Drilling Work Plan for Well CdV-16-3(i)

Primary Purpose	Well CdV-16-3(i) will be installed in an existing borehole approximately 1800 ft southeast of well R-25 (Broxton et al. 2002, 072640). Figure 1 shows the locations of R-25, CdV-16-3(i), and other wells and boreholes associated with Consolidated Unit 16-021(c)-99 (aka the 260 Outfall) groundwater investigations. The purpose of well CdV-16-3(i) is to enhance the Technical Area (TA) 16 monitoring well network by providing a regional aquifer well to the southeast of the 260 Outfall and northeast of S-Site Canyon. The planned screened interval for CdV-16-3(i) will be in the uppermost producing zone in the regional aquifer within the Tschicoma dacites at the proposed drilling location. Currently, the CdV-16-3(i) borehole extends to a depth of 1405 ft and is within massive, nonproducing Tschicoma dacites. The existing borehole will be deepened an additional 300 ft to locate more permeable strata within the dacite lavas or in underlying sedimentary deposits. The proposed approach is to advance the borehole from its current depth of 1405 ft to 1700 ft in 100-ft increments. Observations of water production and geophysical measurements will be used to determine if a producing zone is encountered. Once such a zone is located, a single-screen well will be installed in a producing zone. If no producing zones are encountered by 1700 ft, New Mexico Environment Department (NMED) representatives will be contacted to determine a path forward. Figure 2 shows the stratigraphy of CdV-16-3(i) and the proposed well design. Figure 3 is a geologic cross-section showing the distribution of hydrostratigraphic units in the vicinity of well CdV-16-3(i) and the predicted geology at this location.
Conceptual Model	The Tschicoma dacites consist of a heterogeneous mix of low-porosity massive flow interiors and higher-porosity fracture and rubble zones. The former are probably aquitards, and the latter may be more productive parts of the aquifer. It is more likely that significant contaminant fluxes are transmitted through the more permeable zones, so these are the key locations to monitor.
Drilling Approach	Drilling will be conducted using methods selected to optimize the potential of completing the well without using any drilling additives in the zone of saturation. Specifically, efforts will be made to meet the target depth of approximately 1700 ft below ground surface (bgs) and to provide a stable borehole environment for constructing the well. The primary method for advancing the borehole will be a combination of open-hole air-rotary and casing-advance with air-rotary. The following is a summary of the proposed methods by depth interval. • A 12.25-in. open borehole exists to 1405 ft. • A 10-in. casing will be advanced to the target depth of 1700 ft attempting not to use drilling fluid additives. If the well cannot be completed without using drilling fluids within the regional aquifer, NMED will be consulted and a modified drilling strategy will be developed. Municipal water may be added to cool the drill bit.
Potential Drilling Fluids, Composition, and Use	The following fluids and additives that may be used are consistent with those previously used in the drilling program at Los Alamos National Laboratory (the Laboratory) and have been characterized geochemically: • potable water from the municipal water supply to aid in delivery of other drilling additives • QUIK-FOAM, a blend of alcohol ethoxy sulfates, to be used as a foaming agent • AQF-2, an anionic surfactant, to be used as a foaming agent During the initial phase of drilling this borehole, the following fluids were used: • 48 gal. of QUIK FOAM • 14 gal. of EZ-MUD
Geochemical Objective	The geochemical objective is to provide a groundwater sampling point free of drilling-fluid effects within the regional aquifer.

Potential Groundwater Occurrence and Detection	Observations during the drilling of CdV-16-3(i) indicated extremely low influx of water at total depth. The borehole was allowed to recharge and was bailed several times between 2004 and 2006 to determine if water collecting in the borehole represented regional groundwater. Following bailing, the water level always recovered to a depth of approximately 1350 ft (see Figures 2 and 3). Based on the local water table map, it is hypothesized that this is the top of the regional aquifer.
Core Sampling	Core sampling is not proposed for CdV-16-3(i).
Groundwater Screening Sampling	A screening water sample will be collected from the screened interval following well development. The screening sample will be analyzed by the Earth and Environmental Sciences Group chemistry laboratory for cations/metals (dissolved and total), anions (dissolved), and select high explosives (HE) compounds (total).
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 TA-16-related constituents, including tritium; metals/cations; general inorganic chemicals; volatile organic compounds; semivolatile organic compounds; HE compounds, including RDX (research department explosives [hexahydro-1,3,5-trinitro-1,3,5-triazine]) and related degradation products; and stable isotopes. Subsequent groundwater samples will be collected under the “Interim Facility-Wide Groundwater Monitoring Plan” (LANL 2005, 088789).
Geophysical Testing	The Laboratory’s borehole video camera, natural gamma, and induction tools will be used if open-hole conditions allow logging in the CdV-16-3(i) borehole before each casing string is introduced. If borehole conditions are stable and allow open hole geophysics, the 10-in. casing will be pulled back from total depth to expose the entire saturated interval for borehole logging by Schlumberger tools.
Well Completion Design	The proposed well design is shown in Figure 2. This figure assumes that a producing zone is found at a depth of 1500 ft.
Well Development	The well may be developed by both mechanical and chemical means. Mechanical means include swabbing, bailing, and pumping. Chemical means include using sodium acid pyrophosphate or AQUA-CLEAR PFD to remove natural and added clays and/or chlorination to kill bacteria introduced during well completion. Chemical means will only be used after additional discussions with, and approval by, NMED. After initial swabbing and bailing, the well will be pumped to complete the development. Water-quality parameters to be monitored are as follows: pH, specific conductance, temperature, turbidity, and total organic carbon (TOC), and acetone or ethylene glycol, as applicable. Target water-quality parameters are as follows: turbidity <5 nephelometric turbidity units, TOC <2 parts per million, other parameters stable.
Hydraulic Testing	A single-step pumping test, injection/straddle-packer test, or slug test will be conducted in the well screen.

Investigation-Derived Waste (IDW) Management	All waste water produced during drilling will be managed and disposed of in accordance with the NMED-approved Notice of Intent (NOI) Decision Tree: Drilling, Development, Rehabilitation, and Sampling Purge Water (November 2006). Cuttings produced during drilling will be containerized or stored in lined pits and managed and disposed of in accordance with the NMED-approved NOI Decision Tree: Land Application of IDW Solids from Construction of Wells and Boreholes (November 2006). All wastes , such as contaminated personal protective equipment, disposable sampling equipment, decontamination waste, or other materials contaminated by drilling activities, will be characterized and managed in accordance with the associated waste characterization strategy forms and Standard Operating Procedure 5022, Characterization and Management of Environmental Restoration (ER) Project Waste.
Tentative Drilling Schedule	The following are activities and durations at well CdV-16-3(i): • Drilling and completion of borehole (including mobilization and site preparation): 45 d • Collection of borehole geophysical data: 2 d • Development of CdV-16-3(i): 5 d • Characterization sampling of CdV-16-3(i): 10 to 60 d (following development) • Site restoration at CdV-16-3(i): 7 d The proposed start date for drilling activities is January 1, 2009, contingent on funding availability.

REFERENCES

The following list includes all documents cited in this plan. 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 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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.

Broxton, D., R. Warren, P. Longmire, R. Gilkeson, S. Johnson, D. Rogers, W. Stone, B. Newman, M. Everett, D. Vaniman, S. McLin, J. Skalski, and D. Larssen, March 2002. "Characterization Well R-25 Completion Report," Los Alamos National Laboratory report LA-13909-MS, Los Alamos, New Mexico. (Broxton et al. 2002, 072640)

Broxton, D.E., and D.T. Vaniman, August 2005. "Geologic Framework of a Groundwater System on the Margin of a Rift Basin, Pajarito Plateau, North-Central New Mexico," *Vadose Zone Journal,* Vol. 4, No. 3, pp. 522–550. (Broxton and Vaniman 2005, 090038)

LANL (Los Alamos National Laboratory), May 2005. "Interim Facility-Wide Groundwater Monitoring Plan," Los Alamos National Laboratory document LA-UR-05-3443, Los Alamos, New Mexico. (LANL 2005, 088789)

Lewis, C.J., A. Lavine, S.L. Reneau, J.N. Gardner, R. Channell, and C.W. Criswell, December 2002. "Geology of the Western Part of Los Alamos National Laboratory (TA-3 to TA-16), Rio Grand Rift, New Mexico," Los Alamos National Laboratory report LA-13960-MS, Los Alamos, New Mexico. (Lewis et al. 2002, 073785)

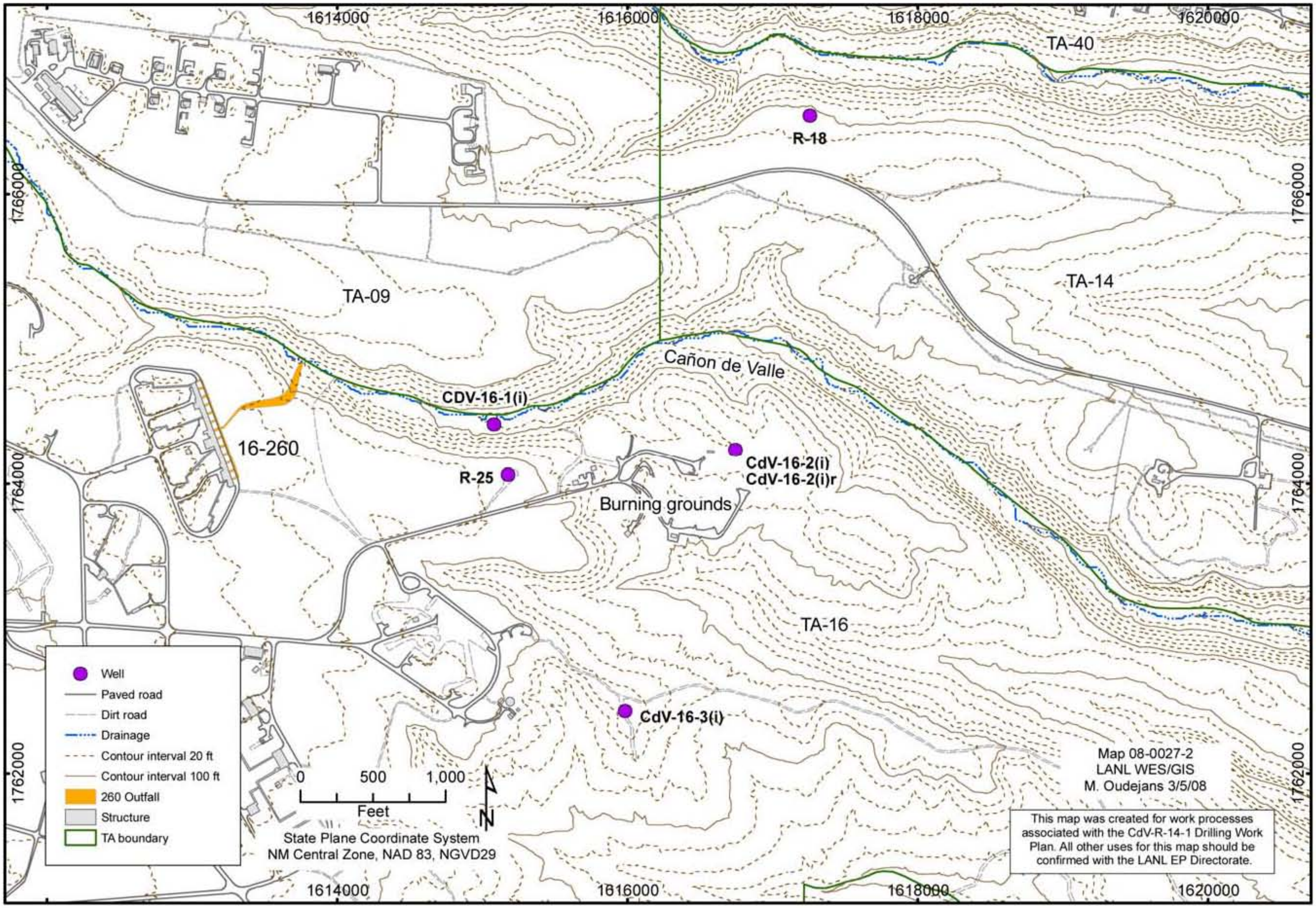
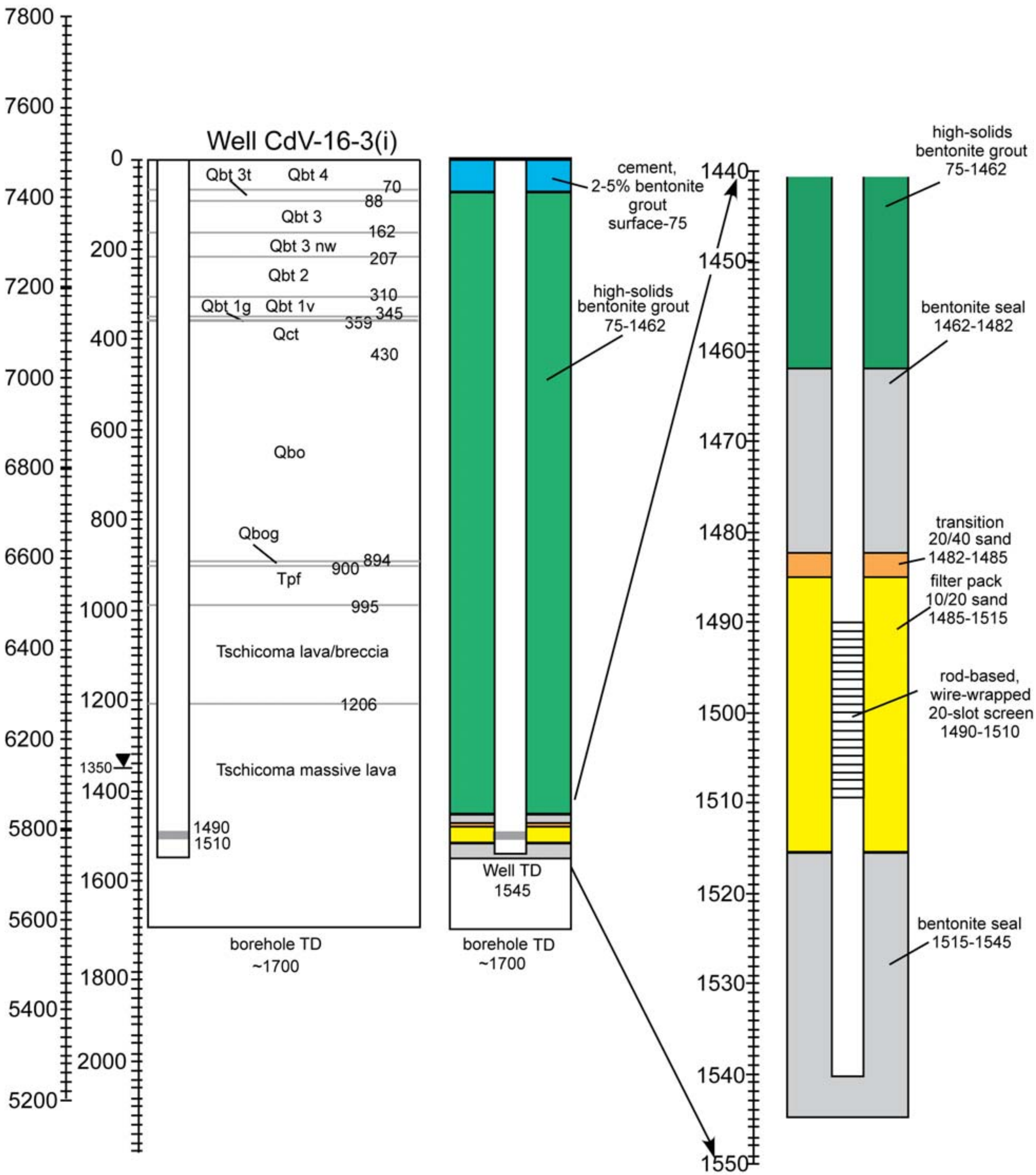
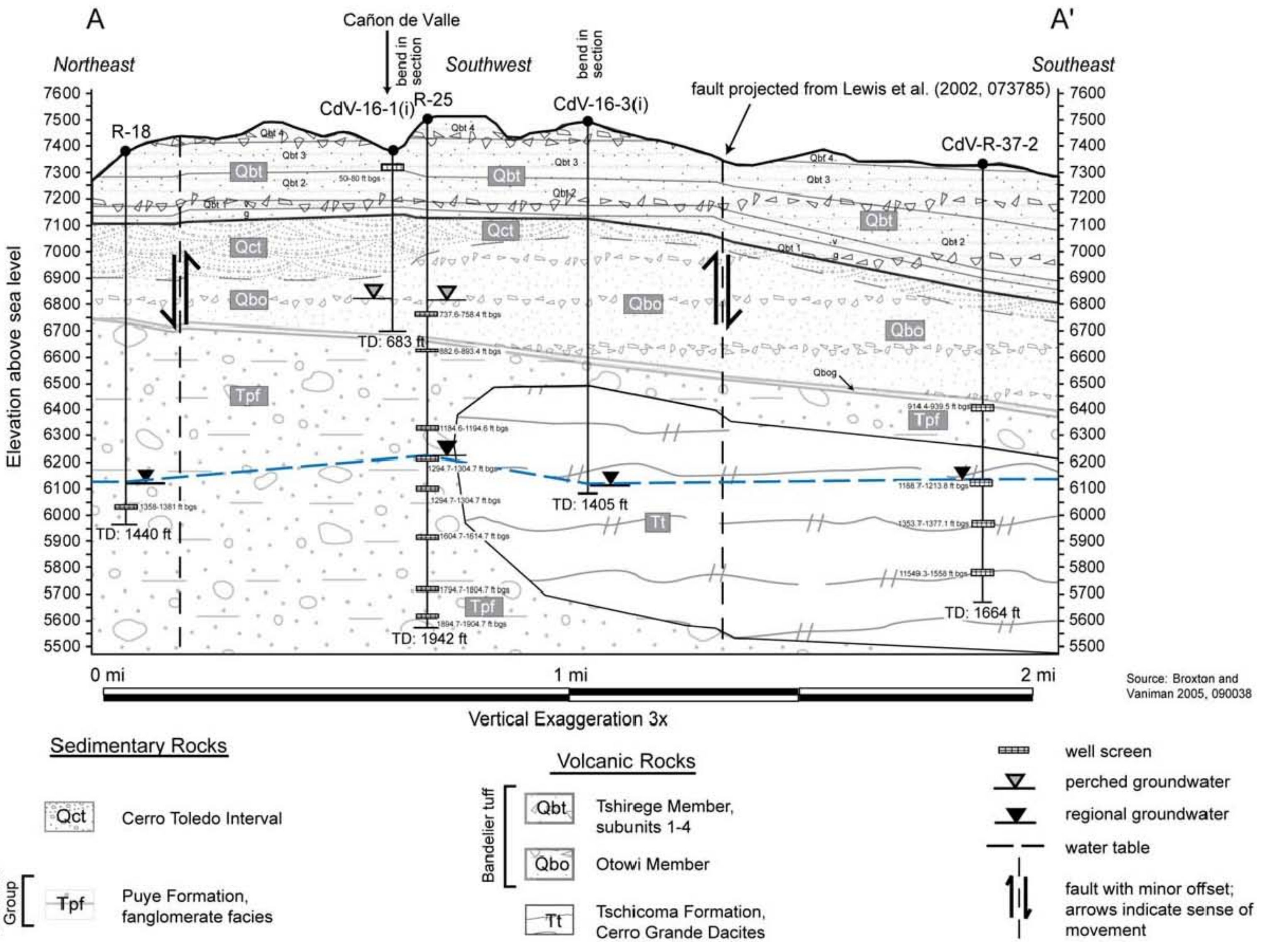


Figure 1 **Proposed location of CdV-16-3(i) relative to R-25 and other TA-16 monitoring wells**



Notes: Qbt = unit 4, 3t, 3, 2, 1v, or 1g of the Tshirege Member of the Bandelier Tuff; Qbtt = Tsankawi Pumice of the Tshirege Member; Qct = Cerro Toledo Interval; Qbo = Otowi Member of the Bandelier Tuff; Qbog = Guaje Pumice of the Otowi Member of the Bandelier Tuff; Tpf = Puye Formation; TD = total depth.

Figure 2 Proposed well design for CdV-16-3(i) in relation to local stratigraphy



Notes: Dashed blue line indicates possible top of regional saturation. Numbers indicate well screens in multiscreen wells. Perched groundwater (?) is shown as a continuous zone of saturation intersecting R-25 and CdV-16-1(i); however, other interpretations about the distribution of groundwater are possible.

Figure 3 Geologic cross-section of the well CdV-16-3(i) area