TA-01

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Los Alamos Site Operations, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
(505) 667-7203/FAX (505) 665-4504

Date: November 13, 2003
Refer to: RRES-GPP-03-099

Mr. John Young, Corrective Action Project Leader
Permits Management Program
NMED – Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building 1
Santa Fe, NM 87505-6303

NOV

SUBJECT: SAMPLING AND ANALYSIS PLAN (SAP) FOR DRILLING AND TESTING CHARACTERIZATION WELLS R-1, R-28, R-33, AND R-34

Dear Mr. Young:

Enclosed are two copies of the SAP for the Drilling and Testing of LANL Regional Aquifer Characterization Wells R-1, R-28, R-33, and R-34. We anticipate that the drilling portion of this work will begin on November 10, 2003.

Please provide any comments to John McCann at (505) 665-1095 or Charles Nylander at (505) 665-4681 at your earliest possible convenience.

Sincerely,

Charles Nylander, Program Manager
Groundwater Protection Program
Los Alamos National Laboratory

Sincerely,

Matthew Johansen, Project Manager
Program Compliance Manager
National Nuclear Security Admin.
Office of Los Alamos Site Operations

CN/MJ/th

Enclosure: SAP for Drilling and Testing Characterization Wells R-1, R-28, R-33, and R-34 (GPP-03-0098/ ER2003-0695)

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IM-5, MS A150
RRES-GPP File, MS M992
RRES-RPF, MS M707 (ER2003-0713)

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1	LETTER	11/13/2003	SAMPLING AND ANALYSIS PLAN (SAP) FOR DRILLING AND TESTING CHARACTERIZATION WELLS R-1, R-28, R-33, AND R-34 (RRES-GPP-03-099, ER2003-0713) RRES-GPP-03-099 ER2003-0713 N/A	1301	
2	SaPmple Collection Log	11/1/2003	SAMPLING AND ANALYSIS PLAN FOR DRILLING AND TESTING CHARACTERIZATION WELLS R-1, R-28, R-33, AND R-34 (LA-UR-03-8324, NOVEMBER 2003, ER2003-0695, GPP-03-098) LA-UR-03-8324 ER2003-0695 N/A	1301	
54	Form	11/13/2003	RRES REMEDIATION SERVICES DOCUMENT SIGNATURE FORM RE LETTER RE SAP FOR DRILLING AND TESTING CHARACTERIZATION WELLS R-1, R-28, R-33 AND R-34 (ER2003-0713) N/A N/A N/A	1301	
56	Form	11/6/2003	RRES REMEDIATION SERVICES PROJECT DOCUMENT SIGNATURE FORM RE SAP FOR DRILLING AND TESTING CHARACTERIZATION WELLS R-1, R-28, R-33 AND R-34 (ER2003-0695) N/A N/A N/A	1301	

#81598

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Sincerely,

Charles L. Nylander

Charles Nylander, Program Manager
Groundwater Protection Program
Los Alamos National Laboratory

Sincerely,

Thomas Whitacre for

Matthew Johansen, Project Manager
Program Compliance Manager
National Nuclear Security Admin.
Office of Los Alamos Site Operations

LA-UR-03-8324
November 2003
ER2003-0695
GPP-03-098

Sampling and Analysis Plan for Drilling and Testing Characterization Wells R-1, R-28, R-33, and R-34

Los Alamos
NATIONAL LABORATORY
Los Alamos NM 87545

Prepared by the Risk Reduction and Environmental Stewardship Division–Groundwater Protection Program

OVERVIEW

Characterization wells R-1, R-28, R-33, and R-34 are being installed at Los Alamos National Laboratory as part of the "Mortandad Canyon Groundwater Work Plan" (LANL 2003, 79557). The work plan for Mortandad Canyon describes revisions and updates to the "Work Plan for Mortandad Canyon Operable Unit (OU) 1049, September 1997" (LANL 1997, 56835). The Mortandad Canyon work plan was first submitted by the Los Alamos National Laboratory (LANL or the Laboratory) to the New Mexico Environment Department (NMED) in 1997 and was approved by the NMED in 2002 (NMED 2002, 73830) following resolution of comments in an NMED request for supplemental information. In 2002, the NMED requested that the Laboratory address groundwater characterization deficiencies in a separate work plan. This is the sampling and analysis plan (SAP) for investigating surface water and groundwater in the Mortandad Canyon system. This SAP supersedes and replaces the surface water and groundwater investigations outlined in Chapter 7 of the Mortandad Canyon work plan (LANL 1997, 56835).

These wells are intended to provide hydrogeologic and water-quality data for regional groundwater in the vicinity of potential contaminant sources in Mortandad Canyon. These data will be used with similar data from other wells in the area to improve the conceptual model for geology, hydrology, and chemistry and will provide constraints on the nature and extent of contamination in this canyon.

Wells R-1 and R-28 were originally planned to be installed in other locations in the Hydrogeologic Workplan (LANL 1998, 59599), but have been relocated to Mortandad Canyon. R-1 replaces the obsolete monitoring well TW-8. It is located at the critical location where Mortandad Canyon widens, and significant changes in the alluvial aquifer gradient occur. This area may have enhanced infiltration of alluvial water containing contaminants. Therefore, this is an important well for contaminant monitoring at the regional aquifer. Well R-28 will provide a contaminant analysis and monitoring point for comparison with regional wells R-15, R-11, and R-13. Well R-33 will be used to provide sentinel contaminant monitoring for supply well PM-5. R-34 will help constrain the nature and extent of potential contamination in the regional aquifer in a large uncharacterized area southeast of Mortandad Canyon. It will be used to monitor groundwater quality on San Ildefonso Pueblo land between characterization wells R-13 and R-22.

All four wells will be installed by drilling boreholes through the regional water table. The wells will undergo hydrologic testing and will be sampled to determine water quality. Wells R-1 and R-28 will be drilled in two phases. Phase I consists of collecting continuous core from the surface to specific target depths for each borehole or to auger refusal. Core from these holes will be used to characterize vertical contaminant profiles in the vadose zone beneath the canyon floor. In Phase II, drilling will be to approximately 100 ft into the regional aquifer, and single screen wells will be installed. Well R-33 will be drilled approximately 642 ft into the regional aquifer to intersect the zones expected to have the highest productivity in PM-5. A multiscreen well will be installed at R-33. R-34 will be drilled approximately 100 ft into the regional aquifer, and a single screen well will be installed.

Information on radioactive materials and proposed work activities for investigation of radionuclide materials is provided in this document for information purposes only. The management of radioactive materials is regulated under the Atomic Energy Act and is specifically excluded from regulation under the Resource Conservation and Recovery Act (RCRA) and the New Mexico Hazardous Waste Act. The US Department of Energy (DOE) conducts investigations of radioactive materials in parallel with the corrective action investigations conducted under RCRA and, therefore, information about the radioactive material is included in this document as a matter of efficiency and not for approval by the NMED Hazardous Waste Bureau (HWB).

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Appendixes

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List of Acronyms and Abbreviations

3-D	three-dimensional
ARS	American Radiation Services of New Mexico
ASTM	American Society for Testing and Materials
bgs	below ground surface
CVAA	cold vapor atomic absorption
DOE	US Department of Energy
DQO	data quality objective
EDL	estimated detection limit
EES	Earth and Environmental Sciences
EPA	US Environmental Protection Agency
FSF	Field Support Facility
FTL	field team leader
FTM	field team manager
GEL	General Engineering Laboratory
GPC	gas proportional counting
HWM	Hazardous Waste Bureau (of the New Mexico Environment Department)
IC	ion chromatography
ICPMS	inductively coupled mass spectroscopy
ICPES	inductively coupled emission spectroscopy
ICPOES	inductively coupled optical emission spectroscopy
LANL	Los Alamos National Laboratory
LCMS	liquid chromatography mass spectrometry
LSC	liquid scintillation counting
NGR	natural gamma radiation
NMED	New Mexico Environment Department
NTU	nephelometric turbidity unit
OU	operable unit
QA	quality assurance
QP	quality procedure
RPF	Records Processing Facility
RRES-RS	Risk Reduction and Environmental Stewardship-Remediation Services
SAP	sampling and analysis plan
SMO	Sample Management Office
SOP	standard operating procedure
SSO	site safety officer
TA	technical area
TD	total depth

TDS	total dissolved solids
TIMS	thermal ionization mass spectrometry
TL	team leader
WCSF	waste characterization strategy form
WWTP	wastewater treatment plant
XRD	x-ray diffraction spectroscopy
XRF	x-ray fluorescence analysis

Metric to US Customary Unit Conversions

Multiply SI (Metric) Unit	by	To Obtain US Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (μm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (μg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

1.0 INTRODUCTION

Characterization wells R-1, R-28, R-33, and R-34 are being installed at Los Alamos National Laboratory as part of the "Mortandad Canyon Groundwater Work Plan" (LANL 2003, 79557). This work plan for Mortandad Canyon describes revisions and updates to the "Work Plan for Mortandad Canyon Operable Unit (OU) 1049, September 1997" (LANL 1997, 56835). The location of the wells is shown on Figure 1.

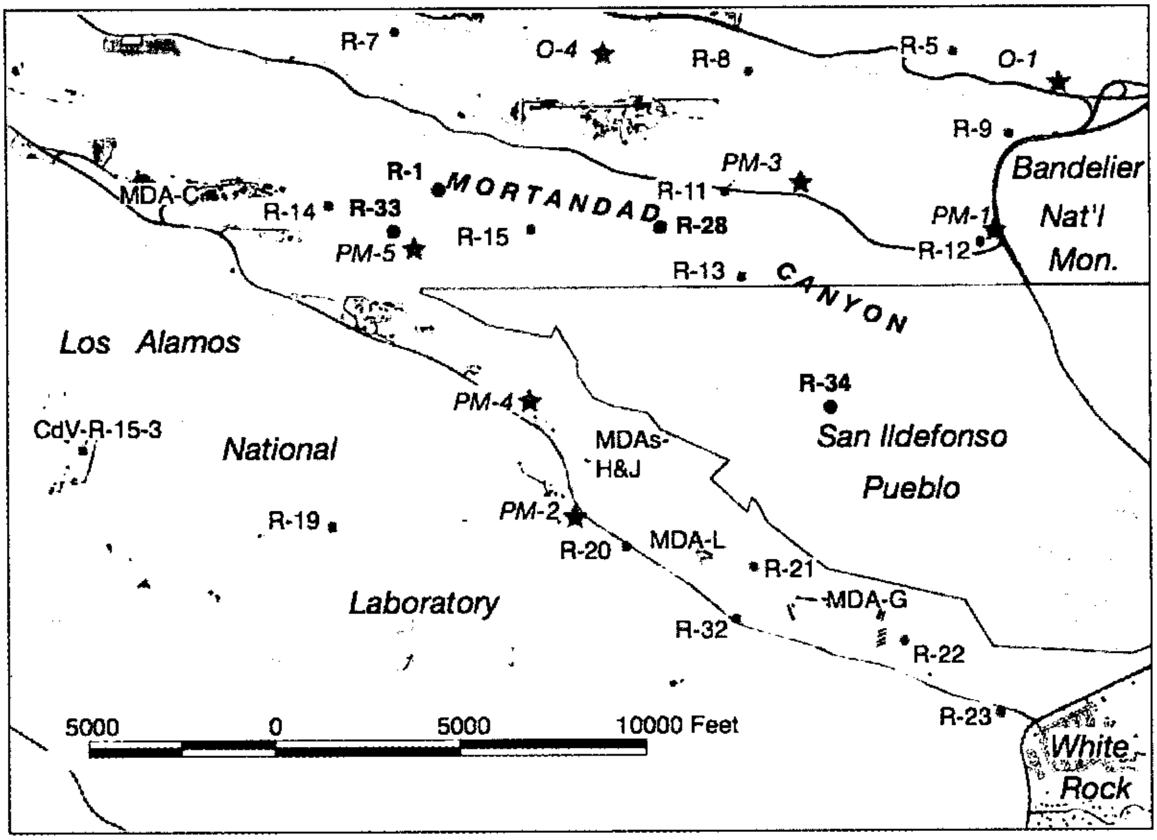

Figure 1. Location map of proposed wells R-1, R-28, R-33, and R-34. Proposed wells are shown as red circles, installed Hydrogeologic Workplan wells are shown as blue circles, and water supply wells are shown as blue stars.

The work plan for Mortandad Canyon was first submitted by the Laboratory to the NMED in 1997 and was approved by the NMED in 2002 (NMED 2002, 73830), following resolution of comments in an NMED request for supplemental information. In 2002, the NMED requested that the Laboratory address groundwater characterization deficiencies in a separate work plan. This is the sampling and analysis plan (SAP) for investigating surface water and groundwater in the Mortandad Canyon system. This SAP supersedes the surface water and groundwater investigations outlined in Chapter 7 of the Mortandad Canyon work plan (LANL 1997, 56835).

These wells are intended to provide hydrogeologic and water-quality data for regional groundwater in the vicinity of potential contaminant sources in Mortandad Canyon. These data will be used with similar data from other wells in the area to improve the conceptual model for geology, hydrology, and chemistry and will provide constraints on the nature and extent of contamination in this canyon.

Wells R-1 and R-28 were originally planned to be installed in other locations in the Hydrogeologic Workplan (LANL 1998, 59599) but have been relocated to Mortandad Canyon. R-1 is located at the critical location where Mortandad Canyon widens, and significant changes in the alluvial aquifer gradient occur. This area may have enhanced infiltration of alluvial water containing contaminants. Therefore, this well is important for contaminant monitoring at the regional aquifer. Well R-28 will provide a contaminant analysis and monitoring point for comparison with regional wells R-15, R-11, and R-13. Well R-33 will be used to provide sentinel contaminant monitoring for supply well PM-5. R-34 will help constrain the nature and extent of potential contamination in the regional aquifer in the eastern (lower) portion of Mortandad Canyon. It may be used as a groundwater monitoring point for San Ildefonso Pueblo between R-13 and R-22.

This SAP includes a brief description of the overall objectives of these wells, the roles and responsibilities of various Laboratory and contractor participants, the type and frequency of data to be collected, and information about the types, frequency, volumes, and containerization of samples that will be collected. The objective of this SAP is to ensure consistency and quality of characterization data. Unless otherwise noted, all tasks in this SAP will be performed by the contractor.

1.1 Summary of Data Quality Objectives

Mortandad Canyon extends for 9.8 mi (15.8 km) from near Diamond Drive in Technical Area (TA-)3 east southeast to the Rio Grande and has a total watershed area (excluding Cañada del Buey) of about 6.0 mi^2 ([15.5 km^2] LANL 1997, 56835; LANL 1999, 62777, p. 1-3). Figure 1 shows the location of Mortandad Canyon and its tributaries. The lower part of Mortandad Canyon is on San Ildefonso Pueblo land. Primary tributary drainages on Laboratory land are Effluent Canyon, which heads in TA-48, and Ten Site Canyon, which heads in TA-50. Active technical areas in the watershed include TA-3, TA-35, TA-50, TA-48, TA-55, TA-60, and TA-63. Inactive technical areas include former TA-4, TA-5, former TA-42, and TA-52. Activities at these sites are discussed in the Mortandad Canyon work plan (LANL 1997, 56835; LANL 1999, 62777, pp. 2-9 to 2-26).

A detailed discussion of previous investigations conducted in Mortandad Canyon and its tributaries prior to 1997 is provided in Chapters 2, 3, and 7 of the "Work Plan for Mortandad Canyon Operable Unit (OU) 1049, September 1997" (LANL 1997, 56835). The Laboratory publishes results of sampling of air, sediments, surface water, and groundwater in Mortandad Canyon in annual Laboratory surveillance reports (ESP 2000, 68661; ESP 2001, 73876; ESP 2002, 71301). The US Environmental Agency (EPA) conducted independent groundwater and surface water monitoring in the canyon in 1999, 2001, and 2002 that confirmed the presence of contaminants observed by the Laboratory.

The Laboratory began monitoring sediments, surface water, and groundwater in Mortandad Canyon and its tributaries in the early 1960s. Contaminants have been identified in alluvial and perched intermediate groundwater and in the regional aquifer within Mortandad Canyon. Historically, the following constituents of concern have been detected in surface water and alluvial groundwater: americium-241; cesium-137; plutonium-238 and plutonium-239,-240; strontium-90; tritium; uranium-234,-235,-236, and -238; nitrate; perchlorate; chloride; sulfate; fluoride; and total dissolved solids ([TDS] ESP 2000, 68661; ESP 2001, 73876; ESP 2002, 71301).

Mortandad Canyon and its tributaries have received effluents from the Laboratory since the early 1950s. These effluents, discharged from TA-3, TA-35, TA-48, and TA-50, have contained a variety of contaminants, including nitrate, perchlorate, tritium, cesium-137, strontium-90, americium-241, and several isotopes of uranium and plutonium (LANL 1997, 56835). Active outfalls discharging to Mortandad Canyon include TA-3 and TA-50. Most contaminants found in Mortandad Canyon are associated with

TA-50 discharges into Effluent Canyon, except for sources of strontium-90 (LANL 1997, 56835), nitrate, and perchlorate from TA-35, which were discharged into Pratt Canyon. The total mass of nitrate and perchlorate discharged from TA-35 is not known.

The data quality objectives (DQOs) identified in Table 1 will be accomplished by collecting geologic and geophysical information about perched groundwater occurrences, installing wells with single and multiple screens in the regional aquifer, collecting groundwater to determine water quality, and, in some wells, collecting core samples to determine the vertical distributions of contaminants and moisture content through the vadose zone. Information for the sitewide, three-dimensional (3-D) geologic model will be provided by examining and interpreting the cuttings, core, and geophysical logs.

Table 1
Data Quality Objectives for Wells R-1, R-28, R-33, and R-34 in Mortandad Canyon

	Well R-1	Well R-28	Well R-33	Well R-34
Primary Purposes	Located at the critical location where Mortandad Canyon widens and significant changes in the alluvial aquifer gradient occur; area may have enhanced infiltration of alluvial water containing contaminants; well is important for contaminant monitoring at the regional aquifer Replaces TW-8, a well with flawed construction that may allow movement of contaminated alluvial water along the well bore to the regional aquifer	Will provide a contaminant analysis and monitoring point for comparison with regional wells R-15 (upstream Mortandad), R-11 (to the north in Sandia Canyon), and R-13 (to the southeast in downstream Mortandad Canyon).	Will be used to provide sentinel contaminant monitoring for supply well PM-5 along with R-14 and R-15; known contamination of nitrate, perchlorate, and tritium occurs in perched groundwater in this section of Mortandad Canyon and perched groundwater probably provides a source of recharge to the regional aquifer Will be sited north of PM-5 south of Mortandad Canyon Drill and sample this well after drilling R-1 and R-28 drilled	Will help constrain the nature and extent of potential contamination in the regional aquifer in the eastern (lower) portion of Mortandad Canyon May be used to provide a groundwater monitoring point for San Ildefonso Pueblo between R-13 and R-22 Drill and sample after drilling R-1, R-28, and R-33
Projected Depth	1126 ft: penetrate to a depth of 100 ft below the regional water table	967 ft: penetrate to a depth of 100 ft below the regional water table	1900 ft: penetrate to a depth of ~642 ft below the regional water table	1015 ft: penetrate to a depth of 100 ft below the regional water table
Geology Issues/ Activities	Confirm stratigraphic contacts identified in the TW-8 lithologic log	Identify contacts for Bandelier Tuff and Cerro Toledo interval, Cerros del Rio basalt, and Puye fanglomerates for sitewide models	Identify contacts for Bandelier Tuff and Cerro Toledo interval, Cerros del Rio basalt, Puye fanglomerates, pumiceous deposits, Totavi Lentil, older fanglomerates, and Santa Fe Group sediments and basalts for sitewide models	Identify contacts for Bandelier Tuff and Cerro Toledo interval, Cerros del Rio basalt, Puye fanglomerates, and pumiceous deposits for sitewide models
Hydrology Issues/ Activities	Determine hydraulic gradient, hydraulic conductivity, and extent of saturation in Puye Formation Conduct cross-hole pumping test with TW-8 if feasible Evaluate localized flow patterns in the regional aquifer	Determine hydraulic gradient, hydraulic conductivity, flow direction, and extent of saturation in Puye Formation Evaluate localized flow patterns in the regional aquifer	Determine hydraulic gradient, hydraulic conductivity, flow direction, and extent of saturation in upper part of regional zone of saturation Evaluate localized flow patterns in the regional aquifer	Determine hydraulic gradient, hydraulic conductivity, flow direction, and extent of saturation in Puye Formation Evaluate localized flow patterns in the regional aquifer
Geochemistry Issues/ Activities	Evaluate effect of releases from TA-50 and other surface release sites on water quality in the regional aquifer Constrain location and rate of percolation from vadose zone to regional aquifer Evaluate groundwater chemistry in Mortandad Canyon in relationship to R-14, R-15, and R-13	Evaluate effect of releases from TA-48, TA-50, and other surface release sites on water quality in the regional aquifer Constrain location and rate of percolation from vadose zone to regional aquifer Evaluate groundwater chemistry in Mortandad Canyon in relationship to R-14, R-15, and R-13	Evaluate effect of releases from TA-48, TA-35, TA-50, and other surface release sites on water quality in the regional aquifer Evaluate groundwater chemistry in Mortandad Canyon in relationship to PM-5, R-14, R-15, and R-13	Evaluate effect of releases from TA-48, TA-50, and other surface release sites on water quality in the regional aquifer on San Ildefonso land Evaluate groundwater chemistry in Mortandad Canyon in relationship to R-11, R-14, R-15, and R-13

Table 1 (continued)

	Well R-1	Well R-28	Well R-33	Well R-34
Vadose Zone Sampling	Collect core and analyze for anions, metals, radionuclides, and stable isotopes Collect water samples if perched water is encountered during drilling	Collect vadose zone core and analyze for anions, metals, radionuclides, and stable isotopes Collect water samples if perched water is encountered during drilling	Collect water samples if perched water is encountered during drilling	Collect water samples if perched water is encountered during drilling
Core Needs	Collect core samples from surface to core refusal (target 590 ft) for contaminant, metal, and anion analyses Identify contacts for Bandelier Tuff and Cerro Toledo interval, upper Puye fanglomerates, and Cerros del Rio basalt	Collect core samples from surface to core refusal (target 336 ft) for contaminant, metal, and anion analyses Identify contacts for Bandelier Tuff and Cerro Toledo interval, and upper Puye fanglomerates	None	None
Regional Aquifer Sampling	Collect screening water samples during drilling at the top of the regional aquifer Install well screen to collect water-quality data for the regional aquifer	Collect screening water samples during drilling at the top of the regional aquifer Install well screen to collect water-quality data for the regional aquifer	Collect screening water samples during drilling at the top of the regional aquifer Install well screens to collect water-quality data for the regional aquifer	Collect screening water samples during drilling at the top of the regional aquifer Install well screen to collect water quality data for the regional aquifer
Hydraulic Testing	Conduct slug test and/or injection/straddle packer test in the screen completely below the regional water table. Conduct cross-hole pumping test with TW-8 if feasible	Conduct slug test and/or injection/straddle packer test in the screen completely below the regional water table	Conduct slug test and/or injection/straddle packer tests in the screens completely below the regional water table	Conduct slug tests and/or injection/straddle packer test in the screen completely below the regional water table
Geophysical Testing	Run cased hole geophysical suite, including neutron log, in TW-8 prior to plugging and abandonment Suite and timing of geophysical logging to depend on borehole conditions in replacement borehole, (see Table 12 for suite of possible logs) In replacement borehole, laboratory borehole video camera to be used when open hole if conditions in the vadose zone are favorable for logging	Suite and timing of geophysical logging to depend on borehole conditions (see Table 12 for suite of possible logs) Laboratory borehole video camera to be used when open hole if conditions in the vadose zone are favorable for logging	Suite and timing of geophysical logging to depend on borehole conditions (see Table 12 for suite of possible logs) Laboratory borehole video camera to be used when open hole if conditions in the vadose zone are favorable for logging	Suite and timing of geophysical logging to depend on borehole conditions (see Table 12 for suite of possible logs) Laboratory borehole video camera to be used when open hole if conditions in the vadose zone are favorable for logging
Number of Well Screens in Regional Aquifer	Single screen to be placed just below the regional aquifer water table Screen length and placement to be determined after evaluation of water table depth, locations of hydrogeologic units, locations of productive water zones, and water-level declines in the area Screen will provide access to groundwater so that contaminant concentration in the upper part of the regional aquifer can be determined	Single screen to be placed just below the regional aquifer water table Screen length and placement to be determined after evaluation of water-table depth, locations of hydrogeologic units, locations of productive water zones, and water-level declines in the area Screen to provide access to groundwater so that contaminant concentration in the upper part of the regional aquifer can be determined	Multiple screens (number to be determined) to be placed at depths that correspond to expected productive zones in PM-5 Screen length and placement to be determined after evaluation of water table depth and location of hydrogeologic units Screen to provide access to groundwater so contaminants potentially approaching PM-5 can be detected	Single screen to be placed in the zone of continuous saturation below the regional aquifer water table Screen length and placement to be determined after evaluation of water-table depth, locations of hydrogeologic units, locations of productive water zones, and water-level declines in the area Screen to provide access to groundwater so contaminant concentration in the upper part of the regional aquifer can be determined

1.2 Locations of Wells

Figure 1 shows the locations of the four wells. Table 2 shows horizontal well coordinates as New Mexico State Plane Grid Coordinates, Central Zone (North American Datum of 1983). Elevations are expressed in feet above sea level relative to the National Geodetic Vertical Datum of 1929 (NAD83).

Table 2
Approximate NAD83 State Plane Coordinates for Proposed Wells

Well	Easting (ft)	Northing (ft)	Elevation (ft)
R-1	1,632,238	1,769,693	6883
R-28	1,638,357	1,768,450	6756
R-33	1,631,644	1,768,275	7108
R-34	1,643,365	1,763,452	6652

1.3 Roles and Responsibilities

The DOE is responsible for drilling and installing the regional wells described in this SAP, as administered through a federal contract to conduct drilling services with Kleinfelder, Inc. DOE/Kleinfelder are responsible for

- planning and drilling cores and boreholes,
- sample collection and transmittal to the Laboratory's Sample Management Office (SMO),
- geophysical investigations,
- well construction,
- site restoration,
- waste management,
- health and safety,
- preparing well completion reports, and
- transmittal of records to Records Processing Facility (RPF).

The Laboratory's role is to provide technical and logistical support to the drilling effort. The functional organization of the implementation of this well installation effort is illustrated in Figure 2. Roles and responsibilities for the investigation team are shown in Table 3.

1.4 Communicating with NMED

The Laboratory/DOE will provide NMED with weekly reports about the status of drilling, characterization, well construction, and well development activities. In addition, NMED will be contacted by phone, with follow-up by email or letter, when changes in borehole conditions, well installation and development activities, or data collection activities result in significant deviations from this SAP. When possible, input from NMED will be sought before changes in planned activities take place. However, some decisions may be made prior to NMED consultation because of the rapid pace of drilling activities. In this case, NMED will be contacted as soon as possible with information about changes to ongoing activities and an assessment of how these changes affect the goals of this SAP. Deviations from this SAP will be enumerated in the well completion reports.

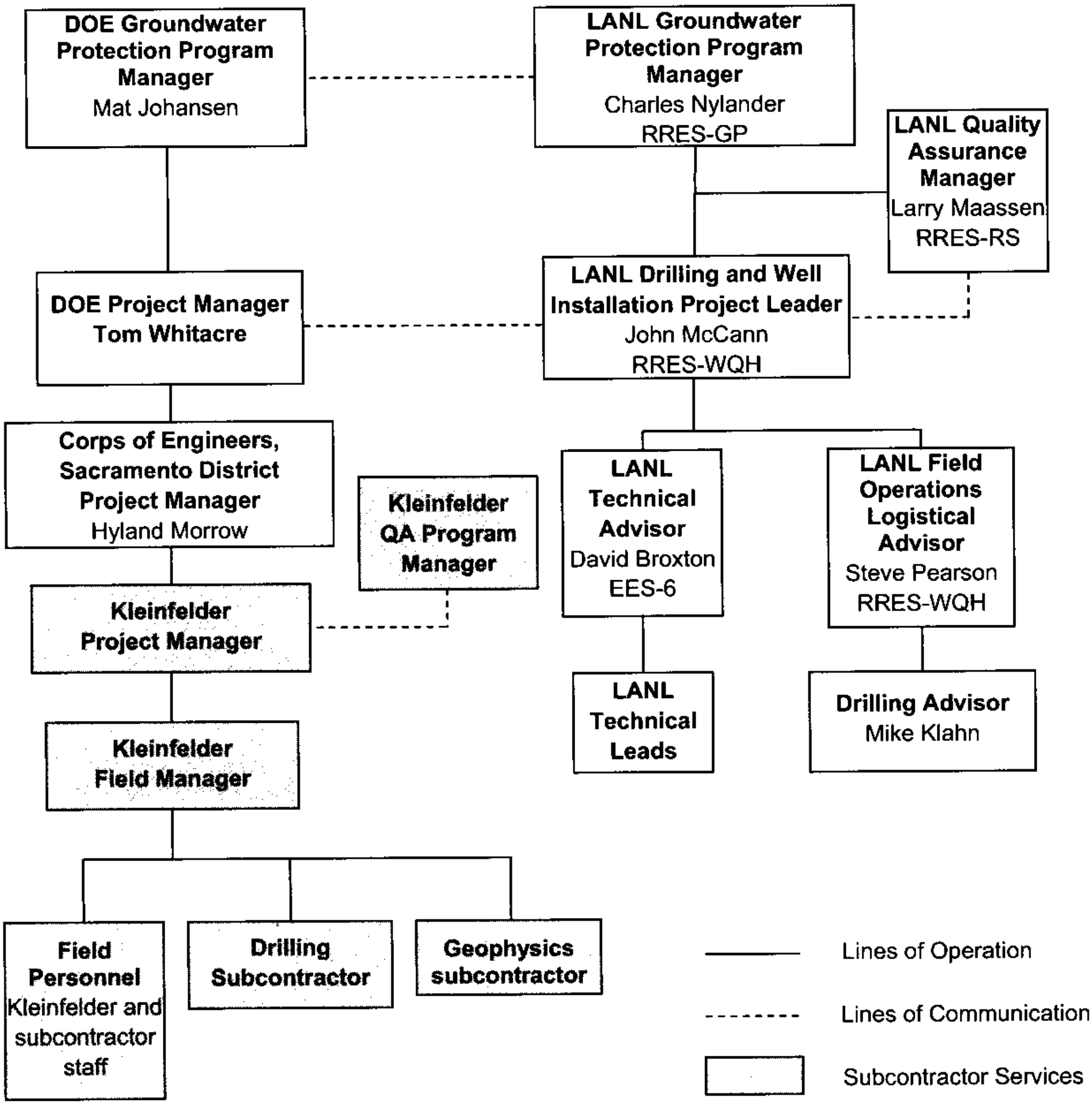

Figure 2. Functional organization for Well R-1, R-28, R-33, and R-34 installation

Table 3
Roles and Responsibilities

Personnel	Phone/Pager	Organization	Position	Project Roles/Responsibilities
Charles Nylander	665-4681 (work) 699-1568 (cell)	LANL[a]/ RRES-GP[b]	Groundwater Protection Program Program Manager	Responsible for LANL Groundwater Protection Program
Mat Johansen	665-5046 (work)	DOE	Program Manager	Management of groundwater programs
Tom Whitacre	665-5042 (work)	DOE	Project Manager	Drilling subcontract technical representative; responsible for successful completion of the drilling program
Hyland Morrow	916-557-7865 (work)	US Army Corps of Engineers	Project Manager	Contract manager for drilling contract
Paul Fensterer	505-344-7373 (work) 505-249-6486 (cell)	Kleinfelder	Program Manager	Responsible for completing drilling program, health and safety, QA, and waste management
Alan Kuhn	505-344-7373	Kleinfelder	Quality Manager	Responsible for project QA
Mark Everett	505-7373 (work) 505-681-5333 (cell)	Kleinfelder	Project Manager	Responsible for oversight of contractor field and drilling activities
Bernie Bockisch	505-401-1955 (cell)	Kleinfelder	Field manager	Responsible for contractor field and drilling activities
John McCann	665-1091 (work) 699-2204 (cell)	LANL/ RRES-WQH[c]	Groundwater Protection Program Project Leader	LANL manager responsible for LANL personnel and activities
Steve Pearson	667-3005 (work) 699-3684 (cell)	LANL/ RRES-WQH	Groundwater Protection Program field operations team leader	Provide LANL oversight for field and drilling activities; coordinate field activities of LANL technical team
David Broxton	667-2492 (work) 699-0950 (cell)	LANL/ EES-6[d]	Groundwater Protection Program technical advisory team leader	Provide technical leadership for design of testing program
Patrick Longmire	665-1264 (work) 699-1987 (cell) 104-3993 (page)	LANL/ EES-6	Groundwater Protection Program geochemistry lead	Provide technical leadership for geochemical characterization and sampling
William Stone	665-8340 (work)	LANL/ EES-5	Groundwater Protection Program hydrology lead	Provide technical leadership for hydrologic characterization and well development.
David Vaniman	667-1863 (work) 104-7019 (page) 699-1079 (cell)	LANL/ EES-6	Groundwater Protection Program geology lead	Provide technical leadership for geologic characterization
Larry Maassen	667-1691 (work)	LANL/ RRES-RS	LANL Quality Manager	Provide QA oversight of LANL technical and logistical support personnel activities.
Mike Klahn	667-7977 (work) (979) 229-8332 (cell)	John M. Klahn Consulting	Drilling advisor	Provide drilling expertise and advice to LANL Program Manager
Ann Lee	667-0753 (work)	LANL/ RRES-WQH	Data steward	Responsible for incorporating data generated during investigations into LANL data bases

[a] LANL = Los Alamos National Laboratory.

[b] EES-6 = Earth and Environmental Sciences Hydrology, Geochemistry, and Geology Group.

[c] RRES-GP = Risk Reduction and Environmental Stewardship–Groundwater Protection Program.

[d] RRES-WQH = Risk Reduction and Environmental Stewardship–Water Quality and Hydrology.

1.5 Health and Safety

All fieldwork will be conducted in accordance with the Kleinfelder health and safety plan as approved by DOE. DOE is responsible for completing the Laboratory Environment, Safety and Health identification (ESH-ID) profile for each of the four wells.

1.6 Quality Assurance

Kleinfelder is responsible for conducting all procurement, field operations, and drilling in accordance with its contractor quality assurance (QA) program. The contractor's quality management plan will be consistent with DOE Order 414.1A, Quality Assurance, and reflect the technical intent of the standard operating procedures (SOPs) and quality procedures (QPs) provided by the University of California and adopted by DOE as pertinent to these investigations. Laboratory personnel are required to perform work under the RRES-RS QA program. Pertinent SOPs and QPs are listed in Appendix A, Pertinent Standard Operating and Quality Procedures.

1.7 Waste Management

Kleinfelder, DOE's contractor for drilling services, is responsible for all waste-management activities. A waste characterization strategy form (WCSF) for wells R-1, R-28, R-33, and R-34 will be prepared to describe the on-site management of groundwater, cuttings, and drilling media as well as the temporary storage of wastes pending waste characterization and/or disposal in accordance with appropriate regulatory requirements. The Laboratory will prepare and submit a notice of intent to NMED to discharge drilling fluids, development water, and groundwater on the site. Drill cuttings will be characterized for potential contaminants and disposed of as nonhazardous, nonradioactive solid waste or reused on the site for restoration activities. After solids are removed and wastes are characterized, options to re-use, apply to the land, or dispose of the drilling fluids will be evaluated.

2.0 GEOLOGIC CHARACTERIZATION

Drill holes R-1, R-28, R-33, and R-34 will provide information on the geologic setting in Mortandad Canyon. Figures 3 through 6 show predicted depths to geologic contacts for all four drill holes. R-1 and R-28 will be drilled in two phases, with core collected in Phase I and cuttings collected in Phase II. The core is needed to determine contaminant distribution in the vadose zone. The cuttings will provide lithologic information for intervals penetrated. R-33 and R-34 will be drilled to total depth (TD) in a single operation. Cuttings will be collected for both boreholes; no core will be collected.

At R-1 and R-28, during Phase I drilling, all recovered core will be preserved for geologic examination and for selection of vadose zone samples. At R-1 (Phase II drilling only) and R-28 (Phase II drilling only) and at R-33 and R-34, an estimated 500 to 700 mL of bulk drill cuttings will be collected every 5 ft, as conditions permit, for the TD of the boring. Table 4 lists sample collection activities for cuttings and core. Cuttings will be stored in plastic bags labeled with the well name and footage range representing the depth interval at which the cuttings were collected. The core samples and cuttings bags will be stored in core boxes labeled with the well name, box number, and footage range for the box. The core boxes will be transported to a Laboratory-designated facility for archiving and storage after the borehole is completed.

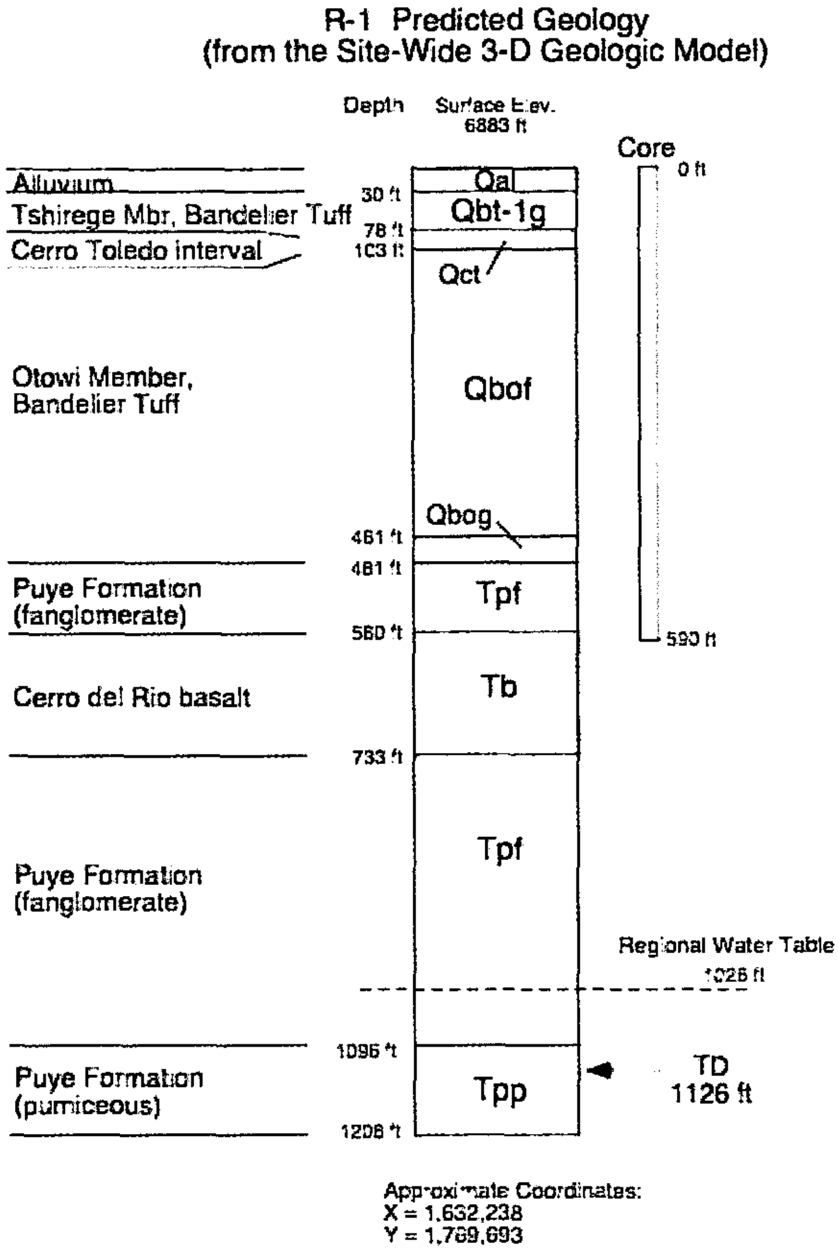

Figure 3. Predicted geology for proposed well R-1

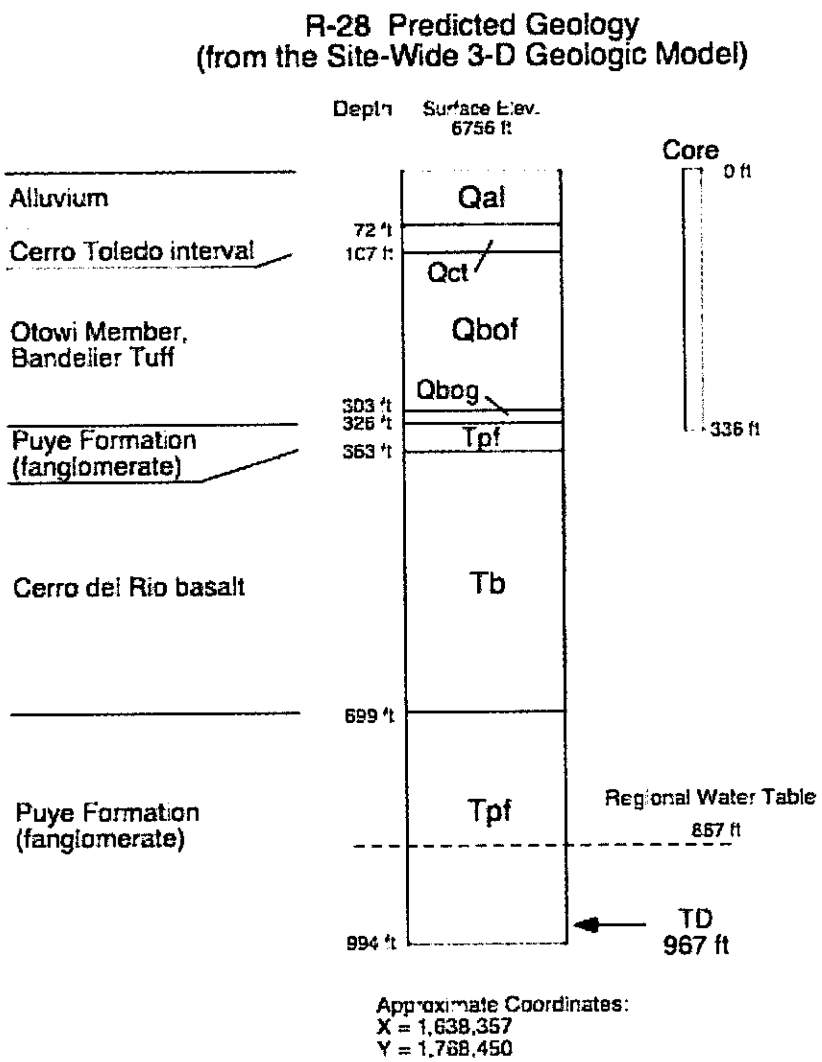

Figure 4. Predicted geology for proposed well R-28

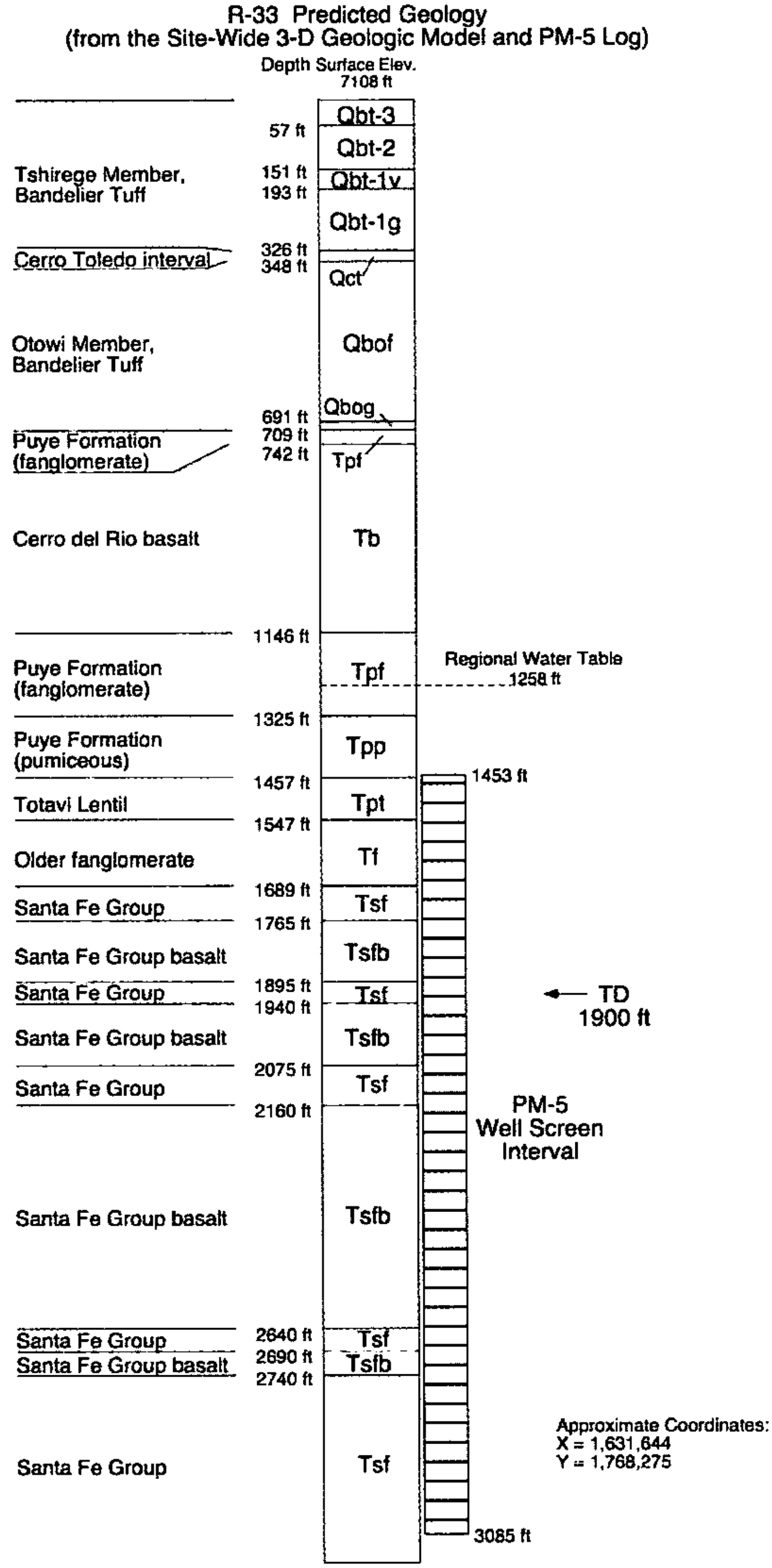

Figure 5. Predicted geology for proposed well R-33

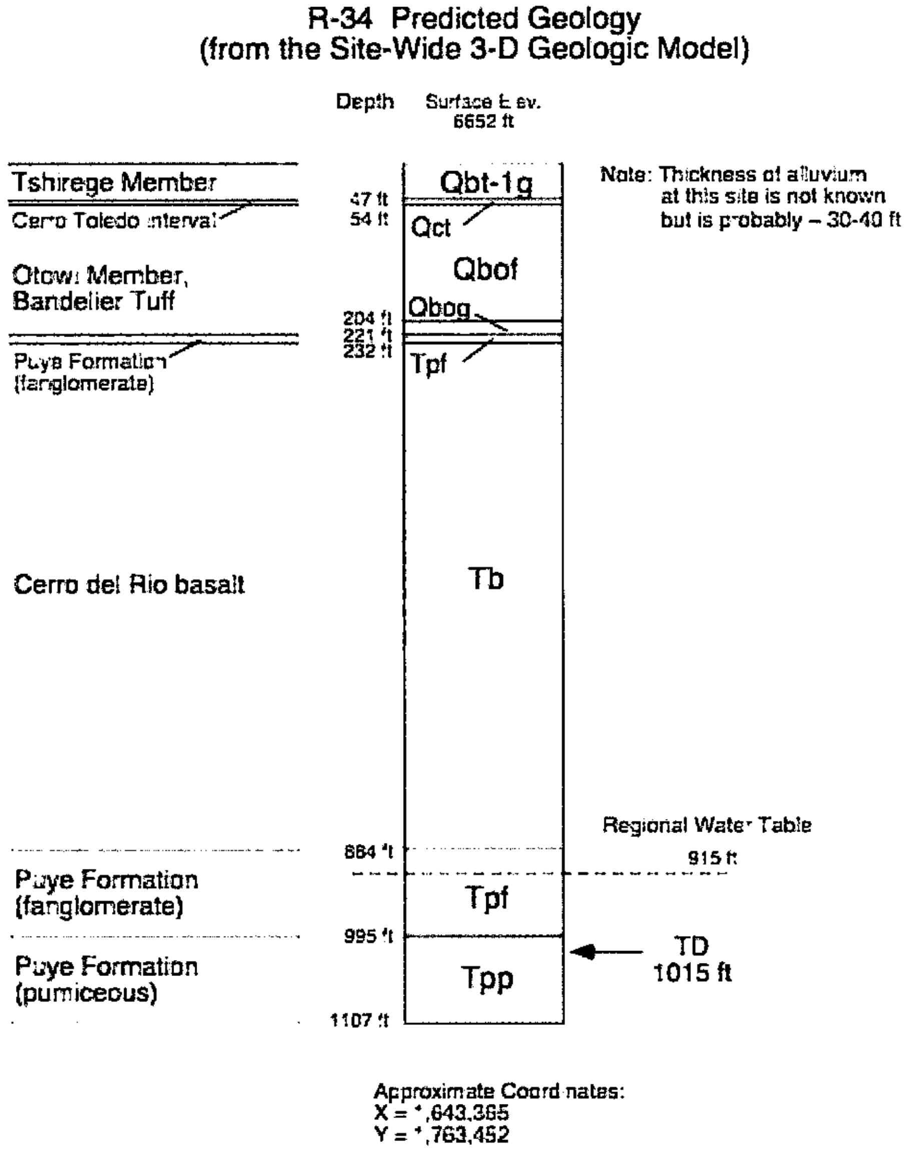

Figure 6. **Predicted geology for proposed well R-34**

A subset of unsieved and sieved samples will be collected from each cuttings interval and stored in plastic chip trays labeled with the well name and cuttings depth ranges (Table 4). Unsieved and sieved cuttings will be placed in individual tray bins and labeled by footage and sieve size-range. Sieve sizes typically will be >10 and >35 mesh but will be >35 and >60 mesh for finer-grained materials. Lost-circulation zones (no cuttings returns) will be indicated by empty trays.

Additionally, about 200 to 300 mL of >10 mesh cuttings will be collected at every cuttings interval (nominally every 5 ft) and stored in sealed plastic bags labeled with the well name and footage range representing the depth interval at which the cuttings were collected (Table 4). Finer sieve sizes or bulk cuttings will be collected when >1 mesh materials are absent. The Laboratory will obtain these samples from the contractor after drilling activities are completed for each well.

Analytical testing of samples by the Laboratory may include mineralogy by x-ray diffraction (XRD); petrography by modal analysis of thin sections, by electron microprobe, and/or by scanning electron microscope; and geochemistry by x-ray fluorescence ([XRF] Table 4). Samples will be identified, labeled, and handled through logbook sample control maintained by the geology lead.

Table 4
Sampling of Core and Cuttings During Drilling of R-1, R-28, R-33, and R-34

Sample Description	Test	Sample Size	Container	Sample Frequency
Coring (For R-1 and R-28 only)				
Core	Anions and moisture	0.4 ft of 2-in.-diameter core	8 oz preweighed glass jar	For upper 100 ft: Every 10 ft when drilling dry For below 100 ft: Every 50 ft to target depth (R-1, 590 ft; R-28, 336 ft) or to refusal
	Tritium	0.5 ft of 2-in.-diameter core	Sealed plastic bag wrapped with tape and core-protected	For upper 100 ft: 10 samples to be collected when drilling dry For below 100 ft: Every 50 ft to target depth (R-1, 590 ft; R-28, 336 ft) or to refusal
	Radiological screening for gross alpha, beta, and gamma (for off-site transport of samples)	0.2 ft of 2-in. diameter core	Sealed plastic bag	Every 50 ft to target depth (R-1, 590 ft; R-28, 336 ft) or to refusal
	Radionuclides	0.5 ft of 2-in.-diameter core	Sealed plastic bag and core-protected	For upper 100 ft: 10 samples to be collected when drilling dry For below 100 ft: Every 50 ft to target depth (R-1, 590 ft; R-28, 336 ft) or to refusal
	Metals and cations	0.5 ft of 2-in.-diameter core	Sealed plastic bag and core protected	For upper 100 ft: 10 samples to be collected when drilling dry For below 100 ft: Every 50 ft to target depth (R-1, 590 ft; R-28, 336 ft) or to refusal
	Stable isotopes	0.5 ft of 2-in.-diameter core	Sealed plastic bag and core protected	For upper 100 ft: 10 samples to be collected when drilling dry For below 100 ft: Every 50 ft to target depth (R-1, 590 ft; R-28, 336 ft) or to refusal

Table 4 (continued)

Sample Description	Test	Sample Size	Container	Sample Frequency
Drilling (For R-1, R-28, R-33, and R-34)				
Cuttings	Bulk cuttings systematically collected for archival purposes and for supplemental sample needs	500–700 ml	Plastic ziplock bag	One sample every cuttings run (nominally every 5 ft), beginning at the bottom of the core hole or throughout the hole if no core is collected
	Sieved cuttings for lithology description, binocular microscope examination	Enough to partly fill trays	Plastic chip trays	One sample every cuttings run (nominally every 5 ft), including overdrilling of the core hole. Normally, an unsieved sample, a >10 mesh sample, and a >35 mesh sample every cuttings run
	Sieved cuttings XRD, XRF, and petrography	200–300 ml sieved or bulk if necessary	Plastic ziplock bag	One >10 mesh sample every cuttings run (nominally every 5 ft); finer sizes or bulk split will be substituted where >10 mesh size cannot be obtained

Note: Priority of sample core collection when recovery is less than 100% should be anions, moisture, and stable isotopes; radionuclides and tritium; and radiological screening, cations, and metals.

3.0 HYDROLOGIC CHARACTERIZATION

The number, location, and extent of saturated zones near the planned well locations in Mortandad Canyon have not been fully characterized. Wells installed as part of this drilling effort will provide additional data to evaluate groundwater occurrences in this area. Table 5 identifies geologic settings where potential saturated zones may occur. These potential occurrences are based on settings where groundwater is known to occur in other parts of the Laboratory, but their inclusion in Table 5 is not based on site-specific data. Figures 3 through 6 show predicted depths to the regional water table for each well.

Table 5
Potential Saturated Zones in Wells R-2, R-4, R-11, and R-26

Well	Groundwater Zone	Approximate Depth (ft)	Comments
R-1	Perched zone 1	0–30	Perched groundwater in alluvium
	Perched zone 2	78–103	Perched groundwater in Cerro Toledo deposits
	Perched zone 3	461–481	Perched groundwater at base of Guaje Pumice Bed
	Perched zone 4	481–580	Perched groundwater within upper Puye Formation; setting similar to perched water at MCOBT-4.4
	Perched zone 5	580–733	Perched groundwater within Cerros del Rio basalt; setting similar to perched water at R-15
	Regional water table	1026	Regional groundwater within Puye Formation
R-28	Perched zone 1	0–72	Perched groundwater in alluvium
	Perched zone 2	72–107	Perched groundwater in Cerro Toledo deposits
	Regional water table	867	Regional groundwater within the Puye Formation
R-33	Perched zone 1	326–348	Perched groundwater in Cerro Toledo deposits
	Perched zone 2	691–709	Perched groundwater at base of Guaje Pumice Bed
	Perched zone 3	742–1146	Perched groundwater within Cerros del Rio basalt; setting similar to perched water at R-15
	Regional water table	1258	Regional groundwater within Puye Formation
R-34	Regional water table	915	Regional groundwater within Puye Formation

3.1 Unsaturated Zones

Water and potential contaminants can move downward from the surface to saturated zones, especially in recharge areas. Thus, the characterization of hydrologic properties of geologic materials lying above perched and regional zones of saturation is important.

Geophysical and video logging will be conducted before casing is set in the vadose zone and after the borehole reaches TD to provide hydrologic information about the vadose zone in each well, if open-borehole conditions are favorable for logging. Selection of intervals to log and the types of logs that will be run will depend on factors such as the availability of open boreholes, questions about characterization that arise during drilling, and synchronization with other drilling and well-construction activities.

Moisture profiles in the vadose zone will be determined by collecting core samples between ground surface and specified target depths for each borehole. General target depths applied to collecting moisture content samples are 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600 ft (Table 4). In R-1, coring will terminate after about 590 feet or refusal, and in R-28 the target coring depth is 336 ft or refusal. No core will be collected in R-33 or R-34. Moisture content samples will be collected in the same 8-oz preweighed glass jar (Table 4) as the anion/cation profile samples described in Section 4.0, Geochemical Characterization, of this SAP.

3.2 Saturated Zones

The depth and evidence for the occurrence of all saturated zones will be noted during drilling by the contractor. Boreholes will be drilled as open borehole, if feasible, using air with minimal fluids. The open hole will facilitate using borehole geophysics to characterize moisture distribution and identify perched groundwater in the vadose zone and the regional water table. Evidence of saturation during drilling may include the drillers' observations of water production in the borehole, wet cuttings or core when drilling dry, open-borehole videos showing zones of flowing groundwater, and geophysical logs.

When the regional water table is first encountered, the contractor will measure a static water level using an electric water-level meter and/or a pressure-transducer system. Water levels will be recorded to the nearest 0.02 of a foot and recorded as depth below ground surface (bgs). If a graduated water-level probe is not used, fractions of a foot will be determined using a measuring tape. To ensure accuracy, individual measurements will be repeated until three reproducible results are obtained. To ensure that water-level values are static, measurements will be repeated every 15 min until results are reproduced within 0.5 ft (all readings will be recorded). Water-level measurements will be provided to the Laboratory/DOE within 12 hr of collection. Water-level data will include the following eight observations, which must be included in the data sheet provided in Appendix B, Water-Level Measurement Data Sheet:

1. borehole TD,
2. casing TD (if applicable),
3. amount of open hole (borehole TD – casing TD),
4. depth to water (ft bgs),
5. date,
6. drilling activity prior to water-level measurement,
7. time elapsed before water-level measurement was made, and
8. additional relevant comments.

As far as possible, the hydraulic properties of regional aquifer materials will be investigated using straddle-packer/injection, pumping, or slug tests. Hydrologic test design will be based on the final well configuration and the productivity of the screen during well development.

Appropriate SOPs for hydrologic tests as well as American Society for Testing and Materials (ASTM) SOPs (ASTM 1994) will be followed. Only potable water will be used for injection tests, and a volume equal to three times the amount introduced will be pumped from the well after testing to minimize dilution of the native groundwater. Tracers (e.g., potassium bromide) may be used to tag drilling water or water injected during testing. To facilitate making a decision to end the test, a real-time plot of results will be constructed on the site.

4.0 GEOCHEMICAL CHARACTERIZATION

Drilling characterization wells R-1, R-28, R-33, and R-34 will provide an opportunity to evaluate the natural and contaminant chemistry of both the unsaturated and saturated hydrogeologic materials in Mortandad Canyon. Groundwater encountered at these well sites will be sampled for selected inorganic and organic chemicals and radionuclides.

4.1 Anion, Cation, Metal, Stable Isotope, and Tritium Profiles and Contaminant Characterization of Core Samples Within the Unsaturated Zone

Core for geochemical characterization will be collected at wells R-1 and R-28. Core samples will be collected between ground surface and specified target depths for each borehole (see Tables 1 and 4).

General target depths applied to geochemical sampling in all four boreholes are 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600 ft. In R-1, coring will terminate after about 590 ft or refusal, and in R-28 the target coring depth is 336 ft or refusal. No core will be collected in R-33 or R-34.

Core and cutting samples from the unsaturated zone will be analyzed for selected radionuclides and stable isotopes. Analyses of anions, including perchlorate and nitrogen isotopes, and metals and cations will be performed on leachate formed from a deionized water slurry of the homogenized core samples. If core cannot be collected from the target depths listed in Table 4, the cation and radionuclide analyses will be performed on unsieved cuttings collected from the same target depths in the Phase II borehole; samples for anion and metal analyses will not be collected from drill cuttings, because they are strongly affected by drilling fluids. Solid samples will be identified, labeled, and handled through normal chain-of-custody control. Table 4 identifies the container and preservation requirements for core and cutting samples. Table 6 lists the analytical suites, analytical methods, and estimated detection limits (EDLs) for geochemical and contaminant characterization of cutting and core samples.

Solid samples will be submitted to the Laboratory's Earth and Environmental Sciences (EES) Division's Hydrology, Geochemistry, and Geology (EES-6) Group, and to appropriate off-site laboratories for various analyses. Core samples will be analyzed for moisture content at EES-6 and General Engineering Laboratory (GEL) (tritium analyses). These samples will be placed in preweighed jars provided by the Laboratory. After moisture content has been determined, these samples will be analyzed for anions (bromide, chloride, fluoride, iodide, nitrate, nitrite, oxalate, perchlorate, phosphate, and sulfate) at EES-6 using ion chromatography (IC). Other analytes and parameters include percent or fraction of solid organic carbon, tritium, americium-241, cesium-137, plutonium-238, -239, -240, strontium-90, and uranium-234, -235, -236, -238, and stable isotopes of hydrogen, nitrogen, and oxygen.

Table 6
Analyses of Core Collected in the Unsaturated Zone During Drilling of R-1, R-28, R-33, and R-34

Analyte	EDL[a]	Analytical Technique	Analytical Method
Anions, Cations[b], Metals, and Stable Isotopes			
Bromide, chloride, fluoride, iodide, nitrate, nitrite, oxalate, phosphate, sulfate	0.02 mg/L	IC	SW-846-EPA Method 300
Carbonate Alkalinity	1 mg/L	Titration	SW-846 – EPA Method 310.1
Perchlorate	0.004 mg/L[c] 0.002 mg/L[d]	IC	SW-846-EPA Method 300 LCMS/MS[e]
Arsenic, strontium, uranium, and others	0.001 mg/L	Inductively coupled mass spectrometry (ICPMS)	SW-846-EPA Method 6020
Aluminum, calcium, iron, magnesium, manganese, sodium, potassium	0.01 mg/L	Inductively coupled optical emission spectroscopy (ICPOES)	SW-846-EPA Method 6010B
$^{18}O/^{16}O$	n/a[f]	Isotope ratio mass spectrometry	Generic – oxygen isotope ratio
$^{2}H/^{1}H$	n/a	Isotope ratio mass spectrometry	Generic – deuterium ratio
$^{15}N/^{14}N$	n/a	Isotope ratio mass spectrometry	Generic – nitrogen isotope ratio
Contaminant Characterization			
Tritium	700 pCi/L	Liquid scintillation counting	EPA Method 906.0
Tritium	0.5 pCi/L	Direct counting or electrolytic enrichment	Generic low-level tritium
Americium-241	0.05 pCi/g	α-spectrometry	HASL-300: americium-241
Plutonium-238	0.05 pCi/g	α-spectrometry	HASL-300: isotopic plutonium
Plutonium-239,240	0.05 pCi/g	α-spectrometry	HASL-300: isotopic plutonium
Strontium-90	0.5 pCi/g	Gas proportional counting	EPA Method 905.0
Uranium-234	0.1 pCi/g	α-spectrometry	HASL-300: isotopic uranium
Uranium-235, -236	0.1 pCi/g	α-spectrometry	HASL-300: isotopic uranium
Uranium-238	0.1 pCi/g	α-spectrometry	HASL-300: isotopic uranium
Gamma spectroscopy	1.0 pCi/g	γ-spectroscopy	EPA Method 901.1

[a] EDL= listed as milligrams per liter for anions and picocuries per gram for radionuclide constituents except tritium (which is listed in picocuries per liter) in extracted or leached water.

[b] Anion and cation analyses will be performed on the leachate formed from a deionized water slurry of the homogenized core sample.

[c] Off-site laboratory.

[d] On-site screening.

[e] LCMS = Liquid chromatography mass spectrometry used for low-level perchlorate analysis (0.25 µg/L for quantitation limit).

[f] n/a = Not applicable.

4.2 Hydrochemistry and Contaminant Characterization Within Perched Zones and the Regional Aquifer

Saturated conditions are anticipated within a variety of geologic settings at the proposed well sites (Table 5). Groundwater screening samples provide an early indication about whether contaminants could be present in perched and regional groundwater before routine characterization samples are collected from the completed well. Depending on the number of perched-water zones encountered, up to five groundwater samples may be collected in each borehole for analysis of potential contaminants. If perched water is encountered within the vadose zone, one groundwater sample will be collected within up to three perched zones. Groundwater samples will be collected within the regional aquifer at the regional water table and at the borehole TD, if feasible.

Tables 7 and 8 provide information about analytical suite, estimated detection limits, analytical methods, and analytical protocols for groundwater samples for post-development characterization sampling. Table 9 provides information on the containers, preservation, and volumes of groundwater samples.

During drilling, nonfiltered borehole water samples containing suspended solids and solutes will be collected within perched zones and the regional aquifer provided that the drilling methods are conducive to such sampling. The nonfiltered groundwater samples will be analyzed for radionuclides and stable isotopes. Water samples will be filtered and acidified at EES-6 prior to delivery to the SMO for processing. Samples will be identified, labeled, and handled through normal chain-of-custody control. Samples should be delivered to EES-6 within 2 hr of collection during normal working hours. Samples that cannot be delivered during normal working hours must be delivered to EES-6 the following morning, after being stored overnight at 4°C in coolers.

When groundwater is encountered, the Laboratory will be notified to determine if groundwater in the borehole should be collected. Groundwater will be analyzed for the constituents listed in Tables 7 and 8. Groundwater samples will be collected according to the following guidelines.

- If casing-advance is used, the depth to the bottom of casing and depth to groundwater will be recorded on the sample collection log for each sample.
- The contractor will ensure that the sample collection, chain-of-custody, and routing to analytical laboratories are properly documented through paperwork provided by the RRES-RS central data management group.
- To minimize drill-rig downtime, water samples will be collected from the cyclone or other appropriate means.

Table 7
Analytical Suite, EDLs, Methods, and Protocols for Inorganic Chemicals in Groundwater Samples for Post-Development Characterization Sampling[a]

Analyte	EDL (µg/L)	Analytical Method	Analytical Protocol[b]
Metals (total and dissolved)			
Aluminum	10	ICPMS	SW-6020
Antimony	0.1	ICPMS	SW-6020
Arsenic	1	ICPMS	SW-6020
Barium	2	ICPMS	SW-6020
Beryllium	5	ICPMS	SW-6020
Boron	10	ICPMS	SW-6020
Cadmium	0.1	ICPMS	SW-6020
Calcium	10	ICPES	SW-6010B
Chromium	2	ICPMS	SW-6020
Cobalt	2	ICPMS	SW-6010B
Copper	2	ICPMS	SW-6020
Iron	10	ICPMS	SW-6020
Lead	0.1	ICPMS	SW-6020
Magnesium	10	ICPES[c]	SW-6010B
Manganese	2	ICPMS	SW-6020
Mercury	0.2	CVAA[d]	SW-7470A
Nickel	2	ICPMS	SW-6020
Potassium	10	ICPES	SW-6010B
Selenium	0.2	ICPMS	SW-6020
Silver	0.2	ICPMS	SW-6020
Sodium	50	ICPES	SW-6010B
Thallium	0.1	ICPMS	SW-6020
Uranium	0.1	ICPMS	SW-6020
Vanadium	2	ICPMS	SW-6020
Zinc	1	ICPMS	SW-6020
Anions (dissolved)			
Bromide	20	IC	SW-300
Chlorate	20	IC	SW-300
Chloride	20	IC	SW-300
Fluoride	20	IC	SW-300
Nitrate	40	IC	SW-300
Nitrite	40	IC	SW-300
Perchlorate	4	IC	SW-300
Orthophosphate	20	IC	SW-300
Sulfate	100	IC	SW-300
Other Inorganic Chemicals (dissolved)			
Silica	200	Colorimetry	EPA Method 370.1
Total cyanide	50	Colorimetry	SW-9012A

[a] Both nonfiltered (total) and filtered (dissolved) water samples will be collected. Water samples will be filtered at the time of collection to remove particles larger than 0.45 µm.
[b] EPA SW-846 Method (EPA 1986, 31732) or equivalent.
[c] ICPES = inductively coupled plasma emission spectroscopy.
[d] CVAA = cold vapor atomic absorption.

Table 8
Analytical Suite, Half-Life, Detection Emission, Minimum Detectable Activity, and Analytical Method for Radionuclides in Groundwater Samples for Post-Development Characterization Sampling[a]

Analyte	Half-Life (yr)	Detected Emission	MDA (pCi/L)	Analytical Method
^{241}Am	432.2	α	0.05	α-Spectrometry
^{238}Pu	87.7	α	0.05	α-Spectrometry
$^{239,240}Pu$[b]	2.411×10^4	α	0.05	α-Spectrometry
^{90}Sr	28.7	β	1.0	Gas proportional counting (GPC)
Tritium	12.3	β	250	Liquid scintillation counting (LSC)
Tritium (low-level)	12.3	β	1	Electrolytic enrichment/ direct counting
^{99}Tc	2.13×10^5	β	5	LSC
^{234}U	2.46×10^5	α	0.1	α-Spectrometry[c]
^{235}U	7.04×10^8	α	0.1	α-Spectrometry[c]
^{236}U[d]	2.342×10^7	α	0.1	Thermal ionization mass spectrometry (TIMS)
^{238}U	4.47×10^9	α	0.1	α-Spectrometry[c]
Gamma spectroscopy[e]	n/a[f]	γ	10[g]	γ-Spectroscopy
Gross-alpha	n/a	α	1.0	GPC or LSC
Gross-beta	n/a	β	1.0	GPC or LSC
Gross-gamma	n/a	γ	20	NaI(Tl) or HPGe detection

[a] Both filtered and non filtered samples will be collected for radionuclide analyses, excluding tritium and ^{99}Tc.
[b] The ^{239}Pu and ^{240}Pu isotopes cannot be distinguished by alpha spectrometry. The half-life of ^{239}Pu is given.
[c] Radionuclide may also be analyzed by ICPMS.
[d] Water sampling for ^{236}U analysis should use clean protocols including EPA 1669 or United States Geological Survey 94-539.
[e] The gamma spectroscopy analyte list includes gamma-emitting isotopes including ^{137}Cs.
[f] n/a = Not applicable.
[g] The minimum detectable activity (MDA) for ^{137}Cs is 15 pCi/L; the MDAs for other analytes will vary.

Table 9
Containers, Preservation, and Volumes of Groundwater Samples

Number of Water Samples	Analyte	Container	Preservation	Filtered through Acetate 0.45 micrometer?	Volume (L)	Laboratory	Archive Sample	Archival Sample Volume (L)
Up to 3 perched and 2 regional	Metals/cations (dissolved)	250-mL plastic	Nitric acid to pH 2, 4°C	Yes	0.25	EES-6	No	No
Up to 3 perched and 2 regional	Anions (dissolved)	250-mL plastic	None	Yes	0.25	EES-6	No	No
Up to 3 perched and 2 regional	Perchlorate, IC and/or LCMS/mass spectrometry	1-L	None	No	1.0	GEL	No	No
Up to 3 perched and 2 regional	Technetium-99 (total)[a]	1-gal. plastic	Hydrochloric acid to pH 2, 4°C	No	4.55	GEL	Yes	4.55
Up to 3 perched and 2 regional	Gamma spectroscopy, americium-241; cesium-137, plutonium-238, 239, 240; uranium-234, 235, 238; strontium-90	1-gal. plastic	Nitric acid to pH 2, 4°C	No	4.55	GEL	Yes	4.55
Up to 3 perched and 2 regional	Stable isotopes (^{18}O /^{16}O, D/H)	30-mL glass w/poly-seal cap	Ambient temperature	No	0.03	Geochron[b]	Yes	0.03
Up to 3 perched and 2 regional	(^{15}N /^{14}N)	1-gal. plastic	Hydrochloric acid to pH 2, ambient temperature	No	3.8	Coastal[c]	Yes	3.8
Up to 3 perched and 2 regional	Tritium (low-level screening)	500-mL poly	Ambient temperature	No	0.5	University of Miami	Yes	0.5
Up to 3 perched and 2 regional	ARS[d] gross alpha, gross gamma plus ARS gross gamma (R-1, R-28, and R-33 only)	500-mL poly	Ambient temperature	No	0.5	ARS	Yes	0.5
Sample volume (L) for archived samples								14

[a] For analysis of tecnicium-99 sample will settle to separate solids from aqueous phase prior to acidification with nitric acid.

[b] Geochron = Geochron Laboratory.

[c] Coastal = Coastal Science Laboratory.

[d] ARS = American Radiation Services of New Mexico.

Additional guidelines to be followed for groundwater sampling, field-parameter measurement, and sample preservation include the following.

- Record in the sample collection log the date, time, borehole inner diameter, depth to water prior to sampling, and the depth at which water entered the borehole.
- Record drilling fluids and additives in the borehole at the time of water collection.
- Prevent groundwater samples from freezing or overheating.
- Obtain air-lifted groundwater samples to collect approximately 7 gal. of groundwater, if practical.
- Record field-measured parameters for groundwater samples immediately (Table 10); see pertinent procedures in Appendix A and the appropriate vendor manual for instrument calibration for field measurement of pH, temperature, specific conductance, and turbidity.
- Filter and preserve selected groundwater samples at EES-6 analytical laboratory for anions and metals (Table 9). Collect appropriate volume (0.5 to 1 L, depending on turbidity or amount of suspended solids) of groundwater for filtering.
- Fill appropriate sample containers with nonfiltered groundwater (Table 9).
- Preserve nonfiltered samples with nitric acid (radionuclides) to pH 2 for samples sent to GEL (Table 9).
- Place labels and custody seals on each sample container.
- Preserve samples on ice (4°C) prior to shipment and analysis.
- Transport samples to EES-6 and the SMO in coordination with the central data management group to provide the electronic and paper chain-of-custody for transfer of samples to the SMO.
- Transport the indicated sample portion to the count laboratory (ARS) for radiological screening required prior to sample shipment from the SMO.
- Send properly preserved archival samples to be held at the Laboratory-designate facility for possible reanalysis; retention period for samples will be 6 months for radiological constituents, metals, and anions and 1 yr for tritium.

Samples of groundwater encountered at each R-well will be submitted for the analyses shown in Tables 7 and 8. Table 11 shows the total volumes of water required for a complete suite of analyses and for archival purposes.

Table 10
Parameters To Be Measured During Groundwater Sampling

Measurement	Sensitivity[a]
pH	±0.02
Carbonate alkalinity	1 mg $CaCO_3$/L
Specific conductance	±1 μmho/cm (25°C)
Temperature	±1 °C
Turbidity (nephelometric)	±1 NTU[b]

[a] Precision with which measurement will be recorded.
[b] NTU = nephelometric turbidity unit.

Table 11
Total Volumes of Water Required for Complete Suite of Analyses

Groundwater Sample	Volume (L)	Archived Sample	Volume (L)	Total Volume (L)	Plus NMED split (L)
Nonfiltered	11.13	Nonfiltered	14	25.13	2.0
Filtered	1.0	Filtered	0	1.0	1.0
Total	12.13	Total	14	26.13	3.0

5.0 GEOPHYSICAL CHARACTERIZATION

The Laboratory's technical advisor and DOE project manager will select the geophysical logs that are appropriate to determine the geologic and hydrologic characteristics of the vadose zone, perched saturated zones, and regional aquifer. Calibration licensing of radioactive source tools and logging will be performed in accordance with ASTM D5753-95e1, "Standard Guide for Planning and Conducting Borehole Geophysical Logging" (ASTM 1995). Borehole and well geophysical data will be obtained from the following two sources.

- Using the Laboratory's geophysical logging equipment, Laboratory/contractor personnel may collect video, caliper, spontaneous potential, single-point resistance and induction (conductivity), and natural gamma radiation (NGR) surveys when conditions permit the collection of open-borehole data.
- A wire-line logging service will be contracted to obtain a suite of borehole geophysical logs once the borehole reaches TD; drilling conditions will determine whether the borehole is open or cased at the time of logging.

The number and types of logs will vary as a function of borehole condition, the presence or absence of drill or well casing, and technical issues addressed by a particular logging run. Table 12 gives the typical suites of logs that have been run by wire-line logging services in cased and open boreholes during installation of previous hydrogeologic work plan wells (LANL 1998, 59599). General logging information and borehole conditions at the time of logging will be documented in the log header form and the borehole status form (Appendix C, Geophysics Data Sheets).

At the request of DOE, Kleinfelder may perform geophysical logging in open boreholes using the Laboratory's geophysical logging equipment. Such requests will be limited in number, and generally correspond to changes in drilling conditions that require casing advance through open-borehole segments. Kleinfelder will follow the SOP governing the operation of a Laboratory-owned borehole logging trailer (Appendix A).

Kleinfelder will collect a borehole video log when well installation is completed to document the as-built condition of installed well components. Kleinfelder will collect a natural gamma log to check tagged depths of annular fill materials. Additional borehole videos may be run during and after well development to assess the effectiveness of development techniques.

Table 12
Typical Wire-Line Geophysical Logging Tools

Cased Hole	Cased Hole	Open Hole	Uncased Hole
Array Induction Tool (AIT)		X	Measures open-hole formation conductivity with multiple depths of investigation at varied vertical resolution
Triple LithoDensity Tool (TLD)	X	X	Evaluates formation porosity where grain density can be estimated
Combinable Magnetic Resonance Tool (CMR)		X	Provides information on water content and relative abundance of hydrous minerals and capillary-bound versus mobile water
Natural Gamma Tool	X	X	Used to distinguish lithologies by their gross gamma signature; also used to calibrate depth of other geophysical tool readings
Natural Gamma Ray Spectrometry Tool (NGS; also called the spectral gamma tool)	X	X	Used to distinguish lithologies where formations vary in relative and overall concentrations of potassium, thorium and/or uranium
Epithermal Compensated Neutron Log (CNL)	X	X	Measures moisture content in unsaturated conditions and porosity in saturated conditions
Caliper		X	Measures rugosity of borehole wall
Fullbore Formation Microimager (FMI)		X	Provides high-quality image of borehole based on electrical properties; used to determine lithologies, bedding attitudes, fracture characteristics, and borehole deviation
Elemental Capture Spectrometer (ECS)	X	X	Determines formation lithology from bulk geochemistry; primary use in determining elemental concentrations of silicon, calcium, iron, titanium, and gadolinium

6.0 DOCUMENTATION AND REPORTING

Information generated in conjunction with the installation of these wells will be presented or preserved in various reports and records described below.

6.1 Field Documentation

Table 13 lists documentation that will be completed during the course of fieldwork. The content and format of most of these documents are well established. However, to ensure consistency in the sample collection logs, team members must include the

- well number,
- sample identification (ID),
- location ID number (if necessary),
- sample type (D = drill cuttings; C = core),
- upper and lower depth of interval sampled (in feet), and
- purpose (Geo = geology, Hydro Prop = hydraulic properties, and Geochem = geochemical analysis).

The identified individual or his or her approved designee will complete all documentation at the frequency given (table 13). Documentation will be relinquished to the field team manager daily or as needed.

Table 13
Required Field Documentation

Documentation	Responsible Kleinfelder Person	Frequency
Daily activity report (see Appendix D)	FTL*	Daily
FTM logbook	FTM*	Daily
Driller's log	Driller	Daily
Geological field log	FTM/geologist/task leader	As needed
Sample collection log	Sampler	As needed
Chain-of-custody, request for analysis	Sampler/FTM/task leader	As needed
Tailgate meeting attendance form	SSO*/FTM	Daily
Visitor's sign-in log	SSO/FTM	Ongoing
Miscellaneous waste management forms	Waste manager	As needed
Weekly summary report	FTM	Weekly
Field photographs	All	As needed
Water-level measurement data sheet (see Appendix B)	FTM	As needed
Pipe tally sheets	FTM	Ongoing
Borehole status form (geophysics) (see Appendix C)	Geologist/technician	As needed
Borehole geophysical logs	Technician performing logging	Within 5 days of logging
Well summary fact sheet	FTM/FTL	Within 5 days of completing well installation
As-built well design drawing	FTM	As needed

* FTL = Field Team Leader, FTM = Field Team Manager, SSO = Site Safety Officer.

6.2 Submittal of Information Management Data Sheets

In addition to the records cited above in the Section 6.1, Field Documentation, the contractor will complete information management data sheets (Table 14) and submit them to the Laboratory data steward. These data sheets summarize drilling information for each well in a form that can be captured by the Laboratory's information management system. Examples of the data sheets are provided in Appendix D, Information Management Data Sheets.

The field geologist is responsible for completing the forms as work progresses. The contractor FTM is responsible for checking the accuracy and completeness of the completed forms. The FTM then submits the completed forms to the Laboratory data steward. The drilling-associated activities, borehole-status, log-header, well-construction, pump-installation, and surface-completion forms may be submitted electronically and as hardcopy (Appendix D). The FTM also will submit hardcopy borehole geophysical logs to the Laboratory data steward and notify the Laboratory data steward when the logs become available electronically.

Table 14
Information Management Forms

Name of Form	Description
Drilling-Associated Activities	Captures all drilling, drill casing, and surface casing related information
Borehole Status (see Appendix C)	Captures status of the borehole at the time of geophysical/video logging runs
Log Header (see Appendix C)	Captures logging detail A new form should be filled out for each logging run
Well Construction	Captures all production casing, centralizer, steel tab, screen, and annular information associated with well construction
Well Development	Captures all well-development activities, including methods and field-parameter measurements
Pump Installation	Captures all non-Westbay® pump installation information
Surface Completion	Captures all surface completion information

Note: The forms will be part of a controlled logbook.

6.3 Well Summary Fact Sheets

A well summary fact sheet for each well will be submitted to the technical advisory team leader. The technical advisory team will review and comment on the fact sheet. The fact sheet requires information on

- well owner,
- location,
- drilling contractor,
- well construction and geology,
- water-bearing strata,
- contaminants detected in screening samples, and
- other general information (drilling method, depth to water, etc.).

6.4 Well Completion Reports

A well completion report for each of the four wells will be prepared after well installation activities are completed. Kleinfelder is responsible for compiling and assembling the well completion reports. The reports will include summaries of drilling, well construction, development, wellhead protection, site restoration, waste management, radiological and geodetic surveys, and lithologic logs. The technical advisory team will review and comment on the well completion report.

6.5 Submission of Records to Records Processing Facility

At the conclusion of field activities for each well, the contractor will transmit all logs, notebooks, data sheets, and records assembled for the readiness review and for the field and drilling operations to the RRES-RS RPF. Records submitted to the RPF must be hardcopy originals or copies that meet the RPF clarity requirements for lifetime retention and dual storage of records.

7.0 REFERENCES

ASTM (American Society for Testing and Materials), 1994. "ASTM Standards on Groundwater and Vadose Zone Investigations," sponsored by ASTM Committee on Rock and Soil (D-18), Philadelphia, Pennsylvania. (ASTM 1994)

ASTM (American Society for Testing and Materials), 1995. "ASTM D5753-95e1 Standard Guide for Planning and Conducting Borehole Geophysical Logging," sponsored by ASTM Committee on Rock and Soil (D-18), Philadelphia, Pennsylvania. (ASTM 1995)

EPA (US Environmental Protection Agency), 1986. "Test Methods for Evaluating Solid Waste, SW-846," Vol. 1A, Washington, D.C. (EPA 1986, 31732)

ESP (Environmental Surveillance Program), December 2000. "Environmental Surveillance at Los Alamos during 1999," Los Alamos National Laboratory report LA-13775-ENV, Los Alamos, New Mexico. (ESP 2000, 68661)

ESP (Environmental Surveillance Program), October 2001. "Environmental Surveillance at Los Alamos during 2000," Los Alamos National Laboratory report LA-13861-ENV, Los Alamos, New Mexico. (ESP 2002, 71301)

ESP (Environmental Surveillance Program), December 2002. "Environmental Surveillance at Los Alamos during 2001," Los Alamos National Laboratory report LA-13979-ENV, Los Alamos, New Mexico. (ESP 2002, 73876)

LANL (Los Alamos National Laboratory), September 1997. "Work Plan for Mortandad Canyon," Los Alamos National Laboratory document LA-UR-97-3291, Los Alamos, New Mexico. (LANL 1997, 56835)

LANL (Los Alamos National Laboratory), May 22, 1998. "Hydrogeologic Workplan," Los Alamos, New Mexico. (LANL 1998, 59599)

LANL (Los Alamos National Laboratory), August 1999. "Response to Request for Supplemental Information for Work Plan for Mortandad Canyon, Los Alamos National Laboratory, NM0890010515, Los Alamos National Laboratory," Los Alamos, New Mexico. (LANL 1999, 62777)

LANL (Los Alamos National Laboratory), August 2003. "Mortandad Canyon Groundwater Work Plan," Los Alamos National Laboratory document LA-UR-03-6221, Los Alamos, New Mexico. (LANL 2003, 79557)

NMED (New Mexico Environment Department), December 12, 2002. "Approval of Work Plan for Mortandad Canyon, Los Alamos National Laboratory," New Mexico Environment Department letter to E. Trollinger, DOE, and J. Browne (LANL) from J. Young, NMED, HWB-LANL-99-023, Santa Fe, New Mexico. (NMED 2002, 73830)

Appendix A

Pertinent Standard Operating and Quality Procedures

The following standard operating procedures (SOPs) and quality procedure (QP) are available at the following site: http://erproject.lanl.gov/documents/procedures.html

Pertinent Standard Operating and Quality Procedures

Procedure	Title
SOP-01.02, Rev.1, ICN1	Sample Containers and Preservation
SOP-01.03, Rev.2, ICN2	Handling, Packaging, and Shipping of Samples
SOP-01.04, Rev.5, ICN1	Sample Control and Field Documentation
SOP-01.06, Rev.2;	Management of Environmental Restoration Project Waste
SOP-01.08, Rev.1	Field Decontamination of Drilling and Sampling Equipment
SOP-01.10, Rev.1	Waste Characterization
SOP-04.01, Rev.2	Drilling Methods and Drill Site Management
SOP-04.04, Rev.2	Contract Geophysical Logging
SOP-05.01, Rev.3	Well Construction
SOP-05.07, Rev.0	Operation of LANL-Owned Borehole Logging Trailer
SOP-06.02, Rev.2	Field Analytical Measurements of Groundwater Samples
SOP-07.02, Rev.1	Water Level Measurements
SOP-07.03, Rev.1	Slug Tests
SOP-07.04, Rev.2	Pumping Tests
SOP-09.10, Rev.0	Field Sampling of Core and Cuttings for Geological Analysis
SOP-12.01, Rev.4	Field Logging, Handling, and Documentation of Borehole Materials
SOP-12.02, Rev.4	Transportation, Receipt, and Admittance of Borehole Samples to the Field Support Facility
SOP-12-.04, Rev.2	Physical Processing, Storage, and Examination of Borehole Material at the FSF
QP-5.3, Rev.3, ICN 2	Readiness Planning and Review

Appendix B

Water-Level Measurement Data Sheet

Water-Level Measurement Data Sheet

Borehole TD (ft)	Drill Casing TD (ft)	Open Hole (ft)	Depth to Water (ft bgs)	Date/time	pre-DTW Activity	Time Since Activity (hr)	Comments

Appendix C

Geophysics Data Sheets

BOREHOLE STATUS FORM

To be filled out by drilling engineer or site geologist

Logging Date: __/__/____ Borehole / Well Name: ____________________

Contractor: ____

Well Status: ☐ Open Hole ☐ Completed ☐ Other ________

Number of Concentric Casing(s): ________ Current Borehole Depth______________________________ft

Casing Top Depth						
Casing Bottom Depth						
Casing Inside Diameter						
Casing Wall Thickness						
Casing Type/Material						
Bit Size						
From						
To						
Cement Plugs						
From						
To						

Type of Fluid in Hole: ______________________ Fluid Level: ___________________________________ft.

Casing Collars: ☐ Yes

Average Spacing: ________ft.

Shoes: ☐ Yes

Other Materials in Hole:

_____________________________From__________To__________ft.

_____________________________From__________To__________ft.

_____________________________From__________To__________ft.

Reason for running log:

Comment:

LOG HEADER FORM

Fill out one form for each logging run

Logging Date: __/__/__ Borehole / Well Name: ____________

Contractor: ____________
Operator: ____________

Run Number: ______ Logging Vehicle
Number: ____________

LANL Logging Trailer ☐

Logging Tool(s) ☐Gamma Ray ☐Induction/Resistivity ☐ Caliper ☐ Borehole Video Camera ________
☐Neutron ☐Hole Deviation ☐Other

Electronic File Name: ____________ Format (LAS, txt, etc.): ____

Null Value (*If Applicable*): ____________

Start Time: ____________ End
Time: ____________

Measuring Point Description: ☐GL (Ground
Level)
Measure from
Ground Level when possible

☐Other ____________

Measuring Point Relative to Ground Level: ____________ ft

Log Run Through: ☐ Casing ☐ Annular
Space ☐ Tremie ☐ Open Hole

Bottom Log Depth: ____________ ft Top Log Depth: ____________ ft

Quality of Log: ☐Good ☐
Fair ☐Poor

Quality Comment (*Required for Fair or Poor*):

Calibration Note:

Logger Remarks:

Appendix D

Information Management Data Sheets

DRILLING ASSOCIATED ACTIVITIES

Provide all depth measurements with respect to ground surface

WELL NAME: ______________________ Submittal Date ______________________
Drilling Company ______________________ Field Geologist/Info Source ______________________
Field Support Company ______________________ QAed By ______________________

DRILLING

Each column represents a new drilling phase. A new drilling phase is defined by change in drilling method, rig type, bit diameter, and/or fluid type. Please refer to the attached list for drilling method, rig type and fluid type options.

Begin Date/Time						
End Date/Time						
Top Depth(ft)						
Bottom Depth(ft)						
Drilling Method[1]						
Rig Type[2]						
Bit Diameter(in)						
Fluid Type[3]						

CASING (Drill Casing and Surface Casing)

Each column represents different casing. Please refer to the attached list for casing type and joint type options.

Begin Install Date						
End Install Date						
Begin Removal Date						
End Removal Date						
Casing Type[4]						
Top Depth(ft)						
Bottom Depth(ft)						
Joint Type[5]						

For Surface Casing: Material used to case it in ______________________
Top Depth ____________ ft Bottom Depth ____________ ft
Hole Diameter ____________ in
Material installation Begin Date ____________ End Date ____________

Comments:

WELL CONSTRUCTION

Provide all depth measurements with respect to ground surface

All information required except where italicized

WELL NAME:	______	Submittal Date	______
Drilling Company	______	Field Geologist/Info Source	______
Field Support Company	______	QAed By	______

PRODUCTION CASING

Each column represents different casing. *Provide removal dates only if applicable.*
Please refer to the attached list for casing type and joint type options.

Begin Install Date						
End Install Date						
Begin Removal Date						
End Removal Date						
Casing Type[4]						
Top Depth(ft)						
Bottom Depth(ft)						
Inner Diameter(in)						
Outer Diameter(in)						
Casing Material[5]						
Joint Type[5]						

CENTRALIZER or STEEL TAB

Each column represents centralizer or tab information.

	Centralizer					
Provide all depths (ft)						
Material (S or SS)						

	Steel Tab					
Provide all depths (ft)						
Material (S or SS)						

SCREEN

Each column represents different screen. Please refer to the attached list for screen type, screen material, and joint type options.

Screen Common Name						
Install Date						
Screen Type[6]						
Screen Material[7]						
Open Top Depth(ft)						
Open Bottom Depth(ft)						
Inner Diameter(in)						
Outer Diameter(in)						
Slot Size(in)						
% Open Area Per Ft						
Joint Type[5]						

ANNULAR FILL

Each column represents different annular fill. Provide geophysics depths only if applicable.
Please refer to the attached list for annular material and annular material function options.

Tagged Top Depth(ft)						
Tagged Bottom Depth(ft)						
Geophysics Top Depth(ft)						
Geophysics Bottom Depth(ft)						
Annular Material[8]						
Annular Material Function[9]						
Hole Diameter(in)						
Begin Date						
End Date						
Calculated Volume (ft^3)						
Actual Volume (ft^3)						

Comments:

WELL DEVELOPMENT (Cover Page)

Well Name: ____________________

Drilling Company: ____________________

Field Support Company: ____________________

Predevelopment Water Level (ft): ____________________

Submittal Date: ________

Field Geologist/Info Source: ____________________

QAed By: ____________________

DEVELOPMENT METHODS

WB (Wirebrushing - Enter begin and end times only)
Bail (Bailing - Measure/record parameters only for the first and last bail; bail after non-pumping methods)
Jet (Jetting - Enter date, time and water injected)
Surg (Surging - Enter begin and end times only)
Swab (Swabbing - Enter date, time and water injected)
Pump (Pumping - Measure/record parameters at regular intervals)

DEVELOPMENT TOOLS

PerfP (Perforated Pipe usded for jetting)
Nozzle (Nozzles used for jetting)
SingleWL (Single block on wireline used for surging)
SingleR (Single block on drill rod used for surging)
SingleBP (Single block with bypass used for swabbing)
Single (Single block without bypass used for swabbing)
DoubleBP (Double block with bypass used for swabbing
Double (Double block without bypass used for swabbing

Screen #	Date	Time	Development Method	Development Tool	Total volume withdrawn / Injected (gal)	pH	Temp (°C)	SC (mS/cm)	Turbidity (NTU)	Comments (water/ sediment observations: color, smell, particulates, etc.)

PUMP INSTALLATION

Provide all depth measurements with respect to ground surface

WELL NAME: ____________ Submittal Date ____________

Field Support Company ____________ Field Geologist/Info Source ____________

QA'd By ____________

____

Installation Company ____________

Installation Start Date/Time ____________

Installation End Date/Time ____________

Intake Depth (Ft) ____________

Manufacturer ____________

Model ____________

Horsepower ____________

Pump Capacity (gal/min) ____________

Power Source ____________

Riser Diameter (in) ____________

Comments:

SURFACE COMPLETION

Provide all depth measurements with respect to ground surface

WELL NAME:	______________	Submittal Date	______________
Drilling Company	______________	Field Geologist/Info Source	______________
Field Support Company	______________	QA'd By	______________
Surface Pad Install Date	______________	Completion Depth(ft)	______________
Surface Pad Thickness(in)	______________	Site Restoration Start Date	______________
Surface Pad Length(ft)	______________	Site Restoration End Date	______________
Surface Pad Width(ft)	______________		

Comments:

Definitions used in drilling-associated activities and well construction forms

Drilling Method[1]	Rig Type[2]	Fluid Type[3]	Casing Type[4]	Joint Type[5]	Screen Type[6]	Screen Material[7]	Annular Material[8]	Annular Material Function[9]
A (Auger)	**T-4** (T-4 Ingersol Rand)	**A** (Air)	**S16** (Surface Casing: 16"OD, 15½"ID, low-carbon steel)	**20W** (20FT Welded)	**PB** (Pipe based)	**SS304** (304 Stainless steel)	**B** (Bentonite)	**B** (Backfill)
CA (Casing Advance)	**T685** (Schramm T685)	**AW** (Air with Water)	**S18** (Surface Casing: 18"OD, 17½"ID, low-carbon steel)	**API L/T** (API Long Thread, external collar)	**MSPVC** (Machine Slotted PVC)	**PVC** (Polyvinyl-chloride)	**C** (Cement)	**FP** (Filter Pack)
C (Coring)	**UDR1000** (Universal Drill Rig 1000)	**AWB** (Air with Water and Bentonite)	**11-3/4DC** (Drill Casing: 11¾"OD, 10¾"ID, low-carbon steel)	**FC** (Flush Coupled)	**WR** (wire wrapped, 304 stainless steel)		**CB** (Cement with Bentonite)	**S** (Seal)
OH (Open-Hole)	**DR24D** (Dual Rotary 24D Foremost)	**AWBLA** (Air with Water, Bentonite, Liqui-Trol, & Attack Foam)	**13-3/8DC** (Drill Casing: $13\frac{3}{8}$"OD, $12\frac{3}{8}$"ID, low-carbon steel)	**FJT** (Flush Joint Threaded)			**W/G** (Ungraded washed gravel upto 3/8)	
CS (Continuous Sampler)	**CME750** (Central Mining Equipment 750: CME75 drill system mounted on an all terrain vehicle)	**AWBSL** (Air with Water, Bentonite, Soda Ash, & Lost Circulation Material)	**13-5/8DC** (Drill Casing: $13\frac{5}{8}$"OD, $12\frac{5}{8}$"ID, High grade tempered carbon steel-N80 grade)	**M3** (Matrix 3 lead)			**6/9** (Sand (6/9))	
	SS-15 (StrataStar brand, can core and auger shallow depth)	**AWBTF** (Air with Water, Bentonite, Tork Ease, and Fiberous material)	**9-5/8DC** (Drill Casing: $9\frac{7}{8}$"OD, $8\frac{3}{8}$"ID, High grade tempered carbon steel-N80 grade)	**PE** (Plain End)			**8/12** (Sand (8/12))	
	T70-W (Dresser brand rotary rig capable of air, mud, and Stratex casing advance drilling)	**AWBTQ** (Air with Water, Bentonite, Tork Ease, Quick Foam, E-Z- Mud, & Fiberous material)	**6-5/8UR** (Under Reaming ODEX Pipe: $6\frac{5}{8}$"OD, $5\frac{5}{8}$"ID, High grade tempered carbon steel-P110 grade)	**RC** (Regular Coupling)			**6/9+8/12** (Sand Combination (6/9+8/12))	
	CME75 (Central Mining Equipment 75)	**AWE** (Air with Water and E-Z Mud)	**8-5/8UR** (Under Reaming ODEX Pipe: $8\frac{5}{8}$"OD, $7\frac{5}{8}$"ID, High grade tempered carbon steel-P110 grade)				**20/40** (Coarse Sand (20/40))	
	F-10 [Failing - 10 (Core/Auger Rig)]	**AWQ** (Air with Water and Quick Foam)	**9-5/8UR** (Under Reaming ODEX Pipe: $9\frac{7}{8}$"OD, $8\frac{3}{8}$"ID, High grade tempered carbon steel-N80 grade)				**30/70** (Fine Sand (30/70))	
	F-2500 [Failing-2500 (Rotary air/mud Rig)]	**AWQE** (Air with Water, Quick Foam and E-Z Mud)	**10-3/4UR** (Under Reaming ODEX Pipe: 10¾"OD, 9¾"ID, High grade tempered carbon steel-N80 grade)				**S** (Mixed fine (30/70) and coarse sand (20/40))	
		AWQET (Air with Water, Quick Foam, E-Z Mud and Tork Ease)	**11-3/4UR** (Under Reaming ODEX Pipe: 12"OD, 10½"ID, High grade tempered carbon steel, N80 grade)				**SL** (Slough)	
		AWT (Air with Water and Tork Ease)	**12-3/4UR** (Under Reaming ODEX Pipe: 12¾"OD, 12"ID, High grade tempered carbon steel-N80 grade)					
		AWTE (Air with Water, TORKease ploymer, and EZ-MUD)	**14UR** (Under Reaming ODEX Pipe: 14"OD, $13\frac{1}{37}$"ID, High grade tempered carbon steel-N80 grade)					
		NONE	**API L/T 8** (API 8 round long thread: 5"OD, 4½"ID, stainless steel)					
		W (Water)	**MS5** (Mild Steel 5"OD, $4\frac{1}{3}$"ID, 40 low-carbon steel)					
			MS5.56 (Production Casing: 5.56"OD, 5"ID, Schedule 40 low-carbon steel casing)					

DAILY ACTIVITY / QUALITY CONTROL REPORT (12HR)

WELL NAME & LOCATION:	FOOTAGE LAST 24 HOURS:	REPORT DATE:
TA-	TOTAL DEPTH AT END OF REPORT TIME:	REPORT NUMBER:
CONTRACTOR:	DRILLING SUBCONTRACTOR, RIG TYPE, & DRILLER:	

AM WEATHER:	PM WEATHER:	PRECIPITATION:	MAX TEMP: °F	MIN. TEMP: °F

DRILL RIG(S) USED

EQUIPMENT DESCRIPTION	Last 12 Hr Shift			Total Since Project Start		
	Operational	Non-operational	Downtime/ Maintenance	Operational	Non-operational	Downtime/ Maintenance

DESCRIPTION OF DAILY ACTIVITIES (include fluid level meas. data:

CASING/BIT SIZE INFORMATION

Casing Type	Casing Size	Bit Type	Bit Size	Depth From	Depth To

JOB SAFETY	YES	NO
SAFETY MEETING HELD TODAY? If YES, attach a copy of meeting minutes		
ANY LOST TIME ACCIDENTS? If YES, attach copy of completed report(s), OSHA 200 log, et al		
TRENCHING/CAFFOLDING/HIGH VOLTAGE ELECTRICAL/ELEVATED WORK/WELDING PERFORMED? If YES, include copy of report(s) of inspection(s) performed by competent or qualified person(s)		
ANY SPILLS OR HAZARDOUS WASTE RELEASED TO THE ENVIRONMENT? If YES, include copy of completed reports indicating response action(s) and notification(s)		
ANY VIOLATIONS OF JOB SAFETY RULES OBSERVED? If YES, include copy of completed reports indicating response action(s)		
DISCUSSION OF SAFETY ACTIONS/INSPECTIONS CONDUCTED: See attached Tailgate Safety Meeting, Daily Safety Inspection, Drill Rig Inspection and Heavy Equipment Checklists		

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DRILL FLUID/ADDITIVE(S) SUMMARY (include potable water)			
MATERIAL DESCRIPTION	QUANTITY	QUANTITY USED LAST 12 HR SHIFT	CUMULATIVE QUANTITY USED

FIELD SCREENING

EQUIPMENT CALIBRATION(S)

SAMPLES COLLECTED (inc. duplicates, splits, etc.)

WASTE/DRILLING MEDIA GENERATION		
TYPE/DESCRIPTION	QUANTITY LAST 12 HR SHIFT	CUMULATIVE QUANTITY ON SITE

GEOPHYSICAL/BOREHOLE VIDEO SURVEYS CONDUCTED (list also depth interval logged, TD of borehole, fluid levels, etc)

SIGNATURE OF SITE SUPERVISOR	DATE

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RRES Remediation Services (RS) Project
Document Signature Form

Document Catalog Number: ER2003-0713
(Please prefix the name of all electronic versions of this document with this number.)

Document Title /Subject: Sampling And Analysis Plan for Drilling and Testing Characterization Wells R-1, R-28, R-33 and R-34

PRSs: None **Privileged Information: Y / N**

Associated Document Catalog Number(s): ER2003-0695

Author: Nylander, Charlie 665-4681 nylander@lanl.gov

Author Organization: Groundwater Investigations Focus Area

Document Team: Herrera, Tanya 667-8285 pth@lanl.gov

Document Type: Letter **Former OU:** N/A

Date Due: 11/13/2003 **Date Final Complete:** 11/13/2003
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Date Sent to RPF: 12/11/2003 **Received Per RPF:** Unknown

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AA Deliverable: No **Certification Required:** No **Force Peer Review:** No
Distribution TO: John Young **Distribution FROM:** Charles Nylander Matthew Johansen
Distribution COPY: **Distribution THRU:**
Attachment Notes:
Status/Comments: RRES-GPP-03-099 is GW Number for Letter ER2003-0695(LA-UR-03-098 is the SAP and RRES-GPP-03-098 is GW Number for SAP

Reviewer Signatures: (By signing below, the reviewer indicates that he/she **reviewed** and **approves** the document. Conditional approval may be indicated by checking the COMMENTS ATTACHED box.)

Reviewer (Print reviewer's name under title)	**Signature**	**Date**	**Comments Attached**
Word Processor			
Proof Reader			
Author			
Team Leader			
Regulatory Compliance Reviewer			
RRES-RS Program Manager, Dave McInroy			
DOE/OLASO Program Manager			
Distributed By			

Attachment Notes	
Status/Comments	RRES-GPP-03-099 is GW Number for Letter ER2003-0695 is the SAP and RRES-GPP-03-098 is GW Number for SAP

Reviewer Signatures: (By signing, the reviewer indicates that he/she **reviewed** and **approves** the document.)

Reviewer (Print reviewer's name under title)	Signature	Date
Word Processor TANYA HERRERA	[signature]	11/7/03
Proof Reader		
Author CHARLES NYLANDER		
Team Leader N/A	N/A	
Regulatory Compliance Reviewer N/A	N/A	
RS Project Director, ~~Dave McInroy~~ CHARLES NYLANDER	Charles Nylander	11/13/03
DOE/OLASO Program Manager MATTHEW JOHANSEN	for [signature]	11/17/03
Distributed By [signature]	[signature]	11/17/03

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Top

RRES Remediation Services (RS) Project
Document Signature Form

Document Catalog Number: ER2003-0695
(Please prefix the name of all electronic versions of this document with this number.)

Document Title /Subject: Sampling and Analysis Plan for Drilling and Testing Characterization Wells R-1, R-28, R-33, and R-34

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Author Organization: Groundwater Investigations Focus Area

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RRES-SWRC Reviewer			
Team Leader			
Regulatory Compliance Reviewer			
RRES ADC Reviewer			
Legal Reviewer			
DOE/LASO Reviewer			

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Status/Comments	

Reviewer Signatures: (By signing, the reviewer indicates that he/she **reviewed** and **approves** the document.)

Reviewer (Print reviewer's name under title)	**Signature**	**Date**
Author DAVID BROXTON	David Broxton	11/6/03
Peer Review Chair KENT RICH	Kent Rich	11/5/03
~~ESH-19 Reviewer~~ QII DAVID HAWKINSON	David R Hawkinson	11/19/03
Team Leader JOHN McCANN	J. P. McCann	11-6-03
Regulatory Compliance Reviewer JOE ENGLISH	Joe English	11/13/03
RRES ADC Reviewer ROY BOHN	Roy Bohn	11/13/03
Legal Reviewer ELLEN LOUDERBOUGH	SEE ATTACHED	
DOE/LAAO Reviewer TOM WHITACRE	Tom Whitacre	11/19/03
RS Project Director, CHARLIE NYLANDER	Charlie Nylander	11/13/03
DOE/OLASO Program Manager		

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Peer Review Chair KENT RICH	Kent Rich	11/5/03
~~PSH-19 Reviewer~~ QII DAVID HAWKINSON		—
Team Leader JOHN McCANN	[signature]	11-6-03
Regulatory Compliance Reviewer JOE ENGLISH	Joe English	11/13/03
RRES ADC Reviewer ROY BOHN	Roy Bohn	11/13/03
Legal Reviewer ELLEN LOUDERBOUGH	Ellen T. Louderbough	11/17/03
DOE/LAAO Reviewer TOM WHITACRE		
RS Project Director, CHARLIE NYLANDER	Charlie Nylander	11/13/03
DOE/OLASO Program Manager		

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