Response to the Notice of Disapproval for the Completion Report for Regional Aquifer Well R-40
EPA ID No: NM0890010515, HWB-LANL-GW-MISC,
Dated November 24, 2009

INTRODUCTION

To facilitate review of this response, the New Mexico Environment Department's (NMED's) comments are included verbatim. The comments are presented in the order they were listed in the notice of disapproval. Los Alamos National Laboratory's (LANL's or the Laboratory's) responses follow each NMED comment.

GENERAL COMMENTS

NMED Comment

Section 1.2, Overview of Regional Well R-40: *Mixing occurred between perched intermediate groundwater and the regional aquifer during the 60 days that it took to install the annular backfill material once the borehole total depth was reached. Sixty days is an excessive amount of time for installing annular fill. It is probable that this mixing affected the representativeness of samples obtained from these well screens. The Permittees shall investigate the potential impacts to groundwater quality by quantifying the amount of mixing that occurred, determining whether or not mixing jeopardized the validity of water-quality data, and, if applicable, proposing corrective action(s). The Permittees must submit a response addressing this issue in the revised Report.*

LANL Response

The Laboratory has investigated the potential impact of screen #1 water on the chemistry at screen #2, and the data demonstrate that any impact appears to be minimal. The validity of water-quality data from screen #2 has not been jeopardized by the temporary absence of packers between the two screened intervals. No corrective action is required beyond continuing to follow appropriate purging protocols during sampling and tracking geochemical trends to verify this preliminary conclusion as additional characterization data are acquired. The bases for this conclusion are summarized below.

The Laboratory acknowledges that dates and durations of packer placement are not clear in the Completion Report for Regional Aquifer Well R-40. A new section 5.2.4 entitled "Evaluation of Groundwater Mixing" was added to the revised report based on the discussion below. Paragraph two in section 5.1.1 of the revised report was modified to clarify the use of packers during pumping development, and paragraph one of section 5.1.3 was modified to include the date of packer deployment during well development.

The following is a chronology of well completion and packer placements:

- November 21, 2008: well casing installed to total depth
- November 25, 2008: annular seal was placed between the two screens
- January 7, 2009: screens were isolated with an inflatable packer for development of screen #2 (lower screen)

- January 12, 2009: screens were in communication while the pump/packer was tripped out after development of screen #2 and a transducer installed for the pumping test
- January 20, 2009: after the pumping and recovery tests of screen #2, inflatable packer was replaced with a TAM detachable packer which remained in the well until the Baski sampling system was installed

The intervals during which mixing could have occurred are between the time of annular seal placement between the screens (November 25, 2008) and placement of the inflatable packer (January 7, 2009), the day on which development and pump testing of screen #2 occurred (January 12, 2009) and the day on which the inflatable packer was replaced with the TAM packer (January 20, 2009). The duration of screen communication was 43 d before the packer was first installed, and no more than 12 h each for the January 7 and January 20 events.

Based on data presented in Appendix F of the R-40 well completion report, the rate of flux of groundwater from screen #1 to screen #2 was duration dependent. The initial flux, which applies to durations up to one or two days, was 12 gal./d. For longer durations, the flux dropped off to 8 gal./d. Based on these rates, a total flux of 356 gal. was estimated as follows:

- 43 d * 8 gal./d = 344 gal.
- 1 d (12 h + 12 h) * 12 gal./d = 12 gal.
- 344 + 12 = 356 gal. total flux

The total of 16,751 gal. of water that was removed from screen #2 during its development and aquifer testing more than offsets the 356 gal. potentially introduced by influx from the intermediate perched zone at screen #1.

An evaluation of characteristics and trends in major-ion chemistries supports the conclusion that any water-quality impacts to the regional groundwater at screen #2 resulting from this influx have been effectively mitigated. Water-quality parameters from the two screen #2 samples that were collected in January 2009 (after the January 20 pump test) and April 2009 (after additional well development) were compared to the characterization sample collected in September 2009. These three samples from screen #2 were also compared to samples collected from screen #1 following the aquifer test of this perched zone in April 2009 and for characterization in September 2009.

Results of these comparisons are shown in Figures 5.2-1, 5.2-2, and 5.2-3 of the revised report, using standard graphical techniques (i.e., Piper, Durov, Stiff and Schoeller diagrams) to depict similarities and differences in major-ion chemistries at screens #1 and #2. In these diagrams, waters plot in distinctive fields or show distinctive patterns that reflect site-specific chemistries. Waters with similar chemistries plot in the same fields or show the same patterns on these types of plots. The following observations from the plots of water quality data from screens #1 and #2 support the conclusion that water-quality impacts have been largely mitigated by development/testing activities and by purging protocols currently in place.

- Groundwater samples from screens #1 and #2 occupy distinctively separate fields on the Piper diagram in Figure 5.2-1a. This shows that any consequences of mixing the regional aquifer with perched water at screen #2 were relatively minor after the completion of screen #2 development/aquifer testing activities. If any significant mixing occurred, the data from the January and/or April screen #2 samples would have plotted closer to the field occupied by the two samples from screen #1.
- The Durov diagram (Figure 5.2-1b) further supports this conclusion by showing that total dissolved solids (TDS) concentrations at screen #2 were approximately the same for the January

and September 2009 events, and both were consistently lower than TDS concentrations at screen #1. If there had been any significant mixing from screen #1 it would have resulted in slightly higher TDS concentrations in the January 2009 sample at screen #2.

- Stiff diagrams (Figure 5.2-2) clearly show that the higher TDS concentrations in screen #1 relative to screen #2 are due to significantly higher concentrations of calcium, magnesium, and carbonate alkalinity. Calcium and magnesium concentrations in screen #2 have been relatively stable, which further demonstrates that there has been minimal mixing of the regional aquifer with water from the intermediate perched zone.
- The Schoeller diagram (Figure 5.2-3) provides a convenient way to visualize comparative changes in solute concentrations and similarities in ratios of solutes to one another. Actual solute concentrations (as milliequivalents [meq]/L) are plotted in this diagram, forming a characteristic fingerprint for waters from a similar source. Mixing relationships are revealed by parallel shifts in parameters with significantly different ratios in the two mixing endmembers. For example, water at screen #1 is characterized by a much higher Ca/Na ratio (1.9 meq/meq for the September 2009 sample) than does water at screen #2 (1.0 meq/meq for the September 2009 sample). However, Ca and Na concentrations at screen #2 are relatively constant for the three sampling events and do not reveal the presence of water from screen #1.
- In addition to major-ion chemistries, total organic carbon (TOC) concentrations provide additional evidence that demonstrates minimal impacts from any leakage of perched water into the regional aquifer at screen #2 because the surfactant AQF-2, a source of TOC, was used during drilling interval at screen #1 interval but was not used at screen #2. At the end of development, the TOC concentration at screen #1 was 2.06 mg/L (April 21, 2009). For comparison, the TOC concentration at screen #2 at the end of development (April 28, 2009) was only 0.47 mg/L, which is well within the range of natural background concentrations for the regional aquifer.

NMED Comment

Section 2.2.1, Drilling Strategy: *The total depth of the first borehole was not documented in this section of the Report. The Permittees must provide the total depth of the first borehole in the revised Report.*

LANL Response

The second sentence in paragraph 1 of section 1.2 was revised to read, “The first R-40 borehole was drilled dry from July 11 to September 23, 2008, but was abandoned after reaching a depth of 630 ft due to stuck drilling tools.”

The fifth sentence of the first paragraph of section 2.2.1 was revised to read, “This borehole encountered multiple drilling problems, including stuck tools, and was abandoned after reaching a depth of 630 ft.”

NMED Comment

Section 2.2.1, Drilling Strategy: *This section states that the first borehole was abandoned. The Report does not document how the first borehole was abandoned or even if it was plugged at all. The Permittees must provide documentation detailing the abandonment of the first borehole in the revised Report.*

LANL Response

The plugging and abandonment of the first borehole was documented in Appendix G (Borehole Abandonment Information Form). The following sentence was added to the end of the first paragraph in Section 2.2.1 of the revised report, “Details of plugging and abandonment for the first borehole are given in Appendix G.”

NMED Comment

Section 2.2.1, Drilling Strategy: *The first paragraph, third sentence, page 3, states that during the drilling of the first borehole, perched groundwater was encountered at a depth of 594 feet below ground surface (bgs); however, on page two, first paragraph, the Report states that perched groundwater was encountered at 584 ft bgs in the first borehole. The Permittees must correct this discrepancy in the revised Report.*

LANL Response

The reference to a depth of 584 ft on page 2 is a typographical error, and the sentence was revised to read: “Perched groundwater was noted at 594 ft below ground surface (bgs).”

NMED Comment

Section 2.2.2, Chronological Drilling Activities: *As presented on page 5, eighth paragraph, the placement of bulk-yard sand into the open borehole to a depth of 664 ft bgs introduced foreign contaminants to the regional aquifer at R-40 screen 2 and to perched intermediate groundwater at R-40 screen 1 and also to R-40i. The integrity of the wells was compromised by this action. The Permittees shall investigate this incident and its effect on water and sample quality at R-40 and R-40i and address this issue in the revised Report*

LANL Response

The bulk-yard sand referred to was washed silica sand that is the same kind of silica sand that is used for well filter packs, except it is not sieved to specific grain sizes. This type of sand is chemically inert and has no effect on the integrity of the well. The sentence in question in section 2.2.2 of the revised report was modified as follows: “On October 21, 2008, washed silica sand was transported from the Pajarito Lay-Down Yard to the R-40 site and backfilled into the open borehole from 753 ft bgs to 664 ft bgs.”

The Laboratory proposes that no further action is needed on this issue.

NMED Comment

Section 2.3, Sampling Activities: *The last sentence on page 6 misstates the year of sample collection as noted in bold, “LWSP collected a full-suite groundwater sample from R-40 screen 2 on January 19,* ***2008****, at the conclusion of the 24-h aquifer test”. The Permittees must correct the date in the revised Report.*

LANL Response

The date in the last sentence on page 6 was corrected to January 28, 2009**,** in the revised well completion report.

NMED Comment

Section 2.3, Sampling Activities: *The first paragraph, last sentence on page 7 misstates the year of sample collection as noted in bold, "On January 28,* ***2008,*** *LWSP collected a full suite groundwater sample from R-40i at the conclusion of the 24-h aquifer test". The Permittees must correct the date in the revised Report.*

LANL Response

The date in the last sentence on page 7 was corrected to January 28, 2009, in the revised well completion report.

NMED Comment

Section 3.1.2, Groundwater: *The open-hole video log for the second borehole clearly shows perched water entering the borehole between 442 - 460 feet bgs and at 488 bgs. This observation is not discussed in this section or anywhere else in the Report. The Permittees shall submit a drilling work plan to install an intermediate aquifer well designed to intersect these depths (442-460 feet bgs and 488 feet bgs) at the approximate location of R-40 in order to monitor for potential releases to groundwater from MDA H and other upgradient contaminant sources. The Permittees must submit the drilling work plan to NMED no later than* ***December 31, 2009****.*

LANL Response

The Laboratory agrees that the borehole video observations should have been discussed in the well completion report and has added this description to section 3.1.2 of the revised report. However, the Laboratory believes that the multiple lines of evidence indicate that a new perched-intermediate well is not needed at this location:

- The source of the water observed in the video of the second borehole may not be native groundwater;
- The volume of water encountered in the interval in question is insufficient to install a viable well;
- Well screens R-40i and R-40 screen 1, which target two deeper perched groundwater zones, clearly represent native groundwater and provide monitoring of perched water in the vadose zone at this location; and,
- Additional characterization and monitoring of the vadose pathways is being conducted by vapor-monitoring wells at Material Disposal Area (MDA) H.

The open-hole video log for the second borehole shows water entering the borehole between 442–460 ft below ground surface (bgs) and at 488 bgs. The origin of this water is uncertain and could represent either native groundwater or introduced drilling fluid. The first of two boreholes drilled through this zone was drilled by air-rotary drilling with casing-advance methods, and no groundwater was observed using this dry drilling method. The second borehole, 20 ft away, was drilled by fluid-assisted air-rotary open-hole techniques, and the borehole video showed small amounts of flowing water on the borehole wall. Unfortunately, using the available data, it is not possible to determine with certainty whether water observed in the second borehole was natural in origin, or whether it was groundwater introduced with the drilling fluid.

More importantly, the amount of water entering the borehole between 442 and 488 ft bgs is insufficient to install a viable well. Based on borehole video logs, water flow in the 442- and 488-ft interval at R-40 is significantly less than another perched zone well with a history of poor production (e.g., R-23i piezometer). Low-producing wells cannot be developed properly and it is questionable whether groundwater samples produced by them are reliable and representative. The following description summarizes observations made of water production and lithology made for the second borehole from the October 10, 2008 video log. The borehole was 645 ft deep and top of foamy water was 638.5 ft bgs at the time the video log was made. A total of 14,425 gal. of water and 185 gal. of AQF-2 foam had been used during drilling up to this point, including 3030 gal. of water and foam the day before logging.

- At 441.5–443.5 ft: Basaltic conglomerate with rounded to angular clasts in a silty matrix. Wet borehole wall, but no water flow.
- At 443.5–450.5 ft: Massive basalt flow interior cut by numerous subhorizontal and high-angle fractures. Minor clay in some fractures. Wet borehole wall, but no water flow.
- At 450.5–452 ft: Clay-rich interflow breccia. Wet borehole wall, but no water flow.
- At 452–456.5 ft: Lava flow interior with vesicular basalt. Horizontal fractures. Wet borehole wall, but no water flow.
- At 456.5–458.5: Blocky interflow breccia. Not much clay present. Wet with a few trickles of water on the borehole wall at 457 ft. Water not seen on walls above, so observed water may be coming out of this interflow breccia.
- At 458.5–471.5: Lava flow interior with vesicular basalt. Contains relatively few fractures. Wet borehole wall, but no water flow.
- At 471.5–480 ft: Blocky interflow breccia. Some red oxidation stains. Wet with trickle of water at 475 ft.
- At 480–490 ft: Lava flow interior. Basalt is blocky and fractured throughout. Small trickles of water below 482 ft. Patches of frothy drilling foam at 487–490 ft.

The borehole video observations show the water production is discontinuous throughout the 442- and 488-ft interval, and the amount of flow is very low. Zones of native groundwater with better flow characteristics were identified in the lower half of the Cerros del Rio basalt at R-40. Two deeper perched groundwater zones were targeted by two separate well screens (R-40i and R-40 screen 1) based on water level measurements, driller's observations, and geophysical log responses. These deeper zones clearly represent native groundwater and provide monitoring of perched water in the vadose zone at this location. Nonetheless, it is notable that field personnel have difficulty collecting full suites of water samples from these zones after purging because of their low flow rates. If a well is installed in the 442- to 488-ft interval, it would be expected to perform similarly or worse based on the observations described above.

Additional characterization and monitoring of the vadose pathways is being conducted by vapor-monitoring wells at MDA H. Together, the vadose zone monitoring of vapor transport at MDA H, monitoring of perched groundwater at wells R-37, R-40 screen 1, and R-40i, and monitoring of regional groundwater at R-37, R-40 screen 2, and soon-to-be-drilled R-53 provide a defense-in-depth approach to detection of potential contaminant releases from MDA H. The benefit of an additional monitoring well targeting the 442- and 488-ft interval at R-40 appears to be very low compared to the cost of installing a new well at this location.

The following paragraph was inserted as the first paragraph of Section 3.1.2 in the well completion report:

> An open-hole video log for the second borehole collected on October 10, 2008 showed small flows of water entering the borehole between 442 and 488 ft bgs. The origin of this water is uncertain and it could represent either native groundwater or introduced drilling fluid. The first of two boreholes drilled through this zone was drilled by air-rotary drilling with casing-advance methods, and no groundwater was observed using this dry drilling method. The second borehole was drilled 20 ft away by fluid-assisted air-rotary open-hole techniques, and the borehole video showed small amounts of flowing water on the borehole wall. A total of 14,425 gal. of water and 185 gal. of AQF-2 foam had been used to drill the second borehole up to this point, including 3030 gal. of water and foam the day before logging. Unfortunately, using the available data, it is not possible to determine with certainty whether water observed in the second borehole was natural in origin, or whether it was groundwater introduced with the drilling fluid. Whatever its origin, the borehole video observations show the water production is discontinuous throughout the 442 and 488 ft interval, and the amount of flow is very low. Deeper zones of perched groundwater in the basalt were targeted for groundwater monitoring because they are unambiguous perched groundwater occurrences that capable of producing representative water quality data.

NMED Comment

Section 5.2.3, R-40 Screen 2: *It is not clear whether or not a packer was placed in R-40 between screens 1 and 2 after the development of screen 2 was completed on April 28, 2009 and prior to the installation of the Baski dual completion sampling system in June, 2009. If a packer was not placed between the screens during this time period, the Permittees shall investigate the potential impact to both screens by quantifying the amount of mixing that occurred, determine whether or not mixing jeopardized the validity of water-quality data, and, if applicable, propose corrective action(s). If a packer was not used, the Permittees must state as such. The Permittees must address this issue in the revised Report.*

LANL Response

Response to this comment is addressed in the section 1.2 response to this NOD.

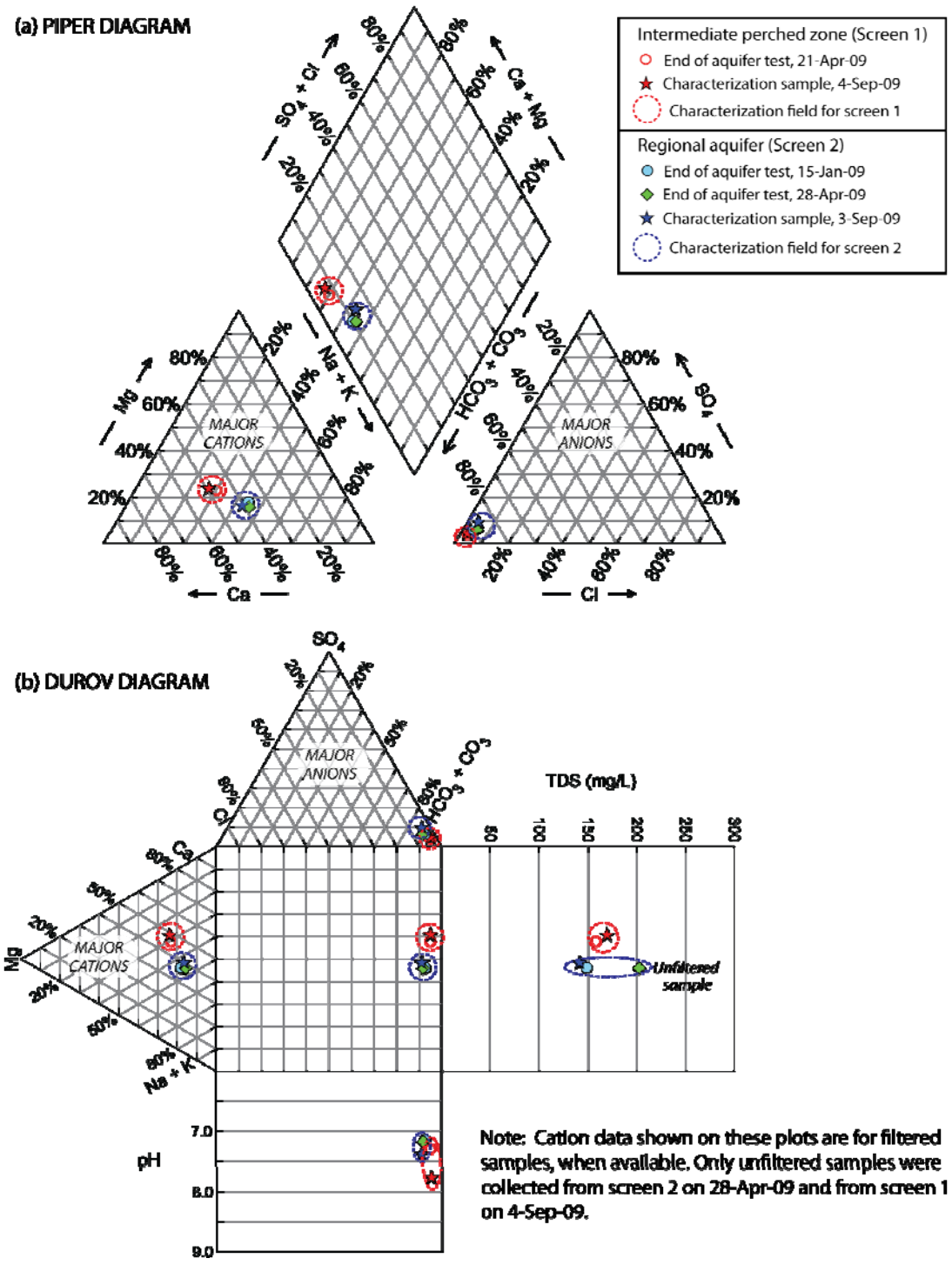


Figure 5.2-1 Comparison of major-ion characteristics of water-quality samples from R-40 screens 1 and 2; (a) Piper diagram and (b) Durov diagram

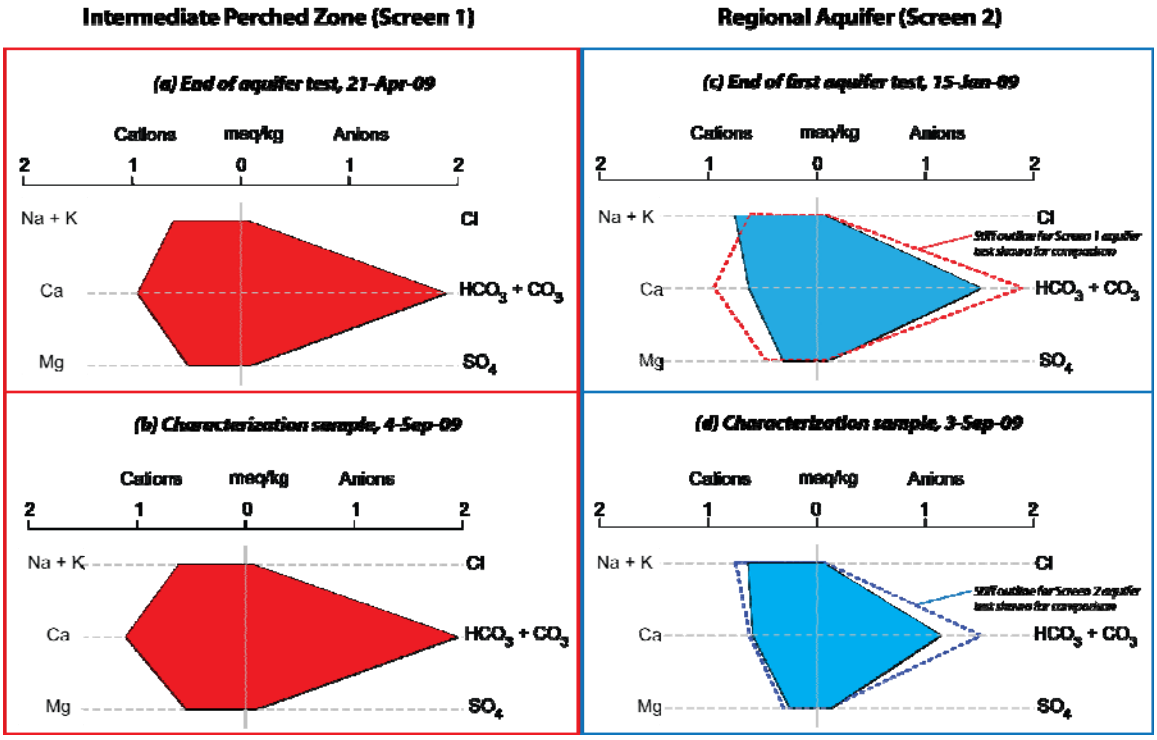


Figure 5.2-2 Comparison of major-ion characteristics of water-quality samples from R-40 screens 1 and 2 using Stiff diagrams

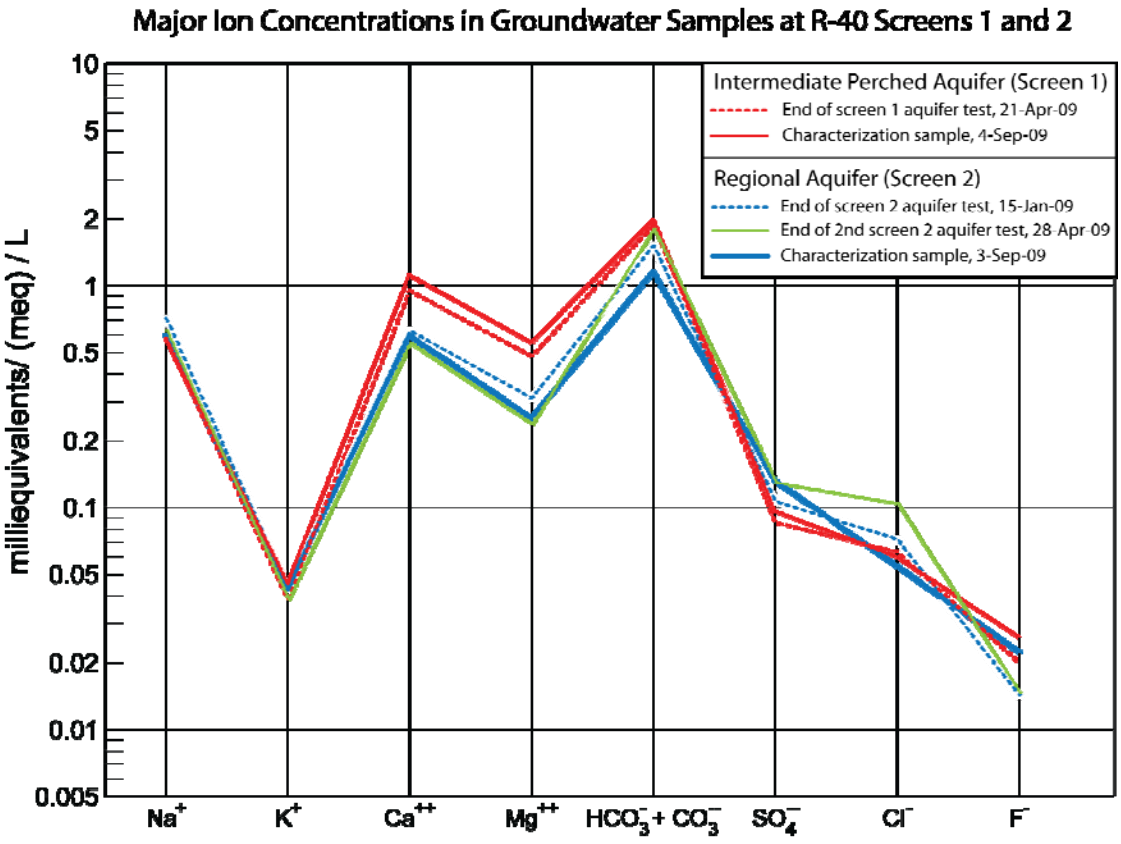


Figure 5.2-3 Comparison of major-ion characteristics of water-quality samples from R-40 screens 1 and 2 using a Schoeller plot