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Date: JUL 30 2014
Refer To: EP2014-0298

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 Drilling Work Plan for Chromium Project Coreholes

Dear Mr. Kieling:

Enclosed please find two hard copies with electronic files of the Drilling Work Plan for Chromium Project Coreholes.

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@nnsa.doe.gov).

Sincerely,

Jeff Mousseau, Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,

Peter Maggiore, Assistant Manager
Environmental Projects Office
Los Alamos Field Office

JM/PM/DM/SS:sm

Enclosures: Two hard copies with electronic files – Drilling Work Plan for Chromium Project Coreholes (LA-UR-14-24829)

Cy: (w/enc.)
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Drilling Work Plan for Chromium Project Coreholes

<table>
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<td>Objectives</td>
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A series of six coreholes is planned as part of ongoing activities being conducted by Los Alamos National Laboratory (LANL or the Laboratory) to evaluate remedial alternatives for chromium contamination in groundwater. A number of overarching objectives are proposed for the coreholes, including the following:

Evaluate the degree of attenuation (reduction and/or adsorption) of contaminant chromium that has occurred within the lower Puye Formation in the vadose zone and within the upper 100 ft of the regional aquifer (Puye Formation and Miocene pumiceous unit). This objective specifically supports the geochemistry studies proposed in the Interim Measures Work Plan for the Evaluation of Chromium Mass Removal (LANL 2013, 241096). This evaluation is being conducted to assess whether natural attenuation of chromium is an existing process within the regional aquifer plume area and to characterize the attenuation mechanism(s) and capacity that might remain within different portions of the plume (centroid versus periphery) in the regional aquifer. Collection of core for this evaluation is intended to supplement studies the Laboratory is conducting on archived cuttings. Analysis of newly collected core and pore water will be used to address potential uncertainties in results of bench-scale studies for chromium attenuation conducted to date on archived cuttings. Cuttings are thought to be somewhat depleted of fine-grained particle fractions that may be important for chromium attenuation. Further, archived cuttings may have also been subjected to changes in redox chemistry that could bias the results of studies of attenuation processes. New core will be collected and preserved with methods that minimize loss of fines and maintain in situ geochemical conditions.
Evaluate evidence of vadose zone infiltration pathways for chromium. The approach for this objective includes detailed analysis of core solids and pore water to characterize the presence of contaminant chromium and the association of chromium to various solids phases.
Characterize the stratification of chromium concentrations in groundwater within the upper 100 ft of the regional aquifer. This objective will provide potentially important information to guide the design of the pumping well and to develop pumping strategies to optimize chromium mass removal. Either field methods or fast-turnaround laboratory analysis will be utilized to potentially guide drilling to depths beyond 100 ft into the regional aquifer if chromium concentrations are still elevated at 100 ft.
Provide dedicated access points (DAPs) in some of the coreholes for a variety of potential purposes, including pressure monitoring in support of a capture zone analysis and field tests that may involve introducing amendments to stimulate attenuation of chromium in the vadose zone or regional aquifer. The construction of these DAPs (i.e., deep 2-in. completions that cannot be adequately developed) inhibits their use as sampling locations with dedicated pumping systems.

A map showing the proposed corehole locations is provided as Figure 1. The objectives described above apply to each of the coreholes. However, each corehole emphasizes a slightly different balance of the objectives. At all coreholes, core from both the deep vadose zone and the regional aquifer will be collected, and stratified groundwater sampling of the regional aquifer will be performed. The following provides a discussion specific to each corehole.
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Objectives (continued)	**Corehole 1 (CrCH-1)** Corehole 1 will be completed as a piezometer for long-term pressure monitoring. Pressure monitoring at this location will be supplemented by pressure monitoring at other nearby locations for analyzing pressure responses (capture-zone analysis) associated with pumping at the planned pumping well CrEX-1 (Figure 1). Well CrEX-1 is scheduled to be installed and pumped during the late summer or early fall of 2014. The goal is to have CrCH-1 in place before or shortly after pumping at CrEX-1 begins. Figure 2 shows the predicted geology and conceptual design for the final piezometer completion at CrCH-1. **Corehole 2 (CrCH-2)** Corehole 2 will be drilled near R-28. A key objective specific to CrCH-2 is the characterization of the vertical profile of chromium and related contaminants above and below the screened interval at R-28. Well R-28 is screened from approximately 43 to 67 ft below the water table and shows chromium concentrations of approximately 400 µg/L. Characterization of the vertical contaminant profile within the regional aquifer above and below the R-28 screened interval will support optimization of pumping well locations and design for optimizing mass removal. It will also provide key information that may explain the decline in chromium concentrations and correspondingly relatively stable nitrate (and other anion) concentrations observed during extended pumping at R-28 in 2011 and 2013. Corehole 2 will be completed as a DAP to enable cross-hole field experiments that involve introduction of chromium-reduction stimulants using R-28 as an observation well. The proposed location is approximately 300 ft upgradient of R-28. Groundwater travel time between CrCH-2 and R-28 is approximately 2 to 3 mo based on groundwater velocities estimated at 3 to 6 ft per day at R-28 based on data from recent aquifer tests. Figure 3 shows the predicted geology and conceptual design for the final DAP completion at CrCH-2. **Corehole 3 (CrCH-3)** Corehole 3 will be drilled near R-42 and completed as a DAP. A key objective specific to CrCH-3 is to characterize the vertical profile of chromium and related contaminants in groundwater beneath the screened interval at R-42. Well R-42 is screened at a depth of 12 to 33 ft below the water table and shows chromium concentrations of approximately 800 µg/L. Characterization of the vertical contaminant profile within the regional aquifer below the R-42 screened interval will support optimization of potential pumping well locations and design to optimize mass removal. It will also provide key information that may explain the decline in chromium concentrations and correspondingly relatively stable nitrate (and other anion) concentrations observed during extended pumping at R-42 in 2013. CrCH-3 will be drilled near R-42 to increase the probability of encountering elevated concentrations of chromium in pore water within the vadose zone. Persistence of chromium concentrations in R-42 and a slight mound in the water table at R-42 indicate the possibility of ongoing percolation of “source” chromium from the vadose zone into the regional aquifer near R-42. Pore water from core obtained from the vadose zone in CrCH-3 will be analyzed with fast turnaround at the Laboratory’s Geochemistry and Geomaterials Research Laboratory. These data will be used to design the DAP at CrCH-3. If elevated concentrations of chromium are present in vadose zone pore water, the corehole will be backfilled to a depth just above the water table, and a DAP will be constructed with a long screened interval completed within the vadose zone. This DAP would then be used for field studies of methods (e.g., injection of gas-phase reductants) to induce the reduction of chromium in the vadose zone using R-42 as an observation well. Figure 4 shows the predicted geology and conceptual design for the final DAP completion in the vadose zone at CrCH-3. If elevated concentrations of chromium are not detected in vadose zone pore water, then the final completion will be a DAP at the top of the regional aquifer in an interval equivalent to R-42. Figure 5 shows the predicted geology and conceptual design for the final piezometer completion at CrCH-3.

Objectives (continued)	**Corehole 4 (CrCH-4)** Corehole 4 will be drilled at a location that has the potential to further define the area of breakthrough of contaminants from the vadose zone into the regional aquifer. The location is along a line between perched-intermediate wells SCI-2 and MCOI-6, which have common geochemical signatures originating from Sandia Canyon and indicate a probable pathway within the Cerros del Rio basalts between the two wells. Observations of chromium concentrations within potential perched-intermediate groundwater in CrCH-4 will also aid in determining possible targets for remediation within the perched-intermediate zone. If a significant zone of saturation is identified within the Cerros del Rio basalts in CrCH-4, drilling will not proceed beneath the base of the basalt. The Laboratory will provide the information (e.g., saturated thickness, chromium concentrations) for NMED's review to determine an appropriate path forward, which may include completion of a perched-intermediate well instead of advancing the corehole into the regional aquifer. If a perched-intermediate aquifer well is not completed, then a piezometer will be installed at the top of the regional aquifer. Figure 6 shows the predicted geology and conceptual design for the final piezometer completion at CrCH-4. **Corehole 5 (CrCH-5)** Corehole 5 will be drilled at a location to evaluate the potential for groundwater mixing occurring from infiltration beneath Mortandad and Sandia Canyons. The primary objective of this corehole location is to characterize an area that exhibits potential mixing and eventual percolation into the regional aquifer of the separate contaminant sources originating from Sandia and Mortandad Canyons. The perched-intermediate wells in Mortandad Canyon are each unique in the relative proportion of groundwater presumably originating from Sandia Canyon, with MCOI-6 showing the greatest amount. Characterization of pore water and stratification of contaminants in the regional aquifer will provide useful insights into this potential mixing zone and, along with information from other planned coreholes in the area, will provide key information to constrain the overall area of chromium arrival at the regional aquifer. Figure 7 shows the predicted geology and conceptual design for the final piezometer completion at CrCH-5. **Corehole 6 (CrCH-6)** Corehole 6 will be drilled at a location to characterize the upgradient portion of the primary chromium plume. Data derived from the corehole will be evaluated with the objective of determining the presence or absence of anthropogenic chromium in vadose zone pore water and core and within the regional aquifer. This location will also help to discern the potential for an infiltration pathway to the regional aquifer originating from the Sandia Canyon wetland. Figure 8 shows the predicted geology and conceptual design for the final piezometer completion at CrCH-6.
Drilling Approach	The method for drilling the coreholes will incorporate a combination of methods to achieve the following: the collection of core and pore water with minimal effects (i.e., changes in moisture content and geochemical conditions) caused by the drilling method; core recovery objectives; depth objectives; and stratified groundwater sampling in the regional aquifer. Currently, the preferred drilling approach is to use a sonic method that does not require the use of drilling fluids in the target coring interval. Sonic drilling will begin at the base of the Cerros del Rio basalts through conductor casing advanced from the ground surface to the base of the basalt using a rotary drilling method. This approach will significantly reduce borehole-wall friction and should allow the sonic method to achieve target depths. Other methods may be considered in consultation with NMED if sonic drilling is unsuccessful.

Drilling Approach (continued)	The specifics of the method selected will be determined through the Laboratory's contracting process and will be reflected in a field implementation plan provided by the drilling subcontractor. Continuous coring will begin at the base of the Cerros del Rio basalts and continue to the total depth of each corehole.
Drilling Fluids, Composition, and Use	The specific objective of collection of core for detailed characterization of pore water and solid material will favor drilling methods that do not require the use of any drilling fluids. Fluids may be used if fluid-free drilling technologies are not capable of achieving the depth objectives or sufficient core recovery. If fluids need to be used during drilling, tracers would likely be utilized in the drilling fluid to estimate dilution from mixing of drilling fluids with pore water.
Water Sampling	Pore water from core collected from the vadose zone will be analyzed for major cations and anions at intervals targeting approximately every 10 ft but will depend on recovery and pore moisture content. Groundwater samples will be collected from near the water table to total depth of 100 ft below the water table in approximately 20-ft intervals to characterize stratification of chromium and related contaminants within the regional aquifer. Either field methods or fast-turnaround laboratory analysis will be used to potentially guide drilling to depths beyond 100 ft into the regional aquifer if chromium concentrations are still elevated at 100 ft below the water table. Each of the DAPs will potentially be used to periodically collect screening-level samples. The method for sample collection has not been determined, nor has it been determined whether dedicated sampling systems will be used or a system or method is used each time a DAP is sampled. Any samples collected from the DAPs will be considered screening-level samples because the DAPs cannot be adequately developed following construction.
Completion Design of DAPs	Depending on the drilling method, each piezometer and DAP will be completed either as a 2-in. casing in a borehole of nominally 6-in. diameter if the coreholes can be successfully drilled with sonic technology; or with a 1-in. casing in a smaller diameter borehole if other conventional-coring methods are required to achieve total depth. Filter pack will be placed around the screened interval, and grout will be placed in the annular space between the top of the filter pack and the surface completion. Screen placement and length will be dependent on observations during drilling, as described in the "Objectives" section above.
Development	Minimal development will occur in the piezometers and DAPs because of the small diameter of the completions. Because of the inability to adequately develop these intervals using surging or pumping methods, any water-quality data that would be collected will be considered only as screening-level data.
Investigation-Derived Waste Management	Investigation-derived waste (IDW) will be managed in accordance with standard operating procedure (SOP) EP-DIR-SOP-10021, Characterization and Management of Environmental Program Waste (available at 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.

Investigation-Derived Waste Management (continued)	Drill cuttings with residual additives 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 (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). The contents of the pits will be characterized with direct sampling following completion of drilling activities and/or via use of a composite of subsamples collected during drilling, 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 points 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	Drilling of these coreholes will begin after NMED approves this work plan and the contract procurement process is completed. It is anticipated that drilling will begin in August 2014 and will continue until the six coreholes are completed and the objectives of this work plan are met. A summary report will be prepared and submitted to NMED 120 d following installation of the last corehole.

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. 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.

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)

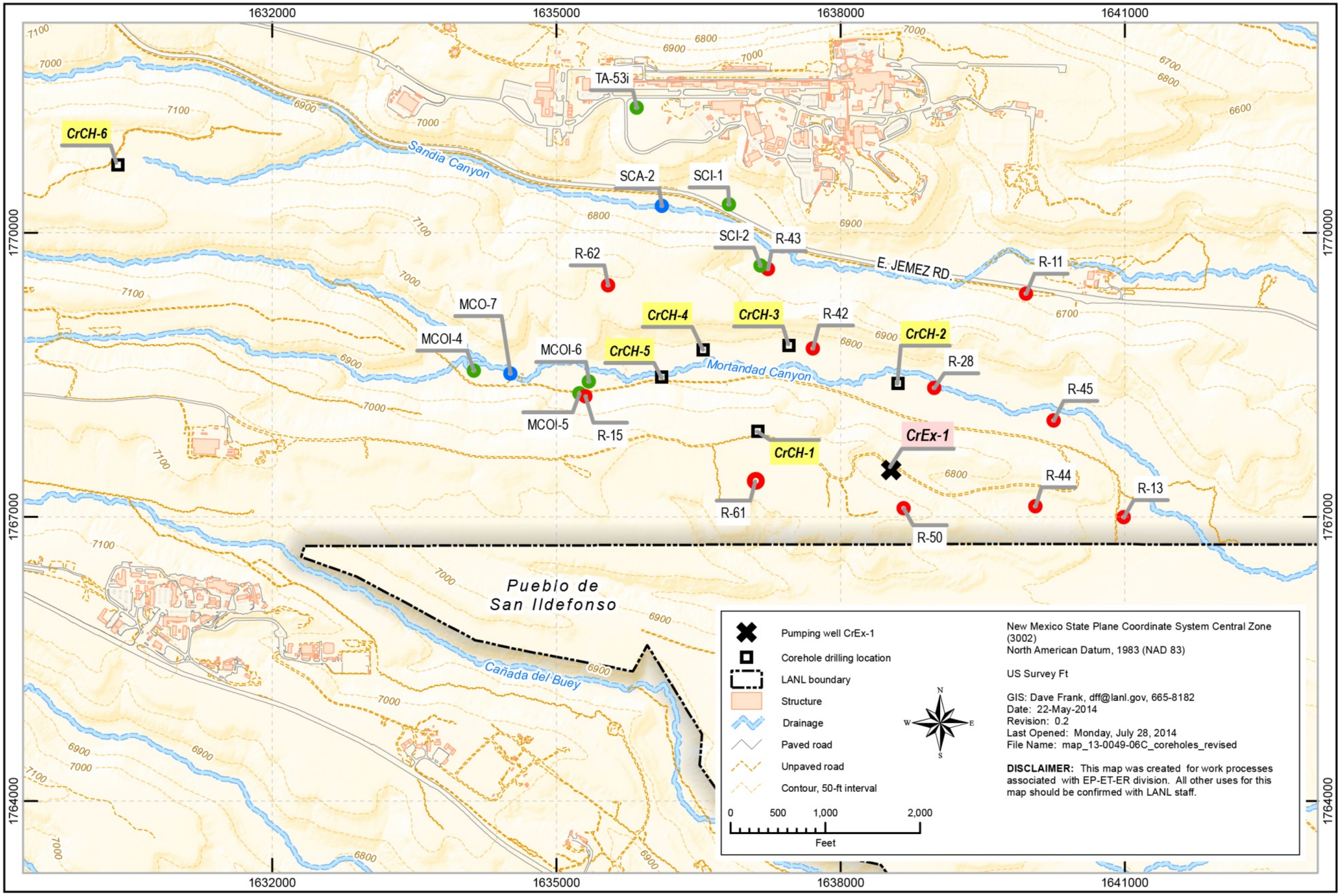

Figure 1 Proposed location for well CrEX-1

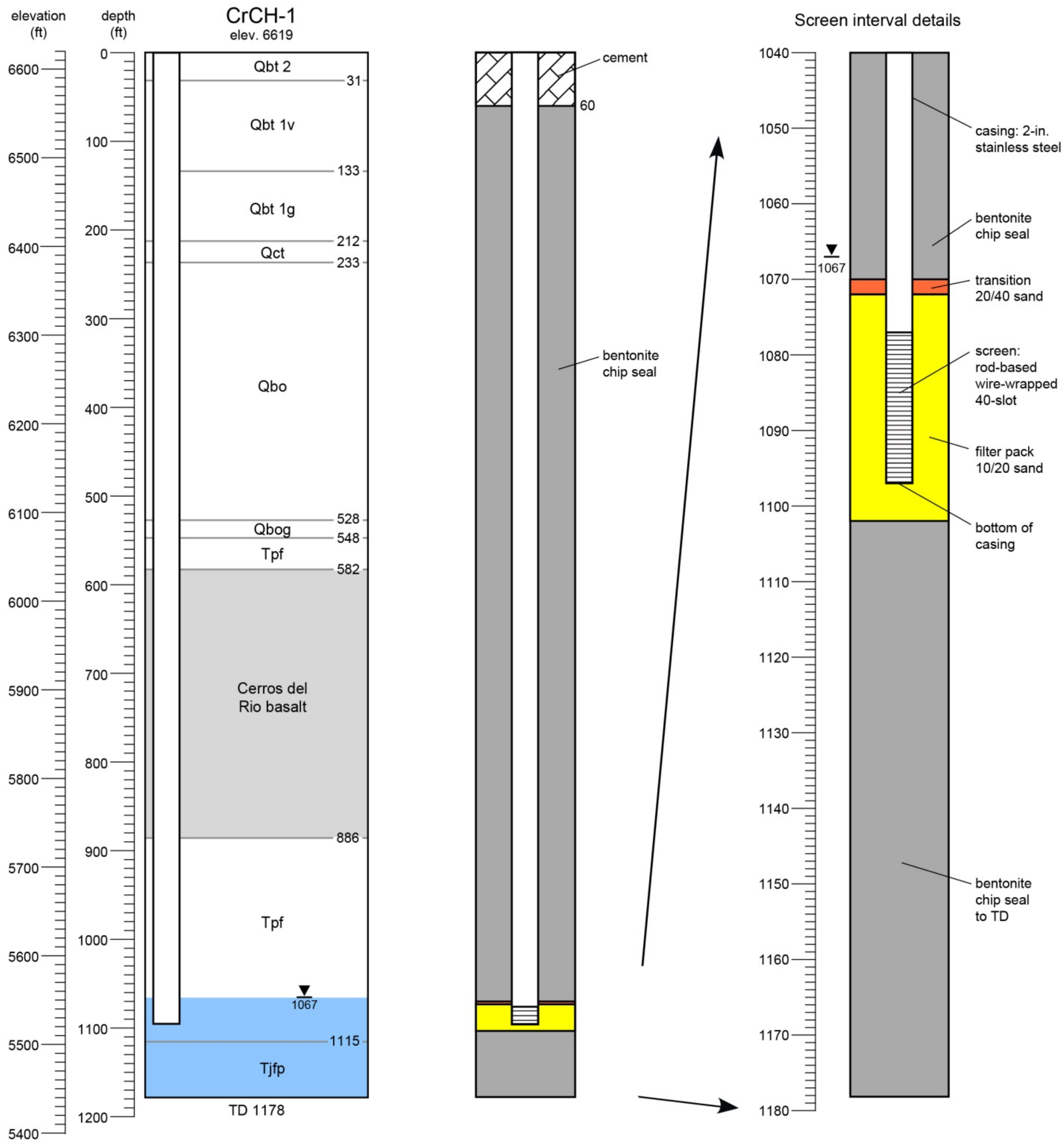

Figure 2 Predicted geology and conceptual design for the final piezometer completion at CrCH-1

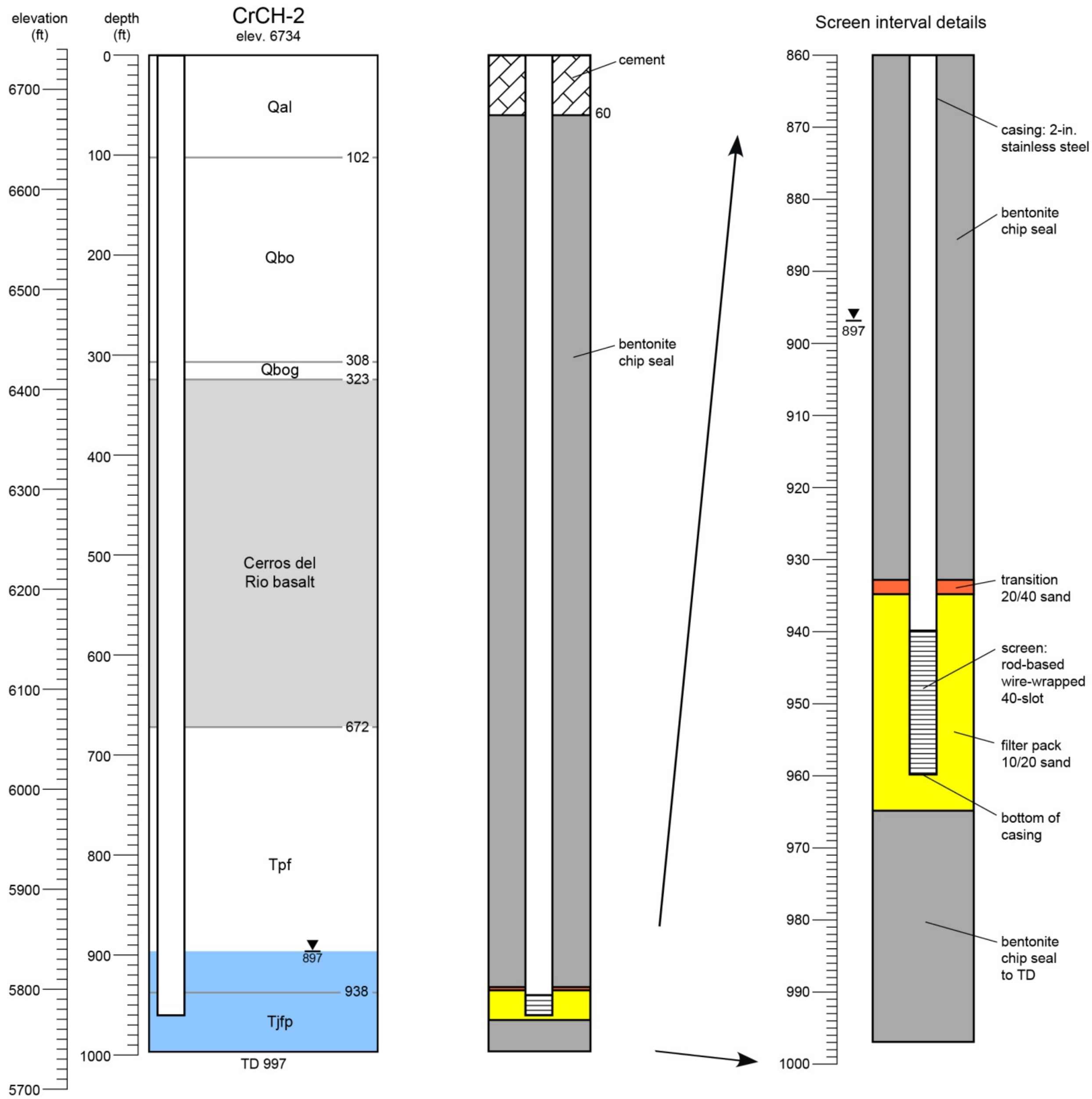

Figure 3 Predicted geology and conceptual design for the final DAP completion at CrCH-2

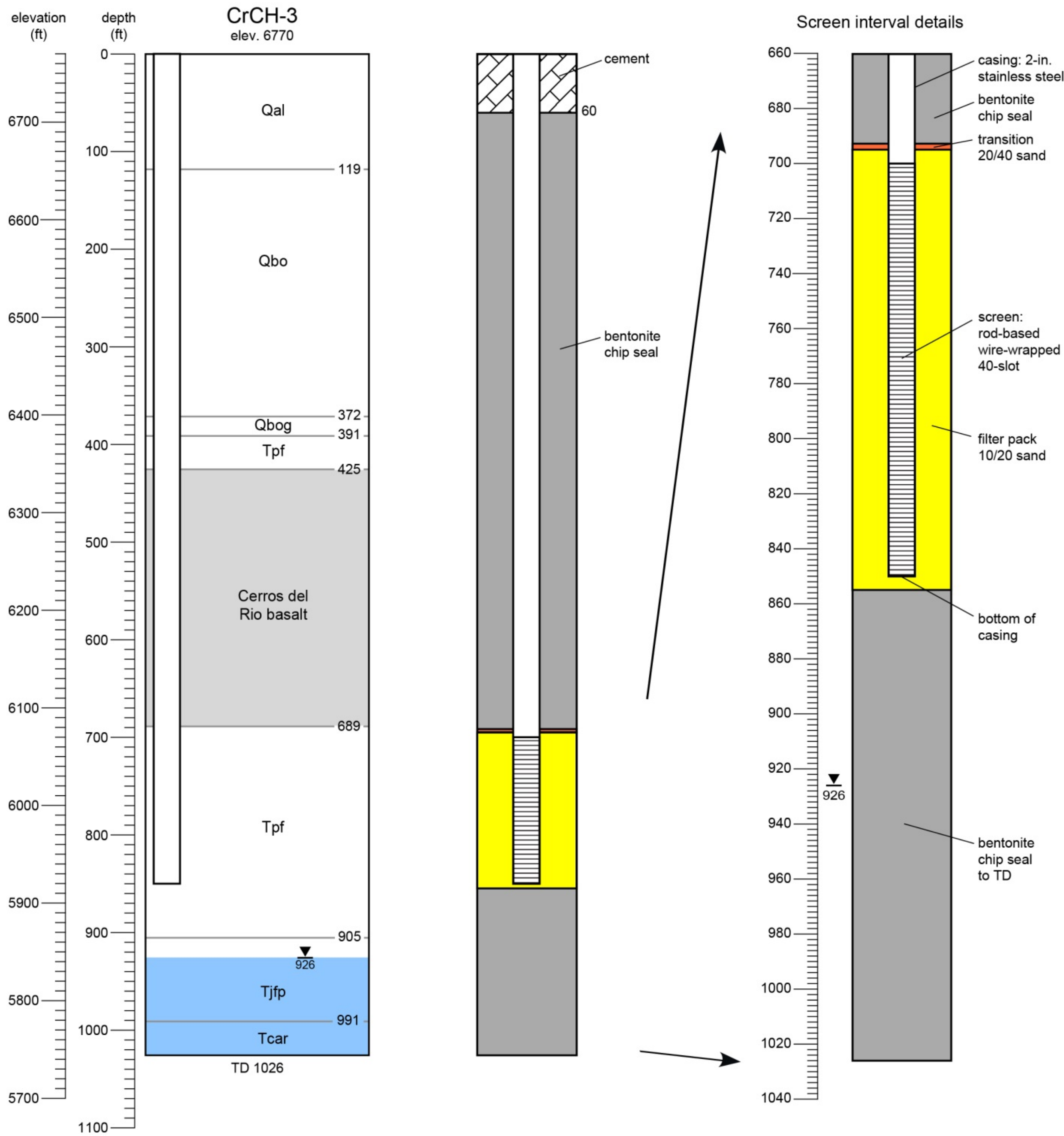

Figure 4 Predicted geology and conceptual design for the final DAP completion in the vadose zone at CrCH-3

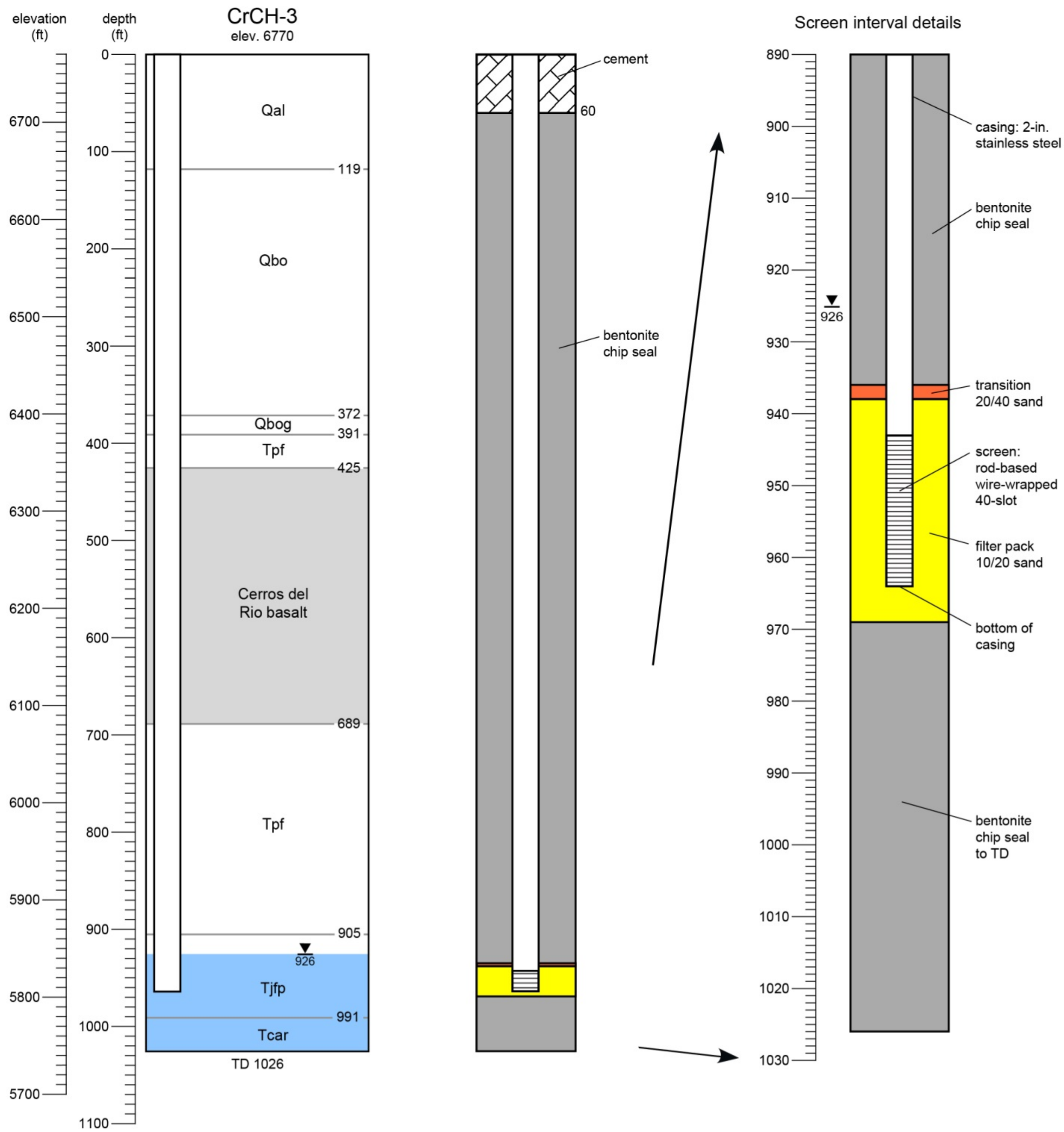

Figure 5 Predicted geology and conceptual design for the final piezometer completion at CrCH-3

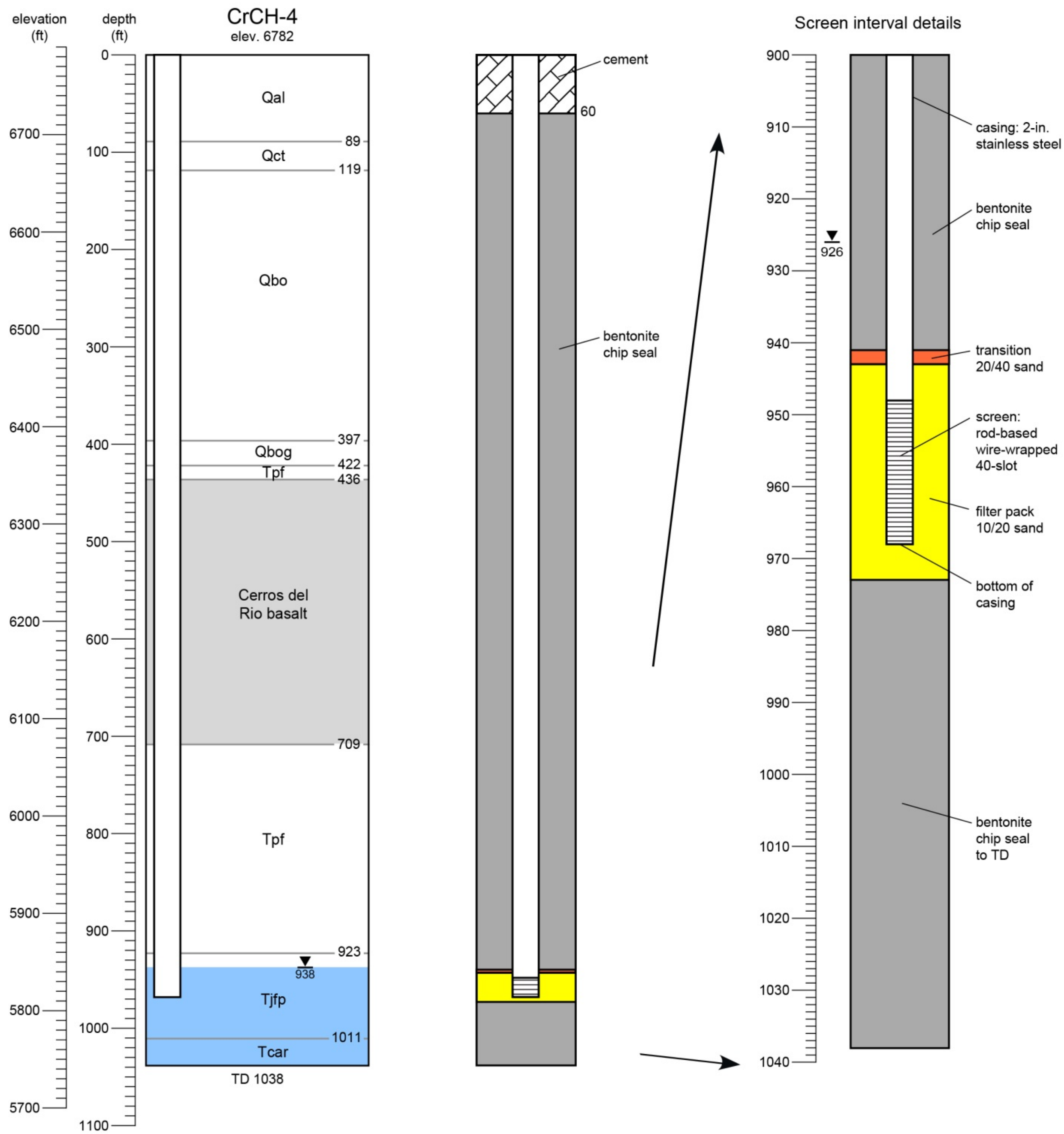

Figure 6 Predicted geology and conceptual design for the final piezometer completion at CrCH-4

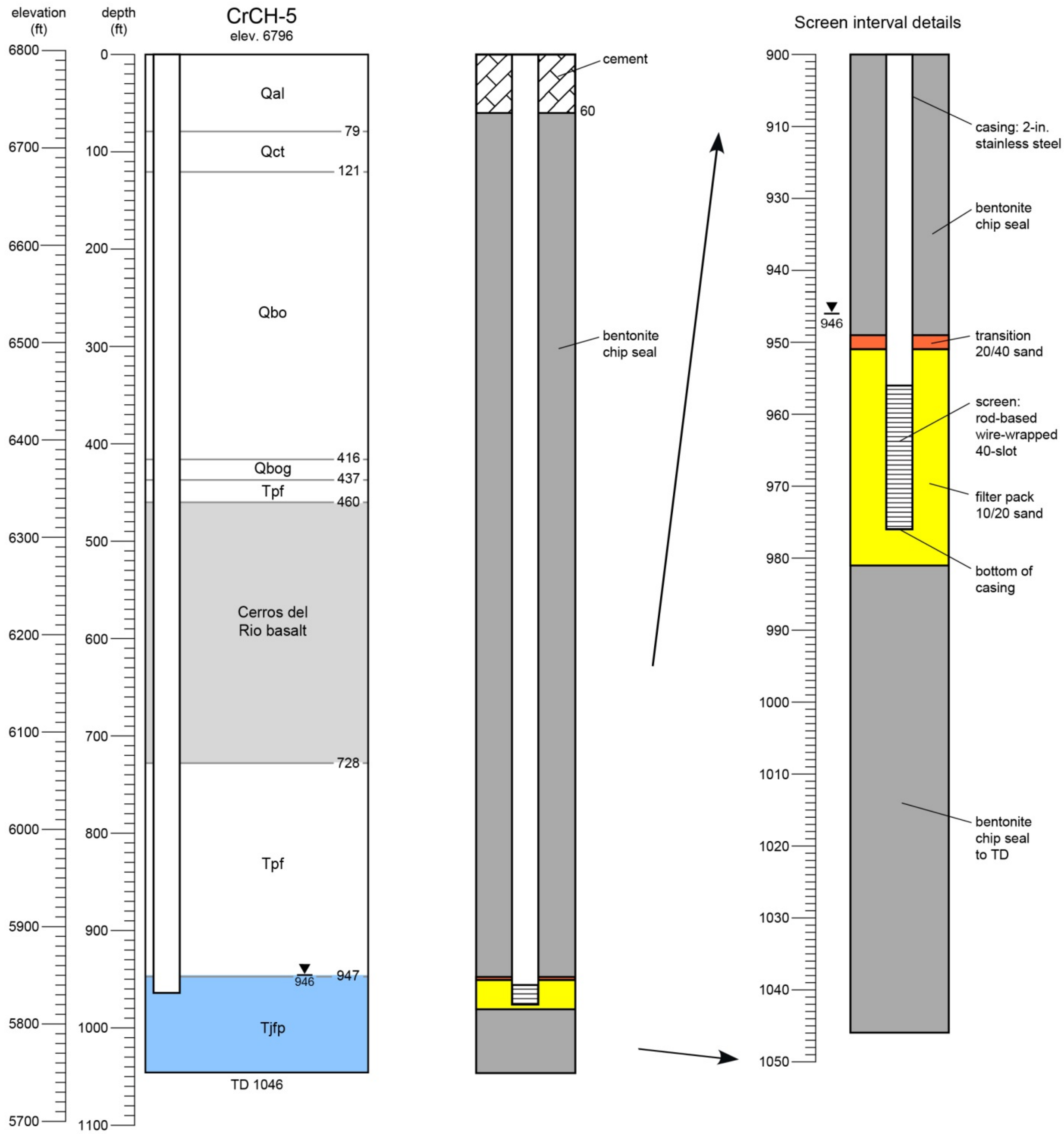

Figure 7 Predicted geology and conceptual design for the final piezometer completion at CrCH-5

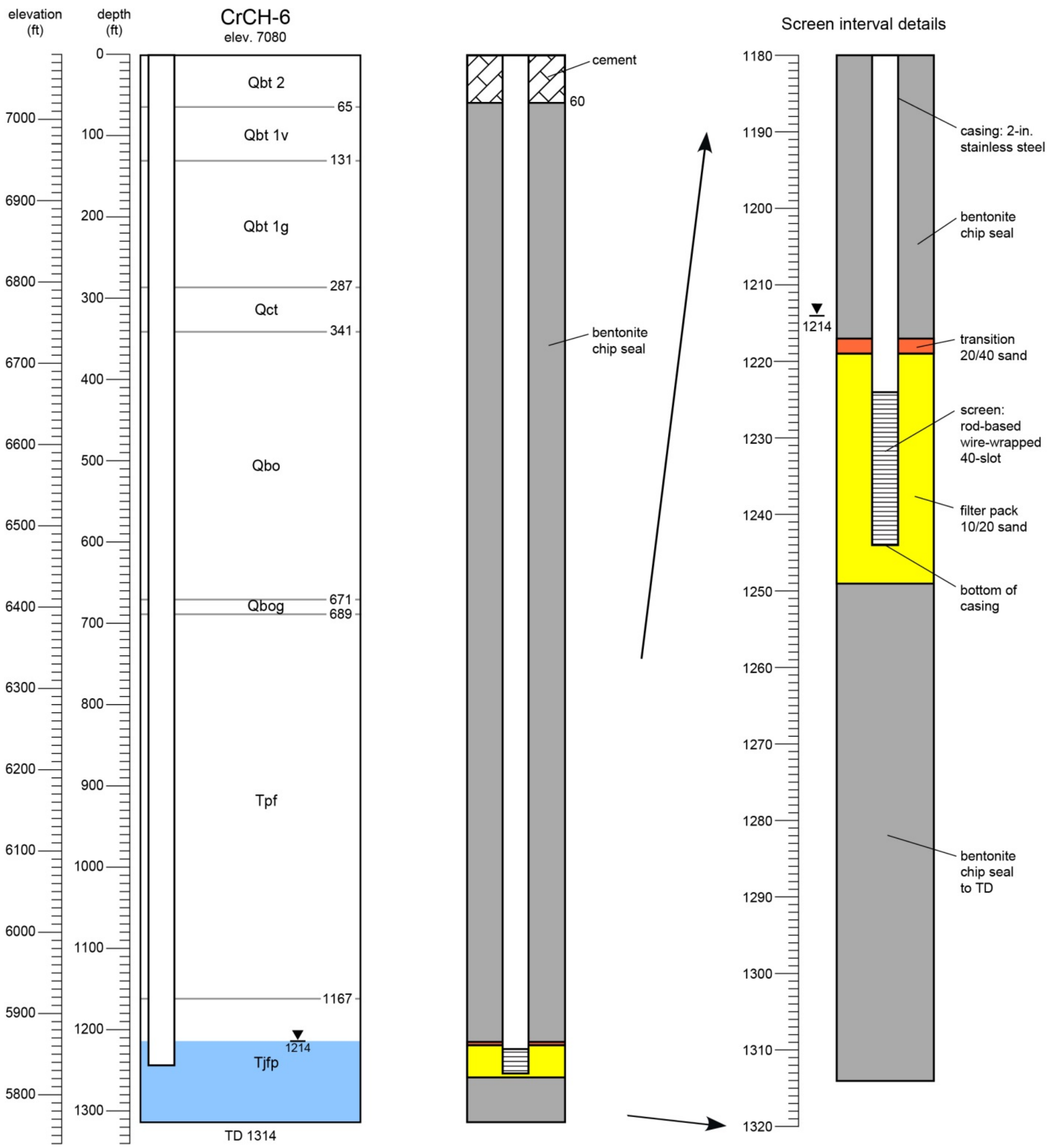

Figure 8 Predicted geology and conceptual design for the final piezometer completion at CrCH-6