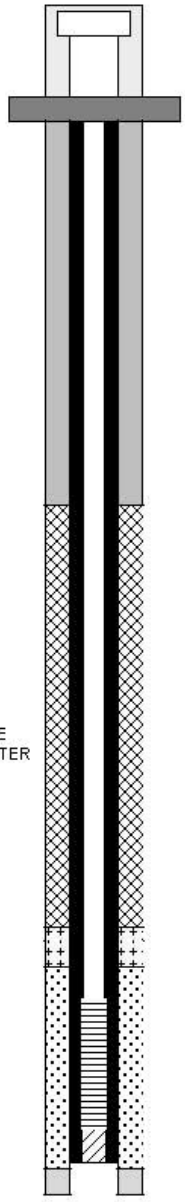
Screen Slot Size (in.): 0.02

Date Updated: 08-NOV-11

Date Printed from EDMS: 11/8/2011 4:02:14 PM

Comments:

GROUNDWATER PRODUCED FROM FRACTURED GRANITE AT 135 TO 155 FEET BGS IN ZONE OF INCREASED DRILLING RATE. NO SIGNIFICANT FRACTURES WERE VISIBLE IN THIS ZONE ON THE VIDEO LOG, BUT THE MODERATELY CLOUDY WATER LIMITED VISIBILITY.



Completion Data Measured Depths (FBGS)

Casing Stickup: 2.3

Interval	Material	Start	Stop	Length	ID/OD(in.)
BOREHOLE		0	165	165	/8.5
CASING	SCHEDULE 80 PVC	0	160	160	4.7 / 5.5
GROUT	GROUT	0	59	59	
SEAL	BENTONITE CHIPS	59	124	65	
SECONDARY PACK	#10-20 SAND	124	126	2	
SECONDARY PACK	#60 SAND	126	130	4	
PRIMARY PACK	#10-20 SAND	130	161	31	
SCREEN	SCHEDULE 80 PVC	135	155	20	4.7 / 5.5
SUMP	SCHEDULE 80 PVC	155	160	5	4.7 / 5.5
SLOUGH		161	165	4	

Well Name:	OBS-MW2	**Drilling Contractor:**	WDC EXPLORATION AND WELLS
Project Name:	ENV. RESTORATION	**Drilling Method:**	ARCH AND AIR ROTARY
NMOSE Well File Code:	RG-90065, POINT OF DIVERSION: 120	**Borehole Depth (FBGS):**	325
Owner Name:	SNL/NM	**Casing Depth (FBGS):**	259
Date Drilling Started:	8/3/2011	**Geo Location:**	OLD BURN SITE (SWMU 68)
Date Well Dev. Completed:	8/30/2011	**Completion Zone:**	CLAYSTONE/CONGLOMERATE
		Completion Formation:	PENNSYLVANIAN SANDIA FORMATION

Survey Data

Survey Date: 9/15/2011
Surveyed By: SURVEYING CONTROL, INC.

State Plane Coordinates: NAD 83
(X) Easting: 1573323.37
(Y) Northing: 1440379.22

Surveyed Evaluations (FAMSL) NAVD 88

Protective Casing: 5863.70
Top of Inner Well Casing: 5863.16
Concrete Pad: 5861.38
Ground Surface: 5860.8

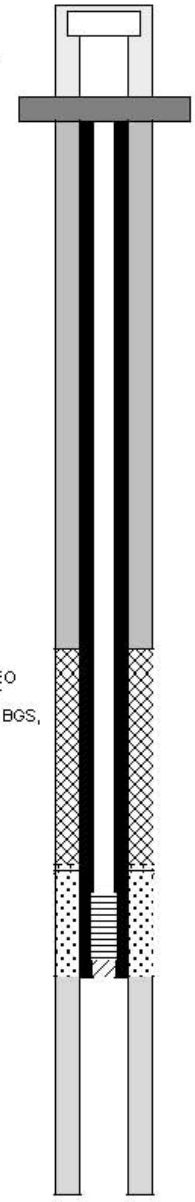
Calculated Depths and Elevations

Initial Depth to Water (FBGS): 240.00
Date Intiial Depth Measured: 05-AUG-11
Last Measured Water Elevation (FAMSL): 5685.98
Date Last Measured: 10/5/2011

Miscellaneous Information

Screen Slot Size (in.): 0.02
Date Updated: 08-NOV-11
Date Printed from EDMS: 11/8/2011 4:02:38 PM

Comments:
WELL DRILLED IN PROBABLE FAULT ZONE. VIDEO LOGGING OF BOREHOLE SHOWED SIGNIFICANT FLOW OF GROUNDWATER AT 240 TO 251 FEET BGS, MOST LIKELY IN FRACTURED INTERVAL OF CLAYSTONE AND CONGLOMERATE.



Completion Data Measured Depths (FBGS)

Casing Stickup: 2.4

Interval	Material	Start	Stop	Length	ID/OD(in.)
BOREHOLE		0	325	325	/8.5
CASING	SCHEDULE 80 PVC	0	259	259	4.7 / 5.5
GROUT	GROUT	0	160	160	
SEAL	BENTONITE CHIPS	160	225	65	
SECONDARY PACK	#10-20 SAND	225	227	2	
SECONDARY PACK	#60 SAND	227	228	1	
PRIMARY PACK	#10-20 SAND	228	259	31	
SCREEN	SCHEDULE 80 PVC	234	254	20	4.7 / 5.5
SUMP	SCHEDULE 80 PVC	254	259	5	4.7 / 5.5
SLOUGH		259	325	66	

Well Name:	OBS-MW3	**Drilling Contractor:**	WDC EXPLORATION AND WELLS
Project Name:	ENV. RESTORATION	**Drilling Method:**	ARCH AND AIR ROTARY
NMOSE Well File Code:	RG-90065, POINT OF DIVERSION: 121	**Borehole Depth (FBGS):**	225
Owner Name:	SNL/NM	**Casing Depth (FBGS):**	215
Date Drilling Started:	8/9/2011	**Geo Location:**	OLD BURN SITE (SWMU 68)
Date Well Dev. Completed:	8/30/2011	**Completion Zone:**	FRACTURED GRANITE
		Completion Formation:	PRECAMBRIAN GRANITE

Survey Data

Survey Date: 9/15/2011
Surveyed By: SURVEYING CONTROL, INC.

State Plane Coordinates: NAD 83

(X) Easting: 1573352.54
(Y) Northing: 1440543.54

Surveyed Evaluations (FAMSL) NAVD 88

Protective Casing:	5866.00
Top of Inner Well Casing:	5865.50
Concrete Pad:	5863.89
Ground Surface:	5863.3

Calculated Depths and Elevations

Initial Depth to Water (FBGS):	190.00
Date Intiial Depth Measured:	10-AUG-11
Last Measured Water Elevation (FAMSL):	5796.12
Date Last Measured:	10/5/2011

Miscellaneous Information

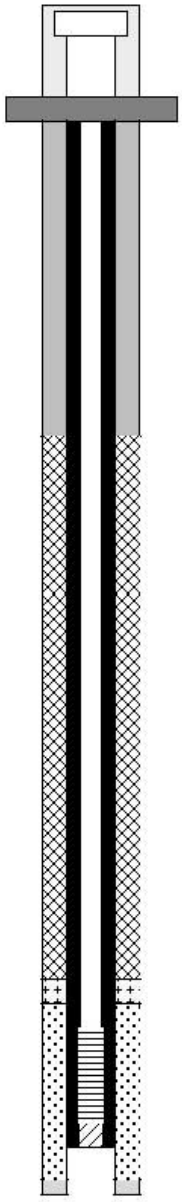
Screen Slot Size (in.): 0.02

Date Updated: 08-NOV-11

Date Printed from EDMS: 11/8/2011 4:03:16 PM

Comments:

GROUNDWATER PRODUCED FROM FRACTURED GRANITE AT 190 TO 210 FT BGS. INCREASED DRILLING RATE IN THIS ZONE. VIDEO LOGGING THROUGH MODERATELY CLOUDY WATER WAS INCONCLUSIVE.



Completion Data Measured Depths (FBGS)

Casing Stickup: 2.2

Interval	Material	Start	Stop	Length	ID/OD(in.)
BOREHOLE		0	225	225	/8.5
CASING	SCHEDULE 80 PVC	0	215	215	4.7 / 5.5
GROUT	GROUT	0	66	66	
SEAL	BENTONITE CHIPS	66	180	114	
SECONDARY PACK	#60 SAND	180	185	5	
PRIMARY PACK	#10-20 SAND	185	222	37	
SCREEN	SCHEDULE 80 PVC	190	210	20	4.7 / 5.5
SUMP	SCHEDULE 80 PVC	210	215	5	4.7 / 5.5
SLOUGH		222	225	3	

APPENDIX D
Well Development Forms for CCBA-MW1, CCBA-MW2, OBS-MW1, OBS-MW2, and OBS-MW3

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: CCBA	Project No.:
Well I.D.: CCBA-MW1	Date: 8/31/11
Well Condition: NEW	Weather Condition: HI CLOUDS, BREEZY, 90°
Method: Portable pump X	Dedicated pump _____ Pump depth: 80'

PURGE MEASUREMENTS

Depth to Water (ft)	Time 24 hr	Vol. (L/gal)	Temp (°C)	SC (µS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments
	—	225	—	—	—	—	—	—	Bailed
	1512	240	18.74	471	289.5	7.45	>1000	56.4	START PUMPING
	1515	255	19.16	467	290.0	7.06	>1000	61.1	
	1518	270	18.82	464	290.9	6.93	683	65.3	
	1522	285	18.87	464	286.7	6.87	104	64.3	
	1527	300	18.84	465	264.3	6.90	37.1	65.2	
	1532	315	18.76	466	245.8	6.83	24.7	65.0	
	1536	330	18.79	465	243.3	6.85	18.1	63.4	
	1541	345	18.80	465	242.6	6.80	13.0	61.4	
	1545	360	18.74	465	242.1	6.82	12.5	62.2	
	1548	375	18.09	464	244.4	6.91	15.7	60.2	
	1552	390	18.17	463	244.7	6.77	51.3	56.5	
	1555	405	18.31	464	243.4	6.84	75.5	56.0	
	1557	420	17.98	464	246.2	6.82	57.0	58.4	
	1600	435	18.01	465	248.7	6.93	42.8	59.2	
	1603	450	17.96	464	247.6	6.90	36.0	57.8	
	1605	465	17.96	464	249.9	6.88	29.3	59.5	
	1608	480	17.95	465	253.3	6.82	25.4	57.4	
	1611	495	17.92	464	257.1	6.76	21.4	55.2	
	1613	510	17.93	465	260.1	6.92	20.6	59.2	
	1615	525	17.91	465	262.1	6.89	50.8	64.2	
	1618	540	17.85	467	263.6	6.95	64.2	63.2	4.56 GPM AVG 8/31/11
9/1/11	0740	555	17.36	488	305.5	7.46	7.64	45.9	
	0742	570	17.41	470	309.4	7.02	22.6	54.8	
	0745	585	17.38	467	308.0	7.02	10.0	57.2	

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: CCBA	Project No.:
Well I.D.: CCBA-MW1	Date: 9/1/2011
Well Condition: New	Weather Condition: overcast
Method: Portable pump ✓ Dedicated pump ____	Pump depth: 80'

PURGE MEASUREMENTS

Depth to Water (ft)	Time 24 hr	Vol. (L/gal)	Temp (°C)	SC (μS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments DO mg/L
	0748	600	17.45	465	309.5	6.97	5.47	57.2	
	0750	615	17.48	465	309.6	6.89	4.73	52.5	5.77 GPM 9/1/11,
									4.8 GPM AVG
									PUMP. RATE

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: CCBA-MW2 DEVELOPMENT	Project No.:
Well I.D.: CCBA-MW2	Date: 8/31/11
Well Condition: NEW WELL	Weather Condition: SUNNY, HIGH CLOUDS, BREEZ
Method: Portable pump X	Dedicated pump _____ Pump depth: 117' BGS

PURGE MEASUREMENTS

Depth to Water (ft)	Time 24 hr	Vol. (L/gal)	Temp (°C)	SC (µS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments DO mg/L
	1228	180	—	—	—	—	—	—	BAILED, SWABBED
	1346	195	20.34	604	269.8	8.11	298	73.9	START PUMPING
	1350	210	18.90	579	296.3	7.59	37.5	67.2	
	1353	225	18.89	578	293.5	7.57	18.2	70.1	
	1357	240	18.93	579	273.8	7.74	6.72	69.1	
	1401	255	18.84	579	290.6	7.67	4.86	67.9	
	1405	270	18.87	578	286.6	7.74	3.45	69.5	STOP PUMPING,
									AVG PUMPING
									RATE ~3.9 GPM

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: OBS	Project No.:
Well I.D.: OBSMW1	Date: 8/30/2011
Well Condition: New	Weather Condition: Sunny Clear, 70s
Method: Portable pump ✓	Dedicated pump _____ Pump depth: 150'BGS

PURGE MEASUREMENTS

Depth to Water (ft)	Time 24 hr	Vol. (L/gal)	Temp (°C)	SC (µS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments
	0800	—	—	—	—	—	—		Begin Purge
	0805	10	—	—	—	—	—	—	Begin Swab
	0820	—	—	—	—	—	—	—	Complete Swab
	0840	45	—	—	—	—	—	—	Brown Silt
	0850	90	—	—	—	—	—	—	" "
	0900	135	✓	✓	✓	—	—	—	" "
Cease Vol Turnover	0905	180	—	✓	✓	✓	—	—	Brown Silty
8/30/11	1530	195	18.60	498	241.5	7.51	>1000	58.7	" "
	1533	210	18.69	495	180.1	7.19	530	56.1	
	1536	225	18.87	495	113.3	7.30	197	49.6	CLEARING
	1540	240	18.80	494	106.9	7.40	107	52.4	
	1543	255	18.81	493	115.7	7.36	103	52.2	
	1546	270	18.73	492	123.0	7.46	91.3	52.2	
	1550	285	18.76	494	136.8	7.42	79.1	52.8	
	1554	300	18.78	493	141.9	7.35	70.7	51.3	
	1557	315	18.74	493	146.8	7.31	59.3	53.4	
	1601	330	18.77	493	156.3	7.42	54.1	54.2	
	1605	345	18.76	493	159.4	7.34	55.4	51.2	
	1610	360	18.78	486	161.3	7.32	44.9	50.9	
	1613	375	18.82	493	163.7	7.35	53.5	52.2	
	1616	390	18.90	494	168.6	7.29	52.7	49.1	
	1624	405	19.23	495	172.4	7.31	53.7	46.2	CHANGED BATTS IN FIELD INST.
	1630	420	19.10	494	179.0	7.36	101	79.6	SHUTDOWN FOR DAY
8/31/11	0725	435	17.86	500	285.9	7.65	24.8	62.0	
	0729	450	18.02	494	294.3	7.58	6.33	58.1	

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: OBS	Project No.:
Well I.D.: OBS-MW1	Date: 8/31/11
Well Condition:	Weather Condition: SUNNY, CLEAR, 90°s.
Method: Portable pump _____ Dedicated pump _____	Pump depth: 150'/365

PURGE MEASUREMENTS

Depth to Water (ft)	Time 24 hr	Vol. (L/gal)	Temp (°C)	SC (µS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments
8/31/11	0733	465	18.16	493	299.0	7.59	2.54	63	
	0736	480	18.18	492	299.4	7.59	2.03	63.2	
	0740	495	18.15	492	301.4	7.58	1.92	65.1	VY CLEAR. AVG
									PUMPING RATE
									3.9 GPM

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: Old Burn Site	Project No.:
Well I.D.: OBS MW 2	Date: 8/29/11
Well Condition: New	Weather Condition: Slight Breeze, Sunny 80s
Method: Portable pump ✓ Dedicated pump ____	Pump depth: 258' BGS

PURGE MEASUREMENTS

TOC Depth to Water (ft)	Time 24 hr	Vol (L/gal)	Temp (°C)	SC (µS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments
171.31	0845	0	—	—	—	—	—	—	
—	0915	45	—	—	—	—	—	—	Begin swab @ 0925
—	0940	45	—	—	—	—	—	—	End Swab
—	045	90	—	—	—	—	—	—	End Bail, set pump
	1118	120	19.74	527	230.5	6.82	62.0	49.8	
	1123	145	20.06	520	174.6	7.09	40.8	45.0	
	1127	160	20.06	517	152.7	7.14	40.3	44.7	
	1132	175	19.99	516	149.2	7.17	30.6	46.4	
	1136	190	19.95	516	148.0	7.20	37.8	42.8	
	1140	205	19.92	515	149.5	7.20	35.2	44.5	
	1145	220	19.96	515	151.9	7.22	36.1	45.2	
	1148	235	19.97	515	153.7	7.24	35.5	46.0	
	1152	250	19.96	514	153.7	7.25	32.7	46.5	
	1155	265	19.94	514	154.4	7.26	30.0	44.7	
	1158	280	20.05	514	155.1	7.24	31.3	44.7	
	1200	295	20.07	514	155.0	7.27	30.8	45.1	
	1204	310	20.08	514	155.8	7.27	26.4	46.5	
	1206	325	20.10	514	158.4	7.26	29.9	44.9	
	1210	340	20.01	514	160.8	7.25	25.9	45.4	
	1213	355	20.08	514	160.0	7.26	24.9	44.4	
	1216	370	20.10	514	161.1	7.26	25.8	45.6	
	1219	385	20.27	514	161.9	7.29	25.7	46.1	STOP PUMPING.
									AVG PUMPING RATE
									~4.4 LPM.

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: OLD BURN SITE	Project No.:
Well I.D.: OBS-MW2	Date: 8/30/11
Well Condition: NEW WELL	Weather Condition: SUNNY, WARM
Method: Portable pump X	Dedicated pump _____ Pump depth: 248' BGS

PURGE MEASUREMENTS

Depth to Water (ft)	Time 24 hr	Vol. (L/gal)	Temp (°C)	SC (µS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments DO mg/L
	0930	385	—	—	—	—	—	—	
	0935	400	18.69	516	260.1	7.70	11.5	60.6	
	0938	415	19.51	514	268.0	7.46	10.6	48.9	
	0940	430	19.55	516	272.5	7.40	9.63	57.5	
	0942	445	19.60	513	274.0	7.39	9.53	58.0	
	0945	460	19.95	510	275.0	7.37	9.40	48.1	
	0947	475	19.86	498	278.2	7.35	9.05	57.7	
	0950	490	19.89	508	280.9	7.37	11.1	59.3	~4.4 GPM PUMP RATE

FIELD MEASUREMENT LOG FOR GROUNDWATER SAMPLE COLLECTION

Project Name: Old Burn Site	Project No.:
Well I.D.: OBS-MW3	Date: 8/29/11, 8/30/11
Well Condition: New	Weather Condition:
Method: Portable pump ✓	Dedicated pump _____ Pump depth: 207' BGS

PURGE MEASUREMENTS

Depth to Water (ft)	Time 24 hr	Vol. (L/gal)	Temp (°C)	SC (µS/cm)	ORP (mV)	pH	Turbidity (NTU)	DO (%)	Comments
8/29/11	1530	180	—	—	—	—	—	—	5 case volumes
8/30/11	1214	195	18.40	507	240.1	7.37	228	59.0	
	1218	210	18.92	506	131.4	7.40	148	54.1	
	1221	225	19.05	506	94.6	7.39	114	53.4	DK SED. (BLK SHALE)
	1225	240	19.08	269	95.1	7.38	88.6	53.2	
	1228	255	19.11	503	98.6	7.33	60.1	54.9	
	1231	270	19.16	503	104.9	7.38	43.8	54.6	
	1234	285	19.29	503	110.1	7.46	35.1	54.7	
	1237	300	19.31	502	116.7	7.47	30.2	55.0	
	1242	315	19.41	501	123.9	7.38	28.1	53.6	
	1247	330	19.52	502	137.1	7.41	19.6	58.3	
	1250	345	19.58	502	140.0	7.43	17.5	54.6	
	1256	360	19.59	501	144.4	7.44	15.7	58.4	
	1300	375	19.56	501	151.0	7.46	15.8	56.2	
	1305	390	19.70	502	161.2	7.43	13.6	56.1	
	1310	405	19.64	501	169.0	7.47	10.0	57.6	
	1315	420	19.71	501	172.2	7.49	8.92	57.6	
	1320	435	19.69	502	176.7	7.48	4.97	56.8	STOP PUMPING.
									AVG. PUMPING RATE ~3.6 GPM