LA-UR-06-3874
June 2006
ER2006-0255

Well Rehabilitation Pilot Study Execution Plan

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by
Environmental Programs–Water Stewardship Project

LA-UR-06-3874
ER2006-0255

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June 2006

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EXECUTIVE SUMMARY

This execution plan presents the approach for studying and determining the effectiveness of redevelopment methods to rehabilitate well screens impacted by residual drilling fluids. This pilot study covers two (R-16 and R-20) of the 33 wells installed in the regional aquifer and perched intermediate zones. The scope of the study is limited to determining the effectiveness of selected redevelopment techniques in removing remnant drilling fluids near the well bore and to quantify the improvement in overall well efficiency and water sample quality. This pilot study does not examine whether the use of drilling fluids impacted the characterization objectives of the Los Alamos National Laboratory's (the Laboratory's) "Hydrogeologic Workplan" but rather evaluates the effect of redevelopment techniques on the immediate and long-term (6-month) water sample quality from the two monitoring wells.

The reliability and accuracy of the data from the 33 wells has been questioned because of the concern that water quality in the screens may have been compromised by various aspects of the drilling, construction, and development history of the wells. An analysis performed on the 33 characterization wells constructed under the Hydrogeologic Workplan identified screens where sample data representativeness is affected by the presence of residual drilling fluids. Based upon results of the well screen analysis report (LANL 2005, 91121), wells R-16 and R-20 were selected for this pilot study.

R-16 was drilled to a depth of 1287 ft using fluid-assisted air-rotary and conventional mud-rotary drilling methods. R-16 is south of Cañada del Buey, near White Rock Overlook Park and immediately upstream from the sanitary sewage treatment plant. This well was installed to provide water-quality, geochemical, hydrologic, and geologic information for the hydrogeology in the area. In addition, the data and information from R-16 contribute to the understanding of the distribution of potential contaminants downgradient of Technical Area (TA) 54 and from Laboratory activities in the Mortandad Canyon watershed.

R-20 was drilled to a depth of 1365 ft below ground surface using fluid-assisted air-rotary and conventional mud-rotary drilling methods. R-20 is east of TA-18 on the south side of Pajarito Road in Pajarito Canyon. The information obtained during the completion and sampling of R-20 provides hydrogeologic and water-quality data for the regional groundwater near potential contaminant release sites at TA-54. In addition, monitoring of R-20 helps satisfy the requirements of the Pajarito Canyon workplan to characterize the regional aquifer in this area.

To evaluate the effectiveness of well redevelopment techniques in rehabilitating well screens impacted by residual drilling fluids, the following tasks are proposed for this pilot project:

- Collect baseline samples using the Westbay sampling system to provide water chemistry data before removing the Westbay sampling system and implementing redevelopment measures.
- Remove the Westbay sampling system and prepare the well for rehabilitation and redevelopment.
- Conduct rehabilitation and redevelopment using one or more mechanical and chemical techniques.
- Sample and evaluate the effects of mechanical redevelopment techniques and chemical redevelopment techniques on water chemistry and the specific capacities of the well screens.
- Reinstall the Westbay sampling system.
- Sample and evaluate the effects of rehabilitation and redevelopment techniques. Samples will be taken monthly for 6 months and will support the evaluation of the long-term effectiveness of the techniques.

A report documenting the results of the pilot study will be submitted to the New Mexico Environment Department in accordance with the schedule included in this execution plan. The report will include recommendations regarding the effectiveness of the redevelopment techniques used in this pilot study and appropriate actions to address the remaining monitoring wells at the Laboratory.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility located in north-central New Mexico approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. Groundwater monitoring has been conducted at the Laboratory for over 50 years starting with U.S. Geological Survey water supply studies in 1945 and Laboratory groundwater quality monitoring in 1949. The Laboratory implemented a site-wide hydrogeologic characterization program, which is described in the Laboratory's "Hydrogeologic Workplan" (LANL 1998, 59599). From 1998 to 2004, the Department of Energy (DOE) and the Laboratory installed 33 regional aquifer wells to characterize groundwater as described in the "Hydrogeologic Workplan."

Since the installation of wells, characterization well geochemistry reports and well analysis reports (listed in section 8.0) have discussed the suitability of the wells for providing monitoring data. The concern is that sample water quality has been compromised by drilling, construction, and development measures used to install the wells. This pilot study execution plan describes how the Laboratory will investigate and evaluate the effectiveness of select redevelopment methods to rehabilitate well screens impacted by residual drilling fluids used to install and develop the wells.

A report will be provided to the New Mexico Environment Department (NMED) upon completion of this pilot study. The report will present results and recommendations for future rehabilitation activities.

1.1 Purpose

The purpose of this plan is to present the need for a pilot study, the rationale for selecting specific wells, the criteria for evaluating redevelopment methods, and a description of how the results will be presented. Through implementation of this plan, the Laboratory will investigate the effectiveness of redevelopment of well screens impacted by residual drilling fluids.

A series of well redevelopment tasks will be completed at two trial wells: R-16 and R-20 (locations are in Figures 1.1-1 and 1.1-2). Both wells selected are multiple-completion wells fitted with Westbay sampling systems (Tables 1.1-1 and 1.1-2 detail the statistics related to the screens). Summaries of the two wells, R-16 and R-20, are included as Figures 1.1-3 and 1.1-4. Data and information will be gathered to use the same criteria used in the well screen analysis report (WSAR) (LANL 2005, 91121) to evaluate the effectiveness of the redevelopment methods.

If redevelopment is successful, these methods will be evaluated to determine if they provide a cost-effective way to address the impacts of residual drilling fluids on groundwater data. Results from this pilot study will be evaluated to determine an appropriate course of action to address the remaining multiscreen wells at the Laboratory.

1.2 Study Objectives

The objectives of this pilot study are to

- quantify, through the use of analytical data and geochemical modeling, the effectiveness of specific physical and chemical redevelopment techniques in removing residual drilling fluids;
- assess whether these wells can provide representative data over time using low-volume, no purge multiscreen sampling systems; and
- provide recommendations for future rehabilitation activities for the impacted well screens that are needed for monitoring groundwater.

2.0 SCOPE OF ACTIVITIES

The scope of activities presented in this pilot study execution plan will investigate the rehabilitation and redevelopment methods of two candidate wells. The wells selected for the pilot study were selected based upon data, results and information from the WSAR (LANL 2005, 91121). The two wells that were selected were R-16 and R-20.

Both wells were found to have screens that were impacted by drilling fluids, as presented in the WSAR (LANL 2005, 91121). Table 2.0-1 summarizes results and ratings from the analysis performed in the WSAR (LANL 2005, 91121). In addition, these wells were selected because they have multiple screens in the regional aquifer and exhibit a range of severity of impacts as discussed in the WSAR (LANL 2005, 91121).

All drilling was performed in accordance with standard industry practices, aligned with the American Society for Testing and Materials (ASTM) procedures and standards, and specified in the Compliance Order on Consent (hereafter the Consent Order). Even though all of the wells used some type of downhole material to assist in the drilling, these specific wells were selected for the pilot study because they were drilled with both polymer-based fluids and bentonite.

In addition, these wells were selected for the pilot project because injection tests indicated that all operable screens at R-16 and R-20 should produce in excess of 10 gal./min, which suggests there is high enough permeability in the screened interval for redevelopment to succeed. (Tables 2.0-2 and 2.0-3 outline the factors that may affect well screen performance.)

Some of the other subjective factors that were considered in selecting R-16 and R-20 for this pilot study are (1) the well locations make them candidates for long-term environmental stewardship groundwater monitoring; (2) the wells are easily accessible so a variety of tools and equipment can easily be brought on site; and (3) the wells are neither the simplest nor the most complex wells in the program based on the number of screens per well. Both subjective and objective criteria indicate R-16 and R-20 are appropriate test wells for the pilot study.

3.0 STUDY METHODS

This section describes the technical methods proposed to (1) redevelop the well screens, (2) collect samples, (3) implement and assess redevelopment procedures and techniques, and (4) evaluate the effectiveness of the redevelopment techniques.

3.1 Well Rehabilitation and Redevelopment Methods

Various methods for improving the quality of groundwater chemistry data were considered, including

- remove the multizone sampling system, redevelop the screens in the impacted wells, and reinstall the multizone sampling system;
- remove the multizone sampling system, plug and abandon the lower screens, redevelop the upper screen(s), and replace the multizone sampling system with a pump system;
- drill an adjacent well to either supplement or replace the existing well; or
- perform no action and leave the well as is.

To utilize the effort already invested in drilling the characterization wells, the scope of this project is to study the option to remove the multizone sampling system, redevelop the screens, and reinstall the multizone sampling system. This pilot study will investigate and determine the feasibility and effectiveness to improve the quality of both the groundwater chemistry and specific capacity of the screen.

The mechanical and chemical redevelopment techniques that may be used in this pilot study are described below.

3.1.1 Pumping Each Screen with a Dual-Packer Isolation System

Pumping each screen will serve two purposes: (1) to mobilize and remove some of the fines and drilling fluid residue and (2) to measure the specific capacity of each screen before and after implementing additional redevelopment techniques.

Before initiating rehabilitation and redevelopment, specific capacity tests will be performed on both wells: the lower three screens of R-16 and all three screens of R-20. The results from the specific capacity tests will provide the baseline of screen performance. To isolate single-screened intervals, the specific capacity tests will consist of installing either dual inflatable packers or inflatable packers above and mechanical packers below the targeted interval. After the packers are installed, there will be 1 hour of equilibrium time for water level to stabilize, at least 3 hours of pumping to determine if the aquifer can sustain pumping levels, and the same amount of recovery time as the well is pumped.

After rehabilitation and redevelopment of the wells and before reinstallation of the Westbay sampling system, another set of specific capacity tests will be performed to assess the final performance of each screen. These specific capacity tests will follow the same steps as the initial tests.

3.1.2 Airlift Pumping and Jetting

Each screen will be airlifted and jetted, which involves forcing water through the screen openings, to agitate the materials in the area immediately around the screens. This mechanical procedure will remove some of the residual fluids and redevelop the area around the screen. Immediately after jetting, the screens will be swabbed and bailed to remove the mobilized fines.

3.1.3 Hydropuls

The Hydropuls process uses pulsations of gases and liquids under high pressure to agitate the material and filter pack adjacent to the screen. The advantage of the Hydropuls technique is that it uses sudden changes of water volume within the well to produce a cavitational effect creating a hydraulic suction. The alternating effects of pressure and discharge within the screened area loosen the material in the filter pack surrounding the well screen and in the pore spaces of water-saturated areas. The Hydropuls will be inserted and positioned in the well screen where impulses of high-pressure nitrogen will be released through a pressurized hose. The impulse generator used in this pilot study is equipped with a valve system that releases the accumulated energy (200 to 1200 psi) in very short and fluctuating bursts (milliseconds) through a large cross section of the screened area.

After the Hydropuls technique is used at a screened interval, each screen will be cleaned by swabbing, bailing, and pumping. The swabbing is performed by rapidly moving the swab up and down in the screened interval. After the screen is swabbed, a bailer removes suspended particles and fines from the well. Because of the time needed to implement each mechanical technique, use of the Hydropuls, swabbing, bailing, and pumping will be continued for a period of 2 days per well screen. The sequence of implementing the mechanical techniques is described in section 4.0.

3.1.4 Chemical techniques

If field tests and analytical results demonstrate no improvement in water quality after the use of mechanical techniques, chemical redevelopment techniques may be employed. Mechanical techniques will be used and exhausted before chemical techniques will be considered or used. Chemical techniques that may be used include phosphate-free detergent (PFD) to mobilize bentonite, chlorine to break down polymers, and acids to dissolve magma-fiber. The chemical treatments will be used as a last resort and only if no improvement is made by using mechanical techniques.

3.2 Sample Collection

Throughout the study, water-quality field parameters will be measured in a flow-through cell, and water samples will be collected for both in-house and off-site analysis. A field technician will monitor discharge from the pump using a flow-through cell and multiparameter meter in data-logging mode. The discharge from each screened interval will be field-measured using a YSI 556 MPS multiparameter meter or equivalent. The field parameters to be measured are pH, temperature, conductivity, oxidation/reduction potential (ORP), and dissolved oxygen. Turbidity samples will also be collected periodically using a Hach 2100P Turbidimeter or equivalent.

The samples will be collected by the Laboratory for both off-site and on-site analysis. Tables of the sample analysis are in Appendix C. Samples will be analyzed on-site by the Earth and Environmental Sciences (EES)–Hydrology, Geochemistry, and Geology laboratory for S^{2-}, total organic carbon (TOC), alkalinity, anions (including perchlorate), and cations. For this pilot study, the EES analysis is identified as the performance-suite analysis. The off-site laboratory will do a full suite analysis for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), general organics (including alkalinity), metals, and stable isotopes of hydrogen, oxygen, radiological screening, and nitrogen.

3.3 Assessing Redevelopment Techniques

The implementation and evaluation process of this pilot study will be dependent on the data retrieved after each redevelopment technique is applied. There are four primary indicators that will be used to determine the effectiveness of well rehabilitation and redevelopment methods. These indicators are turbidity, specific capacity, TOC levels, and concentrations of sulfate, iron and manganese.

The turbidity measurements will give an on-site indicator of redevelopment progress. The turbidity will be measured at each stage in the process. The target value for turbidity after redevelopment is a turbidity value less than five nephelometric turbidity units (NTUs).

Specific capacity tests will be performed before rehabilitation and redevelopment after the Hydropuls method is used and after rehabilitation is completed. The target value of improvement is that specific capacity improves by 5% from the baseline value to the measured value after redevelopment is completed.

The TOC levels will be analyzed by an on-site laboratory. A baseline TOC level will be determined before redevelopment and compared with TOC levels measured during and after redevelopment activities. The target value for TOC is less than 2 ppm, which is the background level in the area.

Sulfate, sodium, manganese, and iron concentrations in groundwater indicate the degree that drilling fluids have affected ambient groundwater chemistry in the region around a screen. Sulfate concentrations are diminished and iron and manganese concentrations increase as bacteria in the aquifer degrade organic polymers. Sulfate and sodium concentrations are elevated in groundwater when screened zones are affected by bentonite. The presence of these constituents at concentrations above or below ambient background levels are important well redevelopment performance measures.

3.4 Geochemical Evaluation Methods

Multiscreen wells R-16 and R-20 contain residual drilling fluids that may have impacted groundwater chemistry and reactive-phase mineralogy within the regional aquifer. Geochemical modeling using the computer codes MINTEQA2 and/or PHREEQC2.2 will evaluate the presence or absence of secondary minerals formed by residual drilling fluid reacting with both native groundwater and aquifer solids. Results of the geochemical simulations should constrain the type, stability, and mass of secondary phases potentially present within the impacted zones as well as their impact on aquifer porosity. These include carbonate and sulfide phases that are stable under the reducing conditions established by residual drilling fluid. Solute speciation and mineral equilibrium are evaluated using groundwater chemistry data, including field parameters, collected at the wells. Dissolution of native solid phases will also be evaluated.

Geochemical modeling will be performed using analytical results from the performance-suite analysis. The results will be evaluated using the WSAR criteria. The modeling will enable us to quantify the effectiveness and the influence of each well rehabilitation method on groundwater chemistry and aquifer mineralogy. Geochemical modeling will also be performed on one or two nearby single screen wells and/or springs not impacted by drilling fluid to establish a representative background for the area.

3.5 Assessing Effectiveness of Multicompletion Sampling Systems

Postredevelopment and Westbay system reinstallation samples will be collected to compare the water quality of the low-flow and no-purge volume groundwater samples with the historical data. Groundwater samples will be collected monthly for 6 months. The first sample set will undergo a full-suite analysis and the five remaining sample sets will undergo a performance analysis. The data from these samples will be evaluated using the WSAR (LANL 2005, 91121) criteria and compared with historical data used to evaluate R-16 and R-20 in the WSAR (LANL 2005, 91121).

4.0 IMPLEMENTATION

This pilot study plan will be a collaboration of DOE, the Laboratory, and subcontractor efforts. Table 4.0-1 summarizes the process, rationale, and sampling for the pilot well rehabilitation project activities. The schedule and roles and responsibilities from each entity are described in Section 7.0 of this pilot study execution plan.

In addition to the rehabilitation and redevelopment activities, a down-hole video log will be completed for each well using a Laboratory logging trailer. This video log will be used as a reference to document activities and will be included in the pilot well rehabilitation summary report.

4.1 R-20 before R-16

R-20 may have a greater likelihood of rehabilitation because R-16 has more clay-rich sediments and more drilling fluid loss into the formation. Once the redevelopment activities are completed for R-20 and there is improvement, the redevelopment techniques will be used on R-16.

4.2 Site Preparation

Each site will be prepared for rehabilitation and redevelopment activities. The following are the site preparation activities.

- Perform radiological survey of equipment by Laboratory radiological control technicians (RCTs), who are assigned to each site.
- Mobilize and install field offices and site services.
- Mobilize and set up 21,000 gal. frac tanks on Visqueen liners with straw berms as secondary containment. The tanks will containerize and store development water produced during redevelopment activities. The tanks will be labeled according to their contents. The containerized water will be sampled and evaluated for compliance with New Mexico Water Quality Control Commission Regulation 3103 groundwater standards and applicable Resource Conservation and Recovery Act regulatory limits, before any release of the containerized water. The waste and water disposal path is described in greater depth in Appendix B. Other best management practices (BMPs) may be installed as needed.
- Bring storage tank for potable water.
- Provide water tank and pump for fire suppression and heath and safety purposes.

4.3 Baseline Sampling with Westbay Sampling System

Before removal of the Westbay sampling system, baseline samples will be collected and field parameters measured. Baseline samples will undergo a full-suite analysis at an off-site laboratory. The full suite will analyze for VOCs, SVOCs, general inorganic chemicals (including alkalinity), metals, stable isotopes of hydrogen, oxygen, and nitrogen. The field parameter measurements will include the pH, ORP, temperature, conductivity, dissolved oxygen, turbidity, and hydrostatic pressure in the aquifer.

4.4 Removal of Westbay Sampling System

The subcontractor will remove the Westbay sampling system. The system that is removed will be evaluated by a Westbay representative to assess if damage has occurred and whether replacement of parts is needed. As the parts of the Westbay sampling system are removed, the components will be rinsed with deionized water, dried and placed in plastic bags for storage. The parts will be stored out of the weather in a covered facility. The deionized rinse water will be captured and stored in the on-site frac tanks.

4.5 Sampling and Evaluation of Pumping and Redevelopment Methods

Once the Westbay sampling system is removed and before rehabilitation activities begin, a specific capacity test will be performed as described in Section 3.1.1. The specific capacity tests will consist of installing dual inflatable packers to isolate the single-screened intervals and the pressure transducers in the interval. After the installation of the dual inflatable packers, there will be 1 hour of equilibrium time, to achieve a static water level before the isolated interval is pumped for a minimum of 3 hours. There are a minimum of 3 hours of pumping to ensure that the aquifer can sustain the pumping level. Three hours of recovery time will follow the pumping, which matches the time duration that pumping occurs. The packer assembly will then be repositioned to isolate the next screened interval and the test series repeated. The specific capacity test will require 2 days at each well.

During the specific capacity tests, performance samples will be taken every 10 minutes for the first 30 minutes, every 30 minutes until the end of the test. Bulk volumes of groundwater will be collected at maximum turbidity for suspended solids analysis. In addition, the pH, temperature, conductivity, ORP, dissolved oxygen, and turbidity will be measured for each sample as described in section 3.2.

After the specific capacity test, each screen will be jetted, swabbed, and bailed before the Hydropuls technique is implemented. The Hydropuls system will be assembled, placed in the open well, and operated at each screened interval. After the Hydropuls system is used, each screen will be swabbed, bailed, and pumped again. Use of the Hydropuls system, swabbing, bailing, and pumping will be continued for 2 days at each well screen. Bulk volume will be sampled at maximum turbidity for suspended solids analysis. The groundwater will also be measured for pH, temperature, conductivity, ORP, dissolved oxygen, and turbidity during each time a sample is collected for either a performance or full-suite analysis.

Finally, each screen will be pumped in isolation and the specific capacity test repeated. The filtered samples will be collected every 10 minutes for the first 30 minutes, every 30 minutes until the end of the test.

After mechanical rehabilitation activities are completed, results for the turbidity, TOC levels, groundwater chemistry, and specific capacity test results will be evaluated to determine the effectiveness of the redevelopment treatments. If specific capacity does not improve by at least 5%, TOC is greater than 2 ppm, or turbidity is greater than 5 NTU, the need for application of well development chemicals will be evaluated. Chemical treatment would consist of a PFD, chlorine, or acids. The well will be pumped after chemical use to remove the chemicals. If acids are used, the pH will be monitored until it returns to pre-acid addition levels. If chlorine is added, the chlorine and chloride concentrations will be measured until it returns to pre-chlorine addition levels. If PFD is added, the TOC will be measured until it is less than 2 ppm, which is the background level in the area.

Throughout rehabilitation and redevelopment activities, the pumped and removed water and materials will be containerized and managed as described in Appendix B.

4.6 Reinstallation of Westbay Sampling System

The Westbay sampling system removed from the well will be reinstalled upon completion of rehabilitation activities at each site. Samples will be collected one month after installation. One filtered and one nonfiltered sample will be collected from each screen in R-16 and R-20. A full-suite analysis will be performed on the collected samples. The groundwater will also be measured for pH, temperature, conductivity, ORP, dissolved oxygen, and turbidity, as described in Section 3.2.

4.7 Site Restoration Activities

Site restoration activities will be performed at each site location. Roads and site pads will be left in place to facilitate future well sampling and maintenance. All equipment used during rehabilitation activities will be removed from both sites. BMPs will be used to stabilize any areas disturbed by redevelopment activities. All water and waste will be managed as presented in Appendix C.

5.0 EVALUATION OF RESULTS

Sampling and evaluation will continue monthly for 6 months after the redevelopment and reinstallation activities have been completed. One filtered and one nonfiltered sample will be collected from each screen in R-16 and R-20. Groundwater samples will be analyzed for iron, manganese, sulfide, anions, cations, and

TOC levels by the EES laboratory to measure the performance of redevelopment techniques. The groundwater will also be analyzed for pH, temperature, conductivity, ORP, dissolved oxygen, and turbidity, as described in Section 3.2. Water produced will be analyzed as presented in Appendix B.

The data from the performance-suite analysis and field parameters will be evaluated using the WSAR criteria. To measure the performance of the redevelopment efforts, the data compared with the data compiled in the WSAR (LANL 2005, 91121).

6.0 DOCUMENTATION AND REPORTING

The subcontractor will prepare and submit a summary report documenting all field activities, variations from the execution plan, redevelopment and sampling procedures, and recommendations for consideration in future rehabilitation activities. The report will tabulate all redevelopment data and sample results.

The Laboratory will prepare a report in accordance with the Consent Order and QP-4.9, "Document Development and Approval Process," and will be reviewed following QP-3.5, "Peer Review Process."

Field activities associated with implementation of this pilot study execution plan will begin in June 2006. A summary report will be prepared and submitted to NMED 60 days of last round of 6-month sampling activities.

7.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities for the pilot study are distributed among a variety of entities. DOE is responsible for pilot studies as administered through a federal contract to conduct well redevelopment methods with a contractor. DOE and/or its contractor are responsible for

- planning,
- Westbay sampling system removal and reinstallation,
- well redevelopment and rehabilitation activities,
- bringing groundwater to the surface and through the flow-through cell and providing a sample access port for the Laboratory's EP-WSP group to retrieve samples,
- site restoration,
- waste management, and
- health and safety.

The role of DOE and/or the Laboratory will be to provide technical and logistical support to the pilot study. DOE and/or the Laboratory is responsible for

- collecting and transmitting samples to the Laboratory's Sample Management Office (SMO),
- developing criteria for evaluation of pilot study data and information,
- evaluating criteria and pilot study data,
- developing recommendations for future rehabilitation activities, and
- preparing pilot study reports

8.0 REFERENCES

The following list includes all documents supporting the information in this execution plan. Parenthetical information following each reference provides the author, publication date, and ER ID number. ER ID numbers are assigned by the Environmental Programs–Environment and Remediation Support Services Records Processing Facility (RPF) and are used to locate the document at the RPF.

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RRES/GPP June 2003. "Characterization Well R-20 Completion Report," Los Alamos National Laboratory document LA-UR-03-1839, Los Alamos, New Mexico. GPP-03-032. (RRES/GPP 2003, 79600)

Robinson, B.A., K.A. Collins, and A.M. Simmons, 2005. "Hydrogeologic Synthesis Report," Los Alamos National Laboratory report LA-UR-05-2814, Los Alamos National Laboratory, Los Alamos, New Mexico. (Robinson et al. 2005, 88767)

9.0 PROCEDURES FOR COLLECTING, ANALYZING, AND REVIEWING WATER DATA

(Note: Several procedures are being revised. Check the ERSS website for the up-to-date version.)

RRES-WQH-SOP-048, Groundwater Sampling Using Bladder Pumps

RRES-WQH-SOP-049, Groundwater Sampling Using Submersible Pumps

RRES-WQH-SOP-050, Groundwater Sampling Using Westbay System

ENV-DO-203, Field Water Quality Analyses

ENV-DO-206, Sample Containers and Preservation

ENV-DO-207, Handling, Packaging, and Transporting Field Samples

ENV-WQH-QP-029, Creating and Maintaining Chain of Custody

ENV-ECR QP-4.4, Record Transmittal to the Records Processing Facility

ENV-ECR SOP-1.02, Sample Containers and Preservation

ENV-ECR SOP-1.03, Handling, Packaging, and Transporting Field Samples

ENV-ECR SOP-1.04, Sample Control and Field Documentation

ENV-ECR SOP-05.02, Well Development

ENV-ECR SOP-06.01, Purging and Sampling Methods for Single Completion Wells

ENV-ECR SOP-06.03, Sampling for Volatile Organic Compounds in Groundwater

ENV-ECR SOP-06.32, Multi-Level Groundwater Sampling of Monitoring Wells—Westbay MP System

ENV-ECR SOP-07.04, Aquifer Pumping Tests

ENV-ECR SOP-15.01, Routine Validation of Volatile Organic Data

ENV-ECR SOP-15.02, Routine Validation of Semivolatile Organic Data

ENV-ECR SOP-15.03, Routine Validation of Organochlorine Pesticides and Polychlorinated Biphenyls Data

ENV-ECR SOP-15.04, Routine Validation of High Explosives Data

ENV-ECR SOP-15.05, Routine Validation of Inorganic Data

ENV-ECR SOP-15.06, Routine Validation of Gamma Spectroscopy Data

ENV-ECR SOP-15.07, Routine Validation of Chemical Separation Alpha Spectrometry, Gas Proportional Counting, and Liquid Scintillation Data

ENV-ECR SOP-15.09, Chain of Custody for Analytical Data Packages

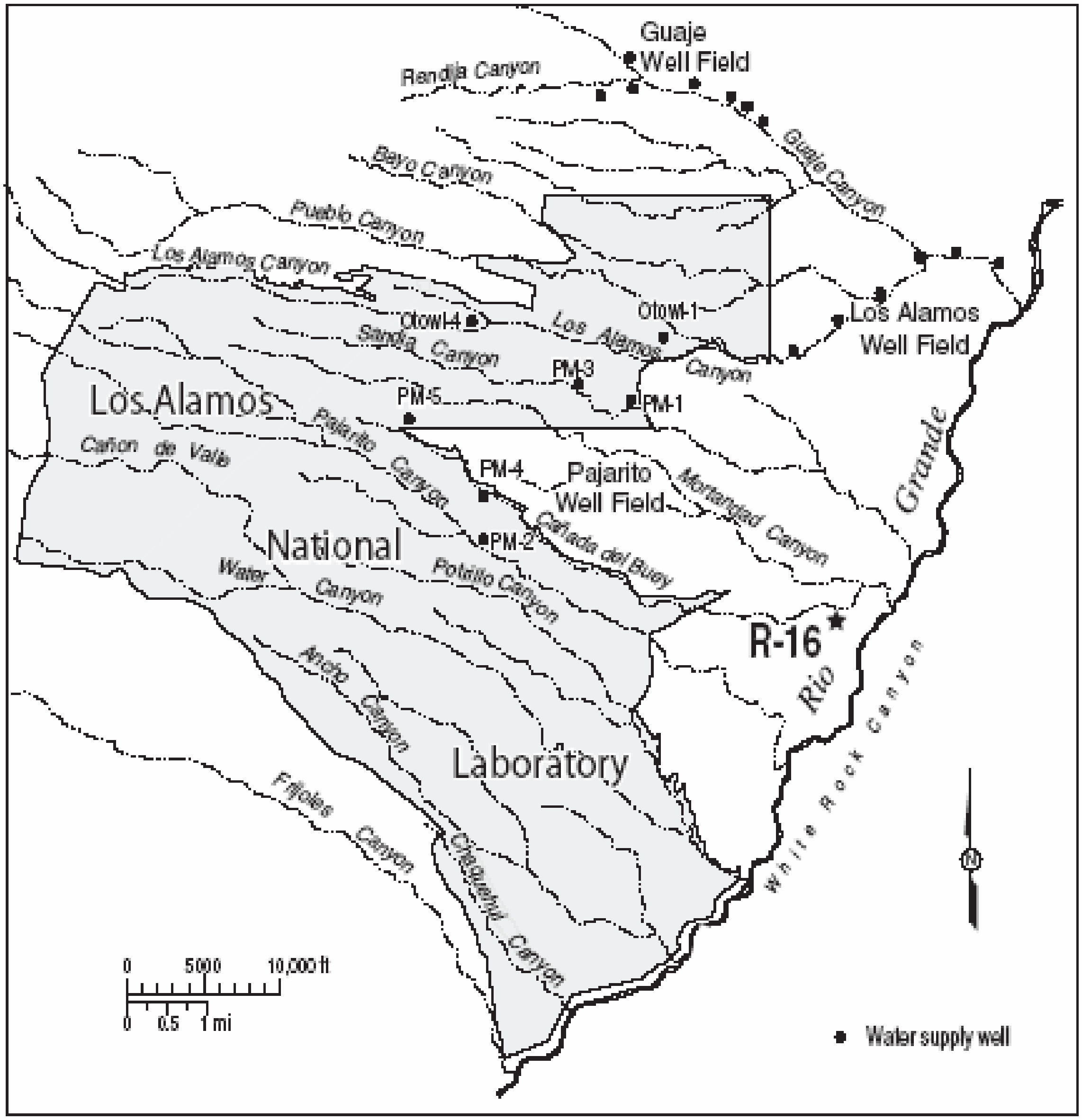

Figure 1.1-1. Location of Well R-16 (LANL 2003, 76061)

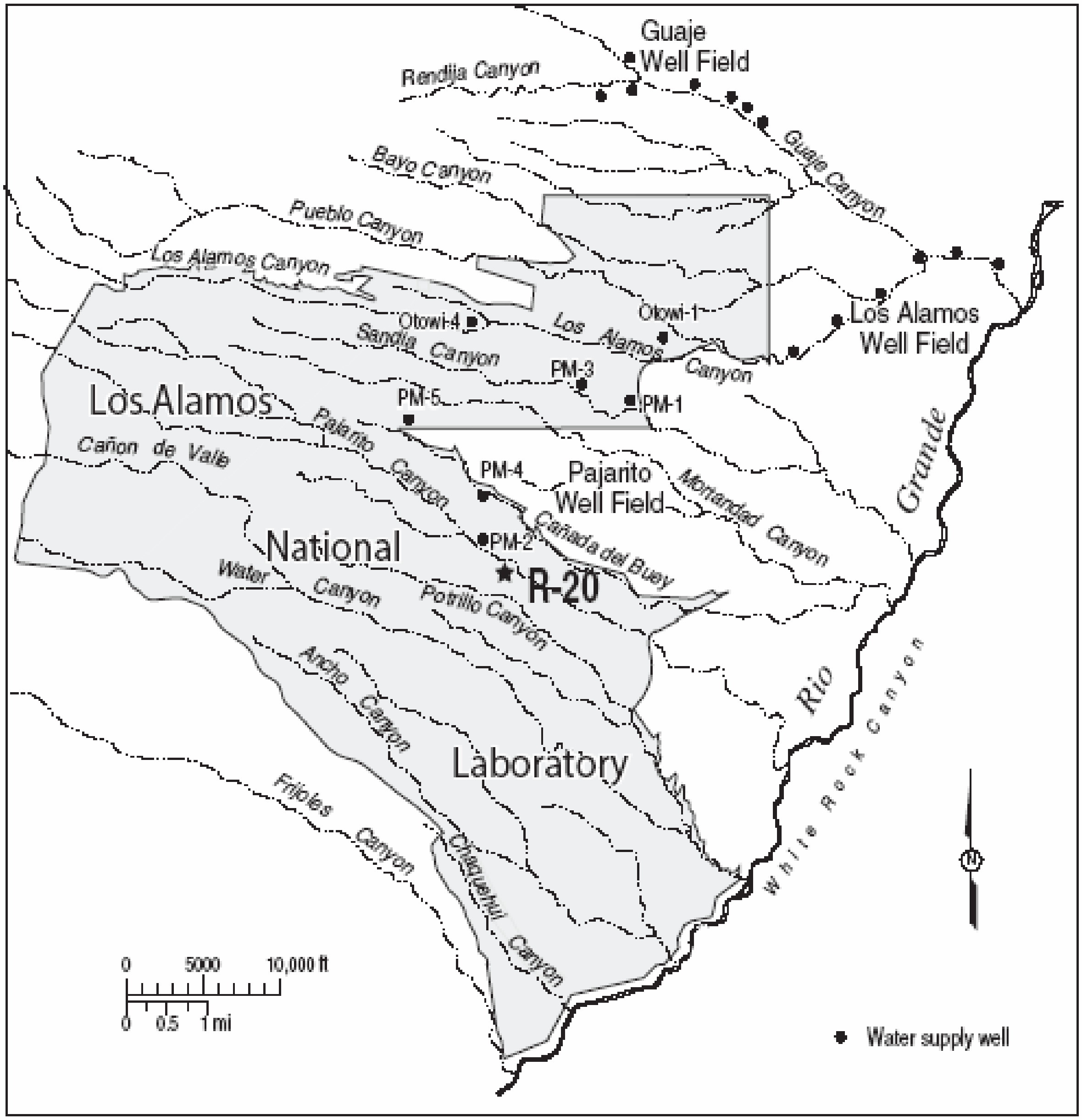

Figure 1.1-2. Location of Well R-20 (LANL 2003, 79600)

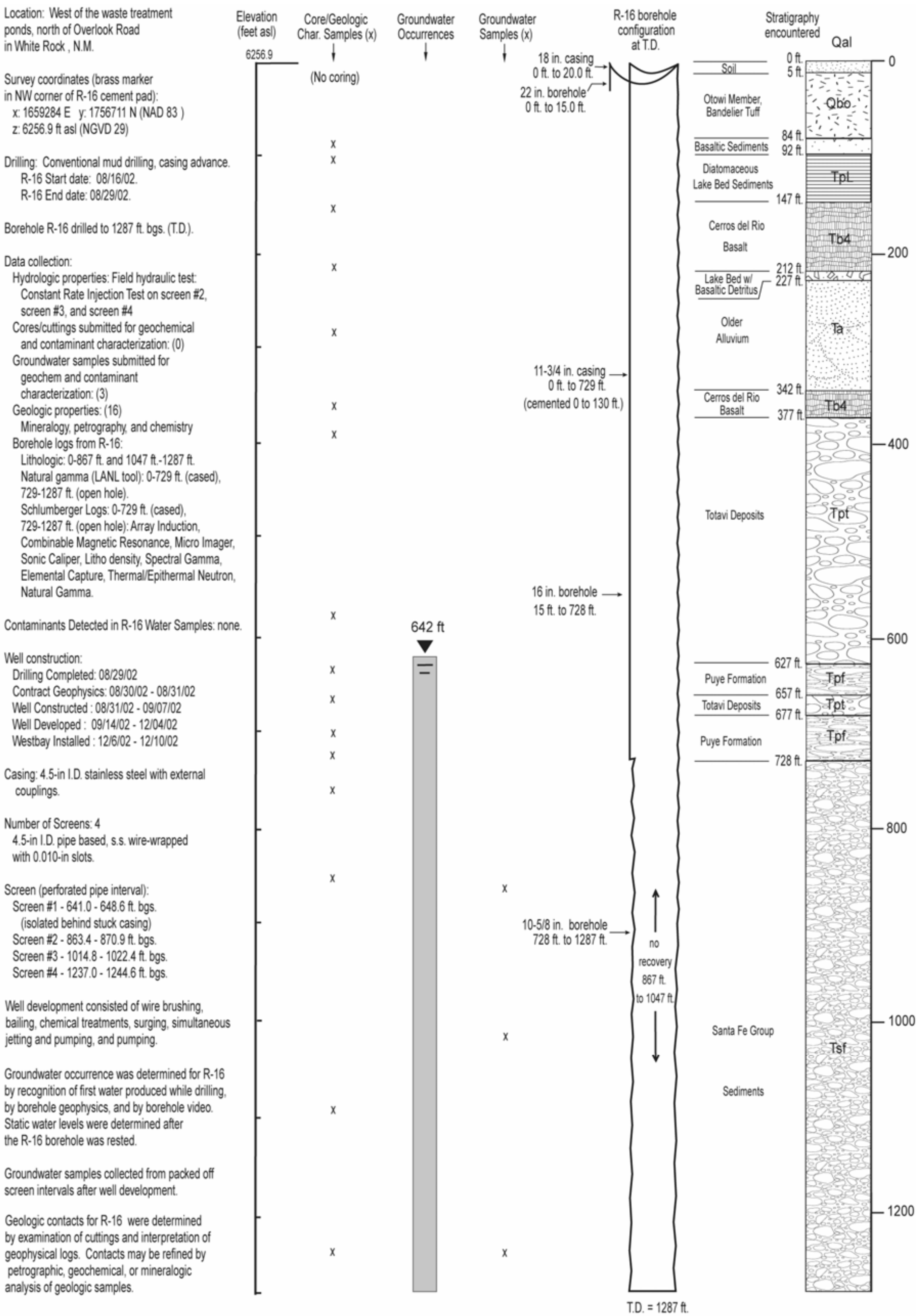

Figure 1.1-3. Summary of Well R-16 (LANL 2003, 76061)

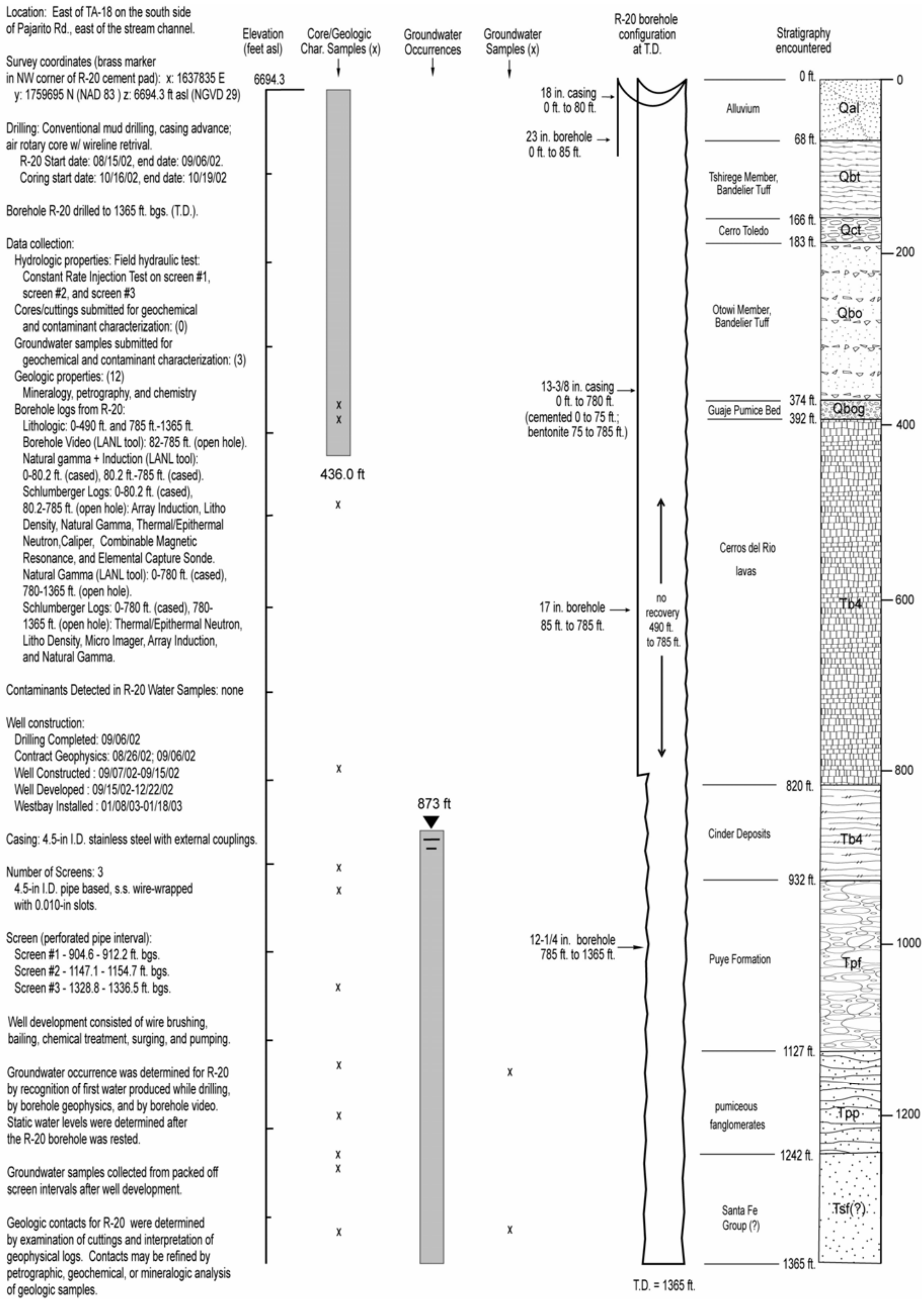

Figure 1.1-4. Summary of Well R-20 (LANL 2003, 79600)

Table 1.1-1
Well Development Statistics for Well R-16

R-16 Well Screen (Sand interval)	Drilling Fluids and Method(s) Used	Additives (i.e. solids, LCM materials)	Well Installation Fluids	Well Development Methods and Volumes added/removed	Time screens/zones in Communication	Lithology at Screen Interval	Geophysical Indication of Interval
Screen 1 (641.0–648.6')	Interval isolated behind abandoned drive casing.						
Screen 2 (863.4–870.9')	Mud rotary for this interval	Water, QUIK-GEL, EZ-Mud, Liqui-Trol, magma fiber, Pac-L, N-Seal, soda ash	Water for filter pack. Water plus EZ-mud for pellet seals.	Wire brushing, swabbing and surging, bailing (screens not isolated). Acid and dispersant added. Pumping with packer isolation.	100 days	Santa Fe Group (Tsf) 852-857: Clayey sand (SC) with gravel, 857-862: No recovery 862-867: Sand (SW) with clay 867-1047: No recovery, lost circulation	Total porosity approximately 30% throughout saturated interval
Screen 3 (1014.8–1022.4')	Mud rotary for this interval	Water, QUIK-GEL, EZ-Mud, Liqui-Trol, magma fiber, Pac-L, N-Seal, soda ash	Water for filter pack. Water plus EZ-mud for pellet seals.	Wire brushing, swabbing and surging, bailing (screens not isolated). Acid and dispersant added. Pumping with packer isolation.	100 days	Santa Fe Group (Tsf) 867-1047: No recovery, lost circulation	Total porosity approximately 30% throughout saturated interval
Screen 4 (1237.0–1244.6')	Mud rotary for this interval	Water, QUIK-GEL, EZ-Mud, Liqui-Trol, magma fiber, Pac-L, N-Seal, soda ash	Water for filter pack. Water plus EZ-mud for pellet seals.	Wire brushing, swabbing and surging, bailing (screens not isolated) and jetting. Acid and dispersant added. Pumping w/wo packer isolation.	100 days	Santa Fe Group (Tsf) 1207-1287: Clastic sediments, sand (SW) with clay and gravel, clayey sands (SC), gravel (GW) with clay and sand near TD.	Total porosity approximately 30% throughout saturated interval

Table 1.1-2
Well Development Statistics for Well R-20

R-20 Screen (Sand interval)	Drilling Fluids and Method(s) Used	Additives (i.e. solids, LCM materials)	Well Installation Fluids	Well Development Methods and Volumes added/removed	Time screens/zones in Communication	Lithology of Interval	Geophysical Indications of Interval
Screen 1 (895.2–926.5)	(Below 780 fbgs) Mud rotary Water, QUIK-GEL, Liqui-Trol,	Pac-L, N-Seal, magma fiber	Water for filter pack, water+EZ-Mud for bentonite (Benseal, Pelplug) seals. Approx. 41,400 gal. of municipal water used for installation.	Wire-brushing, bailing, surging, Chemical treatment (MGA+AE, PFD), Pumping with screens not isolated. Pumping with screens isolated. A total of approx 87,008 gal. removed.	137 days (Sept. 4, 2002 to Jan. 18, 2003)	Cerros del Rio Basalt (Tb4) Scoria/sediments, scoria (altered and bleached). 915-920: No recovery	Total porosity is greater than 20% throughout saturated interval
Screen 2 (1132.5–1165.5)					137 days (Sept. 4, 2002 to Jan. 18, 2003)	Top of Pumiceous Puye Fm (Tpp) Fanglomerate. Volcaniclastic sediments, mainly Clayey Sand (SC) with gravel and Clayey Sand (SC).	Logs used to select a typical porosity/permeability zone for screen placement between Screens 1 and 3.
Screen 3 (1320.6–1344.5)					137 days (Sept. 4, 2002 to Jan 18, 2003)	Santa Fe Group (Tsf) Volcaniclastic sediments, Sand (SW) with clay.	Logs used to select a relatively high-porosity/high-permeability zone so that the upper end of the permeability distributions could be targeted for straddle-packer/injection tests.

Table 2.0-1
Comparison from the Well Screen Analysis Report (LANL 2005, 91121)

	Outcome of Tiered Analysis Method				
	Outcome	Poor Rating < 60%	Fair Rating 60% – 80%	Good Rating 81% – 90%	Very Good Rating 91% – 100%
Outcome of PCA Method	Not analyzed by PCA	R-12-1	R-9i-1 R-9i-2 (P) R-19-2 R-25-1	R-6[B] (P) R-6i (P)	CdV-16-1i MCOBT-4.4 R-5-2 R-18 (P)
	Consistent with WRC springs or existing wells	R-19-6 (P)	CdV-R-15-3-6 CdV-R-37-2-4 R-19-3	CdV-R-15-3-4 R-2[B](P) R-13 R-19-4 R-25-8 R-34 R-26-1	CdV-R-37-2-3 R-1 (P) R-8-1 R-14-1 R-21 R-25-4 R-25-6 (P) R-25-7 (P) R-32-1[B] R-33-2 (P)
	Possible to slight impacts	R-20-1[B] CdV-R-15-3-5	R-5-4		R-4[B](P) R-5-3 R-11 (P) R-15 R-22-2
	Moderate impacts	R-7-3 R-14-2[B] R-19-5 R-32-3[B]	R-8-2 R-12-3 R-16-2[B] R-25-5 R-33-1	R-16-3[B] R-22-3	R-9 R-23
	Significant impacts	CdV-R-37-2-2 R-16-4[B] R-20-2[B] R-22-1 R-22-4 R-22-5 R-31-2(P)	R-19-7 R-20-3[B] R-25-2		R-28 (P)

* Shaded cells indicate consistent outcomes.
B Screen interval drilled with bentonite drilling mud.
(P) Result considered preliminary either because less than 3 sample events were available or because the most recent event occurred more than 2 years ago.

Table 2.0-2
Factors Potentially Influencing Well R-16 Screen Performance and Groundwater Samples

General Factors for Well R-16	The lower three intervals were in communication for approximately 100 days from end of drilling until the Westbay system was installed. Abundant Lost Circulation Material (LCM) was used during drilling. Before well installation, the well annulus was pumped with municipal water and jetted to remove mud cake from the borehole wall. Following borehole jetting, 5 gal. PFD mixed with 2000 gal. of water were injected at 900 fbgs. An additional 2 gal of PFD mixed with 1000 gal. water were added as jetting tool was removed. Weight of mud column could force more material and lost circulation material (LCM) into formation/permeable zones. Possible chemical interactions with drilling mud additives and formation materials (i.e., clays). An “airlifting” procedure was used during well installation to remove the upper portion of the borehole mud column so that lower filter pack and seals could be placed.
Specific Factors for Screen 2	Incomplete “cleaning” of screened interval. Presence of amounts of LCM in formation.
Specific Factors for Screen 3	Inferred geology for interval is clay-rich, zone may be low producer. Poor returns during drilling imply large amounts of LCM in this interval.
Specific Factors for Screen 4	Inferred geology for interval is clay-rich, zone may be low producer. Poor returns during drilling imply large amounts of LCM in this interval. Most of the screen is covered by slough (admixed drilling fluids and LCM). Hard to remove during development.

Table 2.0-3

Factors Potentially Influencing Well R-20 Screen Performance and Groundwater Samples

General Factors for Well R-20	The three intervals were in communication for approximately 137 days from end of drilling until the Westbay system was installed. However, some well development with screen isolated with packers did occur. After well installation, screens were treated with acid and PFD to break up drilling mud. The casing has a 16.8 ft-long sump. Weight of mud column could force more material and lost circulation material (LCM) into formation/permeable zones. Possible chemical interactions with drilling mud additives and formation materials (i.e. clays).
Specific Factors for Screen 1	Zone partially in sediments and partially in basalt. Fracture flow may predominate in this interval. Sediments are fine-grained or clay-rich. Possible intrusion of mud/water/fluids out into formation due to weight of fluid column in borehole.
Specific Factors for Screen 2	Geology for interval is clay-rich sediments. Intrusion of mud/water/fluids out into formation due to weight of fluid column in borehole. Zone is “clogged” with LCM and drilling mud.
Specific Factors for Screen 3	Intrusion of mud/water/fluids out into formation due to weight of fluid column in borehole. Zone is “clogged” with LCM and drilling mud.

Table 4.0-1
Process, Rationale, and Sampling for the Pilot Study Well Rehabilitation Project

Process/Step	Purpose	Sample Collection	Field Parameters	Frequency/number of samples
Baseline Sampling with Westbay	Provide baseline data before pulling Westbay system	Full analytical suite (see sample request table).	pH, ORP, T, EC, DO, turbidity, water level	One filtered/non filtered pair from each screen (R-16 and R-20). [6 sample pairs total for R-16 and R-20 combined]
Remove Westbay system	Prepare well for rehabilitation	None	None	None
Pump each screen in isolation	Measure specific capacity	Performance suite to measure progress and bulk volume at maximum turbidity for suspended solids analysis (see definitions below).	pH, ORP, T, EC, DO, turbidity	Collect performance suite (EES) samples every 10-min for first 30-min; 30-min for next 2.5-hr or until end of SC test [72 F/NF sample pairs total for R-16 and R-20 combined]. Carboys (up to 10 per screen) for suspended solids analysis near beginning of pumping.
Sample each screen in isolation	Provide baseline data after pulling Westbay system	Full analytical suite (see sample request table).	pH, ORP, T, EC, DO, turbidity	One F/NF pair from each screen. Samples to be collected toward the end of the specific capacity pumping test once field parameters have stabilized. [6 sample pairs total for R-16 and R-20 combined]
Jetting and Hydropuls	Agitate screen and filter pack	None	None	None
Isolation swabbing and pumping	Mobilize and remove fines in filter pack and near field formation	Bulk volume at maximum turbidity for suspended solids analysis.	pH, ORP, T, EC, DO, turbidity	Carboys (up to 10 per screen) for suspended solids analysis
Pump each screen in isolation	Measure specific capacity	Performance suite.	pH, ORP, T, EC, DO, turbidity	Collect performance suite (EES) samples every 10-min for first 30-min; 30-min for next 2.5-hr or until end of SC test [72 F/NF sample pairs total for R-16 and R-20 combined].
Sample each screen in isolation	Provide baseline data before reinstalling Westbay system	Full analytical suite (see sample request table).	pH, ORP, T, EC, DO, turbidity	One filtered/non filtered pair from each screen. Samples to be collected toward the end of the pumping test once field parameters have stabilized. [6 sample pairs total]
Full suite, post Westbay reinstallment.	Test effects of rehabilitation	Sample one month after installation; full suite analysis.	pH, ORP, T, EC, DO, turbidity	One filtered/non filtered pair from each screen (R-16 and R-20) [6 sample pairs total for R-16 and R-20 combined].
Performance measurement after Westbay reinstallment.	Test effects of rehabilitation	Performance suite each month for five months	pH, ORP, T, EC, DO, turbidity	One F/NF sample from each screen (R-16 and R-20) per month. [30 sample pairs total for R-16 and R-20 combined]

Performance suite S^{2-}, TOC, metals, alkalinity, anions (including perchlorate) and cations, from the EES laboratory.
Full analytical suite VOC, SVOC, , general inorganics (including alkalinity), metals, stable isotopes of hydrogen, oxygen, and nitrogen

Appendix A

Acronyms and Abbreviations

BMP	best management practice
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EP	Environmental Programs
EPA	U.S. Environmental Protection Agency
ER ID	Environmental Restoration Identification (catalog number)
ERSS	Environment and Remediation Support Services
LANL	Los Alamos National Laboratory
LIR	Laboratory implementation requirement
NMED	New Mexico Environment Department
NTU	nephelometric turbidity unit
ORP	oxidation/reduction potential
PFD	phosphate-free detergent
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QP	quality procedure
RPF	Records Processing Facility
SMO	Sample Management Office
SOP	standard operating procedure
SVOC	semivolatile organic compound
TA	technical area
TOC	total organic carbon
VOC	volatile organic compound
WCSF	waste characterization strategy form
WSAR	well screen analysis report

Appendix B

Management Plan for Investigation–Derived Waste

B-1.0 MANAGEMENT OF WASTE AND GROUNDWATER

This appendix to the execution plan describes how waste and water generated during the pilot study will be managed. The waste that will be generated as a result of field investigation activities may include, but is not limited to, contaminated personal protective equipment (PPE), sampling supplies, plastics, water, and all other wastes. Waste and water generated during the pilot study will be managed to protect human health and the environment, comply with applicable regulatory requirements, and adhere to the Laboratory waste-minimization goals.

In addition, all waste and water generated during pilot study activities will be managed in accordance with applicable Environmental Programs–Water Stewardship Project (EP-WSP) standard operating procedures (SOPs). These SOPs incorporate the requirements of all applicable U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy (DOE) orders, and Laboratory implementation requirements (LIRs). The EP-WSP SOPs applicable to the characterization and management of waste and the water are the following:

- SOP-1.06, Management of Environmental Restoration Project Waste
- SOP-1.10, Waste Characterization

These SOPs are among the SOPs applicable to the pilot study and are available at the following URL: http://erproject.lanl.gov/documents/procedures.html.

A Waste Characterization Strategy Form (WCSF) will be prepared and approved according to the requirements of SOP-1.10. The WCSF will provide detailed information on the waste characterization and management described in this plan. The waste and water characterization will be completed by using existing data and/or documentation, site characterization data from samples of the media being sampled and/or by direct sampling, if needed. To facilitate sample collection and obtain a more representative sample, a 1-gal. aliquot of water will be collected on an hourly basis and placed in a clean, 55-gal.drum. A sample will be collected from the tank or drum and then transported to the Sample Management Office (SMO). In addition, direct waste characterization sampling will be described in the WCSF.

All water produced during rehabilitation activities will be containerized, sampled, and evaluated for compliance with New Mexico Water Quality Control Commission Regulation 3103 groundwater standards and applicable Resource Conservation and Recovery Act regulatory limits before any release of water occurs. Decisions regarding the release of rehabilitation water will be made in accordance with the "Workplan NOI Decision Tree" and in coordination with NMED.

The selection of waste containers will be based on the appropriate U.S. Department of Transportation requirements, waste types, and estimated volumes of wastes to be generated. Each waste container will be individually labeled as to the waste classification, item identification number, and date of generation. Waste containers will be managed in clearly marked and appropriately constructed waste accumulation areas. Waste-accumulation area postings, labeling, storage duration, and inspection requirements will be based on waste type and classification and on regulatory and Laboratory requirements. Container and storage requirements will be detailed in the WCSF and approved before the waste is generated.

Spent PPE: The spent PPE waste stream will consist of PPE that has potentially come into contact with contaminated environmental media and cannot be decontaminated. The bulk of this waste stream will consist of protective clothing such as coveralls, gloves, and shoe covers. Spent PPE will be collected in containers, such as drums, and stored within a locked field trailer. Characterization of this waste stream will be performed through acceptable knowledge (AK) of the waste PPE materials, the methods of generation, and the analytical results from the environmental media samples with which the PPE materials were in contact. Based upon previous samples, the Laboratory expects that these wastes will not be classified as a regulated waste. However, if analytical data show that the environmental media exceeds screening levels, the Laboratory waste management personnel will determine the appropriate waste management actions. The waste management personnel will ensure that all applicable procedures and requirements are met.

Disposable sampling supplies and dry decontamination waste: The disposable sampling supplies waste stream will consist of all equipment and materials necessary for collecting samples that come into direct contact with environmental media. This waste stream also includes wastes associated with dry decontamination activities resulting from decontamination of sampling equipment, if necessary. The dry decontamination wastes will consist primarily of paper and plastic items collected in bags at the sampling location and transferred to accumulation drums. The drums will be stored within a locked field trailer. Characterization of this waste stream will be performed through AK of the sampling and decontamination waste materials, the methods of generation, and the analytical results from environmental media samples with which the materials were in contact. Based upon previous samples, the Laboratory expects that these wastes will not be classified as a regulated waste. However, if analytical data show that the environmental media exceeds screening levels; the Laboratory waste management personnel will determine the appropriate waste management actions. The waste management personnel will ensure that all applicable procedures and requirements are met.

B-2.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs–Environment and Remediation Support Services (ERSS) Program Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the ERSS Programs master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the ENV-ERS Program. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

EPA (U.S. Environmental Protection Agency), April 1994. “Module VIII, Special Conditions Pursuant to the 1984 Hazardous and Solid Waste Amendments to RCRA for Los Alamos National Laboratory, EPA ID NM0890010515 38817,” module of EPA Hazardous Waste Facility Permit issued to Los Alamos National Laboratory, Dallas, Texas. (EPA 1994, 44146)

LANL (Los Alamos National Laboratory), November 2004. “2004 Pollution Prevention Roadmap,” Los Alamos National Laboratory document LA-UR-04-8973, Los Alamos, New Mexico. (LANL 2004, 88465)

Appendix C

Sample Analysis Request Forms