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Date: June 27, 2001
Refer to: ER2001-0531

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

Dear Mr. Young:

Enclosed is the Field Implementation Plan for the drilling and testing of LANL Regional Aquifer TA-16-260 CMS Well CdV-R-37-2. We anticipate that the auger drilling portion of this work will begin on July 9, 2001.

Please provide any comments to John McCann at (505) 665-1091 or Don Hickmott at (505) 665-1116 at your earliest possible convenience.

Sincerely,

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

Sincerely,

Theodore J. Taylor, Project Manager
Department of Energy
Los Alamos Area Office

JC/TT/DH/nr/vn

Enclosure: Field Implementation Plan (ER2001-0254)

Tc

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HSWA LANL 3/1082/16-021(C) '99

Los Alamos National Laboratory

FIELD IMPLEMENTATION PLAN

FOR THE DRILLING AND TESTING OF LANL REGIONAL AQUIFER TA-16-260 CMS WELL CdV-R-37-2

Environmental Restoration Project

Remedial Actions Focus Area

June 2001

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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
MWIP	Monitoring Well Installation Project
NOI	Notice of Intent
NMED	New Mexico Environment Department
NTU	Nephelometric turbidity units
PMC	Program Management Company
QA	Quality assurance
OD	Outer Diameter
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/Task Leader
UTR	University Technical Representative
WCSF	Waste Characterization Strategy Form
WGII	Washington Group International, Incorporated

OVERVIEW

- *Technical Area (TA) -16-260 CMS well CdV-R-37-2 is intended to provide water-quality, potential contamination, and water-level measurements for the intermediate perched zones and the regional aquifer in an area of Technical Area 37 that is downgradient from the R-25 well.*
- *CdV-R-37-2 is located at the west end of TA-37, adjacent to TA-11 and 16 to the southeast of the R-25 well and the TA-16-260 outfall (Figure 1). This location has been reviewed and informally approved by New Mexico Environment Department (NMED).*
- *The first phase of drilling CdV-R-37-2 may be completed by hollow-stem-auger equipment to the depth necessary for installation of surface casing.*
- *In Phase 2, drilling shall be conducted using fluid-assisted, open-hole, air-rotary (AR) methods (if possible).*
- *Zones of saturation may be encountered in the Otowi Member of the Bandelier Tuff and Puye Formation.*
- *The regional water table is projected to occur at a depth of about 1167 ft and the well is planned to penetrate approximately 683 ft of the regional saturated zone for a total depth (TD) of 1850 ft.*
- *The well is planned for multiple-screen completion within perched and regional zones of saturation. Five screens are currently planned for the well, but the number and locations of screens will depend on geologic and hydrologic conditions found during drilling.*

INTRODUCTION

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 well CdV-R-37-2. This FIP includes a brief description of the overall objectives of this well, the roles and responsibilities of various Laboratory and subcontractor 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 subcontractor. All tasks in this FIP shall be performed by the subcontractor unless otherwise noted. In cases of conflict between this FIP and the Statement of Work (SOW) for this borehole, the SOW is to take precedence.

Summary of Data Quality Objectives

The main goal for CdV-R-37-2 is to determine whether Laboratory releases, particularly HE, may be present in the perched and regional groundwater beneath the eastern end of TA-16/37 and if so, the extent to which contaminants have affected groundwater quality. Numerous Laboratory sources, primarily outfalls associated with HE processing activities, are located about 1.5 miles upgradient of the CdV-R-37-2 site. Regional well R-25, located ~ 1 mile NW of CdV-R-37-2 contained elevated levels of HE in both a thick perched zone and possibly in the regional aquifer. Thus, well CdV-R-37-2 may provide additional constraints on the extent of the HE plume at TA-16/37.

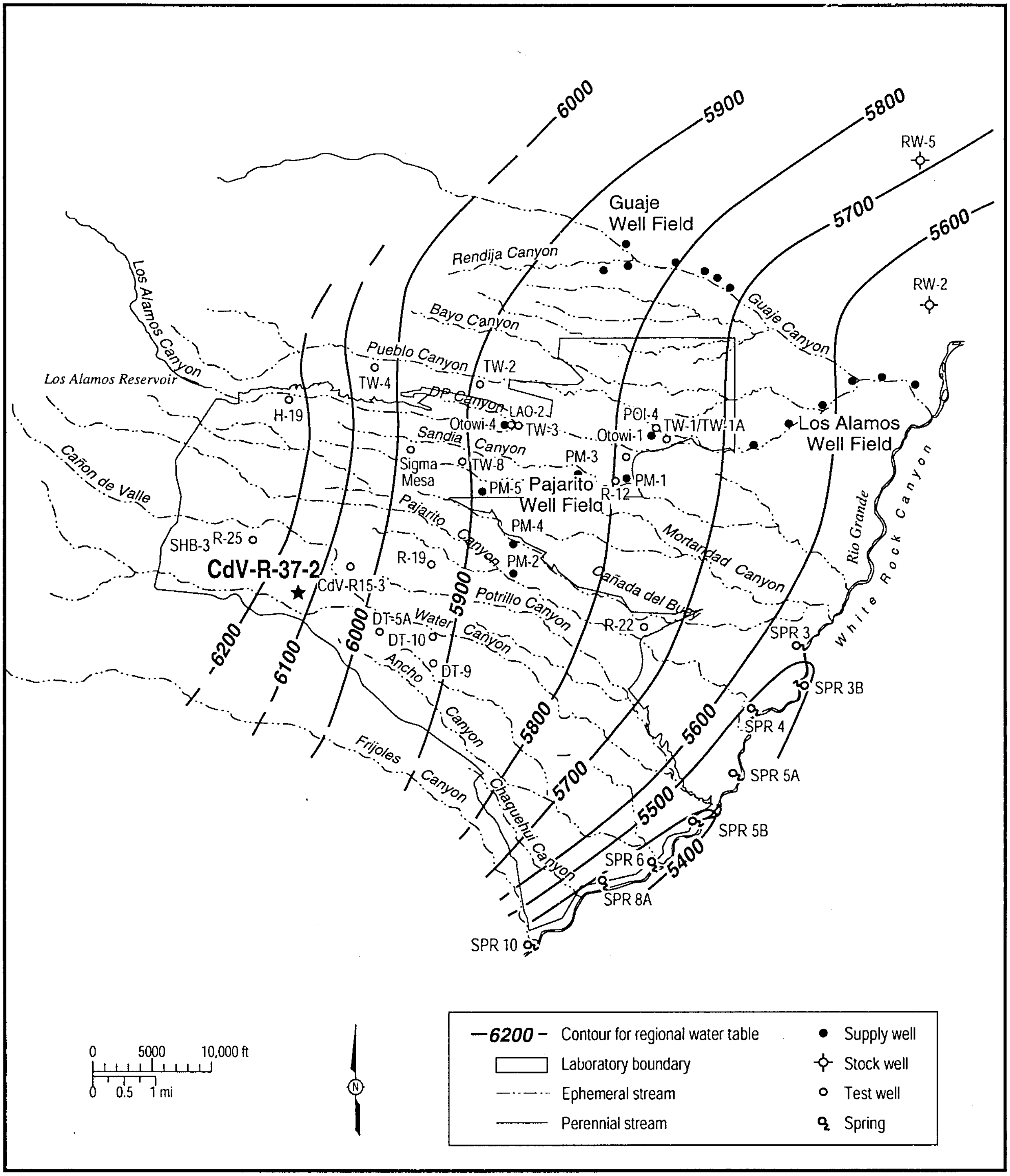


Figure 1. Map showing the location of well CdV-R37-2.

CdV-R-37-2 is located upgradient of the Pajarito well field and relatively near the Laboratory's boundary with Bandelier National Monument. This well can serve as a contaminant monitoring well and/or an early-detection well for potential southward offsite migration of HE from TA-16. The primary objective for this well will be achieved by determining the quality of groundwater and collecting information on hydrogeology from drilling data, from well screens located within perched zones, and from screens at the top and within the regional aquifer. CdV-R-37-2 will also investigate the nature and extent of perched groundwater in this part of the Laboratory. Perched groundwater is known to occur within the lower Otowi Member of the Bandelier tuff at a depth of 747 ft at the R-25 well and in seismic hazards borehole SHB-3. It is not known if perched water encountered in this well extends to the east, north and south of the R-25 well. If present at CdV-R-37-2, perched zones will be characterized to determine whether they are impacted by Laboratory releases. These goals for CdV-R-37-2 will be accomplished by the collection of geologic and geophysical information about perched groundwater occurrences, the installation of well screens within perched zones so that water quality can be determined, and the collection of cuttings and cyclone-water samples to determine vertical distributions of any potential contaminants through the vadose zone and within the regional aquifer.

Additional objectives include delineating the distributions of Puye gravels, fanglomerate, and basaltic lavas in order to construct an accurate picture of hydrostratigraphic units in this area for use in numerical flow and transport modeling of the vadose zone and the regional aquifer. These goals will be achieved by collection and characterization of drill cuttings and by geophysical logs.

Location

TA-16-260 CMS well CdV-R-37-2 is currently located at the west end of TA-37. This location is downgradient in a southeastwardly direction from R-25 and the TA-16-260 outfall (Figure 1).

Roles and Responsibilities

The roles and responsibilities for the technical team are shown in Table 1. The functional organization of the CdV-R-37-2 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) #0011 and modifications or other relevant SSHASP. 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) HEPS Team Leader (Don Hickmott)	665-1116 (pager 104-8239)
4) FTL Operations (Steve Pearson)	667-3005
5) FTM/FTL (Crowder/Everett)	662-1338/662-1322
6) ESA-FMU representative (Ann Sherrard)	665-7226

Additional notifications per SSHASP #0011 will be made by the above listed individuals.

Quality Assurance

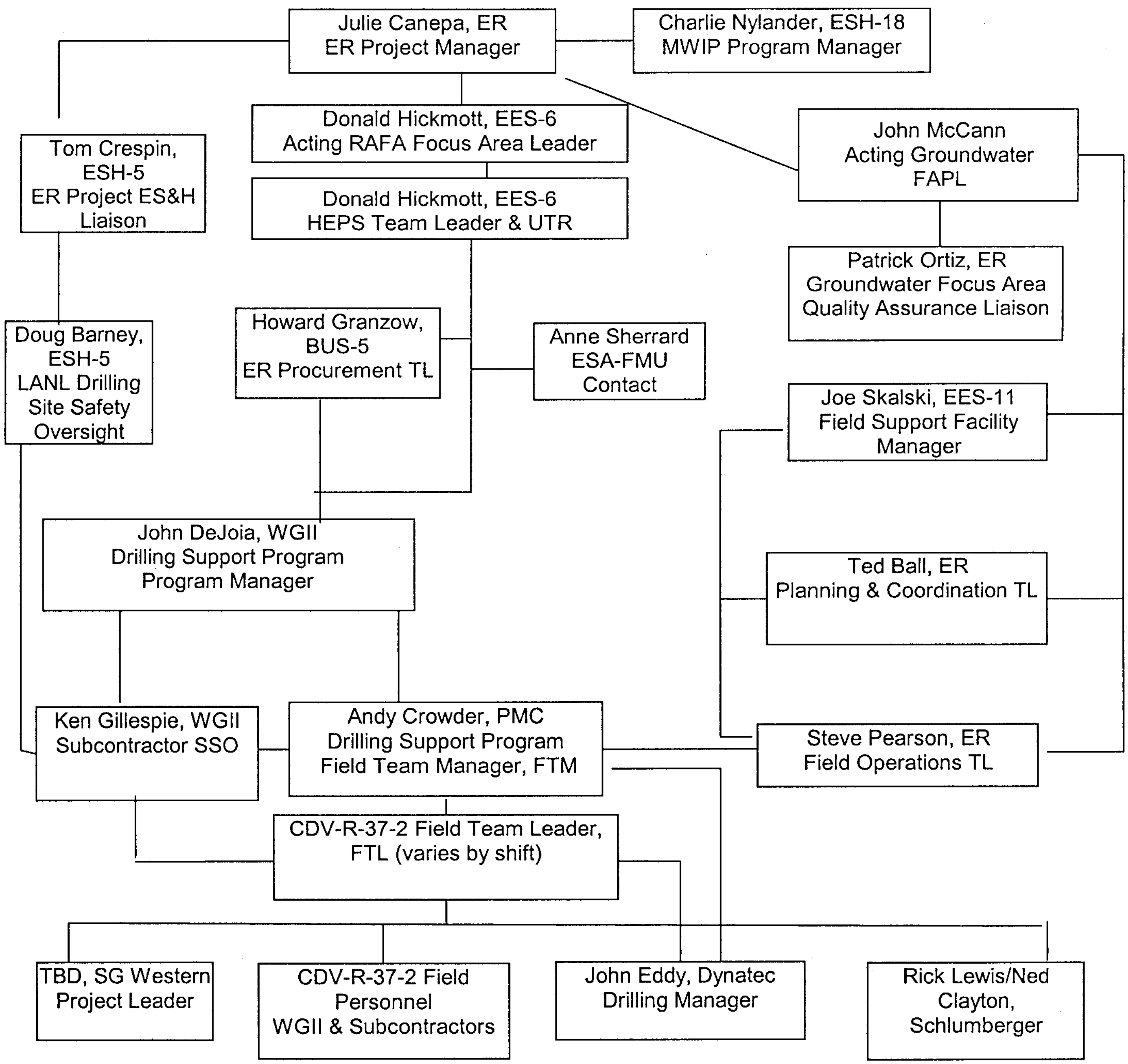
The subcontractor is responsible for conducting all procurement, field operations and drilling in accordance with its own internal Quality Assurance Program. LANL personnel are required to perform work under the ER quality assurance program.

Table 1. Roles and Responsibilities.

Personnel	Phones/Pager	Org.	Position	Project Responsibilities
Charlie Nylander	665-4681(work) 699-1568 (cell.)	ESH-18	MW Installation Program Manager	Responsible for Monitor Well Installation Program management.
Julie Canepa	667-4109 (work)	LANL/ER	ER Project Manager	Responsible for Monitor Well Installation Program construction.
John McCann	665-1091 (work)	LANL/ E/ET	Acting Groundwater Focus Area (GFA) Project Leader (FAPL)	The University Technical Representative (UTR) for the overall drilling contract.
Donald Hickmott	667-8753 104-8239 (page)	LANL/ EES-6	FAPL for RAFA HE Production Sites (HEPS) Team Leader	The RAFA FAPL is the LANL line manager for CdV-R-37-2. UTR for CdV-R-37-2
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.
Howard Granzow	665-0119 (work)	BUS-5	ER Procurement	Contract Administration
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	GFA Planning and Coordination Team Leader	Responsible for baseline development, project status, and project schedule for GFA
Steve Pearson	667-3005 (work) 104-4525 (page) 699-3684 (cell.) 955-1793 (home)	LANL/ ER	GFA Field Operations Team Leader	Provides LANL oversight of field and drilling activities; coordinates activities of LANL technical team and subcontractor field support staff.
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-6	GFA Geochemistry Task Leader (TL)	Provides technical leadership for geochemical characterization.
William Stone	665-8340 (work)	LANL/ EES-6	GFA 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-6	GFA Geology Task Leader (TL)	Provides technical leadership for geologic characterization.
Joe Skalski	667-2876 (work) 996-0891 (page) 672-9060 (home)	LANL/ EES-11	Field Support Facility Manager	Provides drilling support and on-site management of the Field Support Facility (FSF).
Andy Crowder	662-1338 (work) 104-3968 (page) 780-2975(cell/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.) 698-3714 (page)	WGII	SSO	Responsible for subcontractor site safety.
Rene Evans	662-1337 (work) 780-2903 (cell.) 698-4346 (page)	WGII	Waste Manager	Responsible for onsite waste management.
Keith Greene	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, coordination of logging services, 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
Anne Sherrard	665-7226 (work)	LANL/ ESA-FM	Site liaison	Initial contact for TA-16/37 facilities issues
Patrick Ortiz	665-5289 (work)	LANL/ ESH-14	GFA Quality Assurance (QA) Liaison	Oversight of LANL and subcontractor implementation of QA program.

Figure 2. Functional Organization of CdV-R-37-2 Personnel.



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 the determination of disposal requirements. A notice of intent (NOI) to discharge benign wastewater on-site has been prepared by Environment, Safety, & Health (ESH) -18 for NMED approval.

DRILLING PLAN SUMMARY

Pre-Drilling Activities

Pre-drilling activities include obtaining all required permits and access agreements and preparing site-specific plans (SSHASP, WCSF, finalized FIP, etc.). Line-management approval to commence field activities and site preparation must 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 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

CdV-R-37-2 may be installed in two phases. Phase 1 involves drilling as deep as necessary using hollow-stem-auger (HSA) equipment to set surface casing. Phase 2 involves drilling an open hole to TD by fluid-assisted, air-rotary (AR) methods.

Phase 1 Drilling -- During Phase 1, CdV-R-37-2 will be drilled from the surface to the surface-casing target depth of approximately 30 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, CdV-R-37-2 shall be drilled as an open hole to the total depth (TD) of an estimated 1850 ft (or at least 200 ft below the maximum depth of HE contamination as detected by screening analyses) by fluid-assisted air rotary (AR) methods (open-hole if possible) and a characterization well shall be installed in the borehole. Approved additives such as QUIK-FOAM and EZ-MUD plus may be used to aid with lubricity, cuttings recovery, and to stabilize the borehole. Drilling operations shall be conducted in two 12-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 the borehole is nominally 1850 ft; however the total depth may be modified to accomplish the characterization goals for this site based on conditions found during drilling. The principal goal of the well is to bound the lateral extent and depth of the TA-16 HE plume identified in well R-25. A principal DQO is to drill to at least 200 ft beyond the maximum depth of detected HE contamination, as revealed by screening analysis. Thus, this well may be drilled to depths shallower than 1850 ft, if little of no contamination is detected, or to greater than 1850 ft if contamination is detected at depth in the regional aquifer. This decision will be made by the HEPS Team Leader and the LANL UTR in consultation with WGII and NMED personnel. A particular concern in this decision may be potential cross contamination from shallower zones to deeper zones.

- Drilling will proceed uninterrupted except at the regional water table where an accurate water level shall be determined before drilling to TD. LANL does not currently anticipate that casing off of contaminated perched zones will be required, but if high levels of contamination are found, casing off perched water may be required to prevent commingling with the regional aquifer.
- The number of well screens will depend on the depth, size, and number of perched zones encountered.
- Up to 5 groundwater samples for the entire borehole, selected by the geochemistry task leader, may be collected from the cyclone by air lifting the water through the drilling circulation system.
- Fluids circulated out of 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 for discharge or proper disposal.
- 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 CdV-R-37-2, all equipment shall be demobilized and all wastes generated shall be characterized in accordance with the Waste Characterization Strategy Form. Site restoration shall include recontouring and revegetation of peripheral areas, and stabilizing the drill pad for future sampling activities.

WELL DESIGN

Design Assumptions

CdV-R-37-2 shall be completed as a multiple-screen well. One screen will straddle the regional water table. Other screen locations will be based on information obtained during drilling and characterization. The Title I design for placement of filter pack, transition sand, bentonite seals 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, drilling, and QA. 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 the telescoped casing 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

CdV-R-37-2 shall be constructed of 5-in. OD x 4.5-in. ID American Society for Testing & Materials (ASTM) A304 stainless-steel casing built to ASTM A554 standards with 8 round American Petroleum Institute (API) long threaded joints (or functional equivalent as proposed by the Subcontractor and approved in writing by the LANL UTR). 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 Screen

Well screens 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 screens shall be constructed with sufficient strength to withstand the forces of installation, placement of annular fill and development.

Annular-Fill Materials

A tremie line (or lines) 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, and/or cement capped with bentonite.

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.

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 be procurred by the subcontractor to meet the requirements of ASTM C150, *Standard Specifications for Portland Cement*. Cement grout will be used to fill the spaces between the 18-in conductor casing and the borehole wall, the 10-in protective casing and the 18-in conductor casing, and the 10-in protective 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 down for an initial clean-up of the well. An initial measurement of field parameters shall be made before bailing at each screened interval.

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

4. Surging each screened interval with a vented surge block.

4. Pumping of each screened interval, monitoring water quality parameters periodically. Strive for a turbidity value of 5 nephelometric turbiduty units (NTU), but cease pumping when water quality no longer improves. Leave pump off for 15 min. and 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 a table and graphs that depict the development results.

Surface and Well-Head Completion

The ground around the top of the well shall be completed in accordance with ER Project approved design drawing and applicable design documents. Construction standards (ASTM, ACI) for well pad compaction, concrete placement, forms placement, applicable hold and witness points, etc., will be specified in the design documents. The well head will be completed with an estimated 6' x 4' x 1' 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 and wiring will be added by ESH-18 at a later date. A 10 3/4-in protective steel casing shall be installed as deep as possible below ground level (nominally 5-10 ft.), cemented in place with Portland cement, and extend approximately 3 ft. above the surface of the concrete pad. Four steel posts will be placed around the concrete pad to protect the well head, one of which shall be removable for access.

GEOLOGIC CHARACTERIZATION

TA-16-260 CMS well CdV-R-37-2 will provide additional information on the geologic setting at TA-37. Predicted depths to geologic contacts are shown in Table 2 and Figure 3.

Approximately 500 to 700 ml of bulk drill cuttings shall be collected systematically every 5 ft from CdV-R-37-2 for geologic characterization (Table 3). Cuttings will be stored in sealed plastic bags labeled with the well name and footage range representing the depth interval that the cuttings were derived from. The 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 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 3). 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 will be >35 and >60 mesh for finer grained materials. Lost-circulation zones (no cuttings returns) will be indicated by empty trays.

Additionally, about 200 to 300 ml of bulk cuttings will be collected every cuttings run (nominally every 5 ft), sieved to >10 mesh, 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 3). 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.

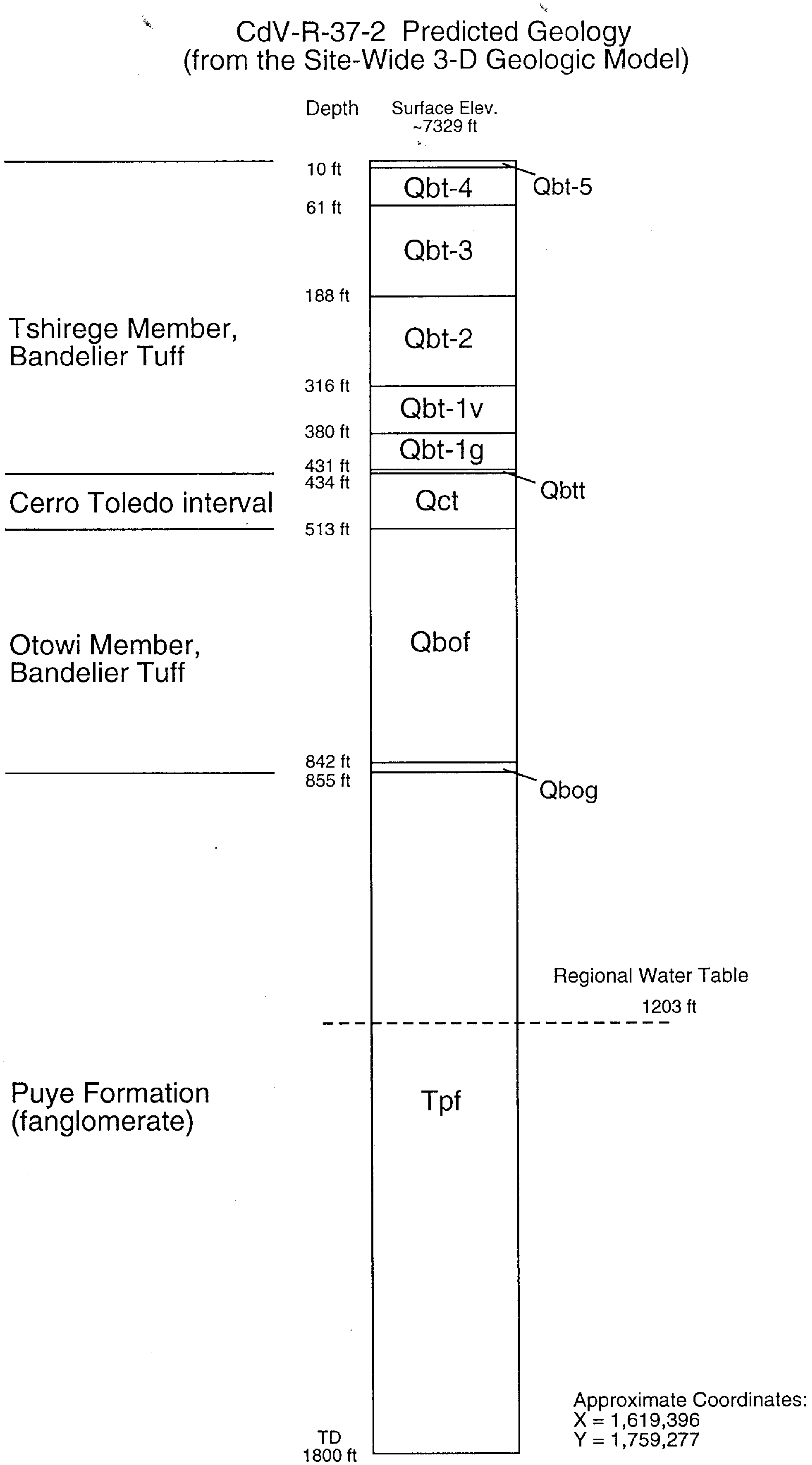


Figure 3. Predicted geology for CdV-R37-2

Testing of samples may include mineralogy by X-ray diffraction; petrography by modal analysis of thin sections; by electron microprobe and by scanning electron microscope; and geochemistry by X-ray fluorescence (Table 3). Samples shall be identified, labeled and handled through logbook and notebook documentation by the Geology Task Leader.

Table 2. Projected Depth to Stratigraphic Contacts in CdV-R-37-2

Rock Unit Name	Symbol	Top (ft)	Bottom (ft)	Thick (ft)	Comments
Phase I					
Unit 4, Tshirege Member, Bandelier Tuff	Qbt 4	0	21	21	
Unit 3, Tshirege Member, Bandelier Tuff	Qbt 3	21	151	130	
Unit 2, Tshirege Member, Bandelier Tuff	Qbt 2	151	272	121	
Unit 1v, Tshirege Member, Bandelier Tuff	Qbt 1v	272	331	59	
Unit 1g, Tshirege Member, Bandelier Tuff	Qbt 1g	331	387	56	Vitric ignimbrite, Tsankawi Pumice Bed at base.
Epiclastic sediments and tephras of the Cerro Toledo interval	Qct	387	469	82	
Otowi Member, Bandelier Tuff	Qbo	469	800	331	Non-welded ignimbrite
Guaje Pumice Bed	Qbog	800	813	13	Non-welded ignimbrite Pumice fall deposit
Puye Formation, fanglomerate	Tpf	813	1879	1066	Fanglomerate facies sediments consisting primarily of coarse sands, gravels, and conglomerates derived from dacitic volcanic rocks, with abundant pumice in the lower part
Puye Formation, axial facies	Tpt	1879	1912	33	Formerly called Totavi Lentil. Ancestral Rio Grande sediments consisting of well rounded cobbles to boulders including some quartizite, gneiss, and other rock types of non-Jemez origin
Santa Fe Group, undivided	Tsfu	1912	2691	779	Medium- to coarse-grained sandstone, conglomerate, and siltstone.

Ground surface elevation ~ 7302 ft ASL

Table 3. Sampling of Cuttings.

Sample Description	Test	Sample Size	Container	No. of Samples
Geologic Characterization				
Systematic Bulk Cuttings	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	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 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				
Within Water-Bearing Zones; Sample location and frequency to be determined by the geochemistry task leader	HE, Metals and Anions	3.5 L of cuttings	Plastic ziploc bag	Up to 10 samples for the entire borehole

HYDROLOGIC CHARACTERIZATION

According to the current conceptual hydrogeologic model, groundwater periodically perched in the alluvium drains into subsurface units such as the lower Bandelier Tuff, Cerros del Rio basalt or other potentially saturated subunits, and ultimately into the regional aquifer. Characterization well CdV-R-37-2 should provide additional data necessary to test this conceptualization. Table 4 gives the number and projected positions of potential saturated zones at CdV-R-37-2.

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. Where possible, geophysical and video logging will be used after the borehole reaches TD to provide hydrologic information about the vadose zone at CdV-R-37-2. Selection of intervals to log and the types of logs to run will depend on factors such as availability of open borehole, characterization questions 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 the regional zone of saturation.

Table 4. Predicted Saturated Zones and Possible Screen Locations at CdV-R-37-2.[1]

Groundwater Zone	Potential Well Screen Targets	Top (ft)	Bottom (ft)	Comments
Perched Zone 1	1	700	710	Possible perched groundwater in lower Otowi Formation
Perched Zone 2	2	850	860	Possible perched groundwater in the Upper Puye Formation
Regional Aquifer	3	1167	1197	Estimated depth to regional water table within axial gravels of the Puye Formation.
Regional Aquifer	4	1270	1280	100 ft into regional aquifer
Regional Aquifer	5	1800	1810	Near bottom of the hole in the Puye Formation

1. Perched zone locations are estimated based on results from R-25.

When the regional aquifer is first encountered, a static water level shall be measured by the FTL, using a water-level meter and/or a pressure transducer system. Ensure instruments are clean before deploying into the borehole or well.

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 the following 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 both perched and the regional zones of saturation 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 Standard Operating Procedures (SOP) (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 well CdV-R-37-2 provides the opportunity to evaluate the natural and potential contaminant chemistry of groundwaters and saturated geologic materials beneath TA-37/16. Up to two cuttings samples and five groundwater samples will be selected for geochemical and contaminant characterization by the geochemistry task leader or the UTR during drilling operations. The locations for samples will depend on the hydrologic and geologic conditions found during drilling. Once samples are identified for collection by the geochemistry task leader or UTR, the samples will be collected by the FTL and submitted for analysis through the FSF.

Cuttings Samples

Up to ten cuttings samples will be collected for geochemical and contaminant characterization within water-bearing zones encountered during drilling. The geochemistry task leader or UTR will identify when collection of cuttings samples is appropriate. Up to 3.5 L of unsieved cuttings will be collected for each sample (Table 3). Testing of samples may include analyses for HE and metals. Samples shall be identified, labeled and handled through normal chain-of-custody control. Table 5 lists the specific analytes, analytical methods, and estimated detection limits (EDL) for geochemical and contaminant characterization of cuttings samples.

Groundwater Samples

Up to five borehole groundwater screening samples will be collected for geochemical and contaminant characterization during drilling. These samples will target groundwater in perched zones and in the regional aquifer as identified in Table 4. They provide the ability to quickly evaluate whether perched groundwater could adversely impact regional groundwater in the open borehole, and they provide an early indication about whether contaminants could be present in perched and regional groundwater before quarterly samples are collected from the completed well. Table 6 lists the analytical suite, sample volumes, and containerization requirements for samples to be collected. Table 7 provides information regarding field parameters for groundwater samples. Samples shall be collected as directed by the geochemistry task leader or UTR, according to the following guidelines:

- When water is encountered, the geochemistry task leader and UTR will be notified to determine if one of the five planned groundwater samples should be collected at that interval,
- Where casing advance is used, the depth to the bottom of casing 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 paperwork provided by the ER Central Data Management Group.

For each groundwater-sampling event, field personnel shall perform the following 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 in order to collect approximately 10 gallons of groundwater;
- Immediately record field-measured parameters for groundwater samples (Table 7);
- Fill two 40-mL septum glass bottles with water collected from the cyclone for organic analysis (VOC) prior to transferring the remaining water to plastic containers;
- Filter approximately 1.75 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 Office at the 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; and
- Transport the indicated sample portion to the count lab for radiological screening required prior to sample shipment from the SMO (if necessary);
- Submit properly preserved archival samples (Table 6) that will be held at the FSF for potential re-analysis needs; the retention period for samples shall be 6 months for metals and anions.

Table 5. Sampling and Analysis of Cuttings and Core

Analyte	EDL[a]	Analytical Method[b]	Analytical Protocol
Cuttings			
Metals			
Aluminum	40	ICPES	SW-6010B
Barium	40	ICPES	SW-6010B
Iron	20	ICPES	SW-6010B
Manganese	3	ICPES	SW-6010B
High Explosives Constituents	0.001	HPLC	SW-846 – EPA Method 8330

a. EDL = estimated detection limit; listed as (mg/kg) for metals, mg/L for anions,

b. Analytical Methods - ICPES = inductively coupled plasma emission spectroscopy, HPLC = high performance liquid chromatography

Table 6. Sampling and Analysis of Groundwater – CdV-R-37-2

Maximum Number of Water Samples	Analysis	Container	Preservation	Filtered-0.45um Acetate	Volume Each Sample (L)	Preferred Laboratory	Collect Archival Sample	Archival Sample Volume (L)
5	HE (degradation)	glass	none	No	1.0	SevernTrent[1]	No	none
5	HE	glass	none	No	1.0	Gel	No	none
5	HE (screening)	40 ml glass	none	No	0.040	EES-1	No	none
5	Low Level Tritium	250 ml poly	none	No	0.250	University of Miami	Yes	1
5	Anions + ClO_4^- (dissolved)	250 ml plastic	Ambient temperature [2]	Yes	0.250	EES-1	Yes	1
5	Metals	250 ml plastic	HNO_3, pH 2	Yes	0.250	EES-1	Yes	1
5	VOCs	40 ml glass septum bottle	HCl, ice	No	0.080 2 bottles	Paragon	No	none
5	NH_4, NO_3+NO_2	1L poly	H_2SO_4 to pH 2, 4°C If turbid, add more preservative	Yes	1.0	Paragon	Yes	1
5	Stable isotopes ($^{18}O/^{16}O$, D/H)	30 ml glass w/ poly seal cap	Ambient temperature	No	0.030	Geochron	Yes	1
5	Stable isotopes ($^{15}N/^{14}N$)	1 gallon plastic	HCL or H_2SO_4 to pH 2, 4°C	No	4.55	Coastal	Yes	4.55
5	ClO_4^-	250 ml poly	Ambient temperature	Yes	0.250	GEL	Yes	1
				Total Volume – Both Filtered and Not Filtered	8.70		Total Volume for Archival Storage – All Not Filtered	10.55
				Part of Total Volume to be Filtered	1.75			

1. HE analyses performed by Severn Trent for RDX degradation products, which are not analyzed by GEL.
2. No preservation for ClO_4^-, Br^{-1}, Cl^{-1}, F^{-1}, SO_4; NH_4, NO_3, NO_2 preserved with H_2SO_4 to pH 2, 4°C.

Note: All sampling and laboratory analytical submittal will be at the discretion of the Geochemistry TL and the LANL UTR.

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 and regional aquifer. Borehole and well geophysical data will be obtained from two sources: 1) drilling subcontractor personnel will obtain borehole video 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 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.

A wire-line logging service shall be contracted to obtain borehole geophysical logs with a comprehensive suite of tools (Table 8) when TD is reached and before well construction.

Geophysical logging with the Laboratory natural-gamma-radiation tool and the borehole video equipment shall be performed in the open borehole after CdV-R-37-2 reaches TD. A borehole video log shall be collected at the completion of the well casing installation to document the as-built condition of installed well components before backfilling the annular space. 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 CdV-R-37-2 shall be presented or preserved in various reports and records.

Field Documentation

Table 9 lists documentation to be completed during the course of fieldwork. The SOW lists additional documentation that is required for this borehole.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 specified frequency. Documentation will be relinquished to the FTM daily or as specified in the SOW.

The FTL shall ensure that a daily activity report that summarizes information in 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 well CdV-R-37-2. The fact sheet requires information on the *well owner, location, drilling subcontractor, well construction, geology, water-bearing strata, contaminants detected in screening samples, and other general information (drilling method, depth to water, etc.).*

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

Cased Hole	*Cased Hole*	*Open Hole*	*Uncased Hole*
Array Induction Imager Tool (AIT)		X	Measure 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.
Fullbore Formation Micro Imager (FMI) (saturated zones only)		X	Provides detailed images of clasts and sedimentary structures of variable resistivity; can determine strike and dip of bedding.
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 litholgies 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 litholgies 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.
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
Daily Activity Report E-mail	FTL	Daily
FTL Logbook	FTL	Daily
Driller's Log	Driller	Daily
Geological Field Log	FTL/Geologist/Task Leader	As Needed
Sample Collection Log	Sampler	As Needed
Chain of Custody, Request For Analysis	Sampler/FTL/Task Leader	As Needed
Miscellaneous Monitoring Forms	Site Safety Officer / Radiological Screening Personnel (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 the 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 assumed to be 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, 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 or as specified in the SOW. Logbooks shall be submitted to the records processing facility when they are completed and the technical and QA reviews have been completed.

REFERENCES

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