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John Kieling, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Drilling Work Plan for Groundwater Injection Well CrIN-6

Dear Mr. Kieling:

Enclosed please find two hard copies with electronic files of the Drilling Work Plan for Groundwater Injection Well CrIN-6.

This submittal fulfills the requirement of the January 22, 2016, New Mexico Environment Department Approval with Modifications Drilling Work Plan for Chromium Plume Control Interim Measure and Plume-Center Characterization Injection Wells CrIN-1 through CrIN-6, to propose a new location for CrIN-6 by December 30, 2016.

If you have any questions, please contact Stephani Swickley at (505) 606-1628 (sfuller@lanl.gov) or Cheryl Rodriguez at (505) 665-5330 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Bruce Robinson, Program Director
Environmental Remediation Program
Los Alamos National Laboratory

Sincerely,

for

David S. Rhodes, Director
Office of Quality and Regulatory Compliance
Environmental Management
Los Alamos Field Office

BR/DH/SS:sm

Enclosures: Two hard copies with electronic files – Drilling Work Plan for Groundwater Injection Well CrIN-6 (EP2016-0157)

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Drilling Work Plan for Groundwater Injection Well CrIN-6

Primary Purpose	In accordance with the New Mexico Environment Department's (NMED's) approval with modifications for the interim measures work plan for chromium plume control, dated October 15, 2015 (NMED 2015, 600958), Los Alamos National Laboratory (LANL or the Laboratory) proposes the following drilling and preliminary design information for injection well CrIN-6. As stated in the May 2015 Interim Measures Work Plan for Chromium Plume Control (hereafter, the IMWP) (LANL 2015, 600615), the primary purpose of the interim measures strategy is to achieve hydraulic control of off-site plume migration. Plume control would be implemented using a method of hydraulic capture that uses existing extraction well CrEX-1 and a potential second extraction well, CrEX-2, in conjunction with a configuration of the injection wells to control the migration of chromium-contaminated groundwater. Existing extraction well CrEX-3 may provide additional hydraulic control while serving as a test well for plume-center characterization. Six injection wells were proposed in the IMWP to support plume control and provide operational flexibility during maintenance downtime. Five of the injection wells are in place. This drilling work plan is in response to the Approval with Modifications Drilling Work Plan for Chromium Plume Control Interim Measure and Plume-Center Characterization Injection Wells CrIN-1 through CrIN-6 (NMED 2016, 601158), which requires a relocation of injection well CrIN-6, with a proposed new location by December 30, 2016. The proposed target location for CrIN-6 and the location of the existing five injection wells are shown in Figure 1. Modeling results indicate the potential for a preferential migration pathway north of CrEX-1 and south of R-11 (Figure 1). Extraction well CrEX-3 may provide hydraulic capture for chromium migrating along that pathway; however, additional plume control may be gained by having an injection well downgradient within the area shown by models as being a possible pathway. There is uncertainty with respect to chromium migration in that area, so samples will be collected from CrIN-6 to provide data on chromium (and other constituent) concentrations before the injection well is operational. The CrIN-6 injection well will be completed with a screen in the upper portion of the regional aquifer. Data from existing monitoring wells and from the core hole drilling campaign indicate contamination is predominantly within the upper 50 ft of the aquifer; therefore, the injection-well screen will be targeted for that interval. Specific hydraulic performance will vary between injection wells depending on the geology encountered, but the basic assumption is that injection wells will be able to accept injection rates comparable with the rates of extraction. Because of terrain constraints, angled drilling will be used to achieve the target location in the aquifer for CrIN-6. Angled drilling will use the existing CrIN-1 well pad. A typical injection well design is shown in Figure 2. The initial design for the injection well consists of an 8-in.-diameter casing with a 40-slot screen placed within the top 50 to 80 ft of the regional aquifer. Final design will be based on data obtained during drilling, including information from lithologic logs of cuttings, water-level measurements, video logs, geophysical logs, and field team observations. Well-design recommendations will be submitted to NMED for approval before construction.
Drilling Approach	The proposed drilling approach for the injection well will use fluid-assisted air-rotary with casing-advance methods. Telescoping casing sizes between 40 in. and 14 in. and dual-rotary methods will be used to advance the borehole to a depth within the upper 100 ft of the regional aquifer. This approach will produce a borehole that can accommodate an approximately 3-in. annular filter pack around the 8-in. well screen.

Drilling Fluids, Composition, and Use	Fluids and additives will be used to facilitate drilling and may include those previously authorized for use by NMED, including the following: • Potable water, municipal water supply, to aid in delivery of other drilling additives and to cool the drill bit; • QUIK-FOAM, a blend of alcohol ethoxy sulfates, used as a foaming agent to lift cuttings; • AQF-2, an anionic surfactant, used as a foaming agent to lift cuttings; and • EZ-MUD, a polymer emulsion to help improve the carrying capacity of air/foam injection fluids. Complete records will be maintained detailing the type, amount, and volume of fluid and additives used and the depth at which fluids or additives were added to the borehole.
Geophysical Testing	Geophysical logs may be collected when the borehole has been drilled to total depth. The suite of geophysical logs will depend on conditions in the borehole and whether logs are run in an open hole or inside the casing. Logging data will be used to refine estimates of the top of regional saturation and to characterize the hydraulic properties of saturated strata beneath the water table. Location surveys will be made for the angled borehole at several points during drilling (e.g., just below the top of basalt and at prescribed depths within the basalt) to ensure aquifer intersection targets are met.
Well Completion Design	Figure 2 shows a conceptual well design for an angled injection well. Screen placement and length will depend upon the geophysical logs, water levels, and field observations. A proposed well design will be submitted to NMED for approval before well construction.
Well Development	The well will be developed by mechanical means, and chemical means will be used only if necessary. Mechanical development includes swabbing, bailing, jetting/air-lifting, and pumping. Chemical methods may include chemicals to disperse bentonite, which is used as annular seal, or other methods. Additionally, sodium hypochlorite will be used to disinfect the well at the conclusion of well-development activities. Chemicals that may be used to aid in the development and disinfection of the well screen and filter pack include the following: • Sodium hypochlorite and • AQUA-CLEAR PFD. Water-quality parameters will be measured in a flow-through cell during the pumping phase of development. The parameters to be monitored are pH, specific conductance, dissolved oxygen, temperature, turbidity, and oxidation-reduction potential. Samples will be collected daily for total organic carbon (TOC) and analyzed at the Laboratory's Geology and Geochemistry Research Laboratory. Well development will be considered complete when target water-quality parameters are met, sand content averages less than 5 mg/L over a 2-h pumping period, and specific capacity no longer increases. The target water-quality parameters are turbidity <5 nephelometric turbidity units, TOC <2 ppm, and other parameters stable.
Hydraulic Testing	Step-drawdown tests will be conducted on the well to determine the sustainable yield. Constant rate testing will also be conducted to assess near-well aquifer characteristics. Following the pumping phase of testing, step-injection tests may be conducted using treated groundwater to obtain information about water-level responses in the injection well. Data from these tests will provide substantial additional information to refine the knowledge of the hydrology at the location and will also be used to select the initial injection rates to meet project objectives.

Water-Quality Sampling	The injection well will be sampled for metals, general inorganics, and tritium after completion of the pumping phase of hydraulic testing. These sampling data will provide additional information to reduce uncertainties of chromium and related contaminants' concentrations at the location and will further characterize the downgradient portion of the plume.
Injection/Pumping System Installation and Operational Practice	An injection and pumping system will be designed and installed in the well. The system will be capable of delivering water to the screen interval during injection and pumping water from the screen interval for periodic well maintenance. Water injection will be managed with a flow-control valve. Flow-control valves provide controlled, noncavitating head loss from the column (supply) pipe. Because of the design of the flow-control valve and its submerged position in the well, injected water will enter the well under low-pressure gravity feed. The flow-control valve also includes a lower check valve that will allow pumping with a single column pipe. The injection well may require pumping, or back-flushing periodically to prevent and/or remedy well-screen plugging. A submersible pump will be installed inside a pump shroud beneath the flow-control valve. Because the pump will likely be located within the screen interval, a pump shroud will be used to ensure adequate pump motor cooling. The pump is anticipated to be a 6-in. model from the Grundfos 85S family.
Investigation-Derived Waste Management	Investigation-derived waste (IDW) will be managed in accordance with Standard Operating Procedure (SOP) 10021, Characterization and Management of Environmental Program Waste (http://www.lanl.gov/community-environment/environmental-stewardship/plans-procedures.php). 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, drilling fluids and additives, development water, purge water generated during hydraulic testing, decontamination water, and contact waste. Drill cuttings will be managed in accordance with the NMED-approved Decision Tree for the Land Application of Drill Cuttings (April 2016). Drilling, purge, and development waters will be managed in accordance with the NMED-approved Decision Tree for Land Application of Groundwater (November 2016). Initially, drill cuttings and drilling fluids will be stored in a lined pit. Representative samples of the drill cuttings and drilling fluids will be collected and analyzed, 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. Decontamination water will be containerized separately at the 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 or the media with which it came in contact. Water generated from future injection well maintenance activities will be managed with applicable permits.
Schedule	The drilling and installation of the injection well is anticipated to start in the spring of 2017 and be completed by the summer of 2017.

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 or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

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

LANL (Los Alamos National Laboratory), July 2015. "Work Plan for Chromium Plume Center Characterization," Los Alamos National Laboratory document LA-UR-15-24861, Los Alamos, New Mexico. (LANL 2015, 600615)

NMED (New Mexico Environment Department), October 15, 2015. "Approval with Modifications, Work Plan for Chromium Plume Center Characterization," New Mexico Environment Department letter to D. Hintze (DOE-NA-LA) and M. Brandt (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2015, 600958)

NMED (New Mexico Environment Department), January 22, 2016. "Approval with Modifications, Drilling Work Plan for Chromium Plume Control Interim Measure and Plume-Center Characterization Injection Wells CrIN-1 through CrIN-6," New Mexico Environment Department letter to D. Hintze (DOE-EM-LA) and M. Brandt (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2016, 601158)

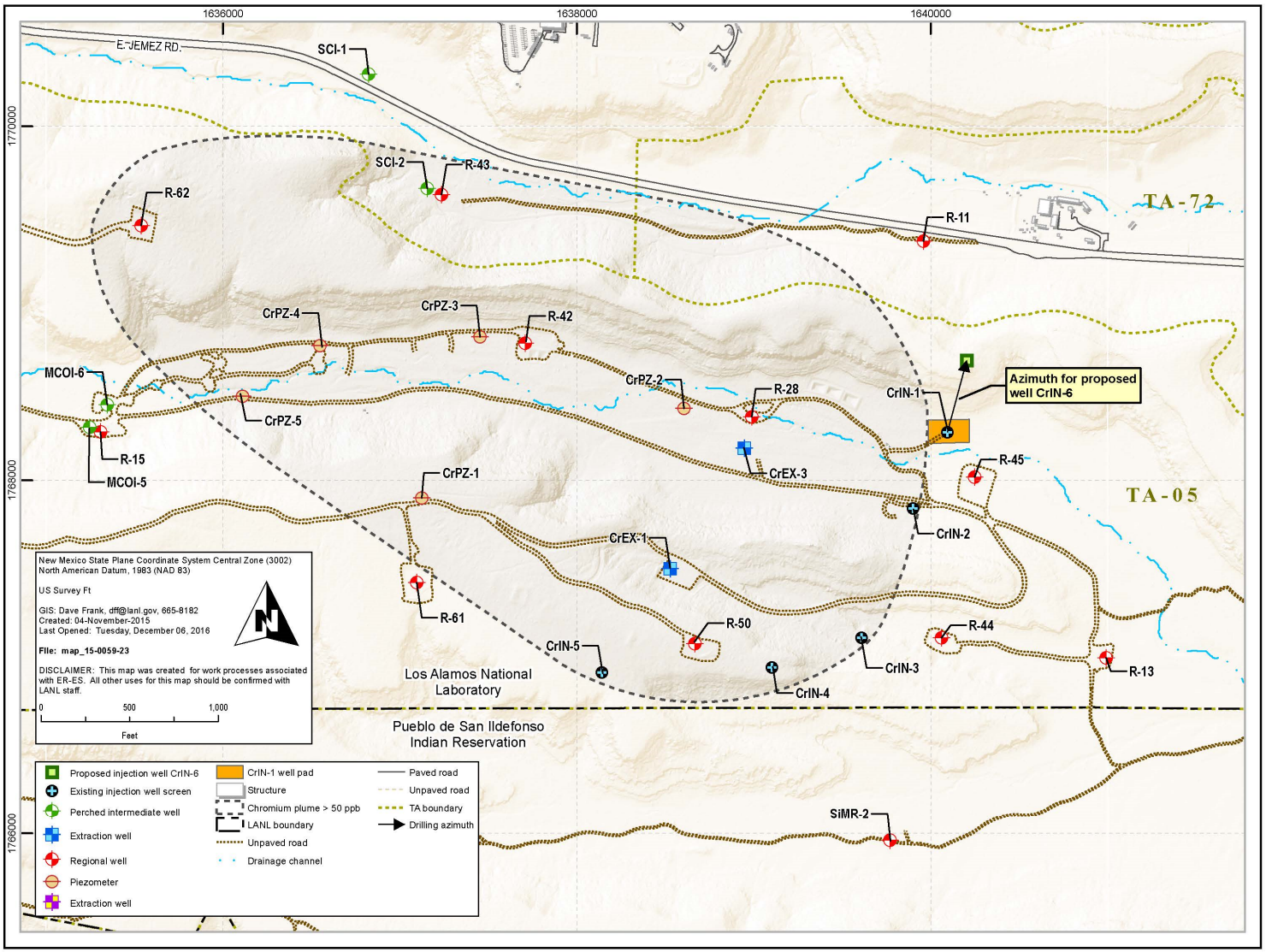

Figure 1 Proposed location for CrIN-6

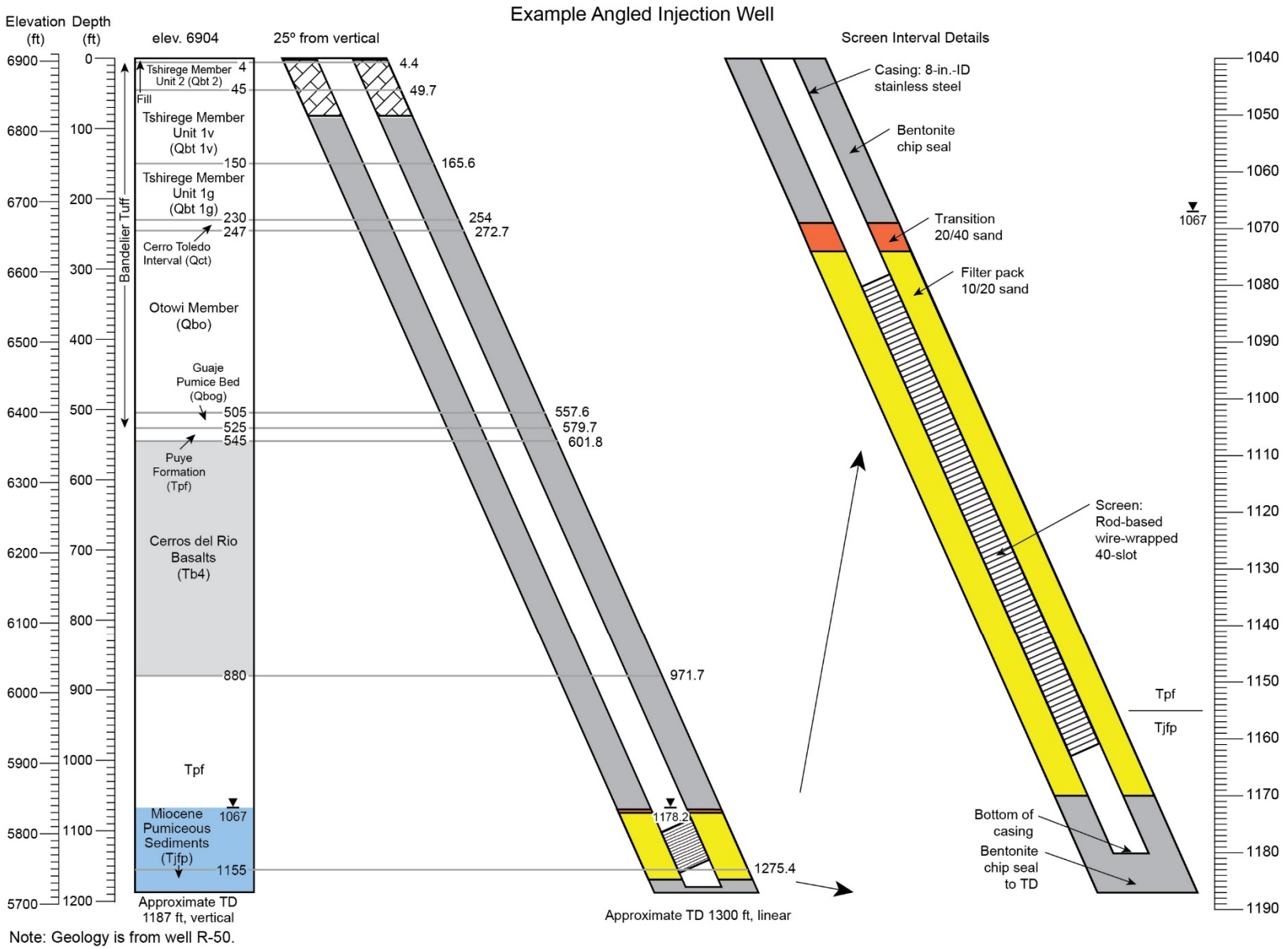

Figure 2 Conceptual well design for angled injection well