Drilling Work Plan for Perched-Intermediate Well R-10i

Primary Purpose	Perched-intermediate well R-10i is being installed to monitor water quality in a perched interval initially encountered while drilling regional aquifer wells R-10 and R-10a. Well R-10i will supplement Laboratory boundary and off-site perched groundwater monitoring that is currently provided by wells R-9i, R-12, and R-23i. Installation of R-10i will proceed as required by the New Mexico Environment Department (NMED) Approval with Modification, Investigation Report for Sandia Canyon dated February 9, 2010, and received at Los Alamos National Laboratory (LANL or the Laboratory) on February 12, 2010 (NMED 2010, 108683). Well R-10i is located on the same drill pad as wells R-10a and R-10 (Figure 1). The R-10i borehole is expected to penetrate perched saturation within riverine sand and gravel deposits (older alluvium) that occur between lavas of the Cerros del Rio volcanic field. The perched zone may be confined and the water level may occur at a depth of approximately 303 ft within the upper Cerros del Rio basalts. The target borehole total depth (TD) is approximately 400 ft (Figure 2). The well will be completed with one well screen, placed within the riverine gravels. Figure 2 shows the predicted geology and proposed well design for well R-10i. A final well design will be based on data acquired during drilling, including information from lithological logs of cuttings, water-level measurements, video logs, geophysical logs, and drillers' observations. A revised well-design document will be submitted to NMED for approval.
Conceptual Model	Multiple perched intervals are possible at this site, with a likely transmissive interval in the older alluvium (330–370 ft depth) and possibly another interval or intervals in Totavi riverine gravels (480–585 ft depth). Initial detection and collection of perched water at R-10a at 303 ft depth, within Cerros del Rio lavas overlying the older alluvium, suggests possible confinement of the uppermost perched interval. Lower confining beds may occur beneath the older alluvium, within the lower Cerros del Rio lavas at 370–460 ft depth, and beneath the Totavi gravels within Miocene basaltic lavas below 585 ft depth, as indicated in Figure 2. The R-10i well is planned to target the upper perched interval within the older alluvium, with screen placement likely between 330 and 370 ft below ground surface (bgs).
Drilling Approach	Drilling will be conducted with methods selected to optimize the potential of completing the well without the use of drilling additives in, or immediately above, the target zone of perched saturation. A combination of open-hole and casing-advance methods may be employed. Each interval of open hole or casing advance will be optimized to meet well objectives. Casing will be used to protect open-hole intervals above, to advance the borehole when open-hole drilling is not possible, and to secure the borehole through unstable zones above the perched groundwater interval.
Potential Drilling Fluids, Composition, and Use	Fluids and additives may be used to facilitate drilling. These fluids and additives are consistent with those previously used in the drilling program at the Laboratory and have been characterized geochemically. Fluids and additives previously authorized for use by NMED include • potable water, municipal water supply, to aid in delivery of other drilling additives and cool the drill bit; • QUIK-FOAM, a blend of alcohol ethoxy sulfates, used as a foaming agent; and • AQF-2, an anionic surfactant, used as a foaming agent. Complete records will be maintained detailing the type, amount, and volume of drilling fluid used; depth of drilling fluid added to the borehole; amount in storage in the borehole; and recovery volume of drilling fluid. No chemicals other than those listed above will be added without approval from NMED. No drilling fluids will be used within 100 ft of the perched groundwater except potable municipal water. If the perched groundwater cannot be reached without adding drilling fluids, the situation will be discussed with NMED.

Hydrogeologic and Geochemical Objectives	• The primary objective is to monitor water quality in the upper perched zone at this locality. • A secondary objective is to establish water levels in the perched aquifer that may constrain the hydrogeology of the perched system, particularly with respect to confinement of flow between lavas.
Perched Groundwater Occurrence and Detection	The upper interval of perched-intermediate groundwater is targeted by the R-10i borehole. Although the unconfined water level is anticipated to be at approximately 303 ft bgs, within Cerros del Rio lavas, the well screen will target the underlying more permeable older alluvium. The confining bed beneath the upper perched groundwater zone is expected to be within the lower Cerros del Rio lavas, at 370–460 ft bgs. The experience of initial detection of perched water followed by drainage of the perched saturation at R-10a indicates the need for extra care in screen placement at R-10i. It may be necessary to drill beyond the base of the older alluvium at 370 ft bgs and into the underlying Cerros del Rio lavas. Drilling will pause at 340 and 370 ft bgs to monitor water levels in the borehole; if a constant water level is observed with sufficient saturated thickness for a well screen, the well will be designed to sample the perched system as high as reasonably possible within the older alluvium. If perched saturation cannot be maintained, a sequence of bentonite lifts may be attempted to identify a stable interval of saturation. Should this attempt fail, drilling may progress through the Totavi riverine gravels to the top of the Miocene lavas at 585 ft bgs, where a similar attempt may be made to establish a stable water level in a perched system above 623 ft bgs (depth to regional saturation recorded in well R-10a; Figure 2). An analogous perched interval occurs to the southwest at R-55i, where the perched interval is within riverine gravels between Cerros del Rio lavas. The well at R-55i was completed successfully above a clay-rich interval at the base of the gravels. Care will be taken in analysis of cuttings at R-10i to identify any clay-rich intervals within or at the base of the older alluvium gravels that might provide perching or poorly transmissive intervals. Groundwater screening samples will be collected during drilling of any perched groundwater zones producing sufficient water for sampling. Analytes for the screening samples are listed in the section below, Perched Groundwater Screening Sampling.
Core Sampling	No core collection or sampling is planned.
Perched Groundwater Screening Sampling	Groundwater screening samples will be collected for perched groundwater as encountered during drilling, for comparison with screening samples that were collected during drilling of R-10a and R-10. Screening samples of perched groundwater will be analyzed for cations/metals (dissolved and total) and anions (dissolved) by the Earth and Environmental Sciences Division's Geochemistry and Geomaterials Research Laboratory and for tritium by off-site laboratories.
Regional Groundwater Characterization Sampling	Not applicable
Geophysical Testing	The Laboratory's borehole video camera, natural gamma, and induction tools will be used in the open borehole if conditions allow. Although unlikely to be necessary, a full suite of geophysical logs will be run if needed for identification of perched intervals, perching horizons, and proper placement of the well screen. The logs will be collected by Schlumberger, Inc. For open-hole conditions, the logs will include accelerator porosity sonde (neutron porosity), array induction, combined magnetic resonance, natural and spectral gamma, and formation micro-imager logs. In cased portions of the borehole, neutron porosity, triple lithodensity, elemental capture, natural gamma, and spectral gamma logs will be collected. These logs will be used to define the top of perched saturation and to characterize the hydraulic properties of saturated rocks in the perched aquifer. The suites run and timing of geophysical logging will depend on borehole conditions.

Well Completion Design	Figure 2 shows the proposed well design for well R-10i.
Well Development	The well may be developed by both mechanical and chemical means. Mechanical means include swabbing, bailing, and pumping. Chemical means include the use of additives to remove clay minerals introduced as annular fill, and/or chlorination to kill bacteria introduced during well completion. • After initial swabbing and bailing, a submersible pump will be used to complete the development process. • Water-quality parameters will be measured in a flow-through cell. The parameters to be monitored are pH, specific conductance, dissolved oxygen, temperature, turbidity, oxidation-reduction potential, and total organic carbon (TOC). • If it is not possible to bring the water-quality parameters within the measurement limits specified below, the use of chemical well development may be discussed with NMED. No chemicals will be added without approval from NMED. • Chemicals that may be used include sodium acid pyrophosphate and AQUACLEAR PFD to remove clay minerals, and/or chlorination to kill bacteria introduced during well completion. Well development will be considered complete when target water-quality parameters are met. The target water-quality parameters are turbidity <5 nephelometric turbidity units, TOC <2 ppm, and other parameters stable.
Hydraulic Testing	Hydraulic testing will take place if the well screen is within a significant water-producing perched horizon. The most likely test will be a 24-h constant-rate pump test.
Investigation-Derived Waste Management	Investigation-derived waste (IDW) will be managed in accordance with Standard Operating Procedure (SOP) 5238, Characterization and Management of Environmental Program Waste (http://www.lanl.gov/environment/all/qa/adep.shtml). This SOP incorporates the requirements of applicable U.S. Environmental Protection Agency and NMED regulations, U.S. Department of Energy orders, and Laboratory requirements. The primary waste streams include drill cuttings, drilling water, development water, purge water, decontamination water, and contact waste. Drill cuttings will be managed in accordance with the NMED-approved Notice of Intent (NOI) Decision Tree for Land Application of IDW Solids from Construction of Wells and Boreholes (November 2007). Drilling, purge, and development waters will be managed in accordance with the NMED-approved NOI Decision Tree for Drilling, Development, Rehabilitation, and Sampling Purge Water (November 2006). Initially, drill cuttings and drilling water will be stored in lined pits. The cuttings may or may not contain residue of drilling/well completion additives (e.g., drilling foam and bentonite clay). The contents of the pits will be characterized with direct sampling following completion of drilling activities, and waste determinations will be made from validated data. If validated analytical data show these wastes cannot be land-applied, they will be removed from the pit, containerized, and placed in accumulation areas appropriate to the type of waste. Cuttings, drilling water, development water, and purge water that cannot be land-applied and are designated as hazardous waste will be sent to an authorized treatment, storage, or disposal facility within 90 d of containerization. Development water, purge water, and decontamination water will be containerized separately at their point of generation, placed in an accumulation area appropriate to the type of waste, and directly sampled. Contact waste will be containerized at the point of generation, placed in an appropriate accumulation area, and characterized using acceptable knowledge of the media with which it came in contact.
Schedule	Well R-10i is proposed for completion on December 1, 2011.

REFERENCE

The following list includes all documents cited in this plan. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. 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.

NMED (New Mexico Environment Department), February 9, 2010. "Approval with Modification, Investigation Report for Sandia Canyon," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 108683)

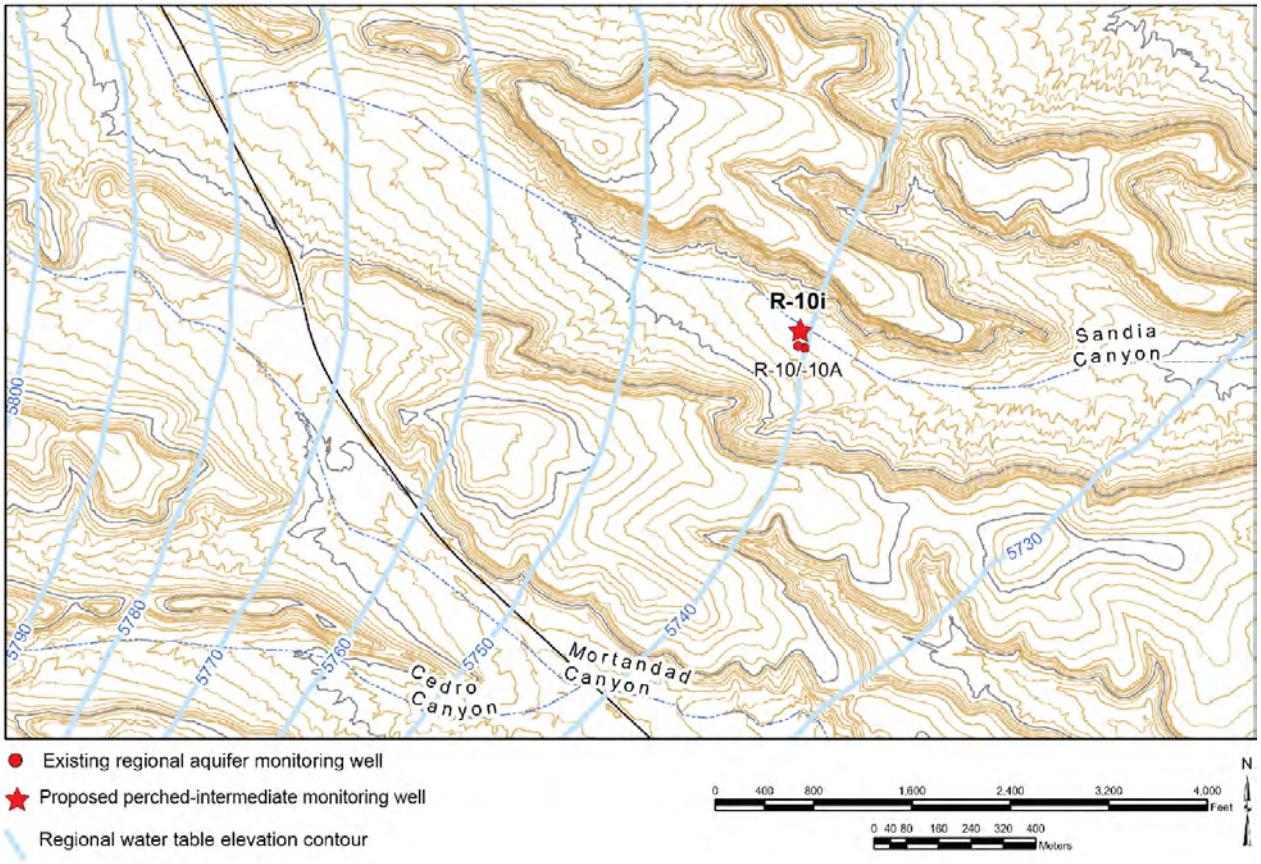
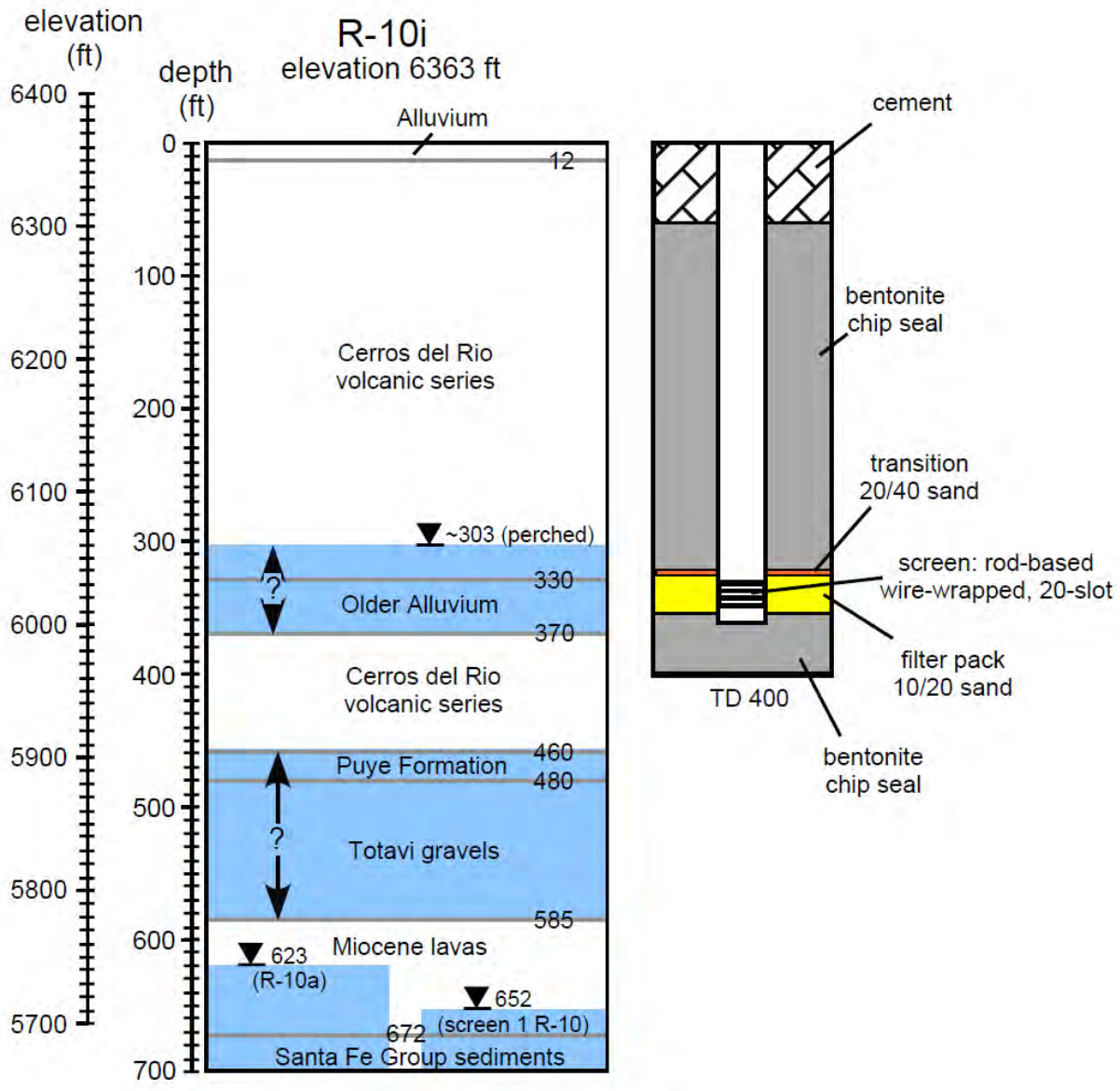


Figure 1 Proposed location for perched-intermediate well R-10i



Notes: Thicknesses and placements of perched intervals are schematic. Currently recorded depths to top of regional saturation are shown based on water-level data for wells R-10a and R-10.

Figure 2 Predicted geology and proposed well design for well R-10i