Drilling Work Plan for Regional Aquifer Well R-61

Primary Purpose	Regional aquifer well R-61 is being installed to monitor water quality in the regional aquifer and to help define the vertical and lateral extent of chromium contamination known to exist in the vicinity of wells R-28, R-42, and R-50, as required by the New Mexico Environment Department's (NMED's) Approval with Modification, Investigation Report for Sandia Canyon, Los Alamos National Laboratory, dated February 9, 2010 (NMED 2010, 108683). The proposed location for well R-61 is shown in Figure 1. The R-61 borehole is expected to penetrate the top of regional saturation at a depth of approximately 1103 ft within sedimentary deposits of the Puye Formation. The target borehole total depth (TD) is approximately 1265 ft (Figure 2). The well will be completed with two well screens. The upper well screen will be placed near the regional water table within the Puye Formation. The lower screen will target Miocene pumiceous sediments approximately 80 to 100 ft below the upper screen. Figure 2 shows the predicted geology and conceptual well design for well R-61. 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 driller's observations. A well design document will be submitted to NMED for approval.
Conceptual Model	Elevated chromium concentrations detected in the regional aquifer at wells R-28, R-42, and R-50 are attributed to releases that occurred in the headwaters of Sandia Canyon. The likely source of the chromium was steam plant effluent and cooling tower blowdown from the Technical Area 03 (TA-03) power plant. From 1956 to 1972, potassium dichromate was used as a corrosion inhibiter, and approximately 31,000 to 72,000 kg of hexavalent chromium [Cr(VI)] was released into upper Sandia Canyon. Surface water flow carried dissolved chromium downcanyon to the vicinity of SCI-1 and R-43 before infiltrating canyon-floor sediments and recharging perched-alluvial groundwater. Percolation of the contaminated alluvial groundwater into bedrock units of the vadose zone recharged perched-intermediate groundwater at wells SCI-1 and SCI-2 and eventually entered the regional aquifer. Dipping geologic surfaces diverted perched-intermediate groundwater southward, causing breakthrough in the regional aquifer near Mortandad Canyon. Based on regional aquifer water-table maps, the hydraulic gradient should generally transport the contaminants towards the east. However, advective transport of contaminants may be diverted to the southeast because of the dip of sedimentary strata making up the regional aquifer in this area. Under this conceptual model, the chromium concentrations detected at well R-50 are a result of southeastward contaminant transport in the regional aquifer from a relatively focused breakthrough location near R-42. The southeast direction of the contaminant transport may be the result of aquifer anisotropy and potentially also of infiltration mounding of the aquifer near R-42. The location of well R-61 is designed to define the western extent of the southerly flow path. Data from well R-61 will also be used in conjunction with information from other monitoring wells in the area to assess whether two distinct sources of chromium (from Sandia and Mortandad Canyons) are impacting the regional aquifer.
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 saturation. A combination of open-hole and casing-advance methods will be used. 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 or through 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 Los Alamos National Laboratory (LANL or 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 drilling fluids will be used within 100 ft of the regional aquifer, except potable municipal water. No chemicals, other than those listed above, will be added without approval from NMED.
Hydrogeologic and Geochemical Objectives	• The primary objective is to monitor water quality in the regional aquifer and to help define the vertical and lateral extent of chromium contamination known to exist in the vicinity of R-42 and R-50. • A secondary objective is to establish water levels and gradients in the regional aquifer in this area for water-table maps and thereby to enable optimization of the monitoring network. • Another secondary objective is to determine if perched-intermediate groundwater occurs beneath the mesa south of Mortandad Canyon. • A third secondary objective is to define the hydrostratigraphy of the site, characterizing rock units that can impact contaminant pathways in the vadose zone and the regional aquifer.
Potential Groundwater Occurrence and Detection	*Potential Perched Water:* Perched-intermediate groundwater may be encountered while drilling the R-61 borehole, but its presence cannot be predicted with certainty. Absence of perched water at MCOI-10 and R-50, and in boreholes east and southeast of R-42, suggests that perched water is unlikely at R-61. If perched groundwater is encountered, it may be necessary to seal off the zone before drilling ahead in order to prevent potentially contaminated perched groundwater from entering the regional aquifer. Decisions about sealing off perched zones will be made in the field after more information is available about whether the perched groundwater is present and productive. Perched-intermediate groundwater occurs within sedimentary deposits of the Puye Formation atop the Cerros del Rio volcanic series at wells SCI-1 and TA-53i in and north of Sandia Canyon and at wells MCOI-4 (near MCOBT-4.4) and MCOBT-4.4 in Mortandad Canyon (Figure 1). The saturated thickness of these perched zones ranges from a few feet to approximately 25 ft. Perched-intermediate groundwater occurs within fractured lavas and interflow breccias in the lower part of the Cerros del Rio volcanic series at well SCI-2 in Sandia Canyon and at wells MCOI-5, MCOI-6, and R-15 in Mortandad Canyon (Figure 1). The saturated thicknesses of these perched groundwater occurrences range between 20 and 110 ft. Perched groundwater was absent when core holes MCOBT-8.5 and MCOI-10 were drilled. Both core holes were drilled into the top of the Puye Formation beneath the Cerros del Rio volcanic series without encountering saturated conditions in any of the penetrated geologic units (Figure 1). Similarly, perched water was absent when regional aquifer wells R-28, R-44, R-45, and R-50 were drilled.

Potential Groundwater Occurrence and Detection (continued)	Well R-42 encountered perched groundwater in a thin (<5-ft) zone just below the Cerros del Rio volcanic series within sedimentary rocks of the Puye Formation. The zone was not productive, and open-hole drilling continued to the regional aquifer after sealing the perched zone off with bentonite. *Regional Groundwater:* Regional groundwater is expected to occur at a depth of 1103 ft within the Puye Formation. Methods for groundwater detection may include driller's observations, water-level measurements, borehole video, and borehole geophysics.
Core Sampling	No core collection is planned.
Perched Groundwater Screening Sampling	Groundwater screening samples will be collected during drilling if perched groundwater is encountered in the vadose zone and if such zones produce sufficient water for sampling. 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	Groundwater samples will be collected from the completed well between 10 and 60 d after well development, in accordance with the Compliance Order on Consent. These samples will be analyzed for the full suite of constituents including radionuclides, metals/cations, general inorganic chemicals, high explosives, volatile organic compounds, and stable isotopes. Subsequent groundwater samples will be collected under the Interim Facility-Wide Groundwater Monitoring Plan.
Geophysical Testing	The Laboratory's borehole video camera and natural gamma and induction tools will be used in the open borehole if conditions allow. A full suite of geophysical logs will be run, if required, for proper placement of the screens. The logs will be collected by Schlumberger, Inc., and for open-hole conditions 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 regional saturation and to characterize the hydraulic properties of saturated rocks in the regional aquifer. The geophysical logs will also be used to select the well-screen depths. The suites run and timing of geophysical logging will depend on borehole conditions.
Well Completion Design	Figure 2 shows the conceptual well design for well R-61.

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 the Laboratory is unable to bring the water-quality parameters within 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 the addition of 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 screens are within significant water-producing horizons. 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 will 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 "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 for 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-61 will be completed by March 30, 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)

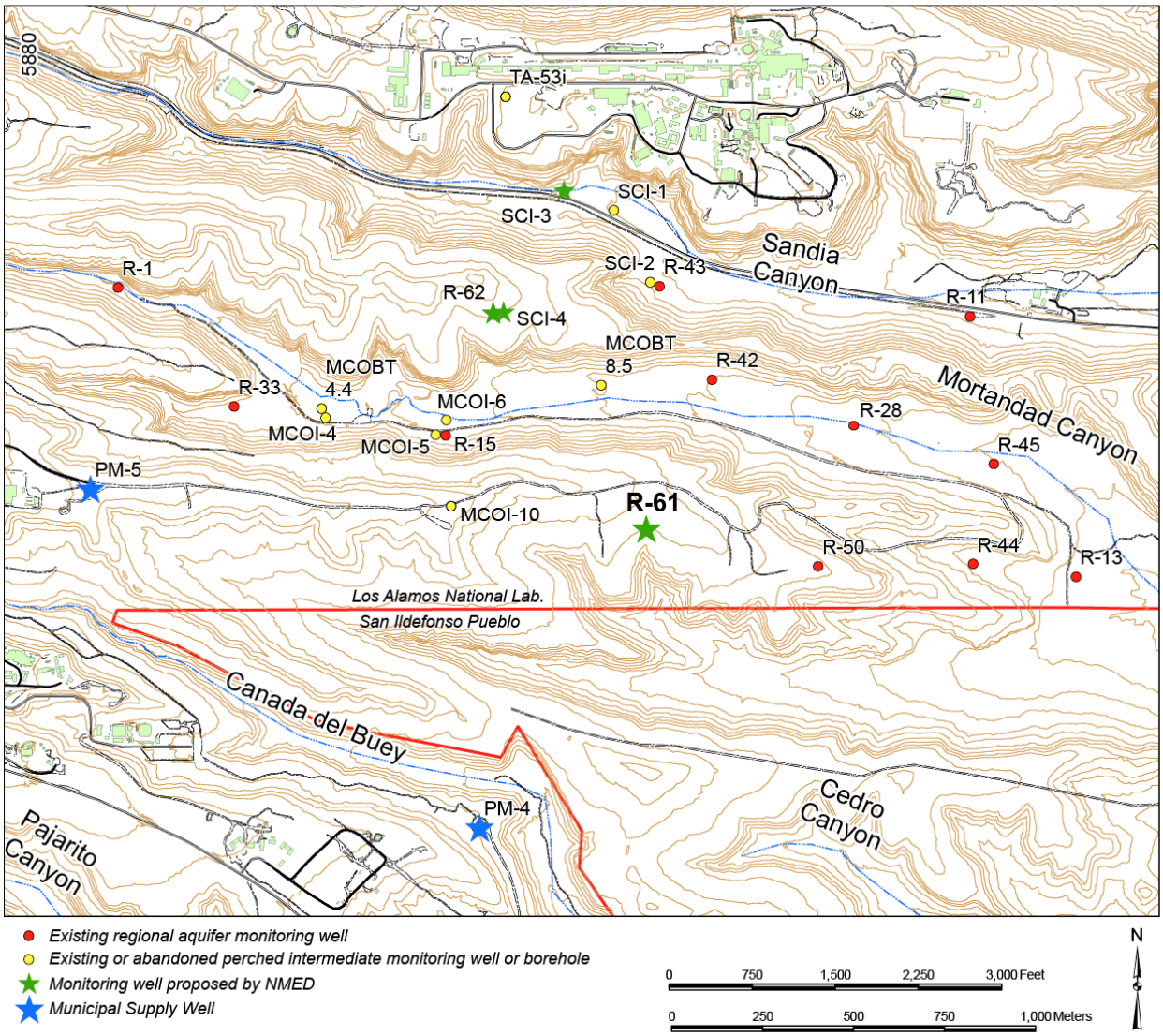

Figure 1 Proposed location for well R-61

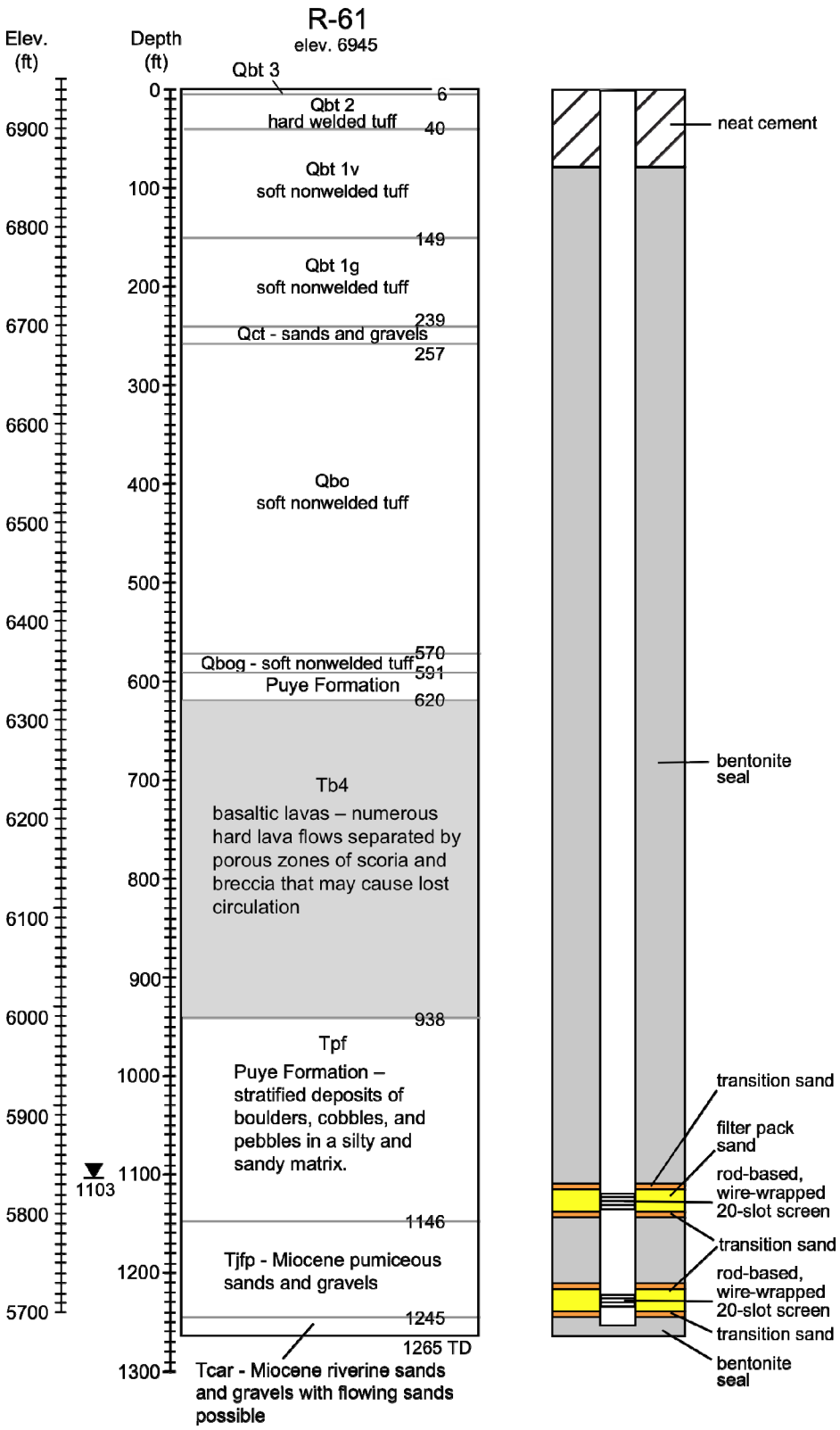

Figure 2 Predicted geology and conceptual well design for well R-61