Environmental Restoration
University of California
Environmental Science and Waste Technology (E)
Environmental Restoration, MS M992
Los Alamos, New Mexico 87545
505-667-0808/FAX 505-665-4747

U.S. Department of Energy
Los Alamos Area Office, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
505-667-7203/FAX 505-665-4504

RECEIVED
AUG 2001

*Date:* August 8, 2001
*Refer to:* ER2001-0645

HWA LANL G/m/HWP 2001 "R-13" TA-5

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

**SUBJECT: FIELD IMPLEMENTATION PLAN FOR R-13**

Dear Mr. Young:

Enclosed is the Field Implementation Plan for the drilling and testing of LANL Regional Aquifer Characterization Well R-13. We anticipate that the drilling portion of this work will begin on Wednesday, August 22, 2001.

Please provide any comments to John McCann at (505) 665-1091 or Dave Broxton at (505) 667-2492 at your earliest possible convenience.

Sincerely,

Julie A. Canepa, Program Manager
Environmental Restoration Project
Los Alamos National Laboratory

Sincerely,

Mat Johansen, Project Manager
Department of Energy
Los Alamos Area Office

JC/MJ/jml

Enclosure: Field Implementation Plan for the Drilling and Testing of LANL Regional Aquifer Characterization Well R-13 (ER2001-0570)

Cy (w/enc.):
M. Kirsch, E/ER, MS M992
J. McCann, E/ER, MS M992
D. Neleigh, US EPA (2 copies)
M. Johansen, LAAO, MS A316
G. Turner, LAAO, MS A316
J. Davis, NMED-SWQB
M. Leavitt, NMED-GWQB
J. Parker, NMED-DOE OB
S. Yanicak, NMED-DOE OB, MS J993
E/ER File, MS M992
RPF, MS M707

Cy (w/o enc.):
J. Canepa, E/ER, MS M992
D. McInroy, E/ER, MS M992
C. Nylander, ESH-18, MS K497
J. Bearzi, NMED-HWB
J. Kieling, NMED-HWB

Los Alamos National Laboratory

# FIELD IMPLEMENTATION PLAN

# FOR THE DRILLING AND TESTING OF LANL REGIONAL AQUIFER CHARACTERIZATION WELL R-13

Environmental Restoration Project

Groundwater Investigations Focus Area

July 2001

## CONTENTS

ACRONYMS AND ABBREVIATIONS ..... 4

OVERVIEW ..... 5

INTRODUCTION ..... 5

- Summary of Data Quality Objectives ..... 5
- Location ..... 6
- Roles and Responsibilities ..... 6
- Health and Safety ..... 6
- Quality Assurance ..... 6
- Waste Management ..... 7

DRILLING PLAN SUMMARY ..... 7

- Pre-Drilling Activities ..... 7
- Drilling Equipment/Procedures ..... 10
- Drilling Contingencies ..... 10
- Decontamination ..... 11
- Demobilization and Site Restoration ..... 11

WELL DESIGN ..... 11

- Design Assumptions ..... 11
- Borehole Annular Space ..... 11
- Well Casings ..... 11
- Well Screens ..... 12
- Annular Fill ..... 12
- Well Development ..... 12
- Surface and Well-Head Completion ..... 13

GEOLOGIC CHARACTERIZATION ..... 13

HYDROLOGIC CHARACTERIZATION ..... 13

- Unsaturated Zone(s) ..... 16
- Saturated Zone(s) ..... 16

GEOCHEMICAL CHARACTERIZATION ..... 17

- Anion, Stable Isotope, and Tritium Profile Core Samples ..... 17
- Contaminant Characterization Core and Cuttings Samples ..... 17
- Groundwater Samples ..... 18

GEOPHYSICAL CHARACTERIZATION ..... 20

DOCUMENTATION AND REPORTING ..... 20

- Field Documentation ..... 20
- Well Summary Fact Sheet ..... 21
- Well-Completion Report ..... 22
- Submission of Records to the Records Processing Facility ..... 22

REFERENCES ..... 22

## Figures


Figure 1. Map showing the location of R-13 ..... 7
Figure 2. Functional Organization of R-13 Personnel ..... 8
Figure 3. R-13 Predicted Geology from the Site-Wide 3-D Geologic Model ..... 15


## Tables


Table 1. Roles and Responsibilities ..... 9
Table 2. Projected Depth to Stratigraphic Contacts in R-13 ..... 14
Table 3. Predicted Saturated Zones at R-13 ..... 14
Table 4. Sampling of Cuttings and Core ..... 16
Table 5. Analysis of Cuttings and Core ..... 18
Table 6. Sampling and Analysis of Groundwater ..... 19
Table 7. Parameters to be Measured in the Field When Sampling Groundwater ..... 20
Table 8. Typical Wire-Line Logging Service Geophysical Logging Tools ..... 21
Table 9. Required Field Documentation ..... 22

## 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 |
| **FPL** | Field Project Leader |
| **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 |
| **MCL** | Maximum contaminant level |
| **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 |
| **RLWTF** | Radioactive Liquid Waste Treatment Facility |
| **RSP** | Radiological Screening Personnel |
| **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** | Team Leader |
| **WCSF** | Waste Characterization Strategy Form |
| **WGII** | Washington Group International, Incorporated |

## OVERVIEW

- *Well R-13 is being installed by the Environmental Restoration (ER) Project as part of the implementation of ER□s Mortandad Canyon Work Plan (LANL, 1997) and 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 of contaminant release sites in Mortandad and Ten Site Canyons. Characterization 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-13 is located in Mortandad Canyon near the Laboratory boundary with San Ildefonso Pueblo land.*
- *R-13 will be drilled by fluid-assisted, open-hole, air-rotary (AR) methods.*
- *R-13 will be a single-screen well targeting the top of the regional aquifer (approximately 854 ft depth).*
- *The borehole will extend to a depth of approximately 1450 ft to characterize the hydrogeologic units that control flow through the upper part of the regional groundwater system.*

## INTRODUCTION

Well R-13 is being installed by the Environmental Restoration (ER) Project as part of the implementation of ER□s Mortandad Canyon Work Plan (LANL, 1997). R-13 is also one of up to 32 proposed wells being installed 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. 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-13 is down gradient of active and inactive outfalls at TA-35, TA-48, TA-50, TA-52, TA-55, and TA-60. From an ER groundwater perspective, the sources of most concern are historic effluent releases from both the wastewater treatment plant at TA-50 and the former wastewater treatment plant at TA-35. R-13 is primarily designed to determine hydrogeologic conditions and groundwater quality in the area where Mortandad Canyon exits Laboratory property. West of the well site, Mortandad Canyon stream channel probably served as a line source of recharge to deeper groundwater systems

The Laboratory□s radioactive liquid waste treatment facility (RLWTF) at TA-50 discharges treated wastewater to Mortandad Canyon via Effluent Canyon through an outfall that is currently permitted as NPDES outfall 051. From 1963 through 1995, a total of 342 million gal. (1,294,500 $m^3$) of treated wastewater were discharged (LANL, 1997). Laboratory surveillance data collected in Mortandad Canyon show elevated concentrations or activities of $NO_3$, $^{3}H$, $^{90}Sr$, $^{137}Cs$, $^{239,240}Pu$, $^{241}Am$, and $^{234,235,238}U$ in ephemeral surface water and in alluvial groundwater.

From 1951 to 1963, the Laboratory□s wastewater treatment plant was operated at TA-35. Routine and accidental discharges from the wastewater treatment plant resulted in release of contaminants to Ten Site Canyon, a major tributary to Mortandad Canyon (Fig. 1). Contaminants of potential concern associated with the TA-35 wastewater plant include $^{140}La$, $^{140}Ba$, $^{89}Sr$ and $^{90}Sr$, $^{90}Y$, $^{137}Cs$, $^{106}Ru$, $^{238}Pu$, $^{239,240}Pu$, caustic,

acid, sodium carbonate, strontium nitrate, iron sulfate, and dielectric oil (LANL, 1997). By the early 1960s, the wastewater treatment plant at TA-35 reached its capacity to handle the increasing volume of liquid radioactive wastes associated with expanding Laboratory operations. In 1963, TA-35 wastewater operations were transferred to the new RLWTF at TA-50.

Together with data from existing and planned wells, water quality data from R-13 will be used to assess impacts on deep groundwater in Mortandad Canyon resulting from the releases described above. R-13 is also being installed as part of a broader groundwater study described in the Hydrogeologic Workplan (LANL, 1998) which is designed to provide an improved understanding of the hydrogeologic environment beneath the Laboratory. Characterization data from R-13 and other existing and planned wells will be used to support the design of a groundwater monitoring system for the Laboratory. Hydrogeologic and water quality data from R-13 are needed to constrain numerical models evaluating contaminant migration through the regional aquifer.

Data needs will be satisfied by the collection and evaluation of drill cuttings, collection of geophysical data in the completed borehole, determination of head data for the regional aquifer, installation of a well screen at the water table, and collection of water quality data. Incorporation of data from R-13 will improve the site-wide 3-D geologic model for this part of the Laboratory and provide constraints during the iterative evaluation of hydrogeologic conceptual models.

**Location**

Characterization well R-13 is located on the floor of Mortandad Canyon, approximately 5890 ft east-southeast of characterization well R-15 (Fig. 1). This location was selected because of its proximity to the Laboratory boundary with San Ildefonso Pueblo (approximately 250 ft to the south) and the need for hydrogeologic characterization in this part of the Laboratory. The selected location is 12,650 to 15,550 ft east-southeast of potential contaminant release sites at TA-35 and TA-50.

**Roles and Responsibilities**

The roles and responsibilities for the investigation team are shown in Table 1. The functional organization of the R-13 implementation is illustrated in Figure 2.

**Health and Safety**

All field work shall be conducted in accordance with LANL 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) EM&R | 667-6211 |
| 3) FAPL (John McCann) | 665-1091 |
| 4) FTL Operations (Steve Pearson) | 667-3005 |
| 5) FTM/FTL (Crowder/Everett) | 662-1338/662-1322 |
| 6) 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.

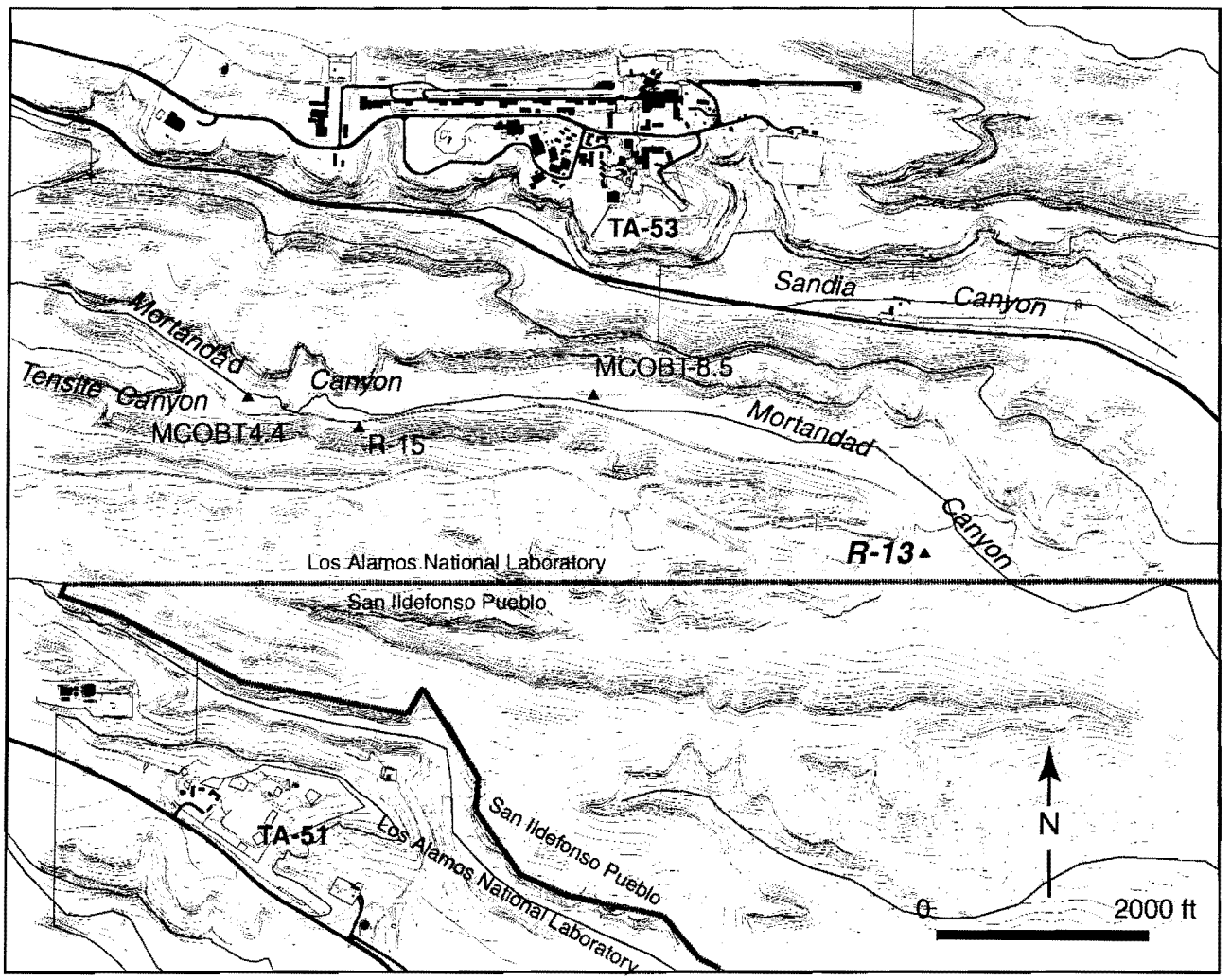


**Figure 1. Map showing the location of R-13**

### 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. A notice of intent (NOI) to discharge benign wastewater on-site will be prepared by 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

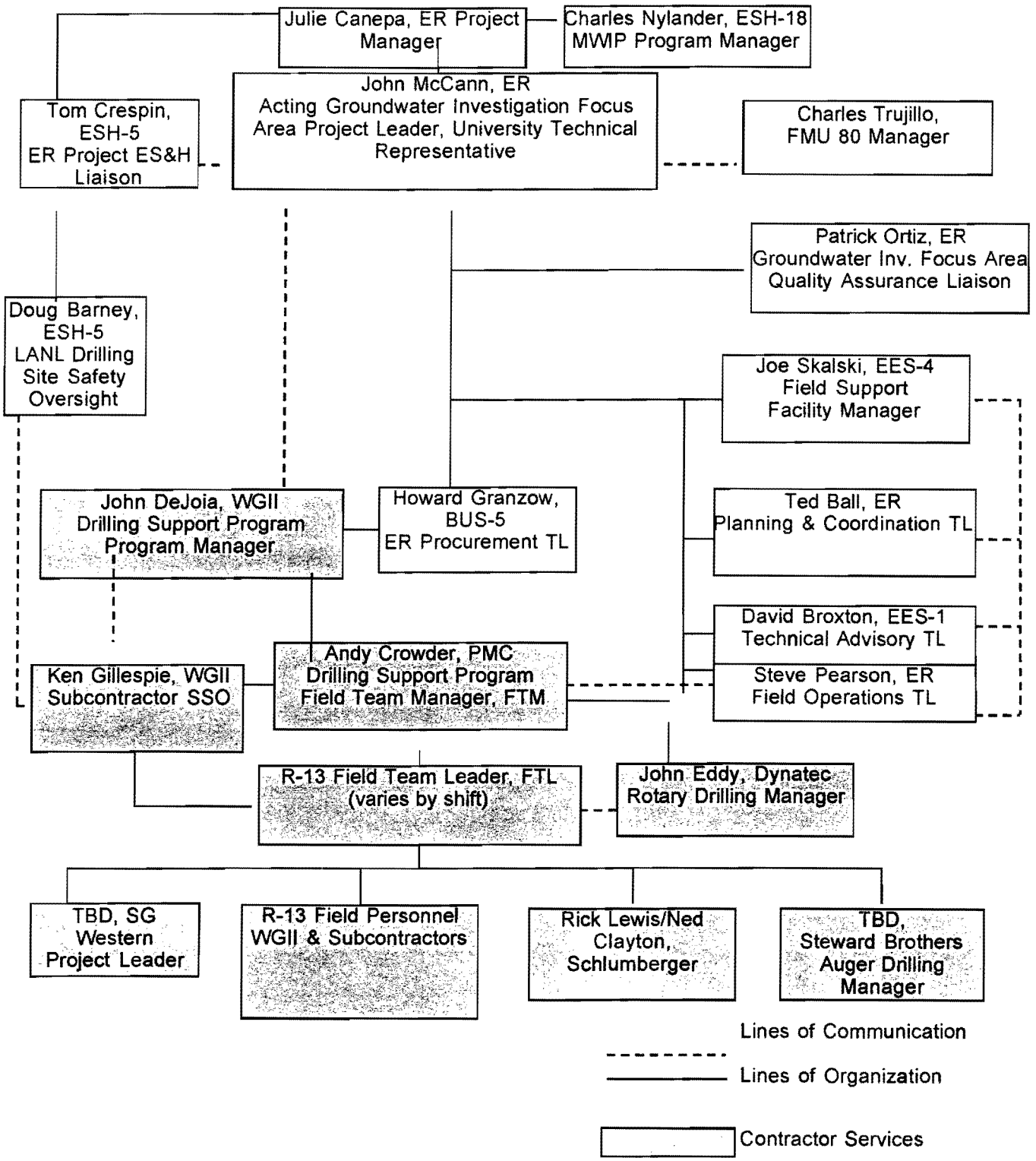


**Figure 2. Functional Organization of R-13 Personnel**

## 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)<br>699-1568 (cell.) | LANL/<br>ESH-18 | Monitor Well Installation Program Manager | Responsible for Monitor Well Installation Program management. |
| John McCann | 665-1091 (work) | LANL/<br>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)<br>996-4042 (page)<br>663-1013 (home) | Dynatec | Drilling Manager | Drill team manager and drilling program design and implementation. |
| Ted Ball | 665-3996 (work)<br>996-3999 (page) | LANL/<br>ER | Groundwater Focus Area Planning and Coordination Team Ldr | Responsible for baseline development, project status, and project schedule development |
| Steve Pearson | 667-3005 (work)<br>104-4525 (page)<br>699-3684 (cell.)<br>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)<br>104-3994 (page)<br>699-0950 (cell.) | LANL/<br>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)<br>699-1987 (cell.)<br>104-3993 (page) | LANL/<br>EES-1 | Groundwater Focus Area Geochemistry Task Leader (TL) | Provides technical leadership for geochemical characterization. |
| William Stone | 665-8340 (work) | LANL/<br>EES-5 | Groundwater Focus Area Hydrology Task Leader (TL) | Provides technical leadership for hydrologic characterization and well development. |
| David Vaniman | 667-1863 (work)<br>104-7019 (page)<br>699-1079 (cell.) | LANL/<br>EES-1 | Groundwater Focus Area Geology Task Leader (TL) | Provides technical leadership for geologic characterization. |
| Joe Skalski | 667-2876 (work)<br>996-0891 (page)<br>672-9060 (home) | LANL/<br>EES-4 | Field Support Facility Manager | Provides drilling support and on-site management of the FSF. |
| Andy Crowder | 662-1338 (work)<br>104-3968 (page)<br>780-2975 (cell.)<br>983-6643 (home) | PMC | Field Team Manager/ Field Team Leader (FTM/FTL) | Drilling contract Task Manager. |
| Mark Everett | 662-1322 (work)<br>698-2281 (page)<br>780-2973 (cell.)<br>986-8186 (home) | WGII | FTL/Geologist | Oversight of on-site field support activities. |
| Doug Barney | 665-5132 (work)<br>104-5506 (page)<br>753-9741 (home) | LANL/<br>ESH-5 | LANL Safety Oversight | Responsible for LANL oversight of site safety. |
| Ken Gillespie | 662-1306 (work)<br>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)<br>303-601-5250 (cell.) | Schlum-<br>berger | Geophysical Support | Responsible for contract issues and deliverables for geophysical logging services |
| Rick Lewis | 303-486-3236 (work)<br>303-618-8825 (cell.) | Schlum-<br>berger | Geophysical Support | Provides technical support for geophysical log collection and interpretation |
| Charles Trujillo | 667-0491 (work)<br>996-1084 (page) | LANL/<br>FWO-UI | FMU 80 Facility Manager | Landlord for FMU 80 |
| Patrick Ortiz | 665-5289 (work) | LANL/<br>ESH-14 | Groundwater Inv. Focus Area QA Liaison | Oversight of LANL and contractor implementation of QA program. |

erosion control 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**

Drilling of R-13 will proceed 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 to the surface-casing target depth of approximately 50 ft below ground surface (bgs) 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-13 shall be drilled as an open hole to the TD of about 1450 ft bgs 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 lubricity, cuttings recovery, and borehole stability 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-13 is nominally 1450 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.

- 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.

- R-13 is planned as a single-screen well completed in the regional zone of saturation. However, a cost/benefit analysis will be performed 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 the 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, selected by the geochemistry task leader, may be collected from the cyclone by air lifting the water through the drilling circulation system.

- Fluids circulated into the borehole will be contained within the lined waste management area onsite.
- Formation water and cuttings generated during drilling operations will be containerized until characterized.
- 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-13, 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-13 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 Integretion 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-13 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 bottom 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 bgs 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 of standing water down to the lowest screened interval 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 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 to geologic contacts are shown in Table 2 and Figure 3. During Phase 2 air-rotary drilling, an estimated 500 to 700 ml of bulk drill cuttings shall be collected every 5 ft for geologic characterization (Table 3). 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 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, petrography by modal analysis of thin sections, analysis by electron microprobe or scanning electron microscope, and geochemistry by X-ray fluorescence (Table 4). Samples shall be identified, labeled and handled through normal chain-of-custody control.

## HYDROLOGIC CHARACTERIZATION

Table 3 gives the number and projected positions of potential saturated zones at and below the regional water table in R-13. 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. However, R-13 is not expected to penetrate significant perched groundwater because of its location in lower Mortandad Canyon which is generally dry.

**Table 2. Projected Depth to Stratigraphic Contacts in R-13**

| Rock Unit Name | Symbol (Fig 3) | Top (ft) | Bottom (ft) | Thickness (ft) | Comments |
|---|---|---|---|---|---|
| Alluvium | Not shown | 0 | 15 | 15 | Unconsolidated alluvial deposits |
| Tshirege Member, Bandelier Tuff | Qbt-1g/ Qbtt | 15 | 27 | 12 | Non-welded ignimbrite with basal pumice fall deposit |
| Cerro Toledo interval | Qct | 27 | 59 | 32 | Volcaniclastic Sediments |
| Otowi Member, Bandelier Tuff | Qbof | 59 | 236 | 177 | Non-welded ignimbrite |
| Guaje Pumice Bed | Qbog | 236 | 257 | 21 | Pumice fall deposit |
| Puye Formation, | Tpf | 257 | 271 | 14 | Upper Fanglomerate |
| Cerros del Rio lava | Tb | 271 | 615 | 344 | Mafic to Intermediate lava |
| Puye Formation, | Tpf | 615 | 884 | 269 | Lower Fanglomerate |
| Totavi Lentil | Tpt | 884 | 945 | 61 | Ancestral Rio Grande river gravels |
| Santa Fe Group (?) | Tsf | 945 | 1394 | 449 | Terrestrial sedimentary deposits |
| Santa Fe Group basalt | Tsfb | 1394 | 1450 TD | 56 | Mafic to Intermediate lava |

**Table 3. Predicted Saturated Zones at R-13**

| Groundwater Zone | Top (ft) | Bottom (ft) | Comments |
|---|---|---|---|
| Regional Aquifer | 854 | N/A | Estimated depth to regional water table within the Puye Formation. |
| Regional Aquifer | 884 | 945 | Regional groundwater within the Totavi lentil |
| Regional Aquifer | 945 | 1394 | Regional groundwater within the Santa Fe Gp.(?) |
| Regional Aquifer | 1394 | 1450 TD | Regional groundwater within Santa Fe Gp. basalt |

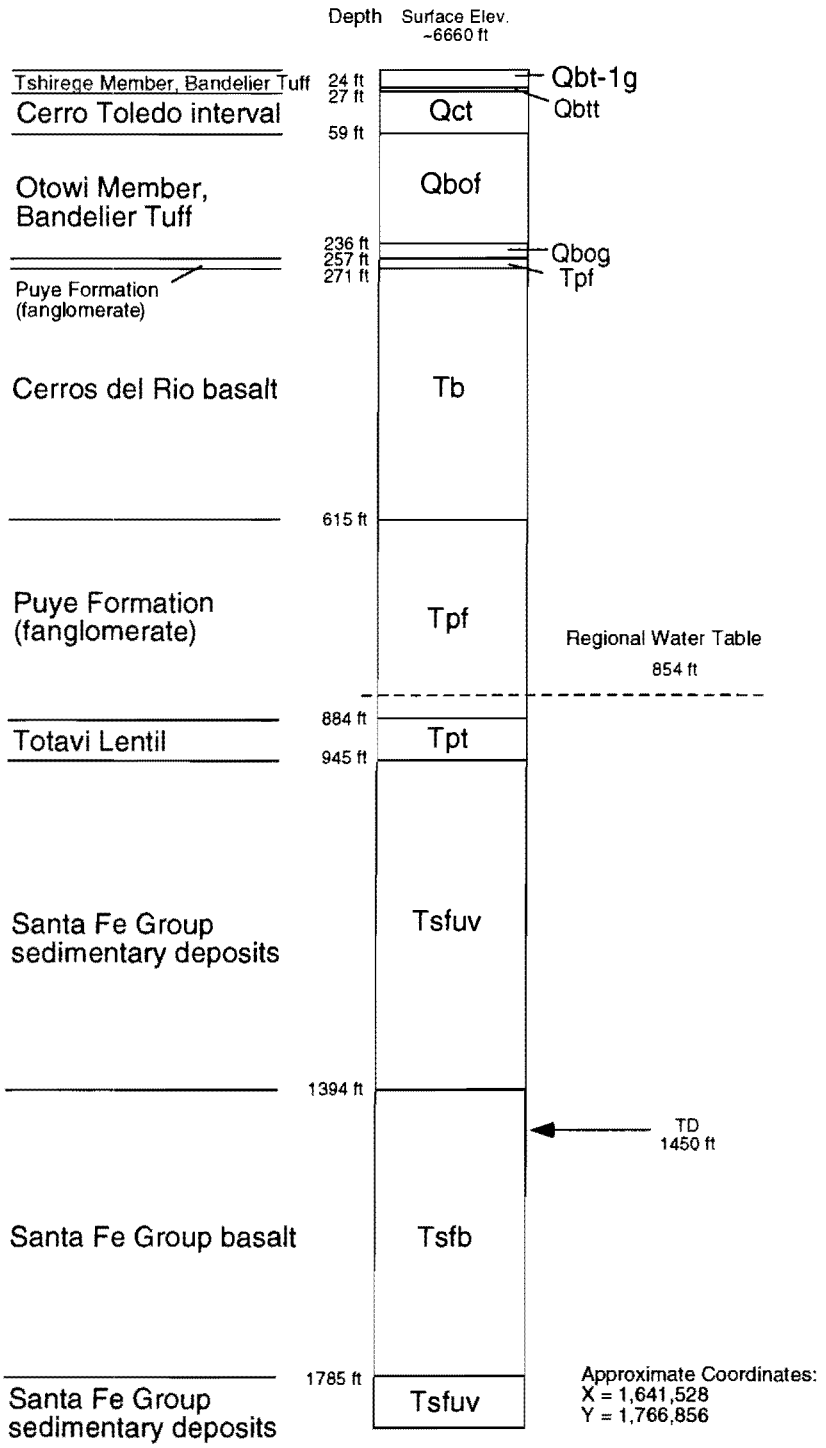


**Figure 3. R-13 Predicted Geology from the Site-Wide 3-D Geologic Model**

## 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 > 30 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 50 ft depth. | bromide, chloride, fluoride, nitrate, perchlorate, sulfate, TKN, tritium, $^{18}O/^{16}O$. D/H, $^{15}N/^{14}N$ | ~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. |
| 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-13. 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 Field Team Leader (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.

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,
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 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-13 provides the opportunity to evaluate the natural and contaminant chemistry of groundwaters and saturated geologic materials within Mortandad 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 in the upper 50 ft of the borehole by collecting core samples every 5 ft during drilling by the hollow-stem auger. 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, $^{15}N/^{14}N$ (Table 5). 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 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.

## 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 | | N/A |
| D/H | N/A | | N/A |
| $^{15}N/^{14}N$ | N/A | | 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/kg) for metals, 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.

### 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 task leader, according to these guidelines:

- When water is encountered, the geochemistry task leader 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.

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.
- Transport the indicated sample portion to the count lab for radiological screening required prior to sample shipment from the 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.

**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-1 | | |
| 3 | Anions (dissolved) | 100 ml plastic | See footnote (3) | Yes | 0.25 | EES-1 | | |
| 3 | γ spec, $^{241}Am$, $^{137}Cs$, $^{236,239,240}Pu$, $^{234,235,238}U$, $^{90}Sr$ (total) | 1 gallon plastic | $HNO_3$ to pH 2, 4¡C | No | 4.55 | Paragon | X | 4.55 |
| 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 | 4.55 |
| 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 | Gross α,β plus Gross γ | 500 ml poly | Ambient temperature | No | 0.5 | Count Laboratory | 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 | No | 1L | Lionville Lab. Inc. | 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

## 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-13 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 Field Team Manager (FTM) daily or as needed.

**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. |

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.

**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-13. 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.).*

**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-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 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)