OS

RECEIVED

JUL 28

NMED
Hazardous Waste Bureau

Los Alamos
NATIONAL LABORATORY
EST. 1943

Associate Director for ESH
Environment, Safety, and Health
P.O. Box 1663, MS K491
Los Alamos, New Mexico 87545
505-667-4218/Fax 505-665-3811

Environmental Management
Los Alamos Field Office, MS A316
3747 West Jemez Road
Los Alamos, New Mexico 87544
(505) 665-5658/FAX (505) 606-2132

Date: JUL 28 2015
Refer To: ADESH-15-102
LAUR: 15-24861
Locates Action No.: N/A

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

Subject: Submittal of the Work Plan for Chromium Plume Center Characterization

Dear Mr. Kieling:

Enclosed please find two hard copies with electronic files of the Work Plan for Chromium Plume Center Characterization. This work plan describes proposed activities to be conducted by Los Alamos National Laboratory (the Laboratory) to further investigate the aquifer in the area of highest known concentrations (center) of the chromium plume and to further characterize the nature and extent of chromium (and related) contamination.

Because the Laboratory seeks to implement this work as soon as applicable permits and reviews are in place, we would like to meet with New Mexico Environment Department personnel to discuss the scope and answer any questions you may have.

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,

Alison M. Dorries, Division Leader
Environmental Protection Division
Los Alamos National Laboratory

Sincerely,

Christine Gelles, Acting Manager
Environmental Management
Los Alamos Field Office

37208

AD/CG/BR/SS:sm

Enclosures: Two hard copies with electronic files – Work Plan for Chromium Plume Center Characterization (EP2015-0127)

Cy: (w/enc.)
Cheryl Rodriguez, DOE-EM-LA, MS A316
Stephani Swickley, ADEP ER Program, MS M992
Public Reading Room (EPRR)
ADESH Records

Cy: (Letter and CD and/or DVD)
Laurie King, EPA Region 6, Dallas, TX
Raymond Martinez, San Ildefonso Pueblo
Dino Chavarria, Santa Clara Pueblo
Steve Yanicak, NMED-DOE-OB, MS M894
Danny Katzman, ADEP ER Program (w/ MS Word files on CD)
PRS Database

Cy: (w/o enc./date-stamped letter emailed)
lasomailbox@nnsa.doe.gov
Kimberly Davis Lebak, DOE-NA-LA
Peter Maggiore, DOE-NA-LA
Annette Russell, DOE-EM-LA
David Rhodes, DOE-EM-LA
Bruce Robinson, ADEP ER Program
Randy Erickson, ADEP
Jocelyn Buckley, ADESH-ENV-CP
Mike Saladen, ADESH-ENV-CP
Tony Grieggs, ADESH-ENV-CP
Alison Dorries, ADESH-ENV-DO
Michael Brandt, ADESH
Amy De Palma, PADOPS
Craig Leasure, PADOPS

LA-UR-15-24861
July 2015
EP2015-0127

Work Plan for Chromium Plume Center Characterization

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by the Environmental Programs Directorate

EP2015-0127

Work Plan for Chromium Plume Center Characterization

July 2015

Responsible project manager:

Printed Name	Signature	Title	Organization	Date
Stephani Swickley	for S. Swickley	Project Manager	Environmental Remediation Program	7/13/15

Responsible LANS representative:

Printed Name	Signature	Title	Organization	Date
Randall Erickson	FOR R. ERICKSON	Acting Associate Director	Environmental Programs	7/13/15

Responsible DOE representative:

Printed Name	Signature	Title	Organization	Date
Christine Gelles		Acting Manager	DOE-EM-LA	7/28/15

CONTENTS

Figures

1.0 INTRODUCTION

This work plan for chromium plume center characterization describes proposed activities to be conducted by Los Alamos National Laboratory (LANL or the Laboratory) to further investigate the aquifer in the area of highest known concentrations (center) of the chromium plume and to further characterize the nature and extent of chromium (and related) contamination (Figure 1.0-1). Results from the plume center characterization work will be included in a corrective measures evaluation report.

The work presented in this plan follows from the “Interim Measures Work Plan for the Evaluation of Chromium Mass Removal,” submitted to the New Mexico Environment Department (NMED) in April 2013 (LANL 2013, 241096). That work plan was prepared in response to requirements in a letter from NMED dated January 25, 2013 (NMED 2013, 521862), which directed the Laboratory to prepare an interim measures work plan to assess the potential for active long-term removal of chromium from the regional aquifer via pumping with a pilot extraction test well. The “Interim Measures Work Plan for Chromium Plume Control” (LANL 2015, 600458) that proposed hydraulic control to address plume migration was submitted to NMED in May 2015. This work plan supplements that document and the NMED’s requirements by proposing an investigation of the potential for active long-term removal of chromium from the regional aquifer. Some of the investigations proposed in this work plan follow from the scope and objectives proposed in the “Drilling Work Plan for Chromium Project Coreholes” (LANL 2014, 259151).

Investigations and conceptual models related to chromium contamination are summarized in a number of reports, including the “Investigation Report for Sandia Canyon” (LANL 2009, 107453) and the “Phase II Investigation Report for Sandia Canyon” (LANL 2012, 228624).

Additional information presented in the “Summary Report for the 2013 Chromium Groundwater Aquifer Tests at R-42, R-28, and SCI-2” (LANL 2014, 255110) inform the technical recommendations in this report. Figure 1.0-1 shows the current extent of the plume defined by the 50 ppb New Mexico groundwater standard.

2.0 OBJECTIVES

The scope of this work plan addresses four objectives.

The first objective is to investigate the feasibility of chromium source removal from the center of the plume (as defined as the portion of the plume with the highest chromium concentrations). It is apparent from previous aquifer tests in groundwater monitoring wells R-28 and R-42 that chromium mass can be readily removed from the centroid even at relatively low pumping rates (R-42 was pumped at 8 gallons per minute [gpm]; R-28 was pumped at approximately 28 gpm) (Figure 2.0-1). However, chromium concentrations decreased substantially and rapidly during the several-week pumping period at both wells (Figure 2.0-2). This investigation proposes (1) to further evaluate the potential for optimizing chromium mass removal, (2) to determine the geochemical transients during pumping and recovery, (3) to investigate the potential for decline in chromium concentrations during pumping and rebound after pumping stops, and (4) to assess what optimal well configuration, well design, and operational mode are required for mass removal within the aquifer as one or more components of a final remedy for the plume.

A second objective is to further characterize key attributes of the aquifer, including heterogeneity and dual porosity principally for the purpose of evaluating potential in situ remedial strategies for the plume. This objective will be addressed with (1) aquifer dilution-tracer tests, and (2) field-scale cross-hole tracer tests, and (3) field-scale deployment of a pilot field test to evaluate potential in situ remediation approaches.

The data from these studies will be used to refine the groundwater models of aquifer flow and contaminant transport properties (heterogeneity, dual porosity, etc.) and associated uncertainties related to possible remediation approaches.

A third objective is to study the hydrologic and geochemical conditions that may occur within and adjacent to proposed injection wells as discussed in the “Interim Measures Work Plan for Chromium Plume Control” (LANL 2015, 600458). This objective will be addressed with field studies to evaluate the hydrogeologic and geochemical conditions that may evolve within and around injection points and that may adversely impact injection efficiency. These data will help optimize approaches to routine or required maintenance of injection wells.

A fourth objective is to characterize the infiltration beneath the shallow alluvial groundwater in Sandia Canyon. Based on the current conceptual model most of the historical and present-day infiltration occurs within that zone (LANL 2012, 228624). This objective will be addressed by installing and monitoring a series of piezometers within the primary infiltration area in Sandia Canyon.

3.0 INVESTIGATION APPROACH

3.1 Investigation of Source Removal

A location for an extraction well, CrEX-3, is proposed to investigate the potential for optimizing removal of chromium from the plume center (Figure 1.0-1). The location, south of R-28, is within a zone of expected high hydraulic conductivity that appears to be relatively continuous from R-11 southward towards CrEX-1 and possibly the deeper zone monitored by R-50, screen 2. The initial design for CrEX-3 consists of an 8-in. casing diameter with a 40-slot screen placed within 35–40 ft of the water table. Data from sampling conducted during sonic drilling in CrCH-2 and from piezometers CrPZ-2a and CrPZ-2b installed within the CrCH-2 corehole (LANL 2015, 600457) indicate contamination in the R-28 area is primarily within an interval zone approximately 30 ft below the aquifer water table (Figure 3.1-1). Thus, the extraction well is proposed to be screened in that same zone near the water table to optimize removal of the contaminant source. The decreases in chromium concentrations and subsequent rebound observed in R-28 during the 87-d pumping test may indicate that under ambient flow or routine sampling conditions (e.g., pumping of only approximately 3 casing volumes), R-28 predominantly receives groundwater flow from the upper portion of its screen and filter pack where the contaminant concentration is highest (Figure 3.1-1). But during extended pumping, the proportion of water entering the well from the less contaminated deeper zone increases, resulting in progressively decreasing concentrations in R-28 (Figure 2.0-2b). Therefore, the CrEX-3 screen is proposed to target that upper zone.

Hydraulic testing conducted for 87 d at R-28 propagated a zone of influence that extended upgradient into the highest known areas of contamination near R-42 but did not result in a significant pressure response at R-42 (Figure 3.1-2) (LANL 2014, 255110). This might be because of (1) a hydraulic boundary (e.g., stratification or channeling) that may exist between the wells or (2) active infiltration recharge near R-42 that may dampen the drawdown impacts (LANL 2014, 255110). Figure 3.1-3 is a cross-section line between R-62 and R-45 that shows the water table and plume span the contact between the overlying Puye Formation (Tpf) and underlying Miocene Pumiceous unit (Tjfp). This contact may be a factor in the potential boundary effects apparent between the R-28 area and R-42.

Continuous pumping at CrEX-3 for extended periods of time will provide key information about the heterogeneity of the aquifer in the plume center and the nature and orientation of a well-established capture zone. All monitoring wells in the chromium monitoring group and newly installed piezometers will have continuous pressure monitoring to evaluate the capture zone established by pumping at CrEX-3.

Additionally, samples will be collected periodically to analyze key plume constituents including chromium, nitrate, sulfate, and tritium to evaluate potential transients in the data. Pumping will likely begin at maximum rates achievable at CrEX-3 and will be reduced incrementally if chromium concentrations begin to decline significantly. The overall goal is to find the operational approach that achieves the greatest mass per gallon removed. Testing that was conducted at R-28 and R-42 showed that because of the higher hydraulic conductivities present in the R-28 area, greater overall mass removal was possible in the R-28 area even though concentrations are approximately half of what they are at R-42. In addition, if the capture zone can be established in the areas of the plume with the highest concentrations, the CrEX-3 location may be very efficient for capturing groundwater from the center portion of the plume with the highest known concentrations.

3.2 Aquifer Characterization and Evaluation of Potential Remediation Approaches

Aquifer (dilution) tracer tests and a field cross-hole tracer study are proposed to provide data to guide potential future field investigations that would support the development of remedial alternatives. Dilution tracer (aquifer) tests will be conducted at newly installed piezometers CrPZ-2a, CrPZ-2b, CrPZ-3, and at R-50 before pumping starts at CrEX-1. An additional dilution tracer test will then be conducted at R-50 late in the pumping period at CrEX-1 to evaluate the influence of CrEX-1 pumping on flow rates in the R-50 area. These data will be compared with flow-rate estimates derived from long-term pumping data from CrEX-1.

For the cross-hole test, piezometers CrPZ-3, CrPZ-2a, and CrPZ-2b will be used to deploy paired conservative tracers with different diffusion coefficients to enhance the potential for seeing different breakthrough behaviors that will be indicative of dual porosity in the aquifer. This information, in conjunction with transient contaminant data from pumping at CrEX-1 and CrEX-3, will be helpful for characterizing the spatial distribution of chromium (and related contaminants) in the aquifer.

The tracers will be monitored at R-42 for tracers used at CrPZ-3 and at R-28, CrEX-3, and CrEX-1 for tracers introduced at the CrPZ-2a and CrPZ-2b. The initial tracer mass that will be introduced will be determined to enhance the probability of detection in nearby downgradient wells. Active pumping at CrEX-3, and possibly CrEX-1, is expected to reduce the travel times between the introduction points and the monitored wells. Specific details of the dilution and cross-hole tracer tests are included in a notice of intent (NOI) to the NMED Groundwater Quality Bureau (GWQB).

After the hydrologic information from the cross-hole tracer tests is available, the Laboratory proposes to conduct an in situ field pilot treatability test. In situ approaches generally involve the use of amendments directly within the aquifer either to favorably alter the geochemistry of the contaminants or to enhance naturally occurring biological processes that favorably alter groundwater contaminants. The specific approach will be proposed at a later date after the cross-hole and bench-scale treatability data are available.

3.3 Injection-Well Study

A study will be conducted to investigate potential hydrologic and/or geochemical conditions that may develop in and surrounding an injection well used for dispositioning treated groundwater pumped from CrEX-3 and from CrEX-1 under the “Interim Measures Work Plan for Chromium Plume Control” (LANL 2015, 600458).

The approach will involve using column experiments at either CrEX-1 or CrEX-3. Treated water will be continuously injected into columns packed with aquifer sediments obtained from the sonic corehole drilling campaign or from other representative regional aquifer materials (Figure 3.3-1). Permeability and geochemistry will be measured from column effluent to gather data that may be useful for trouble-shooting and maintenance of operational injection wells. Two duplicate sequential column flow systems will be set up in the field near a treated water source to use as the feed to the columns. The first column in each duplicate sequence will be 2-in. in diameter and 1-ft long and will be packed with typical well filter-pack material. A second column in each sequence will be 5-in. in diameter and 5-ft long and will be packed with representative aquifer materials. Opaque columns and flow tubing will be used to avoid algae growth within the columns. For the 2-in.-diameter column, this flow will result in an entrance velocity of about 3 cm/min across the full cross-section of the column. This entrance velocity is equivalent to what would be observed across a 60-ft-long screen in a 10-in.-diameter casing flowing at 115 gpm (with uniform flow across the entire screen). The actual linear velocity within the column will be about 6 cm/min if the porosity is 50% and 12 cm/min if the porosity is 25%. Velocities are directly proportional to gallons per minute and inversely proportional to both screen length and diameter. For the 5-in.-diameter column, the linear entrance flow velocity will be about 0.5 cm/min, which translates to a 1 cm/min linear velocity in a 50% porosity column and 2 cm/min in a 25% porosity column. The two columns will approximate the linear flow rates expected in the filter pack (first column) and in the formation near the well bore (second column) of an injection well, although true radial flow will not be approximated. The mean water residence times in the two columns, assuming a 30% porosity, is as follows: in the 2-in.–inside diameter (I.D.) column approximately 3 min, and in the 5-in.-I.D. column approximately 100 min. The goal will be to keep the flow rates as continuous and constant as possible for a long period of time and monitor (1) pressure increases across the columns and (2) geochemical and biogeochemical changes in the water exiting each of the columns as a function of time. The system will be monitored for potential problems, such as a significant permeability decrease or plugging, and will attempt to determine the cause and remedies for these problems (either physical, geochemical, or both).

3.4 Characterization of Infiltration beneath Lower Sandia Canyon

A series of new alluvial piezometers are proposed for installation in a section of lower Sandia Canyon where it is believed that the majority of historical and present-day infiltration occurs. Some information on infiltration (i.e., seepage velocities) is available from piezometer studies presented in the “Sandia Canyon Investigation Report” (LANL 2009, 107453). The overall objective of the piezometer configuration will be to evaluate the integrated area of infiltration over the portion of the canyon highlighted in Figure 3.4-1. The specific design of the new piezometer array will be proposed in a separate work plan, but the general approach will be to obtain pressure data at varying depths throughout the saturated portion of the alluvium shown in Figure 3.4-1. Pressure data will be used to refine the current hydrologic model for infiltration of effluent and other surface water sources in Sandia Canyon. The data will also be used to establish a baseline to compare with potential future changes that may occur either because of operational changes in effluent volumes or future remediation strategies that may include discharge of treated groundwater to Sandia Canyon above the infiltration zone monitored by the piezometers. The estimated maximum depth for the piezometers will be approximately 40 ft, so drilling will probably be accomplished with auger drilling or by drive-points.

3.5 Treatment System Description

Groundwater extracted from the plume-center pumping well will be treated near the well and injected in the same injection wells used for the “Interim Measures Work Plan for Chromium Plume Control” (LANL 2015, 600458). The overall pumping, treatment, and injection system will consist of CrEX-1, CrEX-3, a treatment system, and ultimately of six injection wells (Figure 1.0-1). This system and the operational mode are subject to approval by NMED-GWQB. Once fully operational, the system will run continuously with pumped groundwater treated at the surface and delivered to injection wells via piping. The treatment unit is likely to be sited at each extraction location to minimize the distance contaminated groundwater is conveyed via piping. Two ion-exchange vessels will operate in series to treat groundwater extracted from CrEX-3 (and CrEX-1, which may be operating at the same time and will have its own treatment system). The first vessel removes up to 99% of the chromium (and nitrate), and the second vessel is used for redundancy and polishing. Water quality in the treatment stream will be monitored in accordance with an NMED-approved discharge permit to ensure water land-applied or dispositioned via reinjection will meet the criteria set forth in the permit(s).

When the injection wells are operational, computerized systems will be in place to monitor injection rates into the wells to ensure that systems are operating as designed. The flow rate of injected water will be monitored, and pressure at each injection well will be maintained at a design level. Water levels in all injection wells will be monitored by a control system with system shutdown mechanisms in place. Each injection well will also be equipped with a submersible pump to allow each well to be periodically back-flushed for maintenance. The approved discharge permit will also include contingencies for failures in any part of the treatment and discharge system. In the absence of an injection-well permit, treated water will be land-applied in accordance with a separate discharge permit and the system will operate at a lesser removal volume because of limitations in land application.

4.0 SCHEDULE

Implementation of this work scope, namely the installation of CrEX-3, depends on finalizing the National Environmental Policy Act (NEPA) Environmental Assessment (EA). The NEPA EA is currently expected to be completed in the fall of 2015. Following the installation of CrEX-3, near-term pumping will still depend on the Laboratory's receiving a discharge permit or temporary permission from NMED for land application of treated water and a Change in Point of Diversion permit for well pumping from the New Mexico Office of the State Engineer (NMOSE). NMED received comments on the Laboratory's permit application for the land-application discharge permit (DP-1793) during the second public notice period. A final draft of the permit was issued by NMED on May 28, 2015, but a second request for public hearing was submitted to the NMED on June 15, 2015 by Citizens for Clean Water (CCW 2015, 600514). A permit application to use the injection wells was submitted to the NMED-GWQB on April 9, 2015. An additional permit is required from NMOSE to allow pumping from CrEX-3 and CrEX-1. The Laboratory's goal is to have injection wells in place and permitted in 2016 to enable pumping and injection of water from CrEX-3 and CrEX-1 (LANL 2015, 600458).

Activities related to characterization of the sonic core material are underway. The field tracer studies and the injection well study also depend on the Laboratory's receiving permits with the NMED-GWQB, but it is expected that the field activities will be closely integrated with pumping schedules to optimize data collection.

5.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste will be managed in accordance with EP-DIR-SOP-10021, Characterization and Management of Environmental Programs Waste. This standard operating procedure 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 development water, drill cuttings, drilling fluid, decontamination fluids, and contact waste.

6.0 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.

CCW (Communities for Clean Water), June 15, 2015. "CCW Comments about May 28, 2015 draft DP-1793 for Los Alamos National Laboratory Groundwater Projects," Communities for Clean Water letter to S. Huddleson (NMED-GWQB) from J. Arends, K. Sanchez, B. Tsosie-Peña, M. Naranjo, R. Conn, J. Brown, and M. Perrotte, Santa Fe, New Mexico. (CCW 2015, 600514)

LANL (Los Alamos National Laboratory), October 2009. "Investigation Report for Sandia Canyon," Los Alamos National Laboratory document LA-UR-09-6450, Los Alamos, New Mexico. (LANL 2009, 107453)

LANL (Los Alamos National Laboratory), September 2012. "Phase II Investigation Report for Sandia Canyon," Los Alamos National Laboratory document LA-UR-12-24593, Los Alamos, New Mexico. (LANL 2012, 228624)

LANL (Los Alamos National Laboratory), April 2013. "Interim Measures Work Plan for the Evaluation of Chromium Mass Removal," Los Alamos National Laboratory document LA-UR-13-22534, Los Alamos, New Mexico. (LANL 2013, 241096)

LANL (Los Alamos National Laboratory), March 2014. "Summary Report for the 2013 Chromium Groundwater Aquifer Tests at R-42, R-28, and SCI-2," Los Alamos National Laboratory document LA-UR-14-21642, Los Alamos, New Mexico. (LANL 2014, 255110)

LANL (Los Alamos National Laboratory), July 2014. "Drilling Work Plan for Chromium Project Coreholes," Los Alamos National Laboratory document LA-UR-14-24829, Los Alamos, New Mexico. (LANL 2014, 259151)

LANL (Los Alamos National Laboratory), May 2015. "Interim Measures Work Plan for Chromium Plume Control," Los Alamos National Laboratory document LA-UR-15-23126, Los Alamos, New Mexico. (LANL 2015, 600458)

LANL (Los Alamos National Laboratory), May 2015. "Completion Report for Chromium Project Coreholes 1 through 5," Los Alamos National Laboratory document LA-UR-15-23197, Los Alamos, New Mexico. (LANL 2015, 600457)

NMED (New Mexico Environment Department), January 25, 2013. "Response, Proposal to Submit Interim Measures Work Plan for Chromium Contamination in Groundwater," New Mexico Environment Department letter to P. Maggiore (DOE-LASO) and J.D. Mousseau (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2013, 521862)

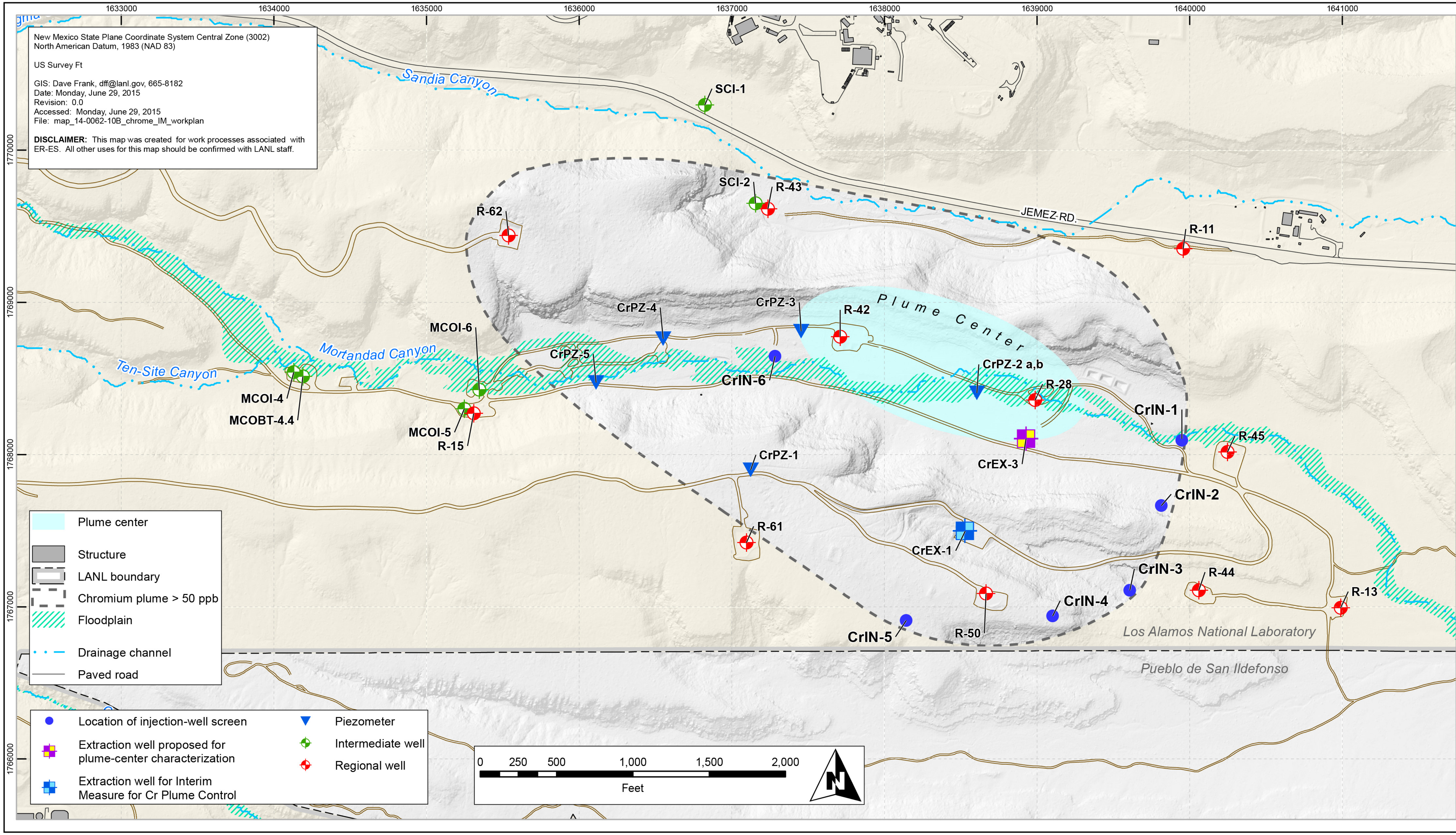
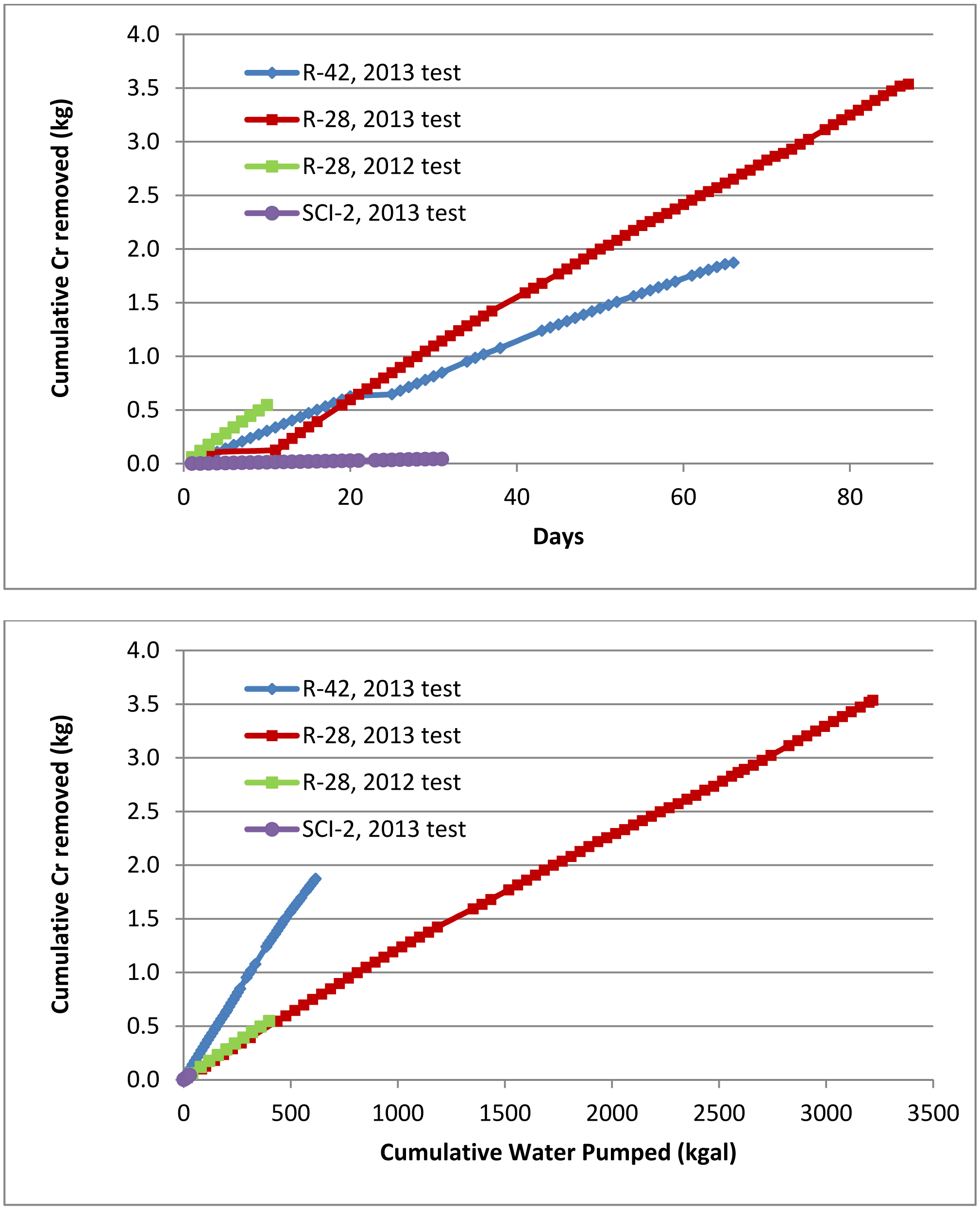
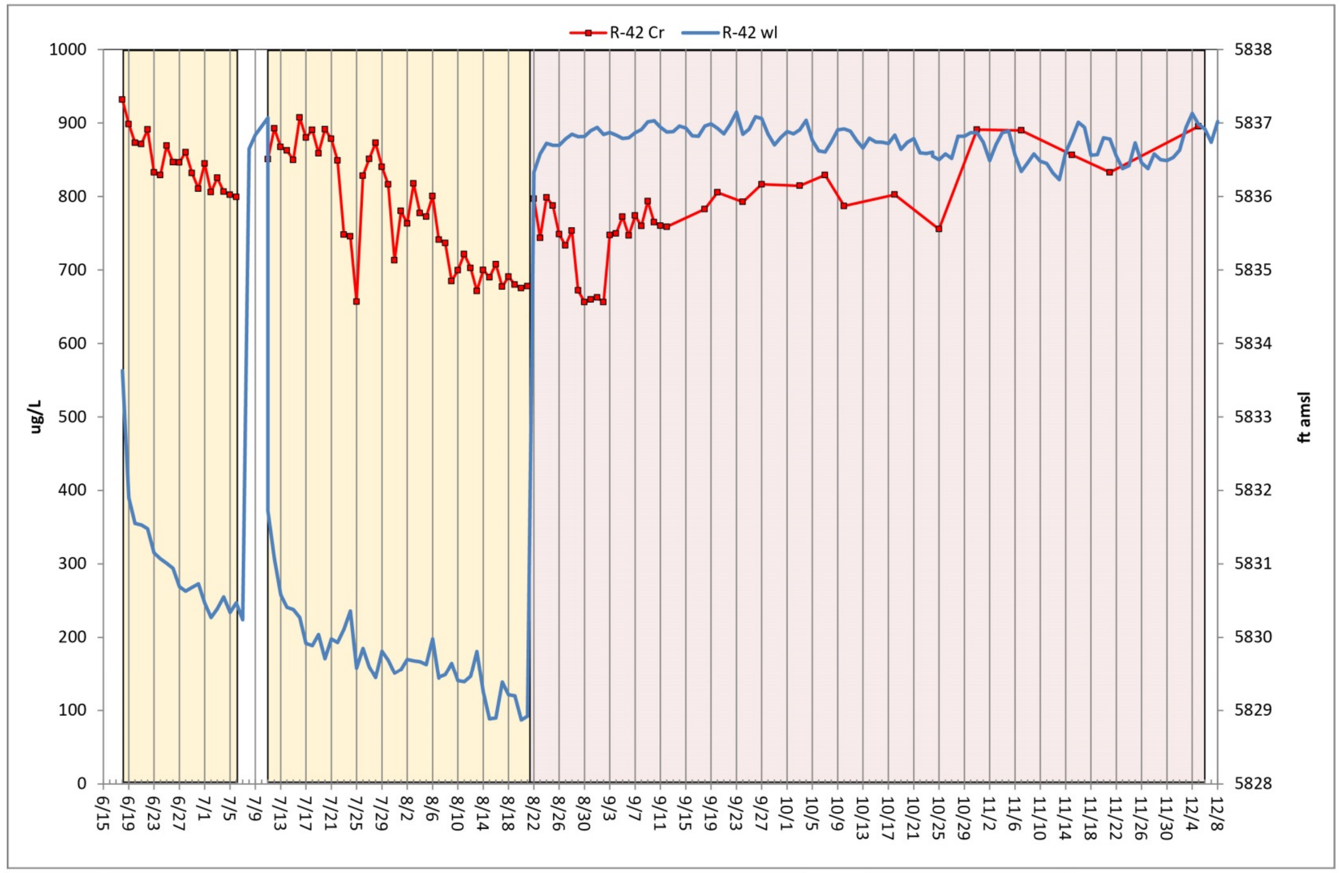


Figure 1.0-1 Current extent of the chromium plume and proposed location of the extraction well for plume center characterization



Notes: The top graph shows chromium mass removal as a function of days of pumping. The bottom graph shows chromium mass removal as a function of gallons pumped.

Figure 2.0-1 Cumulative chromium removal during 2014 pumping at R-28, R-42, and SCI-2

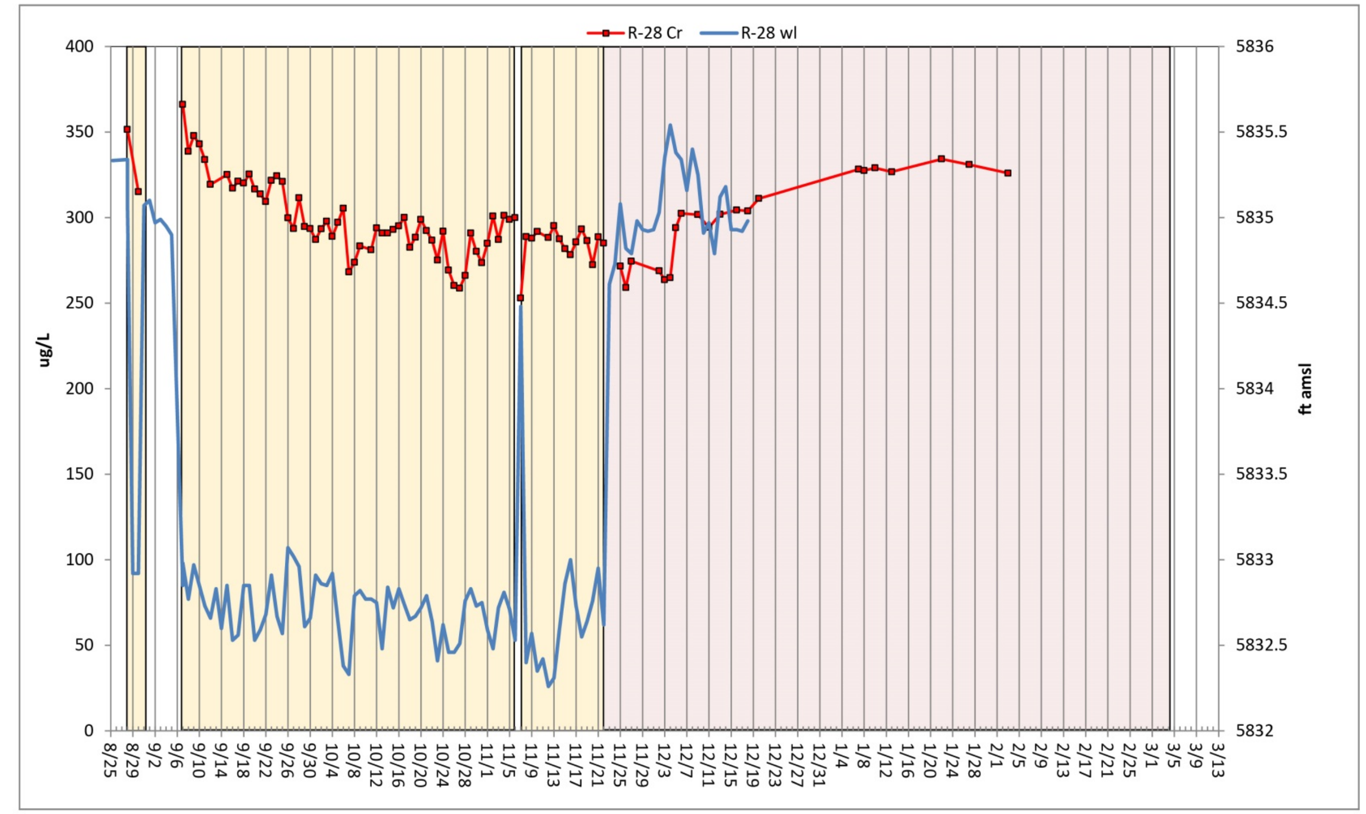


Chronology of pumping and rebound				
Well	Pumping	Pump failure	Rebound	Average Discharge Rate
R-42	6/18 - 7/6/13; 7/12 - 8/21/13	7/7 - 7/11/13	8/22 - 12/5/13	7 gpm*

*gpm = gallons per minute

pumping
recovery

a. R-42 time series plot for chromium and water level during pumping and rebound sampling.



Chronology of pumping and rebound				
Well	Pumping	Pump failure	Rebound	Average Discharge Rate
R-28	• 8/28 - 8/30/13 (pump set in shroud in sump below screen) • 9/7-11/6 (pump removed from shroud and reset above screen) • 11/7-11/22/13	• 8/30 - 9/7/13 • 11/6 (1730 hrs) - 11/7/13 (0700 hrs) generator tripped	11/22/13 - 3/4/14	28.9 gpm*

*gpm = gallons per minute

pumping
recovery

b. R-28 time series plot for chromium and water level during pumping and rebound sampling.

Note: The first graph shows R-42; the second graph shows R-28.

Figure 2.0-2 Graphs showing transient concentrations of chromium during extended pumping periods and during recovery (nonpumping) period

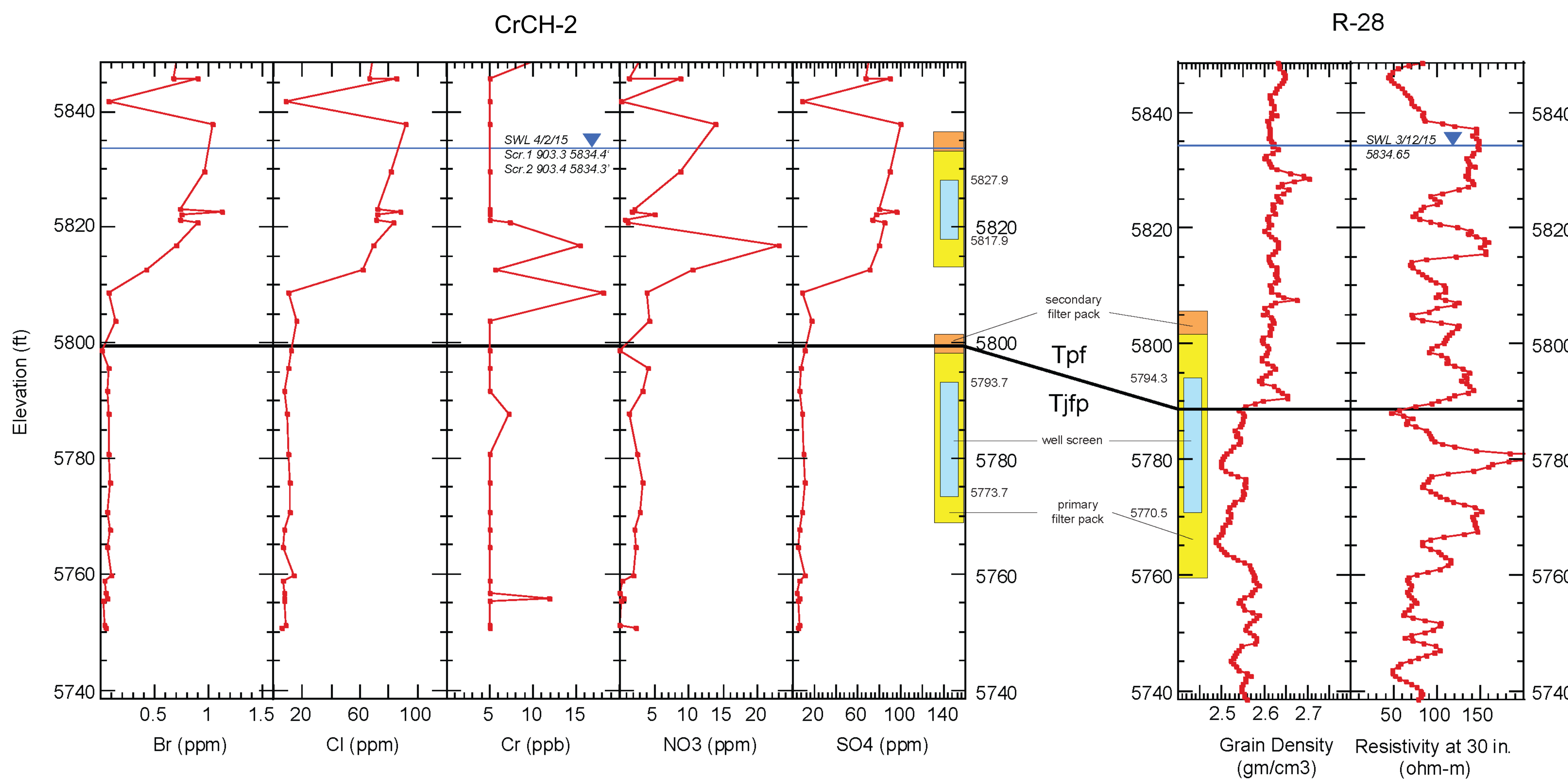
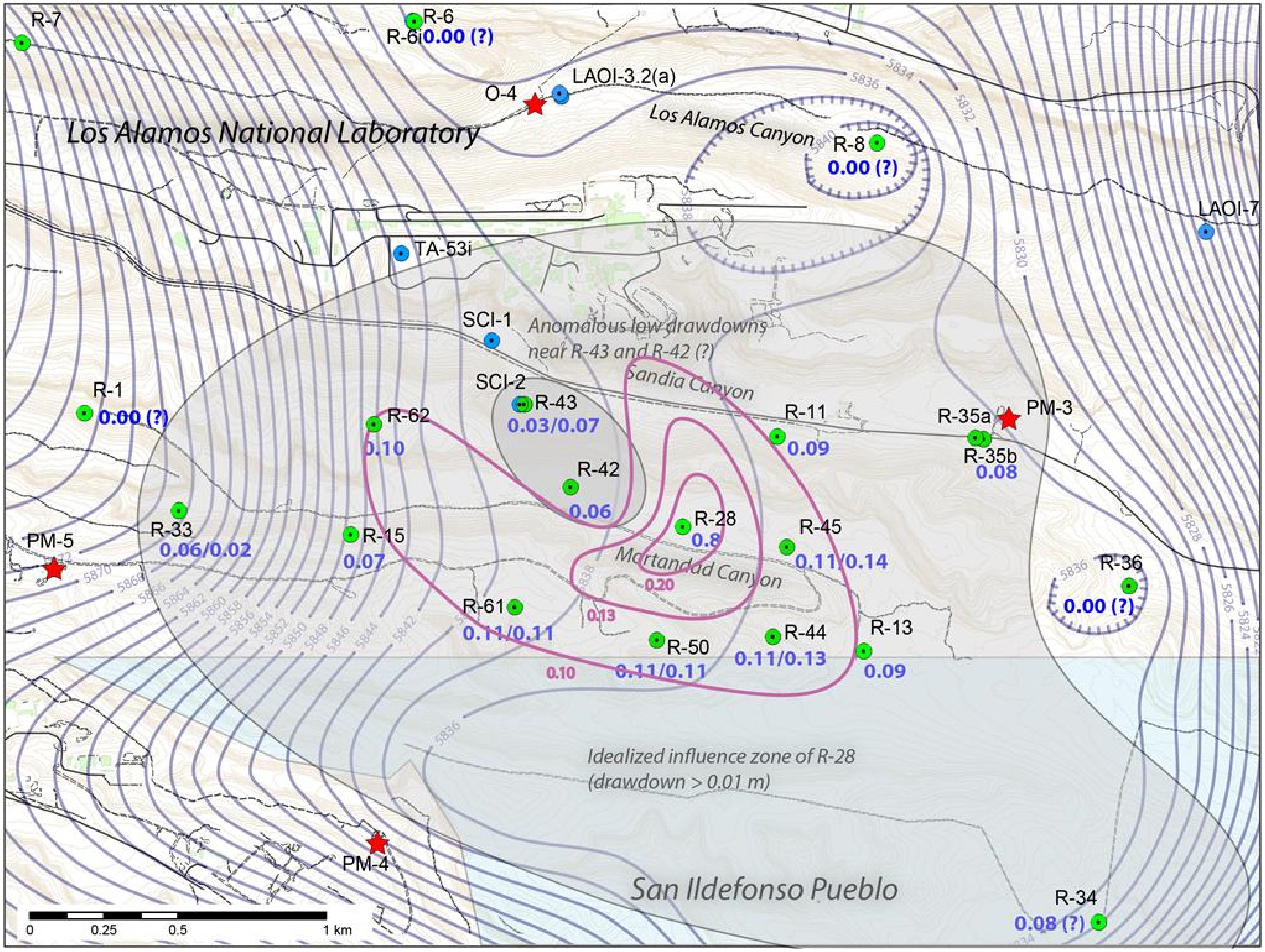


Figure 3.1-1 Concentration profile for representative constituents in CrCH-2 and relation to nearby R-28



Note: The contour lines (in pink) show the spatial distribution of the R-28 cone of depression (ZOI).

Figure 3.1-2 Spatial distribution of the pumping drawdowns in meters at the end of the R-28 aquifer test (shown in blue text)

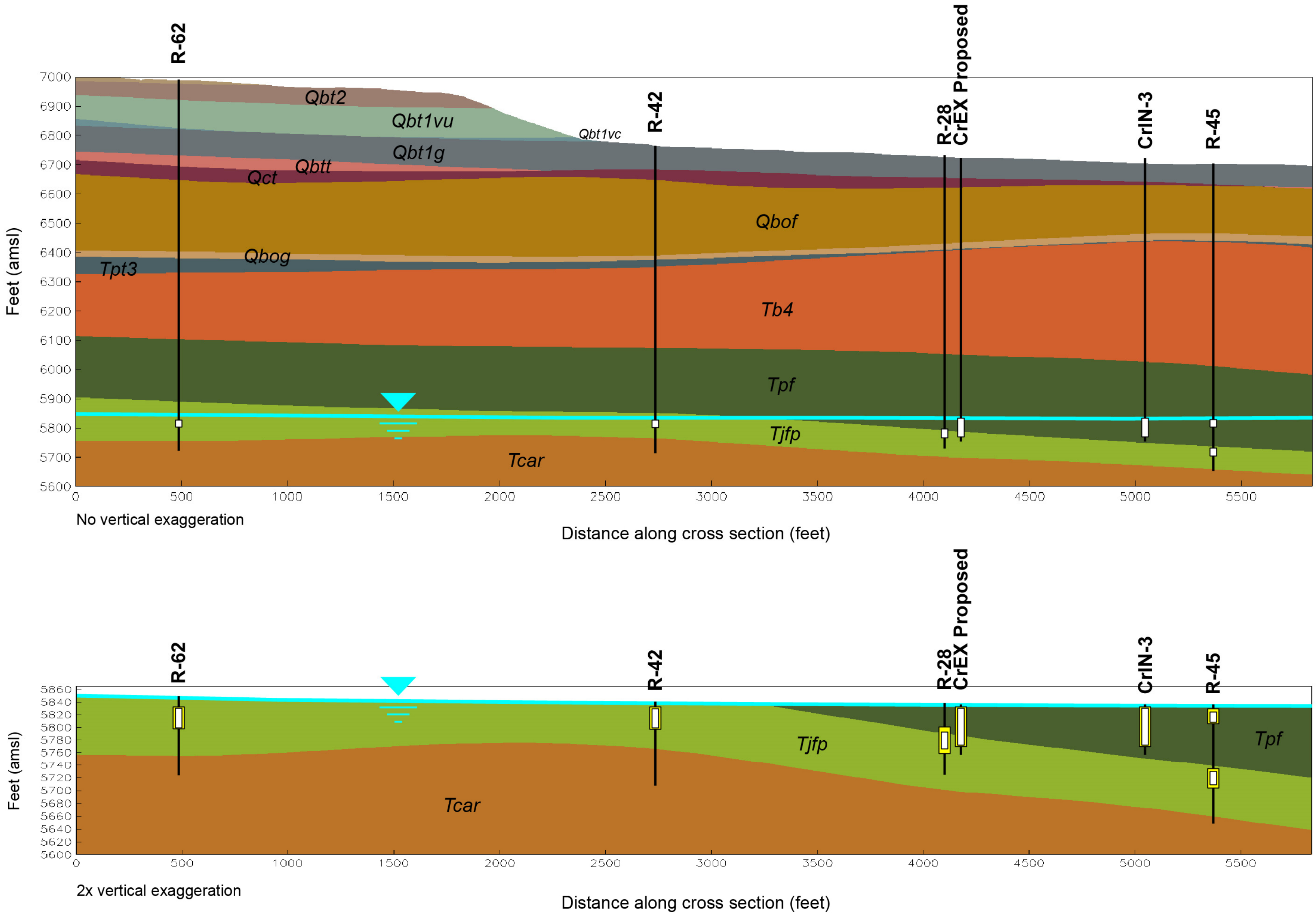


Figure 3.1-3 Cross-section line between R-62 and R-45

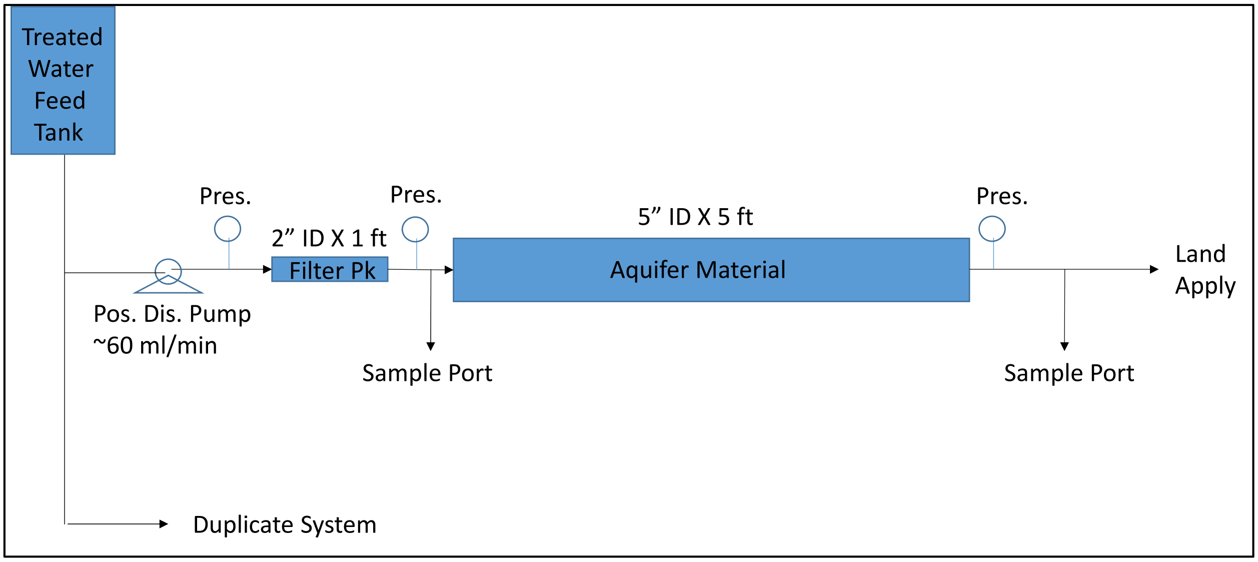


Figure 3.3-1 Conceptual design for injection well column study

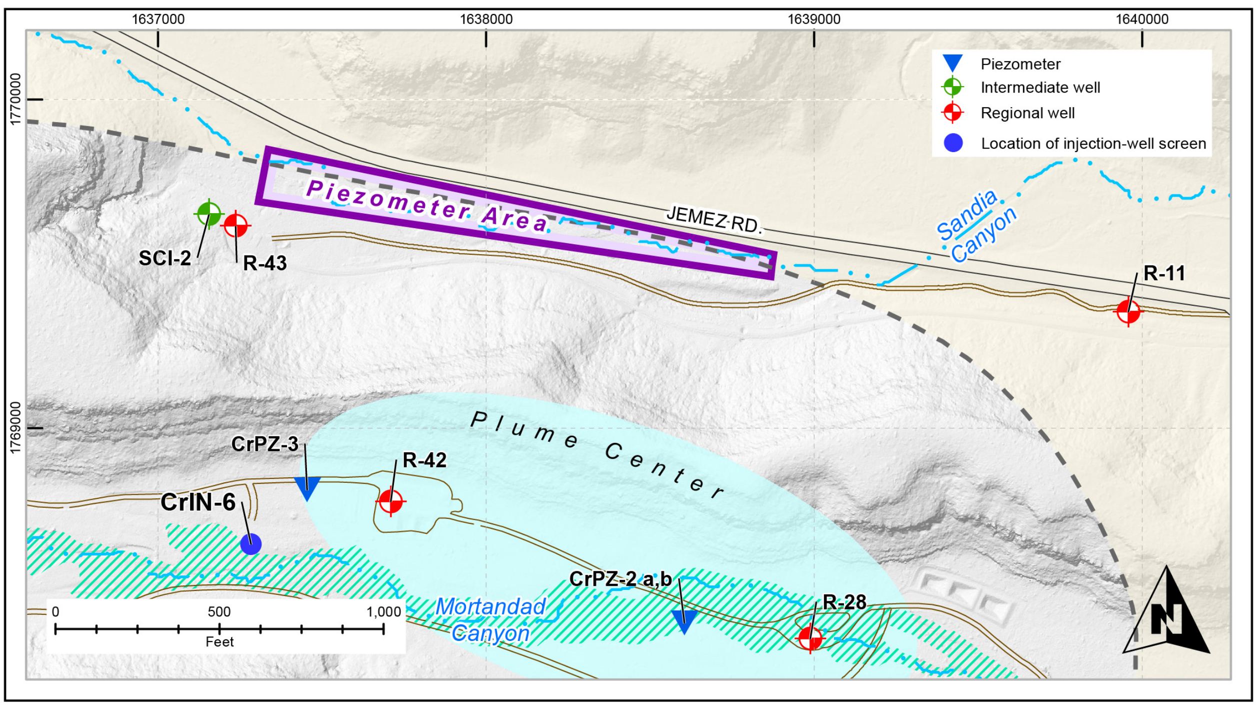


Figure 3.4-1 General location for shallow alluvial piezometer nests in lower Sandia Canyon