Drilling Work Plan for Regional Aquifer Well R-60

Primary Purpose	Regional aquifer well R-60 is being installed to satisfy a requirement by the New Mexico Environment Department (NMED) to install two regional groundwater-monitoring wells downgradient of Material Disposal Area (MDA) C within Technical Area 50 (TA-50). The second monitoring well, R-59, is provisionally located southeast of MDA C, and its location will be refined after the water-level map for MDA C incorporates new information from R-60. The proposed locations for well R-60 and provisional well R-59 are shown in Figure 1. Wells R-60 and R-59 will supplement groundwater monitoring for MDA C provided by well R-46 (Figure 1). The R-60 borehole is expected to penetrate the top of regional saturation at a depth of approximately 1339 ft within sedimentary deposits of the Puye Formation. The target borehole depth is set at approximately 1410 ft. The well will be completed with a single screen set near the top of regional saturation (Figure 2). Well-screen length and position 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. Figure 2 shows the predicted geology and proposed well design for well R-60. A final well design will be based on hydrogeological conditions encountered during drilling, and a revised well-design document will be submitted to NMED for approval.
Conceptual Model	MDA C is located on a mesa top above thick, unsaturated units of the Bandelier Tuff, and present-day aqueous-phase transport is generally believed to be minimal. Because of the low expected infiltration rates, travel times for nonadsorbing aqueous-phase contaminants from the disposal area to the regional aquifer are expected to be greater than several hundred years and significantly longer for sorbing constituents. However, pore-gas sampling shows that vapor-phase transport of contaminants occurs in the upper portion of the unsaturated zone. The primary vapor-phase contaminants at MDA C are tritium, trichloroethene, and tetrachloroethene. A thick (~330 ft) series of dacitic lavas, probably derived from western Tschicoma sources, underlies the Bandelier Tuff. The top of the lava sequence may exert strong controls over travel times and directions for liquid transport. The dacitic lavas have very low permeability and will inhibit downward transport. The dip of the top of the unsaturated dacite lava is also important because pore water percolating to depth may accumulate in the Guaje Pumice Bed above the dacite and move laterally down the dip to the south before infiltrating into fractures. Groundwater flow in the regional aquifer is expected to be dominantly toward the east beneath TA-50. The water table beneath TA-50 occurs primarily within the lower Puye Formation or the upper pumiceous deposits of the Santa Fe Group. Contamination, if present at the R-60 location, is likely to be derived from MDA C and would be the result of contact with vapor-phase constituents.
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 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 or through significant perched groundwater intervals.

Potential Drilling Fluids, Composition, and Use	Fluids and additives that may be used to facilitate drilling are consistent with those previously used in the drilling program at Los Alamos National Laboratory (LANL) 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 borehole; and recovery volume of drilling fluid. No drilling fluids will be used within 100 ft of the regional aquifer except potable municipal water. If the regional aquifer cannot be reached without adding drilling fluids, the situation will be discussed with NMED. 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 downgradient of potential hazardous- or radioactive-chemical releases from MDA C. • A secondary objective is to establish water levels in the regional aquifer in this area for water table maps. • An additional secondary objective is to determine if perched-intermediate groundwater occurs in the vicinity of MDA C. This secondary objective will be addressed to the extent possible, but drilling methods will be optimized to accomplish the primary objective.
Potential Groundwater Occurrence and Detection	*Potential Perched Water:* In Pajarito Canyon, located south of MDA C, perched groundwater was found in the Puye Formation overlying the dacite lavas at wells R-17 and PCI-2. Small pockets of saturation may occur above the dacite lavas near MDA C, but perched groundwater was not found in four deep mesa-top boreholes near MDA C (R-46, 50-24813, 50-603470, and DSC-1B). Perched groundwater may occur above permeability barriers within the stratified deposits of the Puye Formation. Drilling will be halted at a depth of 1239 ft, approximately 100 ft above the regional aquifer, to evaluate whether perched groundwater occurs above or within the dacite lavas or within the Puye Formation. *Regional:* The regional groundwater is expected to occur at a depth of 1339 ft within sedimentary deposits of the Puye Formation. Methods for groundwater detection may include drillers' observations, water-level measurements, borehole video, and borehole geophysics.
Core Sampling	No core collection is planned.
Groundwater Screening Sampling	Groundwater screening samples will be collected during drilling at any perched groundwater zones producing sufficient water for sampling. Screening samples of 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 and volatile organic compounds (VOCs) by off-site laboratories.

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 radiochemistry, metals/cations, general inorganic chemicals, high explosives, VOCs, and stable isotopes. Subsequent groundwater samples will be collected under the Interim Facility-Wide Groundwater Monitoring Plan (IFGMP).
Geophysical Testing	LANL's borehole video camera, 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 screen. 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 microimager 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 characterize the hydraulic properties of saturated rocks in the regional aquifer. The suite and timing of geophysical logging will depend on borehole conditions.
Well Completion Design	The well screen will be placed within volcaniclastic deposits of the Puye Formation near the top of the regional aquifer. Figure 2 shows the proposed well design and predicted geology for well R-60.
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 clays, 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 LANL is unable to bring the water-quality parameters to measure within the limits specified below, the use of chemical well development may be discussed with NMED. No chemicals will be added without approval from NMED. • Chemical means that may be used include sodium acid pyrophosphate and AQUA-CLEAR PFD to remove clays, 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 less than 5 nephelometric turbidity units, TOC less than 2 ppm, and other parameters stable.
Hydraulic Testing	Hydraulic testing will be considered if significant water-producing horizons are encountered. The most likely test will be a 24-h, constant-rate test.

Investigation-Derived Waste Management	Investigation-derived waste (IDW) will be managed in accordance with Standard Operating Procedure (SOP) EP-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 LANL requirements. The primary waste streams include drill cuttings, drilling water, development water, purge water, decontamination water, and contact waste. Where Resource Conservation and Recovery Act constituents are detected and duplicate samples are collected during the same sampling event and one is a nondetect and the other is detected, LANL assumes the detection is the result of laboratory or field contamination. The detection will not be used for waste determination and/or land application. 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 (March 2010). 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-60 is proposed for completion by October 31, 2010. Monitoring conducted after installation of R-60 will be implemented under the IFGMP and will support investigations and potential corrective actions at MDA C and other sites in the vicinity, as applicable.

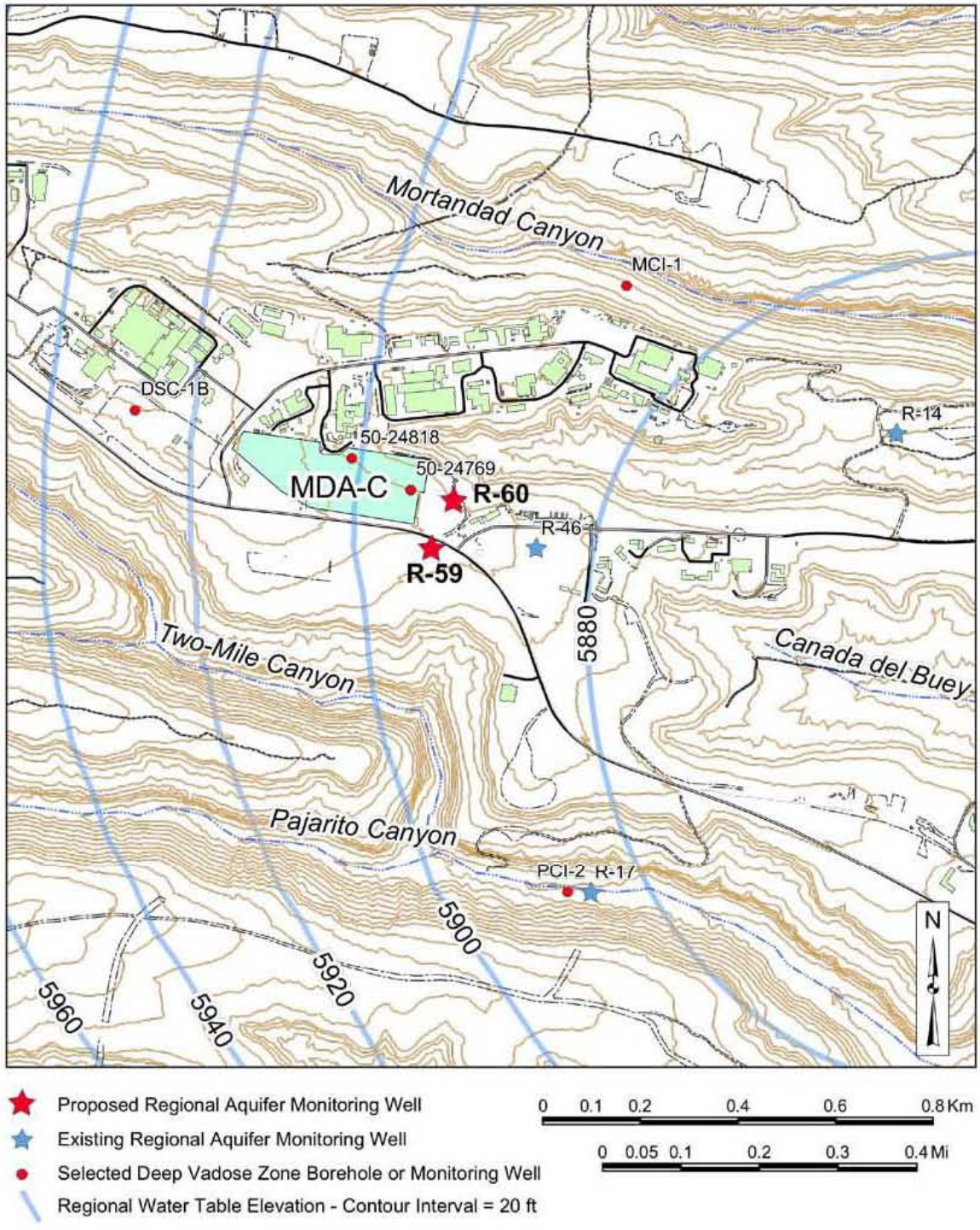

Figure 1 Location of R-60. Provisional location of R-59 is also shown.

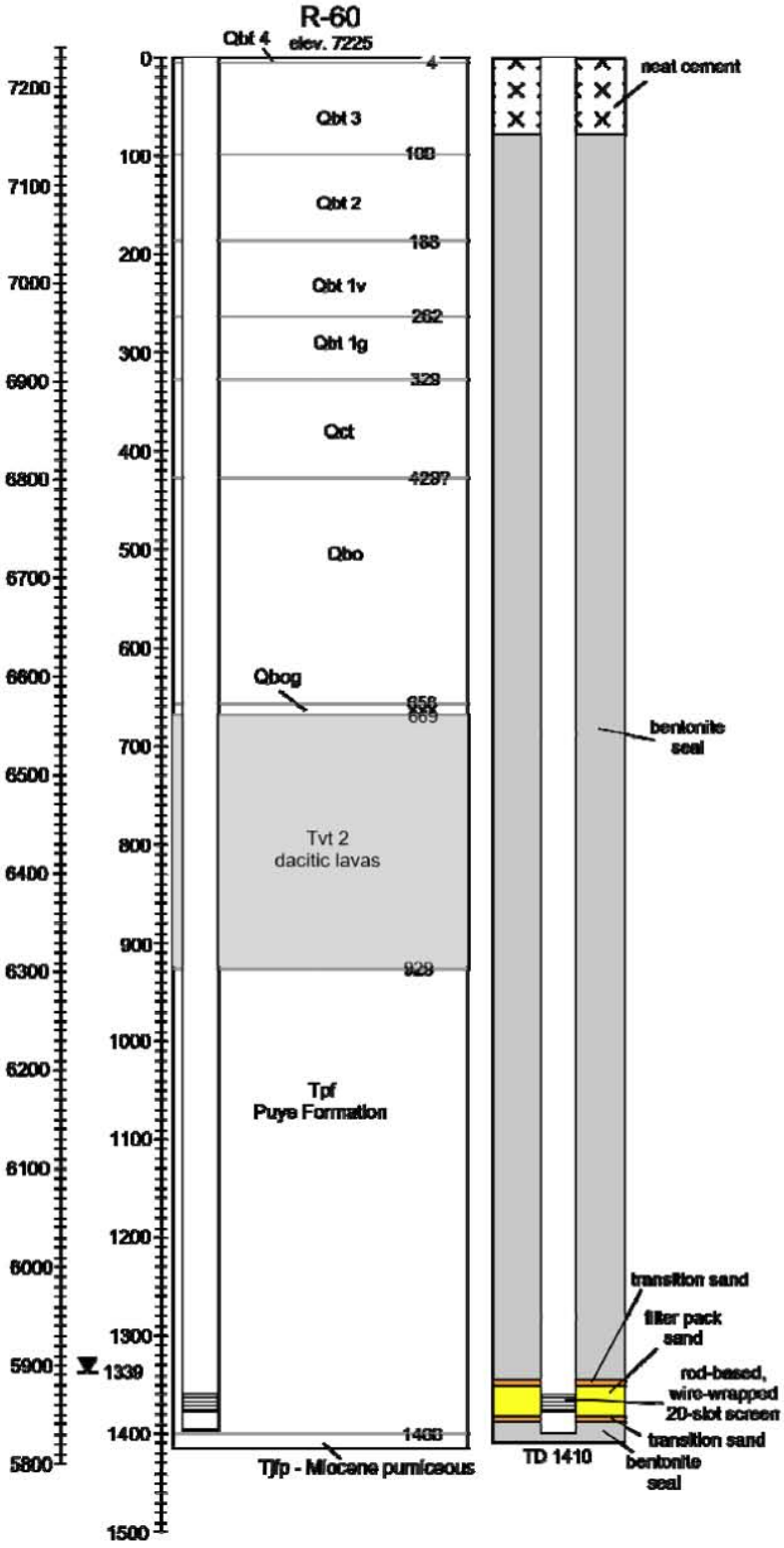

Figure 2 Predicted geology and proposed well design for well R-60