TA 00 9/19/01

Los Alamos National Laboratory

LA Canyon

FIELD IMPLEMENTATION PLAN

FOR THE DRILLING AND TESTING OF LANL REGIONAL AQUIFER CHARACTERIZATION WELL R-8

Environmental Restoration Project

Groundwater Investigations Focus Area

July 2001

CONTENTS

Page #5 of 82

Figures

Tables

ACRONYMS AND ABBREVIATIONS

API	American Petroleum Institute
AR	Air Rotary
ASTM	American Society for Testing and Materials
BUS	Business Operations
DOE	Department of Energy
EDL	Estimated Detection Limit
EES	Earth and Environmental Sciences
EM&R	Emergency Management and Response
EPA	Environmental Protection Agency
ER	Environmental Restoration
ESH	Environmental Safety and Health
FAPL	Focus Area Project Leader
FIP	Field Implementation Plan
FSF	Field Support Facility
FTL	Field Team Leader
FTM	Field Team Manager
GIT	Groundwater Integration Team
HSA	Hollow-stem auger
HASP	Health and Safety Plan
ID	Inner Diameter
LANL	Los Alamos National Laboratory
MSCT	Mechanical Sidewall-Coring Tool
MWIP	Monitoring Well Installation Project
NGR	Natural Gamma Radiation
NOI	Notice of Intent
NMED	New Mexico Environment Department
NTU	Nephelometric turbidity units
PMC	Project Management Company
QA	Quality assurance
OD	Outer Diameter
SMO	Sample Management Organization
SSO	Site Safety Officer
SSHASP	Site Specific Health and Safety Plan
SOP	Standard Operating Procedure
TA	Technical Area
TD	Total depth
TL	Task Leader
WCSF	Waste Characterization Strategy Form
WGII	Washington Group International, Incorporated

OVERVIEW

- *Well R-8 is being installed by Defense Programs (DP) as part of the implementation of the Groundwater Protection Management Program's Hydrogeologic Workplan (LANL,1998). This well is intended to provide hydrogeologic and water-quality data for regional groundwater downgradient from contaminant release sites in Los Alamos and DP Canyons. Data from this well will also improve the conceptual model for regional hydrogeology and provide constraints on numerical models addressing contaminant migration in the regional aquifer.*
- *R-8 is located in Los Alamos Canyon approximately 3300 ft downstream of the confluence with DP Canyon.*
- *R-8 will be drilled by fluid-assisted, open-hole, air-rotary (AR) methods.*
- *R-8 will be a single-screen well targeting the top of the regional aquifer (approximately 696 ft depth).*
- *The borehole will extend to a depth of approximately 1200 ft to characterize the hydrogeologic units that control flow through the upper part of the regional groundwater system.*

INTRODUCTION

Well R-8 is being installed by the Defense Programs as part of the Groundwater Protection Management Program's Hydrogeologic Workplan (LANL,1998).

This Field Implementation Plan (FIP) provides guidance to the subcontractor field support team for the execution of planned drilling, development, testing, and completion activities for this characterization well. This FIP includes a brief description of the overall objectives of this well, 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 the FIP is to ensure consistency and quality of characterization data. It also provides a detailed scope of work for procurement of subcontract services. A detailed drilling plan that includes a description of the drilling rig, equipment, casings, bits, planned approach, cost, and schedule is beyond the scope of this document and is the responsibility of the drilling contractor. All tasks in this FIP shall be performed by the subcontractor unless otherwise noted.

Summary of Data Quality Objectives

R-8 is primarily designed to characterize impacts to regional groundwater due to Laboratory activities in the Los Alamos Canyon watershed. R-8 is located downstream of the confluence of Los Alamos and DP Canyon; this segment of canyon below the confluence may have acted as a line-source of percolation affecting deeper groundwater bodies. Work in recent years by the Canyons Focus Area indicates that the major source of contaminated sediments in Los Alamos Canyon is Technical Area (TA)-21 via DP Canyon. DP Canyon contributes both surface water and shallow groundwater flow to Los Alamos Canyon.

R-8 is designed to address the following data needs:

1. To determine subsurface distribution of contaminants in an area expected to contain groundwater contamination from a line-source of recharge in Los Alamos Canyon downstream of TA-21. In particular, this well is downstream of the confluence with DP Canyon that was a surface water pathway for releases from outfalls on the north side of TA-21. These outfalls (e.g. 21-011k) were the most important sources of contaminants to Los Alamos Canyon. Data about contaminant distributions are needed to assess Laboratory impacts to deep groundwater in Los Alamos Canyon.

2. To determine the up canyon extent of intermediate-depth perched groundwater bodies identified at R-9/9i and at the low-flow weir wells near the Laboratory boundary.
3. To provide general characterization of the groundwater conditions beneath the Laboratory and support ongoing efforts to improve the hydrogeologic conceptual model.

These data needs will be satisfied by the collection of geologic, hydrologic, and geophysical information about perched and regional groundwater, determination of water levels, installation of a well screen at the top of the regional aquifer, collection of groundwater for determination of water quality in each of the groundwater zones encountered, and the collection of core samples to determine vertical distributions of contaminants and moisture through the vadose zone. Information for the site-wide 3-D geologic model will be provided by examination and interpretation of cuttings and core.

Location

Characterization well R-8 is located in Los Alamos Canyon appproximately 3300 ft downstream of the confluence with DP Canyon (Figure 1). R-8 is approximately 1.2 mi west of wells R-9 and R9i.

Roles and Responsibilities

The roles and responsibilities for the investigation team are shown in Table 1. The functional organization of the R-8 implementation is illustrated in Figure 2.

Health and Safety

All fieldwork shall be conducted in accordance with Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Project Health and Safety Plan (HASP) and the Site Specific Health and Safety Plan (SSHASP) #273 and modifications, and LANL ESH ID Nos. 01-0176.

In the event of an accident or emergency the following initial contacts will be made:

Contact Numbers	*Phone Number (see Table 1 for additional phone #s)*
1) Emergency services, if necessary	911
2) Emergency Management and Response (EM&R)	667-6211
3) Focus Area Project Leader (FAPL) (John McCann)	665-1091
4) Field Team Leader (FTL) Operations (Steve Pearson)	667-3005
5) Field team manager (FTM)/FTL (Crowder/Everett)	662-1338/662-1322
6) Facility Management Unit (FMU)-80 (Charles Trujillo)	667-0491/996-1084

Additional notifications per SSHASP #273 will be made by the above listed individuals.

Quality Assurance

The subcontractor is responsible for conducting all procurement, field operations and drilling in accordance with its own internal Quality Assurance Program. LANL personnel are required to perform work under the ER quality assurance program.

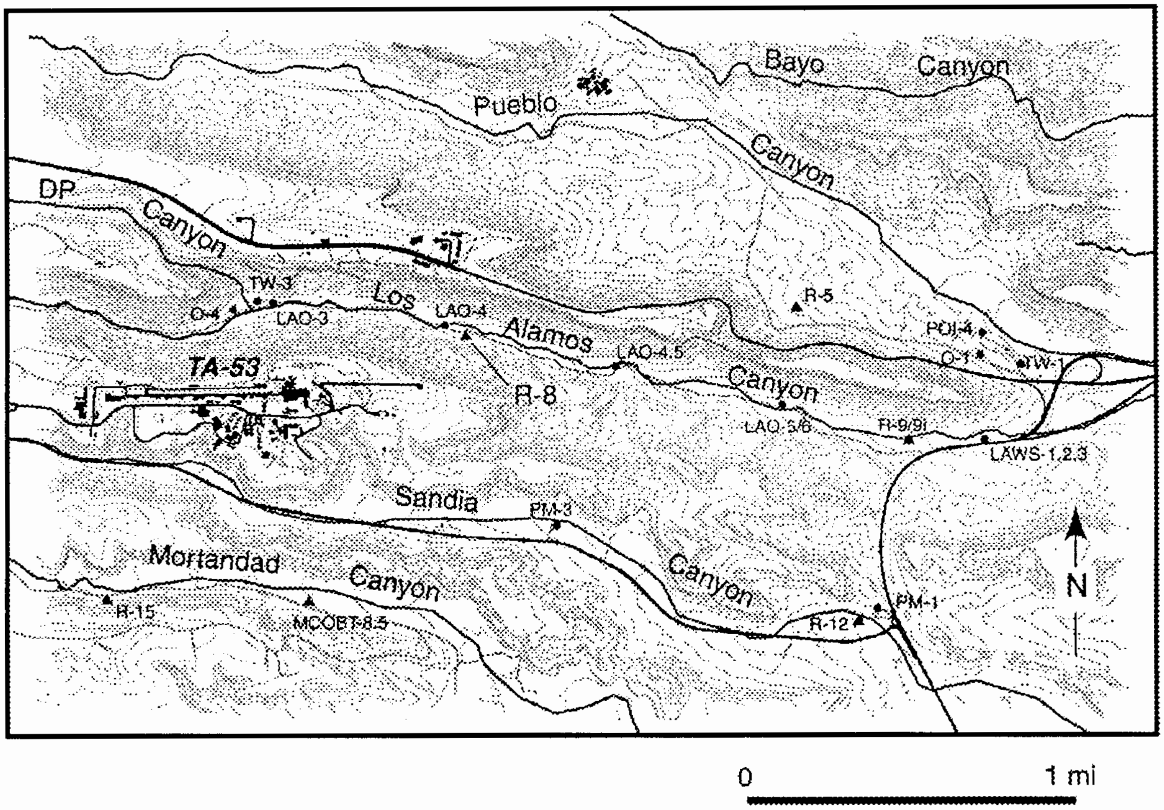

Figure 1. Map showing the location of R-8

Waste Management

A site-specific Waste Characterization Strategy Form (WCSF) describes the on-site management of groundwater and cuttings as well as the temporary storage of wastes that are pending waste characterization and/or disposal in accordance with appropriate regulatory requirements. Formation water and cuttings generated during drilling operation will be containerized until characterized. A notice of intent (NOI) to discharge benign wastewater on-site will be prepared by Environmental Safety and Health ESH-18 and submitted to the New Mexico Environment Department (NMED).

DRILLING PLAN SUMMARY

Pre-Drilling Activities

Pre-drilling activities include obtaining all required permits and access agreements and preparing site-specific plans and documents (SSHASP, WCSF, FIP, etc.). Line-management approval to commence field activities and site preparation will be obtained through the readiness-review process. Site preparation involves earth work consisting of leveling and grading the drill pad; blading an access road; installing erosion control

Figure 2. Functional Organization of R-8 Personnel.

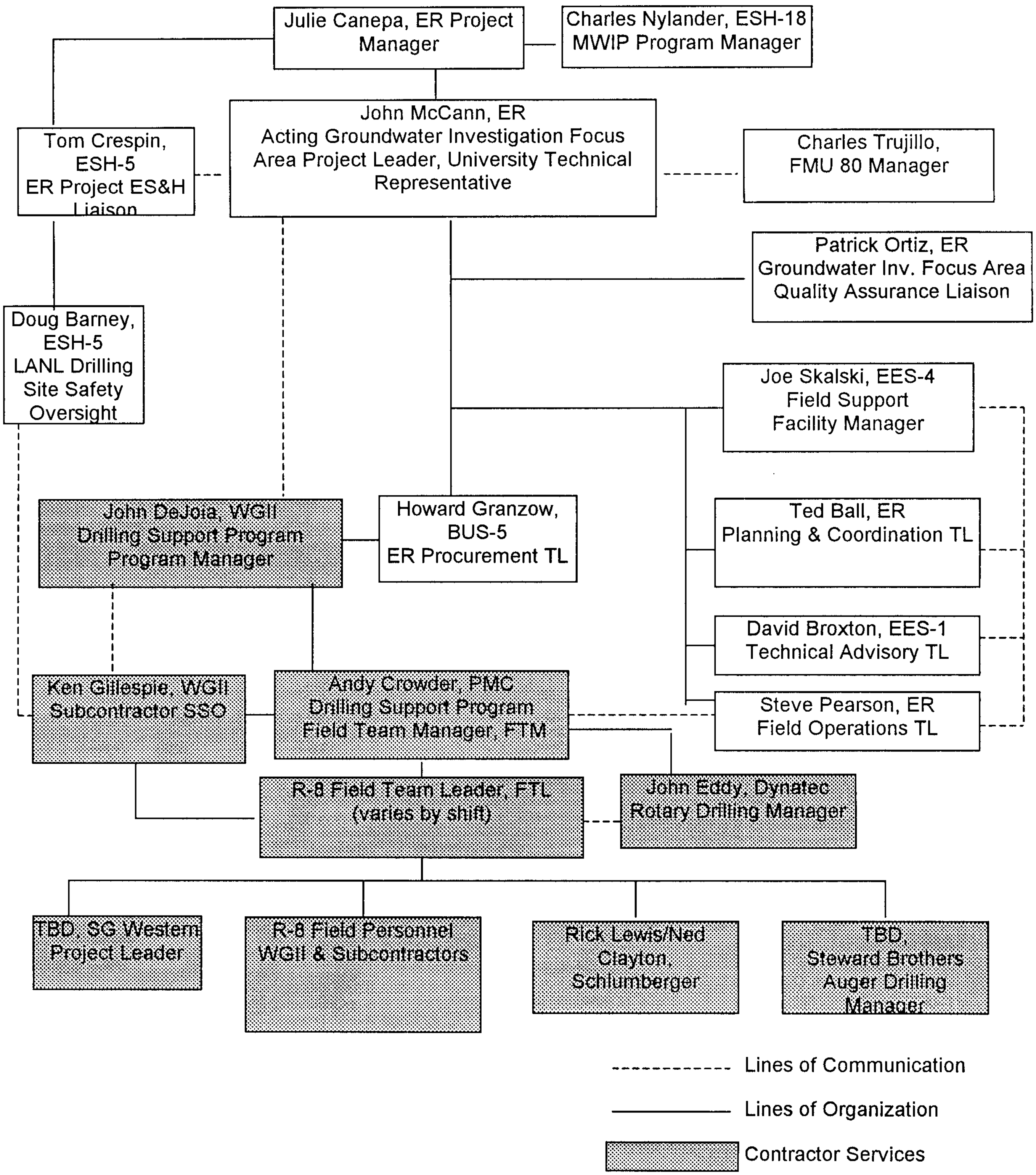

Table 1. Roles and Responsibilities.

Personnel	Phones/Pager	Org.	Position	Project Responsibilities
Julie Canepa	667-4109 (work)	LANL/ER	ER Project Manager	Responsible for Monitor Well Installation Program construction.
Charles Nylander	665-4681 (work) 699-1568 (cell.)	LANL/ ESH-18	Monitor Well Installation Program Manager	Responsible for Monitor Well Installation Program management.
John McCann	665-1091 (work)	LANL/ E/ET	Acting Groundwater Focus Area Project Leader (FAPL)	The FAPL is the LANL line manager for well installation and University Tech. Representative for the drilling contract.
John DeJoia	662-1359 (work)	WGII	WGII Program Manager	Overall WGII/PMC Team program management; responsible for implementation of drilling and field support contract and for the success of the drilling program.
John Eddy	667-2876 (work) 996-4042 (page) 663-1013 (home)	Dynatec	Drilling Manager	Drill team manager and drilling program design and implementation.
Ted Ball	665-3996 (work) 996-3999 (page)	LANL/ ER	Groundwater Focus Area Planning and Coordination Team Ldr	Responsible for baseline development, project status, and project schedule development
Steve Pearson	667-3005 (work) 104-4525 (page) 699-3684 (cell.) 955-1793 (home)	LANL/ ER	Groundwater Focus Area Field Operations Team Leader	Provides LANL oversight field and drilling activities; coordinates activities of LANL technical team and contractor field support staff.
David Broxton	667-2492 (work) 104-3994 (page) 699-0950 (cell.)	LANL/ EES-1	Groundwater Focus Area Technical Team Leader	Responsible for the design and implementation of the testing program.
Matt Johansen	665-5046 (work)	DOE	DOE Oversight	Liaison between DOE and LANL.
Patrick Longmire	665-1264 (work) 699-1987 (cell.) 104-3993 (page)	LANL/ EES-1	Groundwater Focus Area Geochemistry Task Leader (TL)	Provides technical leadership for geochemical characterization.
William Stone	665-8340 (work)	LANL/ EES-5	Groundwater Focus Area Hydrology Task Leader (TL)	Provides technical leadership for hydrologic characterization and well development.
David Vaniman	667-1863 (work) 104-7019 (page) 699-1079 (cell.)	LANL/ EES-1	Groundwater Focus Area Geology Task Leader (TL)	Provides technical leadership for geologic characterization.
Joe Skalski	667-2876 (work) 996-0891 (page) 672-9060 (home)	LANL/ EES-4	Field Support Facility Manager	Provides drilling support and on-site management of the FSF.
Andy Crowder	662-1338 (work) 104-3968 (page) 780-2975 (cell.) 983-6643 (home)	PMC	Field Team Manager/ Field Team Leader (FTM/FTL)	Drilling contract Task Manager.
Mark Everett	662-1322 (work) 698-2281 (page) 780-2973 (cell.) 986-8186 (home)	WGII	FTL/Geologist	Oversight of on-site field support activities.
Doug Barney	665-5132 (work) 104-5506 (page) 753-9741 (home)	LANL/ ESH-5	LANL Safety Oversight	Responsible for LANL oversight of site safety.
Ken Gillespie	662-1306 (work) 780-2905 (cell)	WGII	SSO	Responsible for contractor site safety.
Rene Evans	662-1337 (work)	WGII	Waste Manager	Responsible for onsite waste management.
Keith Green	665-9966 (work)	LANL/ER	Sample Management Task Leader	Responsible for coordinating analytical lab procurements, and sample shipping/receiving.
Ned Clayton	303-486-3228 (work) 303-601-5250 (cell.)	Schlum- berger	Geophysical Support	Responsible for contract issues and deliverables for geophysical logging services
Rick Lewis	303-486-3236 (work) 303-618-8825 (cell.)	Schlum- berger	Geophysical Support	Provides technical support for geophysical log collection and interpretation
Charles Trujillo	667-0491 (work) 996-1084 (page)	LANL/ FWO-UI	FMU 80 Facility Manager	Landlord for FMU 80
Patrick Ortiz	665-5289 (work)	LANL/	Groundwater Inv. Focus	Oversight of LANL and contractor

Personnel	Phones/Pager	Org.	Position	Project Responsibilities
		ESH-14	Area QA Liaison	implementation of QA program.

following best management practices; excavating a drill-cuttings pit, excavating a jack cellar, pouring a concrete cellar floor, and installing and backfilling around a steel box for hydraulic casing jacks (jack cellar).

Drilling Equipment/Procedures

R-8 will be drilled in two phases. Phase 1 involves installation of surface casing using hollow-stem auger (HSA) equipment. Phase 2 involves drilling open hole to total depth (TD) by fluid-assisted, AR methods.

Phase 1 Drilling -- During Phase 1, the borehole will be drilled from the surface to the surface-casing target depth of approximately 50 ft using 4.25-in inner diameter (ID) Truspin™ hollow-stem augers with a Moss™ wireline core retrieval system. The hole will then be reamed to a nominal 23-in diameter using nominal 12-in ID and nominal 22-in outer diameter (OD) hollow-stem augers. An 18-in outside diameter steel surface casing will be installed and cemented in place to isolate the borehole and to stabilize the upper part of the borehole from caving and collapse.

Phase 2 Drilling -- During Phase 2, R-8 shall be drilled as an open hole to the TD of about 1200 ft by fluid-assisted air rotary methods and a characterization well shall be installed.

Approved additives such as glass beads, QUIK-FOAM and EZ-MUD may be used to aid with lubricity, cuttings recovery, and borehole stabilization during drilling. EZ-MUD use must be minimized to the extent possible to reduce possible deleterious affects on water quality measurements in the completed well. The field team leader or site geologist shall maintain a Drilling Additives Log that records the amount of additives, municipal water, and other fluids that are used during drilling, well construction, development, and hydraulic testing.

Drilling operations shall be conducted in two 12-hour shifts per day, 7 days per week. Field support personnel may work in three 9-hour shifts per day, 7 days per week.

During Phase 2, drill cuttings shall be collected to:

- obtain the lithologic information required for drilling operations and well construction,
- provide material for geological and geochemical testing.

Drilling Contingencies

During Phase 2, the following drilling contingencies may be implemented depending on the results of characterization activities:

- The planned depth of borehole R-8 is nominally 1200 ft; however the total depth may be modified to accomplish the characterization goals for this site based on conditions found during drilling. In addition, unstable borehole conditions (e.g. flowing sand) may threaten the driller's ability to achieve the desired hole depth without risking loss of drilling equipment or the borehole; in such cases the driller may terminate drilling activities after consulting the Groundwater Focus Area Leader and the Groundwater Protection Management Program manager.

- Drilling will proceed uninterrupted except at saturated perched water zones and the regional aquifer where accurate water levels shall be determined before drilling to TD.

- For the first perched groundwater encountered, which is the zone most likely to contain Laboratory-derived contamination, quick turnaround analyses of soluable constituents will be performed by the LANL Hydrology, Geochemistry, and Geology Group analytical laboratory. If contaminants are detected, a meeting or conference call between LANL and NMED will be arranged as quickly as possible to discuss whether isolation of the perched zone by advancing drill casing is warranted. The decision to isolate the zone with drill casing will consider all available information including factors such as types of contaminants identified, their concentrations, the amount of water being produced by the perched zone, the vertical extent of the perched water body (if it can be determined), and the position of the perched water body relative to the regional aquifer.

- R-8 is planned as a single-screen well completed in the regional zone of saturation. However, a cost/benefit analysis will be peformed towards the end of the drilling effort to evaluate information about the need for a multiple-screen well vs. a single-screen well. Ultimately, the decision to complete this well with a single screen or multiple screens will depend on the depth, size, and number of perched zones encountered; this decision will also consider whether it is more cost effective to install a separate intermediate-depth well targeting any perched zones.

- Up to three groundwater samples may be collected to determine borehole water quality at the direction of the geochemistry task leader; these samples may be collected from the cyclone by air lifting the water through the drilling circulation system.

- Drill casings may be used at the driller's discretion to seal off lost-circulation zones or unstable geologic formations in order to successfully complete the well to the desired TD.

Decontamination

Large pieces of drilling equipment (i.e. drilling strings, casings, etc) will be decontaminated onsite on a bermed plastic-lined pad. Decontamination fluids will be containerized on-site pending waste characterization results. Following characterization, waste shall be disposed of in accordance with applicable requirements.

Demobilization and Site Restoration

Upon completion of drilling activities at R-8, all equipment shall be demobilized and all wastes generated shall be disposed of in accordance with appropriate regulatory requirements. Site restoration shall include stabilizing the drill pad for future sampling activities.

WELL DESIGN

Design Assumptions

R-8 shall be completed with a single screen that straddles the regional water table. The Title I design for placement of filter pack, transition sand, bentonite and cement will be specified once the borehole has been drilled to TD and geophysical logs of the borehole are collected and analyzed. Individuals involved in the well design represent a cross section of Groundwater Integration Team (GIT) technical disciplines including geochemistry, hydrology, geology, quality assurance, and drilling. Data considered during well design shall include borehole geophysics, borehole videos, driller's observations, interpretation of drill cuttings, water levels collected during drilling, and available groundwater screening results.

The well design will be provided to NMED for comment.

Borehole Annular Space

The final borehole diameter shall be sized so as to provide a minimum annular space of 2-in. between the outside diameter of the well screen/casing and the borehole wall. If steel drill casing is used to advance the hole, the well shall be constructed inside a telescoped borehole during retraction of the casing. Otherwise the well will be constructed in the open borehole. A record of borehole diameters and depth intervals shall be kept during drilling.

Well Casings

R-8 shall be constructed of 5-in. OD x 4.5-in. ID A304 stainless-steel casing built to American Society for Testing and Materials (ASTM) A554 standards with 8 round American Petroleum Institute (API) long threaded joints. A capped 30-ft. section of stainless-steel casing shall be placed at the bottom of the well to serve as a sump. Centralizers shall be placed above and below the well screen(s); additional centralizers may be placed as necessary to assist in centering the casing within the borehole and to allow proper placement of annular fill materials.

Well Screens

The well screen shall be constructed with multiple sections of wire-wrapped 5.56-in. OD, pipe-based stainless-steel screen, with a 0.01-in. slot size. The screen shall be constructed with sufficient strength to withstand the forces of installation, placement of annular fill and development.

Annular Fill

A tremie line shall be used to place all annular fill materials in the borehole.

Borehole Below Final Well Depth -- The interval from TD to approximately 10 ft below the well screen may be filled with gravel, silica sand, bentonite and/or cement.

Primary Filter Packs --The filter packs shall consist of round, clean, washed and resieved silica sand with a uniformity coefficient of 2.0 or less. The primary filter packs shall extend a minimum distance of 10 ft above and 5 ft below the well screen. The size of the filter pack shall be selected based on the characteristics of the formation to be screened. Either 20-40, 8-12 or other appropriate size may be used. The selected pack must be fine enough to stabilize the formation materials and also must retain the secondary filter packs described below.

Secondary Filter Pack – Finer, clean, washed, 30-70, 20-40, or other appropriate silica sand sizes shall be emplaced a minimum of 2 ft below and above the primary filter packs to impede the movement of any bentonite toward the well screen(s).

Borehole Between Filter Pack(s) -- The annular space in the blank zones between filter packs associated with screens (for a multiscreen well) and above the top-most secondary filter pack of a single-completion well shall be sealed with a mixture of approximately 50% bentonite (chips or pellets) and 50% gravel or sand. As necessary, 5- to 10-foot cement plugs may be placed within the bentonite and gravel/sand intervals to provide stable floors for the placement of annular fill. The annular space from a depth of approximately 75-ft to land surface shall be sealed with cement grout. The cement grout shall meet the requirements of ASTM C150, *Standard Specifications for Portland Cement (ASTM, 2000).* Cement grout will be used to fill the spaces between the 18-in surface casing and the borehole wall and the surface casing and well casing.

Well Development

Development of the well shall involve several steps:

1. Wire-brushing each screened interval.

2. Bailing along the entire well length from the top at standing water down for an initial clean-up of the well. An initial measurement of field parameters (pH, alkalinity, temperature, specific conductance) shall be made before bailing at each screened interval.

3. Cleaning the sump with the bailer or a sand pump.

4. Pumping of each screened interval, monitoring water quality parameters periodically. Strive for a turbidity value of 5 nephelometric turbidity units (NTU), but cease pumping when water quality no longer improves. Leave pump off for 15 min. Repeat the process three more times (pump until field parameters are acceptable or stabilized and turn pump off for a minimum of 15 min before each pumping event).

5. Recording the time and value of all field-parameter measurements on the field parameter data sheet following proper document control procedures. Use these data to prepare both tables and graphs that depict the development results.

Surface and Well-Head Completion

The ground around the top of the well shall be completed with a 6 ft x 4 ft x 1 ft deep concrete pad keyed into the surface casing. A 3" diameter conduit will be installed in the pad for a solar panel system. The solar panel wiring and instrument enclosure will be added by ESH-18 at a later date. The well head shall consist of approximately 3' of 10 3/4" steel casing sticking up through the cement pad. Casing shall be offset to one end of the pad to allow placement of the instrument enclosure. A chain-link fence with a gate will be placed around the concrete pad to protect the well head from unauthorized access.

GEOLOGIC CHARACTERIZATION

Predicted depths of geologic units and the expected occurrences of groundwater are shown in Tables 2 and 3 and in Figure 3. During Phase 2 air-rotary drilling, an estimated 500 to 700 ml of bulk drill cuttings shall be collected nominally every 5 ft for geologic characterization (Table 4). Cuttings will be stored in plastic bags labeled with the well name and footage range representing the depth interval that the cuttings were derived from. The core samples and cuttings bags will be stored in core boxes labeled with the well name, box number, and the footage range for the box. The core boxes will be transported to the Field Support Facility (FSF) for archiving and storage after the borehole is completed.

A subset of unsieved and sieved samples will be collected from each cuttings run and stored in plastic chip trays labeled with the well name and cuttings depth ranges (Table 4). Unsieved and sieved cuttings will be placed into individual tray bins and labeled by footage and sieve size range. Sieve sizes will typically be >10 and >35 mesh, but may 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 every cuttings run (nominally every 5 ft) and stored in sealed plastic bags labeled with the well name and footage range representing the depth interval that the cuttings were derived from (Table 4). Finer sieve sizes or bulk cuttings may be collected when >10 mesh materials are absent. These samples will be transferred to the Geology Task Leader.

Analytical testing of samples may include mineralogy by X-ray diffraction (XRD), petrography by modal analysis of thin sections, analysis by electron microprobe or scanning electron microscope, and geochemistry by X-ray fluorescence (XRF) (Table 4). Samples shall be identified, labeled and handled through normal chain-of-custody control.

HYDROLOGIC CHARACTERIZATION

Table 3 gives the number and general positions of potential saturated zones in R-8. According to the current conceptual hydrogeologic model, groundwater periodically perched in the alluvium drains into subsurface units such as the Cerros del Rio basalt, and ultimately perhaps into deeper units. R-8 could penetrate significant perched groundwater zones because surface water, which may act as a line source of recharge, commonly flows through this part of Los Alamos Canyon during spring runoff and during runoff events associated with summer thunder storms. Also, up to five perched water zones were found at R-9 east of this site.

Table 2. Projected Depth to Stratigraphic Contacts in R-8

Rock Unit Name	Symbol (Fig 3)	Top (ft)	Bottom (ft)	Thickness (ft)	Comments
Alluvium	Not shown	0	20	20	Unconsolidated alluvial deposits
Otowi Member, Bandelier Tuff	Qbof	20	46	26	Non-welded ignimbrite
Guaje Pumice Bed	Qbog	46	66	20	Pumice fall deposit
Puye Formation,	Tpf	66	160	94	Upper Fanglomerate
Cerros del Rio lava	Tb	160	356	196	Mafic to Intermediate lava
Puye Formation,	Tpf	356	652	296	Lower Fanglomerate
Totavi Lentil	Tpt	652	728	76	Ancestral Rio Grande river gravels
Santa Fe Group (?)	Tsf	728	1002	274	Terrestrial sedimentary deposits
Santa Fe Group basalt	Tsfb	1002	1200 TD	198	Mafic to Intermediate lava

Table 3. Predicted Saturated Zones at R-8

Groundwater Zone	Top (ft)	Bottom (ft)	Comments
Perched Groundwater	160	356	One or more perched zones in Cerros del Rio lavas similar to those found at R-9
Perched Groundwater	356	652	One or more perched zones in clay-rich tuffaceous rocks of the Puye Formation; similar to those found at R-9
Regional Aquifer	696	N/A	Estimated depth to regional water table within the Totavi lentil
Regional Aquifer	696	728	Regional groundwater within the Totavi lentil
Regional Aquifer	728	1002	Regional groundwater within the Santa Fe Gp.(?)
Regional Aquifer	1002	1200 TD	Regional groundwater within Santa Fe Gp. basalt

Figure 3. R-8 Predicted Geology from the Site-Wide 3-D Geologic Model

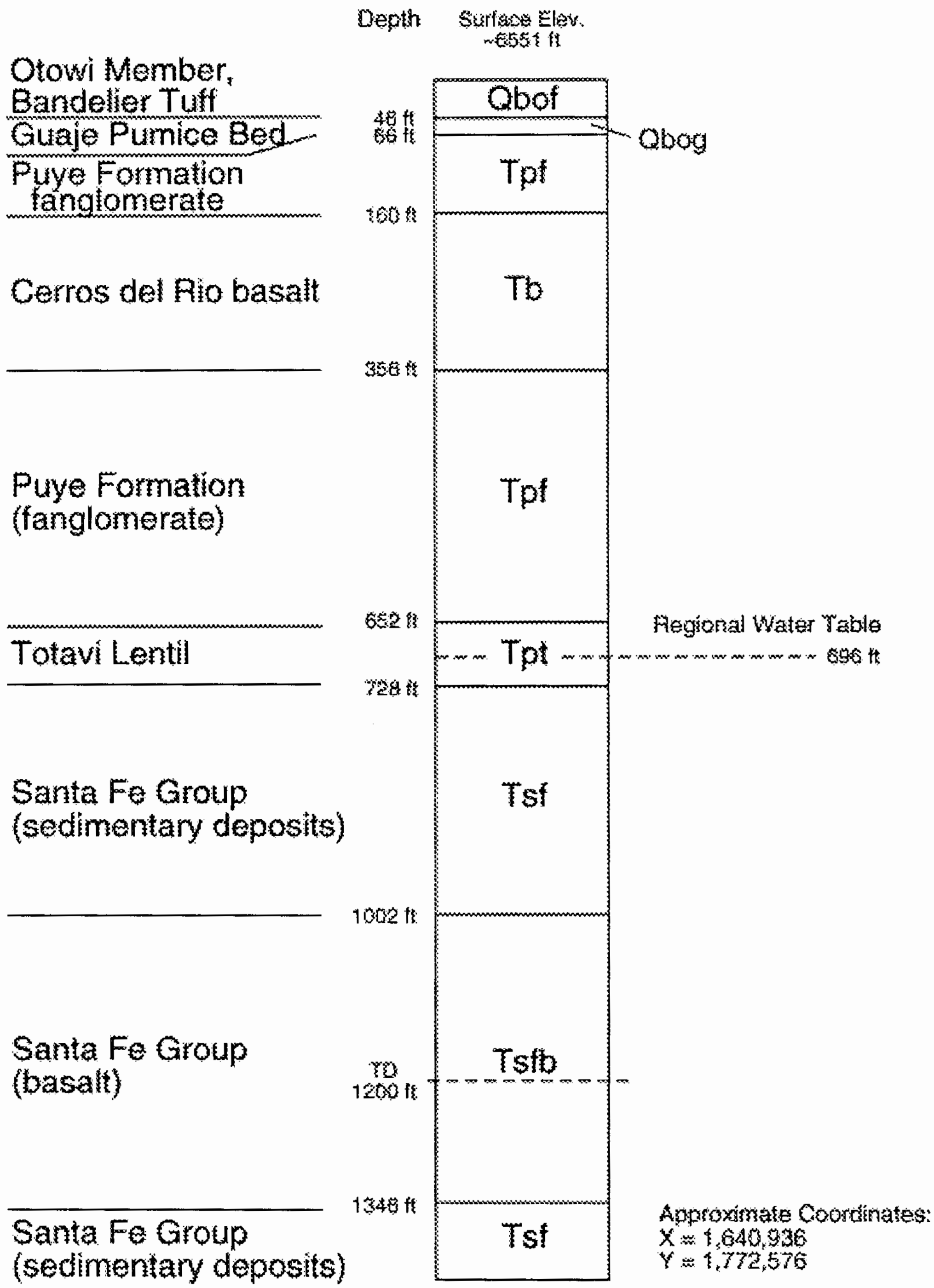

Table 4. Sampling of Cuttings and Core

Sample Description	Test	Sample Size	Container	No. of Samples
Geologic Characterization				
Systematic Bulk Cuttings Collected During Rotary Drilling	Sample for an archive and for supplemental sample needs	500-700 ml	Plastic ziploc bag	One sample every cuttings run (nominally every 5 ft)
Sieved Cuttings Collected During Rotary Drilling	Lithology description, binocular microscope examination	Enough to partly fill trays	Plastic chip trays	Normally, an unsieved sample, a >10 mesh sample, and a > 35 mesh sample every cuttings run (nominally every 5 ft)
Systematic Sieved Cuttings Collected During Rotary Drilling for Geology Task Leader	XRD, XRF, petrography	200-300 ml sieved, or bulk if necessary	Plastic ziploc bag	One >10-mesh sample every cuttings run (nominally every 5 ft); finer sizes or bulk split may be substituted where >10-mesh size can not be obtained.
Geochemical and Contaminant Characterization				
Core Samples from canyon bottom to 70 ft depth.(base of Bandelier Tuff)	boron, bromide, chloride, fluoride, nitrate, nitrite, oxalate, perchlorate, phosphate, and sulfate	~300 g ; fill to point where no head space is left in jar.	250 ml glass jar with moisture-seal lid	One sample every 5 ft. Approximately 15 samples total.
Sidewall Core Samples from Puye Formation and Cerros del Rio lava	boron, bromide, chloride, fluoride, nitrate, nitrite, oxalate, perchlorate, phosphate, and sulfate	2.0-in long by 0.91-in diameter	Plastic ziploc bag	One sample every 10 ft; locations determined after running suite of geophysical logs after hole reaches TD. Approximately 63 samples total.
Within Water-Bearing Zones; Sample location and frequency to be determined by the geochemistry task leader	Radiological	2 L of cuttings	Plastic ziploc bag	Up to 5 samples for the entire borehole
Within Water-Bearing Zones; Sample location and frequency to be determined by the geochemistry task leader	Metals and Anions	1.5 L of cuttings	Plastic ziploc bag	Up to 5 samples for the entire borehole

Unsaturated Zone(s)

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

Geophysical and video logging will be used after the borehole reaches TD to provide hydrologic information about the vadose zone at R-8. Selection of intervals to log and the types of logs to run will depend on factors such as availability of open borehole, characterization issues that arise during drilling, and synchronization with other drilling and well construction activities. The borehole logs will also be used to supplement the saturated zone investigations described below.

Saturated Zone(s)

The depth and evidence for the occurrence of all saturated zones shall be noted by the FTL during drilling. This includes both perched zones and, if applicable, the regional water table. When a saturated zone of perched water is first encountered, a static water level shall be measured by the FTL, using a dedicated water-level meter and/or a pressure transducer system set with a water-level tape.

The water levels shall be measured to the nearest 1/100th of a foot and recorded as depth below ground surface. If the water-level probe used is not graduated, fractions of a foot shall be determined using a measuring tape. To assure *accuracy*, individual measurements shall be repeated until reproducible results are obtained. To assure that water-level values are *static*, repeat measurements every 15 min until results are reproduced within 0.2 ft (all readings shall be recorded). Water-level data sheets shall be kept that tabulate eight observations in order:

1. borehole TD,
2. casing TD,
3. amount of open hole,
4. depth to water,
5. date and time,
6. pre-water-level-measurement drilling activity,
7. time between drilling activity and water-level measurement, and
8. comments.

Hydraulic properties of materials in perched zones and, if applicable, the regional water table shall be investigated by in-situ methods, as far as possible. The hydrology task leader shall design and conduct slug or pumping tests once the well is completed.

Appropriate Standard Operating Procedures (SOP) for well slug tests and aquifer pumping tests as well as ASTM SOPs (ASTM 1994) shall be followed. Water level shall be allowed to recover to a static level, but shall be verified before the test. Only potable water shall be injected for slug tests. Tracers (e.g. potassium bromide) may be used to tag drilling water or water injected during testing. Recovery water-level data shall be collected by transducer. A real-time plot of results shall be constructed on site to facilitate the decision as to when to end the test.

GEOCHEMICAL CHARACTERIZATION

The drilling of characterization well R-8 provides the opportunity to evaluate the natural and contaminant chemistry of groundwaters and saturated geologic materials within Los Alamos Canyon. Core, cuttings, and groundwater samples will be selected for geochemical and contaminant characterization by the geochemistry task leader during drilling operations. The locations for samples will depend on the hydrologic and geologic conditions found during drilling. Once the geochemistry task leader identifies samples for collection, the samples will be collected by the FTL and submitted for analysis through the FSF.

Anion, Stable Isotope, and Tritium Profile Core Samples

Anion, stable isotope, and tritium profiles will be determined from the surface to the base of the Bandelier Tuff (approximately the upper 70 ft of the borehole) by collecting core samples every 5 ft during drilling by the HSA. For the Puye Formation and Cerros del Rio lavas, a mechanical sidewall-coring tool (MSCT) will be used to collect sidewall cores at ~10 ft intervals down to the depth of the regional aquifer. The sidewall core is a cylinder 2.0-in long with a diameter of 0.91 in. The locations of sidewall core samples may be modified after the results of geophysical logs are evaluated.

Thus, the anion-, stable isotope-, and tritium-profile studies will involve the collection of core samples both during auger drilling and during geophysical logging (for sidewall cores) after rotary drilling is completed. Approximately fifteen (15) core samples will be collected during auger drilling and sixty-three (63) sidewall cores will be collected during geophysical logging.

Samples will be placed in tightly-sealed glass jars as soon as possible after the core run (Table 4). Each core sample shall be analyzed for the following constituents: bromide, chloride, fluoride, nitrate, perchlorate, sulfate, TKN, tritium, $^{18}O/^{16}O$, D/H, and $^{15}N/^{14}N$. Anion analyses will be performed on the leachate formed from a deionized water slurry of the homogenized core sample. Samples shall be identified, labeled and handled through normal chain-of-custody control. Table 5 lists the analytical suites, analytical methods, and detection limits for characterization of the core samples.

Contaminant Characterization Core and Cuttings Samples

Up to five core or cuttings samples will be collected for geochemical and contaminant characterization within water-bearing zones encountered during drilling. The geochemistry task leader (TL) will identify when collection of samples is appropriate. Up to 3.5 L of unsieved cuttings will be collected for each sample (Table 4). Testing of samples may include radionuclides, metals, and anions. Samples shall be identified, labeled and handled through normal chain-of-custody control. Table 5 lists the analytical suites, analytical methods, and detection limits for geochemical and contaminant characterization of cuttings and core samples.

Groundwater Samples

Up to three borehole groundwater screening samples will be collected for geochemical and contaminant characterization during drilling. These samples will target groundwater in the perched zone(s) and in the regional aquifer. These 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. Table 6 lists the analytical suite, sample volumes, and containerization requirements for samples to be collected. Samples shall be collected as directed by the geochemistry TL, according to these guidelines:

- When water is encountered, the geochemistry TL will be notified to determine if one of the three samples set aside to sample groundwater in the borehole should be collected,
- Where casing advance is used, the depth to the bottom of casing and depth to groundwater shall be recorded on the sample collection log for each sample.

Table 5. Analysis of Cuttings and Core

Analyte	EDL[a]	Analytical Method[b]	Analytical Protocol
Anions[c]/ Stable Isotopes/ ^{3}H Profiles			
Bromide	0.02	IC	SW-846 – EPA Method 300
Chloride	0.02	IC	SW-846 – EPA Method 300
Fluoride	0.02	IC	SW-846 – EPA Method 300
Nitrate	0.02	IC	SW-846 – EPA Method 300
Sulfate	0.02	IC	SW-846 – EPA Method 300
Perchlorate	0.002	IC	SW-846 – EPA Method 300
TKN	0.1	C	SW-846 – EPA Method 351
$^{18}O/^{16}O$	N/A	Mass Spectrometry	N/A
D/H	N/A	Mass Spectrometry	N/A
$^{15}N/^{14}N$	N/A	Mass Spectrometry	N/A
^{3}H	300 pCi/l	LSC	N/A
Contaminant Characterization Constituents			
^{241}Am	0.01	α-Spectrometry	N/A
^{238}Pu	0.1	α-Spectrometry	N/A
$^{239,240}Pu$	0.1	α-Spectrometry	N/A
^{90}Sr	2	GPC	N/A
^{234}U	0.1	α-Spectrometry	N/A
^{235}U	0.1	α-Spectrometry	N/A
^{238}U	0.1	α-Spectrometry	N/A
Gamma spectroscopy	1.0	γ-Spectroscopy	N/A
Gross-alpha	10	α-Spectrometry	N/A
Gross-beta	10	GPC or LSC	N/A
Gross-gamma	2.0	NaI(Tl) HPGe detection	N/A

a. EDL = estimated detection limit; listed as mg/L for anions, and pCi/g for radionuclide constitutents except for tritium (pCi/l) extracted water.

b. Analytical Methods - IC = ion chromatography, C = colorimetric analysis, LSC = liquid scintillation counting, GPC = gas proportional counter, NaI(Tl) = thallium-doped sodium iodide, HPGe = high-purity germanium.

c. Anion analyses will be performed on the leachate formed from a deionized water slurry of the homogenized core sample.

The FTL will ensure that the sample collection, chain of custody, and routing to analytical laboratories are properly documented via paper work provided by the ER Central Data Management Group.

For each groundwater-sampling event, field personnel shall perform specific activities:

- Record the *date, time, borehole ID, depth to water prior to sampling, and the depth that water entered the borehole*, on the sample collection log.
- Prevent groundwater samples from freezing or over-heating.
- Obtain air-lifted groundwater samples to collect approximately 10 gallons of groundwater.
- Immediately record field-measured parameters for groundwater samples (Table 7).
- Filter approximately 1.25 L of each groundwater sample (Table 6).
- Fill appropriate sample containers with filtered and nonfiltered groundwater (Table 6).
- Place labels and custody seals on each sample container.
- Transport the samples to the Sample management Organization (SMO) at the Field Support Facility (FSF); this will require coordination with the Central Data Management Group to provide the electronic and paper chains-of-custody for transfer of samples to the SMO.

Table 6. Sampling and Analysis of Groundwater

Estimated Number of Water Samples/Well	Analysis	Container	Preservation	Filtered through acetate 0.45 micrometer	Volume each sample (L)	Preferred Laboratory	Collect Archival Sample	Archival Sample Volume (L)
3	Metals (dissolved)	100 ml plastic	HNO_3 to pH 2, 4°C	Yes	0.25	EES-6		
3	Anions (dissolved)	100 ml plastic	See footnote (3)	Yes	0.25	EES-6		
3	γ spec, ^{241}Am, ^{137}Cs, ^{238,239,240}Pu, ^{234,235,238}U, ^{90}Sr (total)	1 gallon plastic	HNO_3 to pH 2, 4°C	No	4.55	STL Richland	X	4.5
3	Stable isotopes ($^{18}O/^{16}O$, D/H)	30 ml glass w/ poly seal cap	Ambient temperature	No	0.03	Geochron	X	0.03
3	Stable isotopes ($^{15}N/^{14}N$)	1 gallon plastic	HCL or H_2SO_4 to pH 2, 4°C	No	4.55	Coastal	X	4.5
3	Tritium(1)	500 ml poly	Ambient temperature	No	0.5	Paragon	X	0.5
3	Tritium (low level or direct counting) (1)	500 ml poly	Ambient temperature	No	0.5	University of Miami	X	1
3	Grossα,β,γ (for on-site shipping)	500 ml poly	Ambient temperature	No	0.5	ARS	X	0.5
3	TUICPMS(2)	500 ml poly	HNO_3 to pH 2, 4°C	Yes	0.5	GEL	X	0.5
3	TKN	1L poly	H_2SO_4 to pH 2, 4°C (3)	No	1L	GEL	X	1
3	ClO_4^-	250 ml poly	Ambient temperature	Yes	0.25	GEL	X	0.25
				Total Volume – Both Filtered and Not Filtered	12.88		Total Volume for Archival Storage – All Not Filtered	12.88
				Part of Total Volume to be Filtered	1.25			

(1) Initially analyze tritium using liquid scintillation. If activity is less than 300 pCi/L, analyze archival sample using direct counting or electrolytic enrichment at University of Miami.
(2) TUICPMS = total uranium inductively-coupled plasma mass spectrometry.
(3) No preservation for Br^{-1}, Cl^{-1}, F^{-1}, SO_4^{-2}; and PO_4^{-3}. TKN, NH_4^+, NO_3^-, and NO_2^- are preserved with H_2SO_4 to pH 2, 4°C.

Table 7. Parameters to be Measured in the Field When Sampling Groundwater

Measurement	Precision[1]
pH	±0.02
Specific conductance	±1 μmho/cm (25 °C)
Temperature	±1 °C
Turbidity (nephelometric)	±1 NTU[2]

1. Precision with which measurement shall be recorded
2. NTU = nephelometric turbidity unit

- Transport the indicated sample portion to the count lab for radiological screening required prior to sample shipment from the Sample Management Organization (SMO).
- Properly preserved archival samples (Table 6) will be held at the FSF for potential re-analysis needs; the retention period for samples shall be 6 months for radiological constituents, metals, and anions and one year for tritium.

GEOPHYSICAL CHARACTERIZATION

Geophysical logs will be collected as specified by the technical advisory team leader to determine the geologic and hydrologic characteristics of the vadose zone, perched saturated zones and regional aquifer, if required. Borehole and well geophysical data will be obtained from two sources: 1) drilling subcontractor personnel may obtain borehole video, caliper, spontaneous potential, single point resistance, and natural gamma radiation (NGR) surveys using the Laboratory's geophysical logging equipment, and 2) a wire-line logging service will be contracted to obtain a suite of borehole geophysical logs. The number and types of logs collected by the wire-line logging services will vary as a function of borehole condition, the presence or absence of drill or well casing, and technical issues being addressed by a particular logging run. Table 8 gives typical suites of logs that have been run by wire-line logging services in cased and uncased boreholes during installation of previous Hydrogeologic Workplan wells.

Drilling subcontractor personnel will use a Laboratory-supplied natural-gamma-radiation tool and borehole video equipment to log any open borehole after TD is reached; cased hole may also be logged as necessary. Drilling subcontractor personnel will also collect a borehole video log at the completion of the well installation to document the as-built condition of installed well components. The natural gamma tool shall be used 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.

DOCUMENTATION AND REPORTING

Information generated in conjunction with the well installation of R-8 shall be presented or preserved in various reports and records.

Field Documentation

Table 9 lists all documentation to be completed during the course of fieldwork. The contents and format of most of these documents are well established. However, to ensure consistency in the Sample Collection Logs, team members are reminded to *include well number, sample ID, location ID (if necessary), sample type*

(D = drill cuttings; C = core), upper and lower depth of interval sampled (ft) and purpose (Geo = geology, Hydro Prop = hydraulic properties and Geochem = geochemical analysis).

The identified individual or their approved designee shall complete all documentation at the frequency given. Documentation will be relinquished to the FTM daily or as needed.

The FTL shall ensure that the Daily Activity Log is e-mailed to project participants the following day. This will ensure that participants and managers are fully informed about current status and recent activities.

Table 8. Typical Wire-Line Logging Service Geophysical Logging Tools

Cased Hole	*Cased Hole*	*Open Hole*	*Uncased Hole*
Array Induction imager Tool (AIT)		X	Measures open-hole formation conductivity with multiple depths of investigation at varied vertical resolution.
Triple LithoDensity tool (TLD)	X	X	Evaluation of 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 deviations/variation in borehole diameter.
Mechanical Sidewall Coring Tool (MSCT)		X	Designed to retrieve multiple, high quality sidewall cores in hard formations for chemical analysis or hydraulic-property testing.
Fullbore Formation Microimager (FMI)		X	Provides high quality image of borehole; 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 determination of elemental concentrations of Si, Ca, Fe, Ti and Gd.

Table 9. Required Field Documentation

Documentation	Responsible Person	Frequency
Daily Activity Log	FTL	Daily
FTL Logbook	FTL	Daily
Driller's Log	Driller	Daily
Geological Field Log	FTL/Geologist/Task Leader	As Needed
Drilling Additives Log	FTL/Geologist	Daily
Sample Collection Log	Sampler	As Needed
Chain of Custody, Request For Analysis	Sampler/FTL/Task Leader	As Needed
Miscellaneous Monitoring Forms	SSO/RSP	Daily
Tailgate Meeting Attendance Form	SSO/FTL	Daily
SSO Logbook	SSO	Daily
Visitor's Sign In Log	SSO/FTL	Ongoing
Well Development Field Parameter Log	FTL	During Development
Waste Mgt. Logbook	Waste Mgr.	As Needed
Miscellaneous Waste Mgt. Forms	Waste Mgr.	As Needed
Weekly Summary Report	FTM	Weekly
Field Photographs	All	As Needed
Water Level Field Log	FTL	As Needed
Pipe Tally Sheets	FTL	On Going
Borehole Geophysics Forms	Technician	As Needed
Well Summary Fact Sheet	FTM/FTL	Within 10 days of geodetic survey

Well Summary Fact Sheet

A well summary fact sheet shall be completed and submitted to the technical advisory team leader within 10 days following geodetic survey of R-8. The fact sheet requires information on the *well owner, location, drilling contractor, well construction, geology, water-bearing strata, contaminants detected in screening samples, and other general information (drilling method, depth to water, etc.).*

Well-Completion Report

The Well-Completion Report shall be prepared following demobilization and restoration of the drill site. The report, written to document not only well construction, but also geologic, hydrologic and geochemical characterization findings, shall be submitted to Department of Energy (DOE) and NMED (for information only). LANL shall be responsible for the compilation and assembly of the well completion report. The subcontractor is responsible for preparing the following report sections: drilling, well construction, development, well-head protection, site restoration, waste management, radiological and geodetic surveys, and lithologic logs.

Submission of Records to the Records Processing Facility

The subcontractor shall submit all logs, notebooks, data sheets, and records assembled for the readiness review and for the field and drilling operations to the ER Records Processing Facility at the conclusion of field activities.

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), 2000. C150-00a "ASTM Standard Specification for Portland Cement," Developed by ASTM Subcommittee: C01.01, West Conshohocken, Pennsylvania.

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

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

Subject: **R-8 FIP contents and suggestions**
Date: Thu, 06 Sep 2001 11:21:53 -0600
From: Michael Dale <mdale@lanl.gov>
To: john young <john_young@nmenv.state.nm.us>
CC: stephen Yanicak <syanicak@lanl.gov>

Page #'s off in table of contents

R-8 FIP and what they intend to do:

1. Objectives are to determine the distribution of contamination in the subsurface, determine extent of intermediate ground water, and provide general characterization of the ground water beneath the Laboratory and support/improve the hydrogeologic conceptual model. They state that these data needs or objectives will be satisfied via the collection of geologic, hydrologic and geophysical about the perched and regional aquifer. (These objectives will be tough to satisfy especially when one has very little data to work with)

2. Drilling sequence includes first augering and coring to about 50', then drilling to TD (1200') with fluid-assisted air rotary using glass beads and/or QUIK-FOAM and/or EZ-MUD as a drilling media. (I would auger as far as you can, hopefully to the Guaje Pumice which they should hit 60' to 70' bgs) (Otowi-4 hit perched water at 253' bgs in the Puye, but the FIP does not mention it - don't you think they should?)

3. First perched water/zone will be sampled immediately and data will be looked at asap to determine if the zone will need be sealed off or isolated. They state that the first water encountered would be the zone most likely to contain contaminants. (maybe so, but flow velocities and directions, source terms, etc. may play a bigger role in which perched zones contain more or less contamination)

4. Well is planned to be single completion. (Sounds good to me, but they may will need separate intermediate well at this location)

5. Well development includes wire-brushing, bailing across the screened zone ending with pumping of the screened zone. (This may not be enough; jetting, surging, etc. - a professional/seasoned well-development operator needs to do this work)

6. CHARACTERIZATION

a. **Geologic** information will be derived via the collection of cuttings, 65 sidewall core in the Puye and Cerros del Rio basalt flows, up to 5 sidewall cores in the saturated/water-bearing zones and geophysics.

b. **Hydrogeologic** information will be derived via the collection of geophysical logs and video logs (visual yes or no presence) in the unsaturated zone, and only in-situ slug tests at the top of water regional aquifer (saturated zone). (Conventional coring in the areas of suspected saturation and perching horizons will be needed if accurate and precise hydraulic data are to be obtained. Needed information would include - is water really present?, saturated thickness, percent saturation, matrix-flow permeability, fracture properties, contaminant concentrations and distributions, etc. Dry drilling will be required, I think.) (High cost will need to be considered)

c. **Geochemical** information will be derived from the collection of cuttings, sidewall core, auger core and ground-water screening samples up to 3. (Once again, some conventional core will greatly enhance the geochemical/hydrochemical characterization of the subsurface in this particular area beneath Los Alamos Canyon)

In a nutshell, I suggest that they drill the well dry or at least during or at depths which coring is needed, collect some conventional core at targeted depths, analyze the core to its fullest extent, do as much geophysical logging as possible and perform their proposed slug test in the regional as well as the first water-bearing zone. First encountered water will need special attention - multiple purging/water withdraw followed by water-level measurements or do their slug test routine. This will help determine the productivity of the zone. They may want to complete the first "good producing" water-bearing zone as a monitoring well before going any further; then move over and start back drilling to deeper depths.

I don't think they realize the importance of this borehole/well. It's lunch, I'm going for a walk.
LATER>

UDR

Continuous Core 700' - Wire line

May make a piezometer or intermediate well. or over ream and install

Core: utilized for Contam profiling
Hydraulic Properties
Kd's