DEPARTMENT OF ENERGY

Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

EMLA-23-BF272-2-1

July 14, 2023

Mr. Rick Shean
Designated Agency Manager
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of the Response to the New Mexico Environment Department Review of the Annual Progress Report on Chromium Plume Control Interim Measure Performance, July 2021 to March 2022 (June 2022)

Dear Mr. Shean:

Enclosed please find two hard copies with electronic files of the "Response to the New Mexico Environment Department Review of the Annual Progress Report on Chromium Plume Control Interim Measure Performance, July 2021 to March 2022" (June 2022). This response addresses comments provided by the New Mexico Environment Department on the "Annual Progress Report on Chromium Plume Control Interim Measure Performance, July 2021 through March 2022," dated May 31, 2023.

If you have any questions, please contact Cheryl Fountain at (505) 695-3292 (cheryl.fountain@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Digitally signed by BRIAN HARCEK
Date: 2023.07.14 12:27:37 -06'00'

Arturo Q. Duran For
Compliance and Permitting Manager
U.S. Department of Energy
Environmental Management
Los Alamos Field Office

Enclosure(s):

1. Two hard copies with electronic files – Response to the New Mexico Environment Department Review of the Annual Progress Report on Chromium Plume Control Interim Measure Performance, July 2021 to March 2022 (June 2022) (EM2023-0434)

cc (letter with CD/DVD enclosure[s]):
Laurie King, EPA Region 6, Dallas, TX
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Response to the New Mexico Environment Department Review of the Annual Progress Report on Chromium Plume Control Interim Measure Performance, July 2021 to March 2022 (June 2022), Los Alamos National Laboratory, EPA ID#NM0890010515, HWB-LANL-22-045, Dated May 31, 2023

INTRODUCTION

To facilitate review of this response, the New Mexico Environment Department's (NMED's) comments are included verbatim. The U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office responses follow each NMED comment.

COMMENTS

NMED Comment

1. 3.3 Water-Table Map, pg. 3.

DOE Statement: *"Where multiple screens are present, only the upper screen data are used."*

NMED Comment: *DOE must provide water table screen data points for the screen 2 intervals and must provide water-table mapping for the screen 2 deeper heads. NMED understands that, initially, the data points available to construct the water-table mapping for the lower screen depths will be minimal. However, providing this lower plume representation is crucial to include in each Annual Progress Report in future. The water-table mapping will continue to improve as additional wells are drilled and more data points can be incorporated.*

DOE Response

1. Water table maps for both shallow regional screens and deep regional screens are provided in the 2023 "Annual Progress Report on Chromium Plume Control Interim Measure Performance, April 2022 through March 2023" (hereafter, the Annual Progress Report) and will continue to be provided in future annual progress reports as described below.

   Water table maps are generated using the NMED-approved well list:

Shallow Regional Screen	Comment
CrPZ-1	None
CrPZ-2a	None
CrPZ-3	None
CrPZ-4	None
CrPZ-5	None
SIMR-2	None
R-1	None
R-11	None
R-13	Deeper than other shallow regional screens; crosses Tpf/Tpf(p)/Tjfp
R-15	Longer than most shallow screens, crosses Tpf/Tpf(p)/Tjfp
R-28	None

Shallow Regional Screen	Comment
R-33 Screen 1 (S1)	None
R-35b	None
R-42	In Tjfp
R-43 S1	Straddles Tjfp/Tcar, mostly in Tcar
R-44 S1	None
R-45 S1	None
R-50 S1	None
R-61 S1	None
R-62	In Tjfp
R-70 S1	None
CrPZ-2b	Shallower than other screen 2 depths
R-13	Crosses Tpf/Tpf(p)/Tjfp
R-33 Screen 2 (S2)	Excluded when PM-4 is pumping
R-43 S2	Entirely in Tcar
R-44 S2	None
R-50 S2	None
R-61 S2	None
R-70 S2	None

Shallow Regional Potentiometric Contours

Shallow regional potentiometric contours, using the shallower screens (<50 ft below the regional water table), are included in the 2023 Annual Progress Report. Shallow regional potentiometric contours were generated for May 1, 2020; April 2, 2022; September 10, 2022; and March 19, 2022.

Additionally, shallow regional potentiometric contours are shown in Enclosure 4 of the 2023 Annual Progress Report submittal, titled "Chromium Interim Measure Capture Zone Analysis" (Neptune 2023, 702782), for May 1, 2020; June 15, 2021; and November 1, 2021.

Deep Regional Potentiometric Contours

Deep potentiometric contours, using the deeper screens (>50 ft below the water table), are included in the 2023 Annual Progress Report. Deep regional potentiometric contours were generated for May 1, 2020; April 2, 2022; September 10, 2022; and March 19, 2022.

Additionally, deep regional potentiometric contours are shown in Enclosure 4 of the 2023 Annual Progress Report submittal (Neptune 2023, 702082) for May 1, 2020; June 15, 2021; and November 1 2021.

The deep regional potentiometric maps in the 2023 Annual Progress Report show a gradient that is generally toward the southeast, similar to the baseline shallow regional potentiometric surface map. A further discussion of comparisons between the shallow regional and deep regional potentiometric surfaces is included in Enclosure 4 of the 2023 Annual Progress Report submittal (Neptune 2023, 702082).

NMED Comment

2. 3.2 Monitoring Results, pg. 3.

DOE Statement*: "Figures 3.2-24 through 3.2-25 provide tracer chemistry results for a few wells related to recent tracer tests."*

NMED Comment: *Figure 3.2-24,* Time-series plots of tracer detections for R-50 screen 1*, show the following tracer tests: 1, 5-NDS (5kg/15 k-gals) injected at CrIN-4 on 5/17-18/2017; and 2,6-NDS (5kg/15k-gals) injected at CrIN-4 on 9/17/2018. Additionally, Figure 3.2-25, Time-series plots of tracer detections for R-44 screen 1, show one tracer test of 1,3,6-NTS (50kg/15 k-gals) injected at CrIN-3 on 9/12/18. However, Table 3.1-1,* Performance Monitoring Locations and Analyte Suites, Including Tracers that Have Been or Will Be Deployed in Monitoring Wells, Piezometers, and Injection Wells in the Project Area*, demonstrates that Naphthalene Sulfonate tracer, Sodium Bromide tracer, Sodium Perrhenate tracer, and Deuterated Water tracer are deployed in monitoring wells either monthly or quarterly. DOE must present a discussion summarizing the tracer activities conducted during the Annual Progress Report monitoring period. The Annual Progress Report must include the results of the calculations of the tracer travel time, a discussion of any associated aquifer parameters found using results of tracer tests, and a discussion of the observed responses to the tracer tests. The tracer test discussions have been included in previous documents, including the* Semiannual Progress Reports on Chromium Plume Control Interim Measure Performance, January through June 2021*. An updated discussion of the tracer tests conducted during the monitoring period for this Annual Progress Report must be provided in a written response.*

The Semiannual Progress Report on Chromium Plume Control Interim Measure Performance, January through June 2021 *specifically mentioned that the sulfonate tracers deployed into CrIN-1 and CrIN-2 have neither been detected in CrEX-5 nor R-45 screen 1 and screen 2. In a written response, DOE must update the results of these sulfonate tracer deployments and include a discussion to address the potential reasons for the observed responses.*

DOE Response

2. No additional injected tracers were deployed during the 2022 Annual Progress Report period. In the previous 5 yr, a one-time injection was deployed into each of the five injection wells. These injected tracers were then monitored either monthly or quarterly per Table 3.1-1 of the 2022 Annual Progress Report to understand breakthrough curves. This table, included as Table 1 in this comment response, was renamed in the 2023 Annual Progress Report to "Frequency of Analytical Suites Collected at Performance Monitoring Locations, Piezometers, and Additional Monitoring Wells Addressed in this Report."

   Injected tracers have been deployed into each of the five injection wells to allow observations of tracer arrivals at monitoring wells and extraction wells. Naphthalene sulfonate tracers were used for all injection wells because they are highly soluble; generally nonbiodegrading, nontoxic, and nonadsorbing; have very low detection limits; and are relatively inexpensive for the large injection masses necessary for detection at monitoring and extraction wells (Rose et al. 2001, 232203). The following tracers were deployed into the injection wells:

   - CrIN-1: 2,6-naphthalene disulfonic acid (2,6-NDS) was injected on March 31, 2021.
   - CrIN-2: 1,3,5-naphthalene trisulfonic acid (1,3,5-NTS) was injected on March 30, 2021.
   - CrIN-3: 1,3,6-NTS was injected on September 10, 2018.

- CrIN-4: 1,5-NDS was injected on May 17 and 18, 2017, and 2,6-NDS was injected on September 17, 2018.
- CrIN-5: 1,6-NDS was injected on May 18 and May 19, 2017, and 2,7-NDS was injected on September 18, 2018.

Concentrations of sulfate are unaffected, and concentrations of chloride are minimally affected by the treatment process. Chloride replaces the hexavalent chromium anion; however, chloride concentrations contributed from the treatment process are significantly lower than the contaminant concentrations of chloride in the regional aquifer, which typically range from 20 to 60 mg/L within the centroid of the chromium plume. This is the primary source of chloride present in treated water. Hence, chloride and sulfate concentrations in injection water are largely a continuous, flow-weighted average of extraction well concentrations. These concentrations can determine only whether treated injected water is present but cannot be traced to a particular injection well. Therefore, naphthalene sulfonate tracers were introduced as a concentrated slug of short duration and can indicate an unequivocal arrival of treated water from a specific injection well. By combining tracer data with geochemical responses of chloride and sulfate due to injection water signals, flow patterns, and mixing associated with interim measures (IM) operation can be discerned.

CrIN-4 and CrIN-5 Tracers

NDS[1,5-] tracer injection into CrIN-4 occurred in May 2017, and 2,6-NDS tracer injection occurred in September 2018. NDS[1,6-] tracer injection into CrIN-5 occurred in May 2017, and 2,7-NDS tracer injection occurred in September 2018. Figure 3.2-24 from the 2022 Annual Progress Report presents a time-series plot of chromium and tracers detected in R-50 screen 1, including 1,5-NDS and 2,6-NDS (Figure 3.2-24 and other figures are included in this response for the convenience of the reviewer). The screen is approximately 10 ft below the regional water table at R-50. NDS[1,5-] was detected in August 2018. As shown in Figure 3.2-8 from the 2022 Annual Progress Report, shortly after the 1,5-NDS arrival, the chloride concentration reached 20 mg/L, which is approximately the injection water concentration, suggesting that the regional aquifer water originally present in R-50 screen 1 was completely replaced by the injection water. NDS[2,6-] was detected once on January 15, 2019, at R-50 screen 1. The tracer appears to have biodegraded in the regional aquifer soon after it arrived at R-50 screen 1, an unexpected outcome given that naphthalene sulfonate tracers are known to have lifetimes of many years in geothermal reservoirs (Rose et al. 2001, 232203). As can be seen in Figure 3.2-24, R-50 screen 1 chromium concentrations rapidly declined as the injection water from CrIN-4 arrived.

The 1,5-NDS tracer was detected in CrEX-1 on August 15, 2018, similar to the August 9, 2018, arrival at R-50 screen 1, despite CrEX-1 being located twice as far from the CrIN-4 injection site. Unlike R-50 screen 1, the tracer concentration at CrEX-1 has not significantly decreased and remains relatively high.

Although CrIN-4 is the major contributor of injected water to CrEX-1, with the apparent susceptibility of some of these tracers to biodegrade, it is possible that some contributions of injected water are from CrIN-5. However, CrIN-5 tracers have not been detected at CrEX-1 or at any monitoring well.

Finally, chloride, sulfate, and chromium concentration histories in R-50 screen 2, as well as lack of tracer arrivals, indicate that injection fluid has not arrived in the deeper screen (see Figure 3.2-9 from the 2022 Annual Progress Report). There has also been no evidence of tracer or injection water arrivals at SIMR-2, despite its relatively close proximity to CrIN-4 and CrIN-5, approximately 1100 and 2000 ft to the southeast, respectively.

CrIN-3 Tracers

NTS[1,3,6-] tracer injection into CrIN-3 occurred on September 12, 2018.

Figure 3.2-25 from the 2022 Annual Progress Report presents a time-series plot of chromium and tracers in R-44 screen 1, including 1,3,6-NTS. The screen is approximately 15 ft below the regional water table. NTS[1,3,6-] was first detected at R-44 screen 1 in December 2018 and has shown a definitive response to injection water and the 1,3,6-NTS tracer. Shortly after the 1,3,6-NTS arrival, the chloride concentration trends rapidly approached injection water concentrations (Figure 3.2-4 in the 2022 Annual Progress Report). No tracer or injection water signal has been detected in R-44 screen 2, which is approximately 100 ft below the regional water table. Chloride concentration trends at R-45 screen 2 are similar for R-45 screen 1 (Figure 3.2-4 from the 2022 Annual Progress Report).

Thus, the CrIN-3 injection water seems to remain relatively shallow, similar to the injection water from CrIN-4. The CrIN-3 tracer and injection water signatures have not been detected at R-13 or SIMR-2.

CrIN-1 and CrIN-2 Tracers

NDS[2,6-] tracer injection into CrIN-1 occurred in March 2021. NTS[1,3,5-] tracer injection into CrIN-2 also occurred in March 2021.

The 2,6-NDS tracer injected into CrIN-1 appears to have inexplicably biodegraded before it could be detected in any monitoring or extraction well. If the 2,6-NDS tracer had a longevity in the regional aquifer similar to the 2,6-NDS CrIN-4 injection, it should have been detected in R-45 screen 1 or CrEX-5. The reason the 2,6-NDS tracer had a shorter longevity in the regional aquifer (relative to CrIN-4) has not yet been determined.

On December 21, 2021, 1,3,5-NTS was first detected at CrEX-3. The total tracer mass recovery is increasing with no indication of biodegradation. This result suggests that the injection water arriving in R-45 screen 1 came from CrIN-1 rather than CrIN-2.

Figure 3.2-23 from the 2022 Annual Progress Report shows the chloride, sulfate, and chromium concentration histories in CrEX-5, which, in lieu of a tracer response, can be used to look for evidence of treated water arrival from CrIN-1. While the trends in sulfate and chromium are consistent with the possibility of a treated water arrival, it is clear that the concentrations of all constituents have been decreasing since CrEX-5 began operations. Hence, the lower concentrations may be due to a concentration decrease in groundwater drawn into CrEX-5, treated water arrival, or both. Because chloride concentrations in CrEX-5 have dropped below the average concentration in injection water, then at least some of the observed decrease is from groundwater being treated at CrEX-5, presumably from locations within or at the edge of the plume where concentrations are lower.

Figure 3.2-13 in the 2022 Annual Progress Report shows chloride, sulfate, and chromium trends in R-70 screen 2, which has higher concentrations relative to R-70 screen 1 (Figure 3.2-12 from the 2022 Annual Progress Report). R-70 screen 1 appears to be better connected to the plume centroid than the upper screen at R-70. Chloride, sulfate, and chromium trends at R-70 screen 2 are similar to those at CrEX-5, although the chloride concentration at R-70 screen 2 has dropped to even lower levels than in CrEX-5. These results suggest that treated injection water has not yet arrived at R-70 screen 2, given the continuously declining concentrations of chloride and sulfate to levels lower than the injection fluid concentrations. Furthermore, there are no signs of injection water reaching R-70 screen 1. Instead, a reasonable assumption is that CrEX-5 is, at least in part, pulling groundwater from R-70 preferentially from the depths of R-70 screen 2 and perhaps from R-70 screen 1 as well.

IM Flow Inferences from Tracers

A qualitative picture of injection footprints is shown in Figure 3.5-5 from the 2023 Annual Progress Report, which not only integrates information provided in the Annual Progress Report, but also draws on results from previous tracer studies documented in Reimus et al. (2021, 701331) and the absence of a cross-hole response with the R-28 amendment injection. Inferences from injection water tracers and geochemistry are as follows:

- Injection flow into CrIN-4 reached both R-50 screen 1 and CrEX-1. CrIN-4 injection water has not reached other observation locations, including R-50 screen 2 and SIMR-2. The injection water appears to remain shallow, at least in the vicinity of R-50.
- Injection flow into CrIN-5 has not been definitively observed at any location, possibly due to the biodegradation of the CrIN-5 tracer. Injection flow into CrIN-2 reached CrEX-3.
- CrIN-2 injection water has not reached either R-45 screen 1 or R-45 screen 2 or any other location.
- Injection flow into CrIN-1 reached R-45 screen 1 very rapidly, but the rapid degradation of the tracer injected into CrIN-1 has prevented a positive detection of arrival at CrEX-5. CrIN-1 injection flow does not appear to be reaching R-45 screen 2, R-70 screen 1, or R-70 screen 2.
- CrEX-3 is extracting groundwater from CrIN-2.

To date, tracers introduced in injection wells and the distinct geochemical signature of injection water are present only in the shallow upper 50 ft of the regional aquifer and only in the upper screens at wells R-44, R-45, and R-50. There is no tracer evidence to date of injection water migration below depths of the upper screens.

Estimation of Flow Velocities

Tracer injections, which are observed at monitoring or extraction wells, aid in understanding the details of plume-scale groundwater flow dynamics under the influence of the IM extraction and injection. In addition to the tracer results, monitoring-well observations of various geochemical signatures in injection water provide insights into plume-scale groundwater flow dynamics, including estimates of flow porosity and how volumetric flow is distributed within the aquifer porosity over large interrogation volumes. These estimations are described in the proceedings of the 2021 Waste Management Symposium (Reimus et al. 2021, 701331); Figure 2 and Table 2 from the proceedings are included in this document. Figure 2 shows estimates of the groundwater flow rates and Cr(VI) fluxes estimated in borehole dilution tracer tests, and Table 2 shows estimates of flow porosities associated with the first and mean arrival times. Additional information for these calculations are provided in the proceedings.

Starting in 2024, annual progress reports will include the associated aquifer parameters determined from tracer tests, and tracer travel times will be evaluated for future inclusion in the annual progress reports.

NMED Comment

3. Figure 3.3-2 Water table for June 15, 2021, pg. 38.

In a written response, DOE must provide a modified Figure 3.3-2 that only uses the chromium monitoring wells. It appears that the contour lines provided on the Figure are being skewed by monitoring wells that are not associated with the chromium plume. Specifically, the region north of R-43 and R-11 show skewed contour lines that are not representative of the data gathered from the chromium monitoring wells. Since there are currently no monitoring wells located in that region, the contour lines should end at the boundary for the approximate position of 50 ppb extent of chromium and should not be extrapolated for the areas where monitoring well information is not available.

DOE Response

3. Figure 3.3-2 is generated per the NMED approved parameters, and no edit to the figure is required. Synoptic regional aquifer surface contours were drawn by hand using the three-point method according to the NMED-approved well list (see DOE response to comment 1 for the list).

   In this method, adjacent wells are grouped into triplets, and a gradient vector is calculated for each set of triplets using the method of Heath, "Basic Ground-Water Hydrology" (Heath 1983, 700907) https://pubs.usgs.gov/wsp/2220/report.pdf. This method assumes that

   - the water table surface is planar,
   - flow is mostly horizontal, and
   - there is no pumping or injection within a triplet.

   Because these assumptions are not always appropriate, some interpretation is necessary to produce a realistic potentiometric surface.

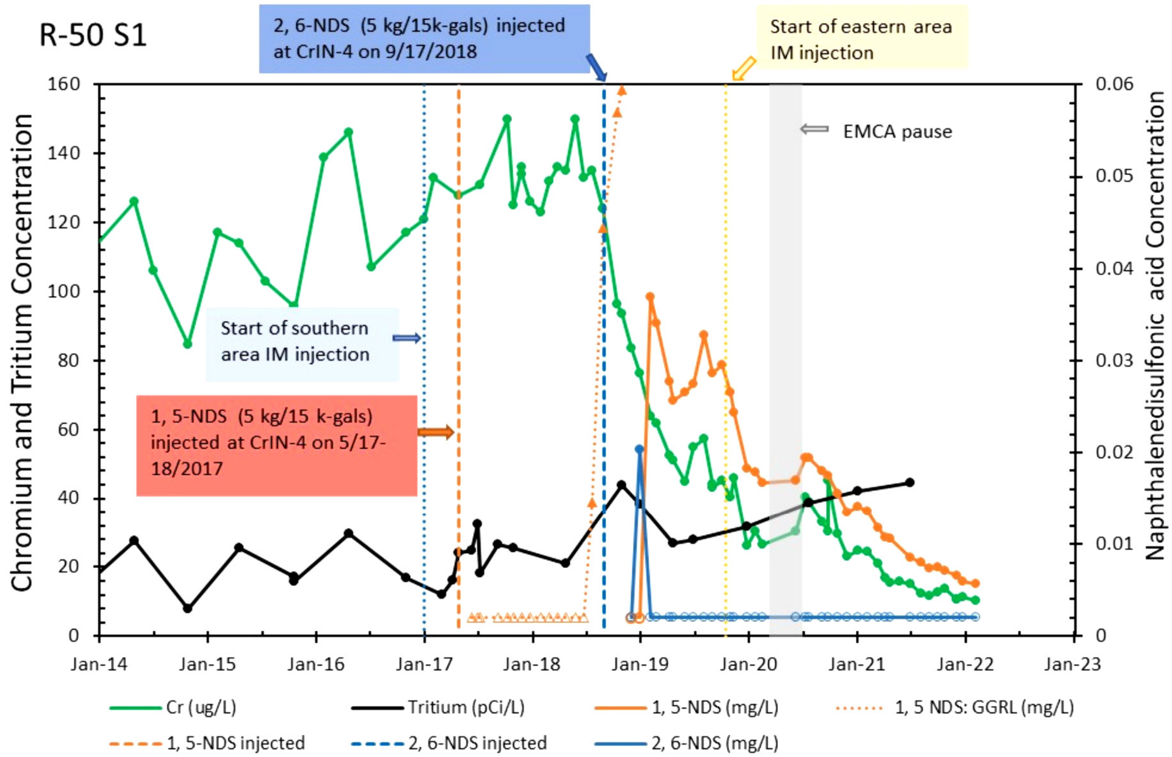
REFERENCES

Heath, R.C., 1983. "Basic Ground-Water Hydrology," prepared in cooperation with the North Carolina Department of Natural Resources and Community Development, U.S. Geological Survey Water-Supply Paper 2220, Reston, Virginia. (Heath 1983, 700907)

Neptune (Neptune and Company, Inc), January 31, 2023. "Chromium Interim Measure Capture Zone Analysis," report prepared by Neptune and Company, Inc, for the U.S. Department of Energy Environmental Management Los Alamos Field Office, Los Alamos, New Mexico. (Neptune 2023, 702782)

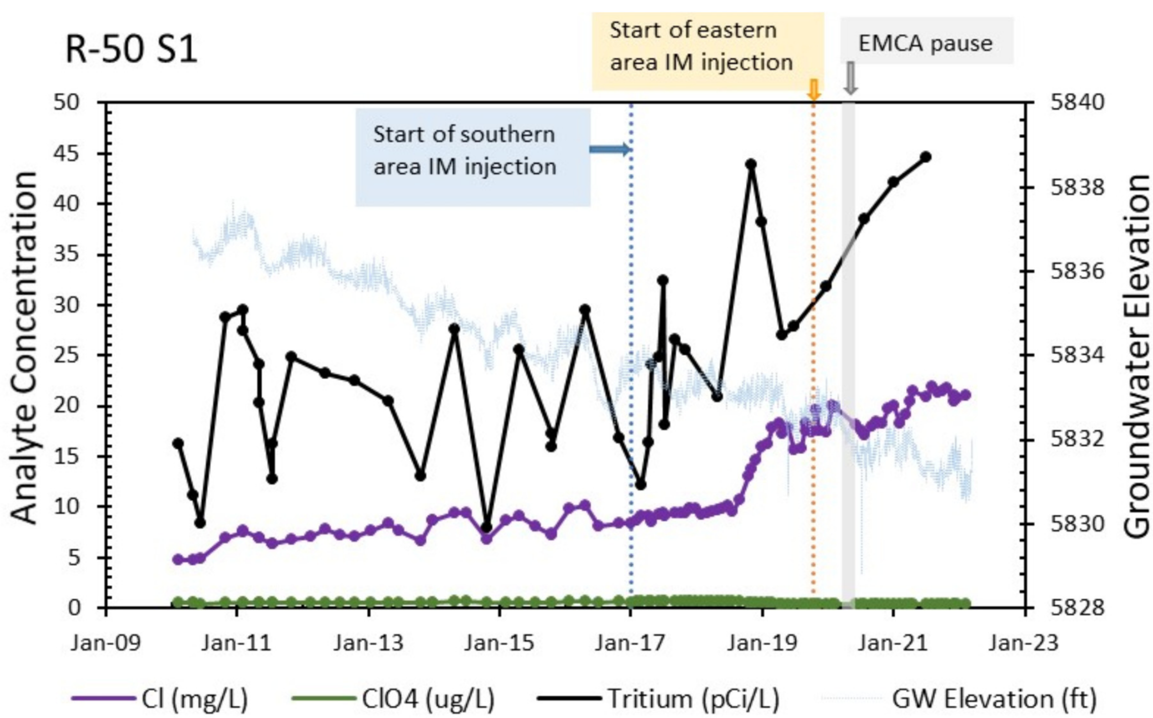
Reimus, P., D. Katzman, M. Ding, and B. Willis, March 8–12, 2021. "Using Tracers and Opportunistic Geochemical Signatures to Inform Modeling of Cr(VI) Migration at LANL," Waste Management 2021 Conference, March 8–12, 2021, Phoenix, Arizona. (Reimus et al. 2021, 701331)

Rose, P.E., W.R. Benoit, and P.M. Kilbourn, December 2001. "The Application of the Polyaromatic Sulfonates as Tracers in Geothermal Reservoirs," *Geothermics,* Vol. 30, No. 6, pp. 617–640. (Rose et al. 2001, 232203)



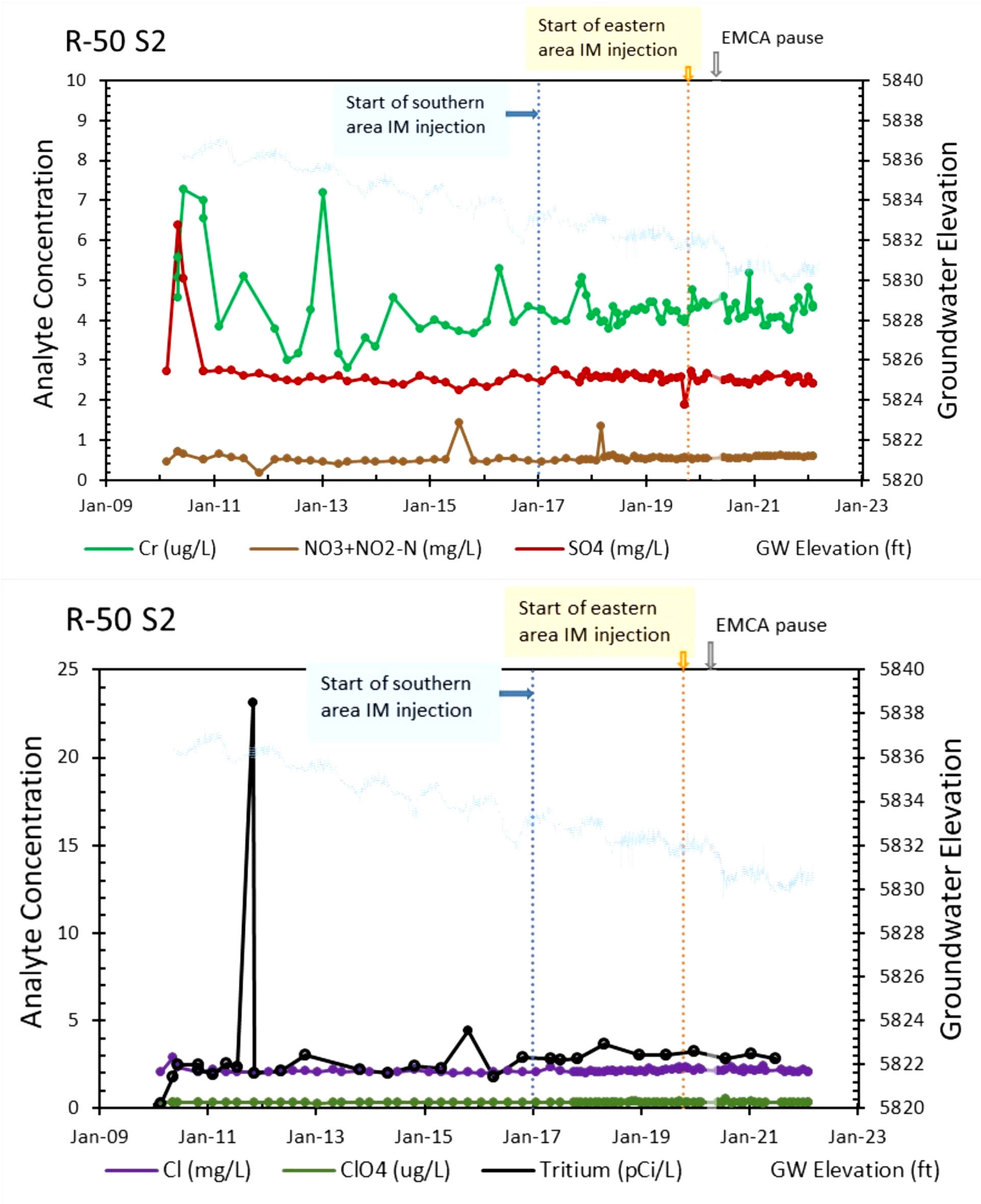
Notes: Open symbols represent nondetection results, and solid symbols represent detection results at the plotted value. The background for chromium is 7.48 µg/L. Groundwater elevations represent raw data (without barometric adjustment).

Figure 3.2-24 Time-series plots of tracer detections for R-50 screen 1



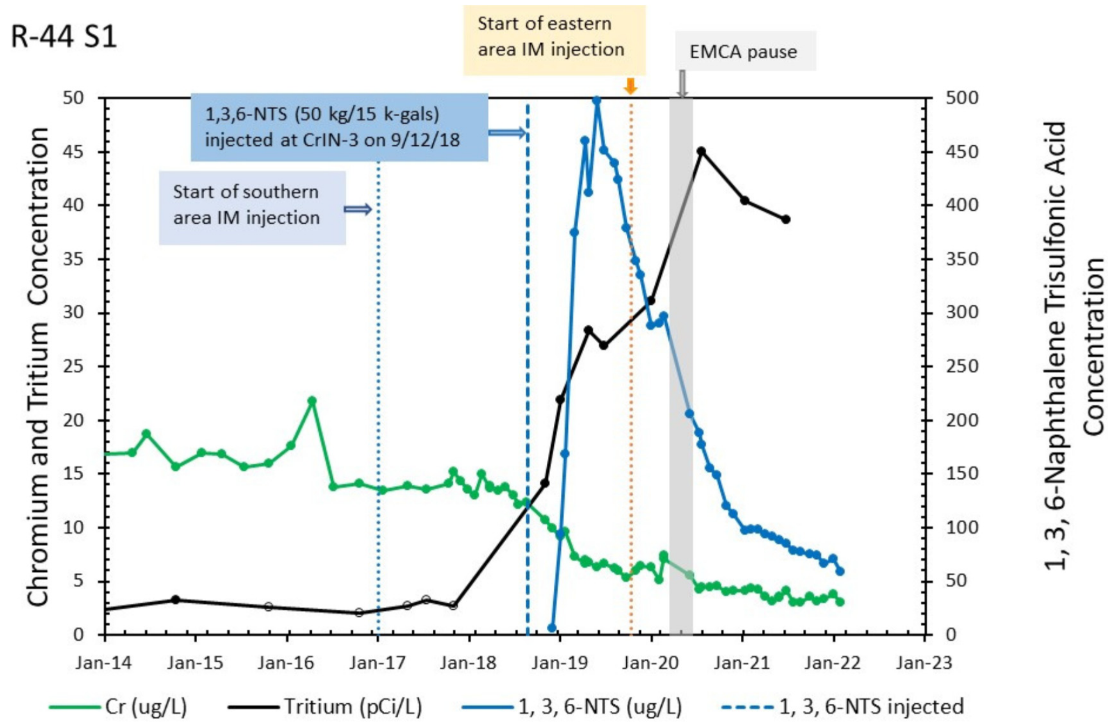
Notes: Solid symbols represent detection results at the plotted value. The background for chromium is 7.48 µg/L. Groundwater elevations represent raw data (without barometric adjustment). S1 = Screen 1.

Figure 3.2-8 Time-series plots for R-50 screen 1



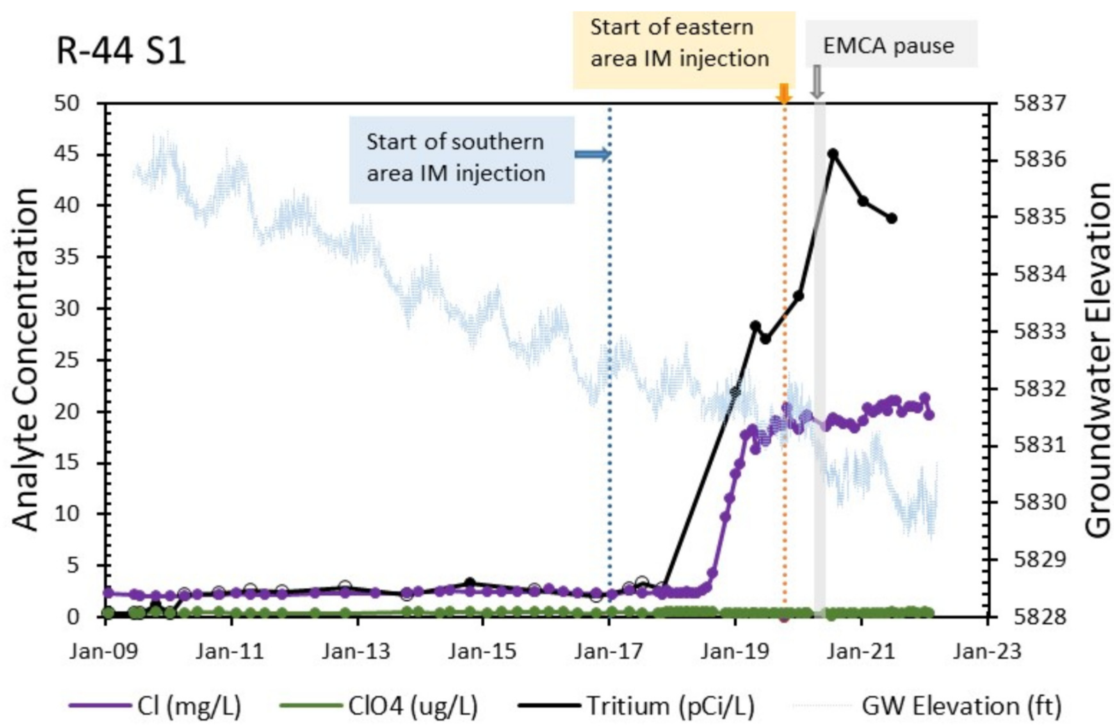
Notes: Open symbols represent nondetection results and solid symbols represent detection results at the plotted value. The background for chromium is 7.48 µg/L. Groundwater elevations represent raw data (without barometric adjustment). S2 = Screen 2.

Figure 3.2-9 Time-series plots for R-50 screen 2



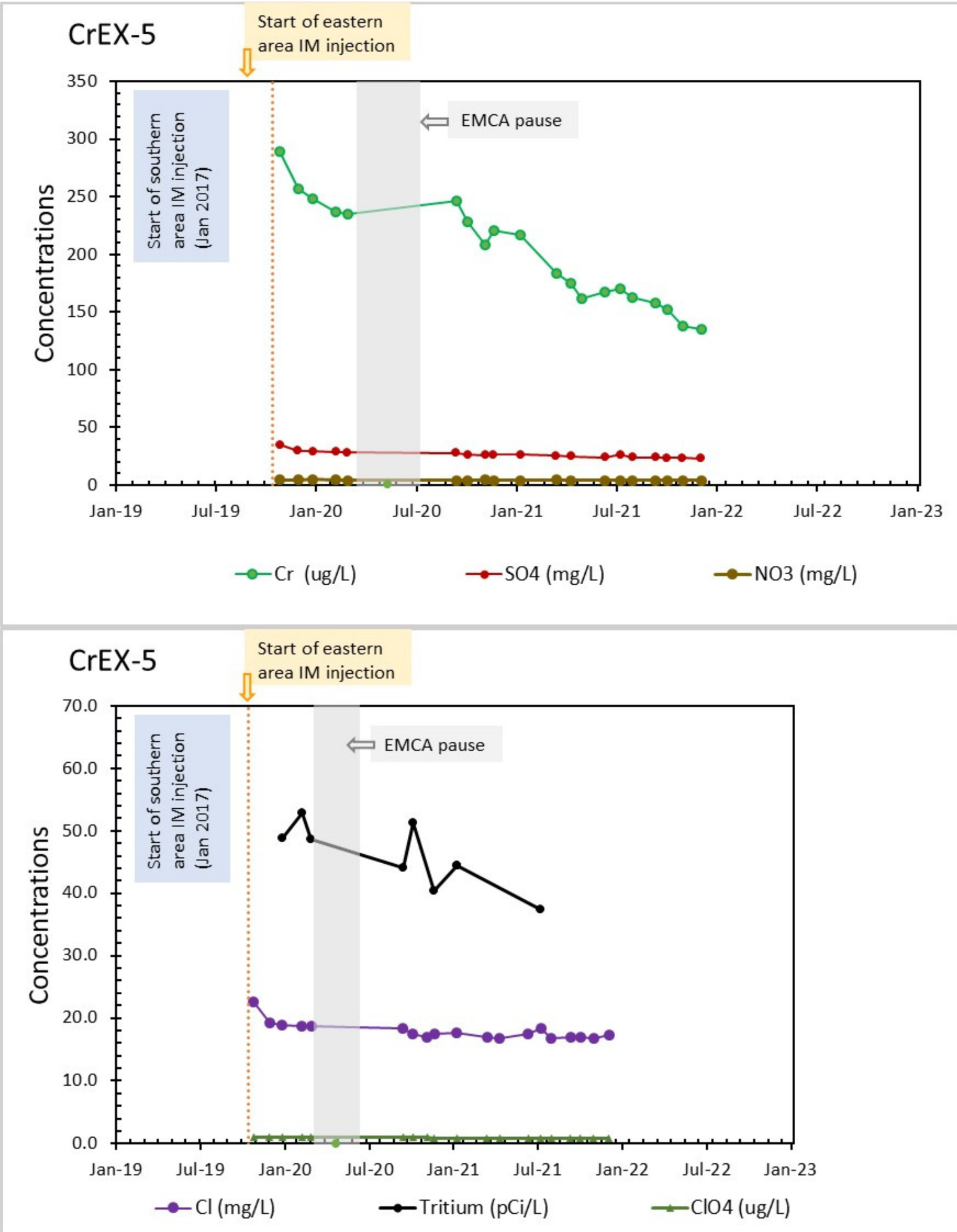
Notes: Open symbols represent nondetection results and solid symbols represent detection results at the plotted value. The background for chromium is 7.48 µg/L. Groundwater elevations represent raw data (without barometric adjustment).

Figure 3.2-25 Time-series plots of tracer detections for R-44 screen 1



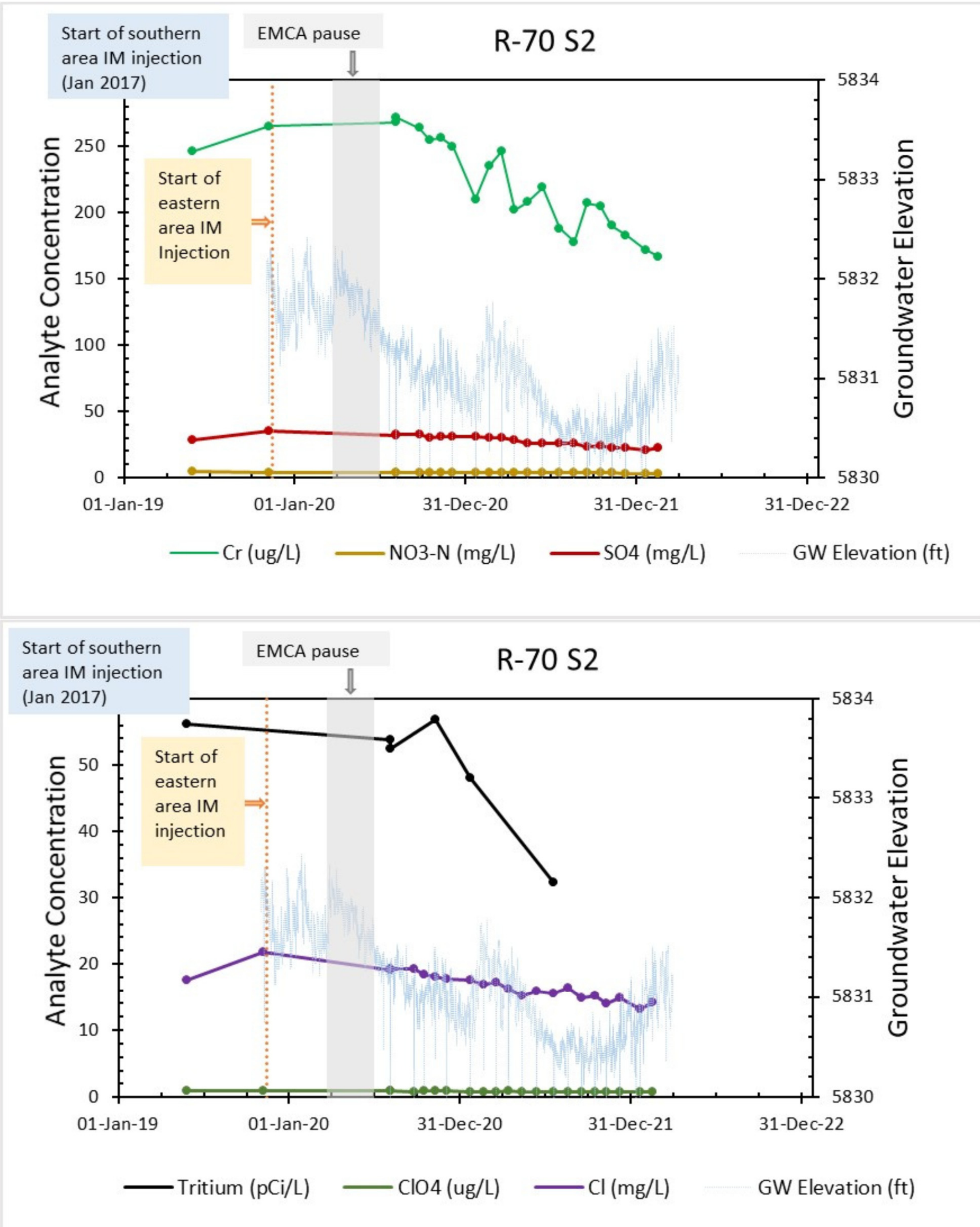
Notes: Open symbols represent nondetection results and solid symbols represent detection results at the plotted value. The background for chromium is 7.48 µg/L. Groundwater elevations represent raw data (without barometric adjustment). S1 = Screen 1.

Figure 3.2-4 Time-series plots for R-44 screen 1



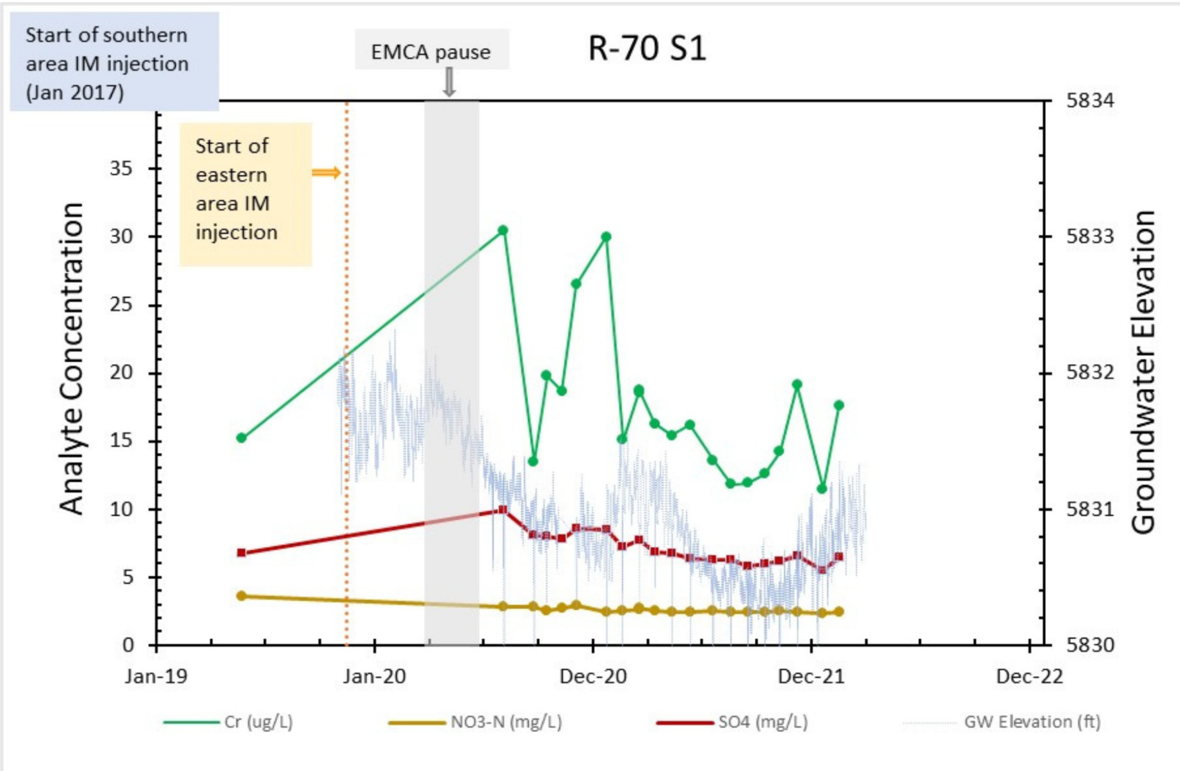
Notes: Solid symbols represent detection results at the plotted value. The background for chromium is 7.48 µg/L. Groundwater elevations represent raw data (without barometric adjustment).

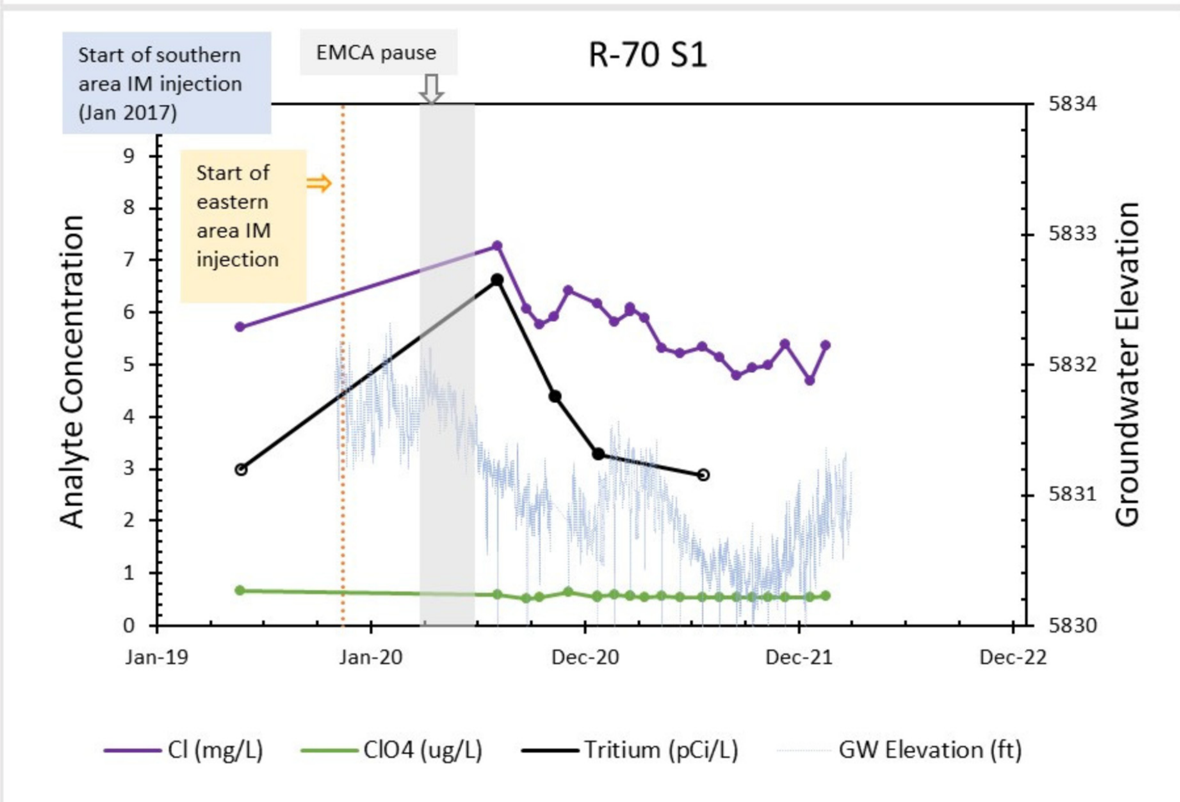
Figure 3.2-23 Time-series plots for CrEX-5



Notes: Solid symbols represent detection results at the plotted value. The background for chromium is 7.48 μg/L. Groundwater elevations represent raw data (without barometric adjustment). S2 = Screen 2.

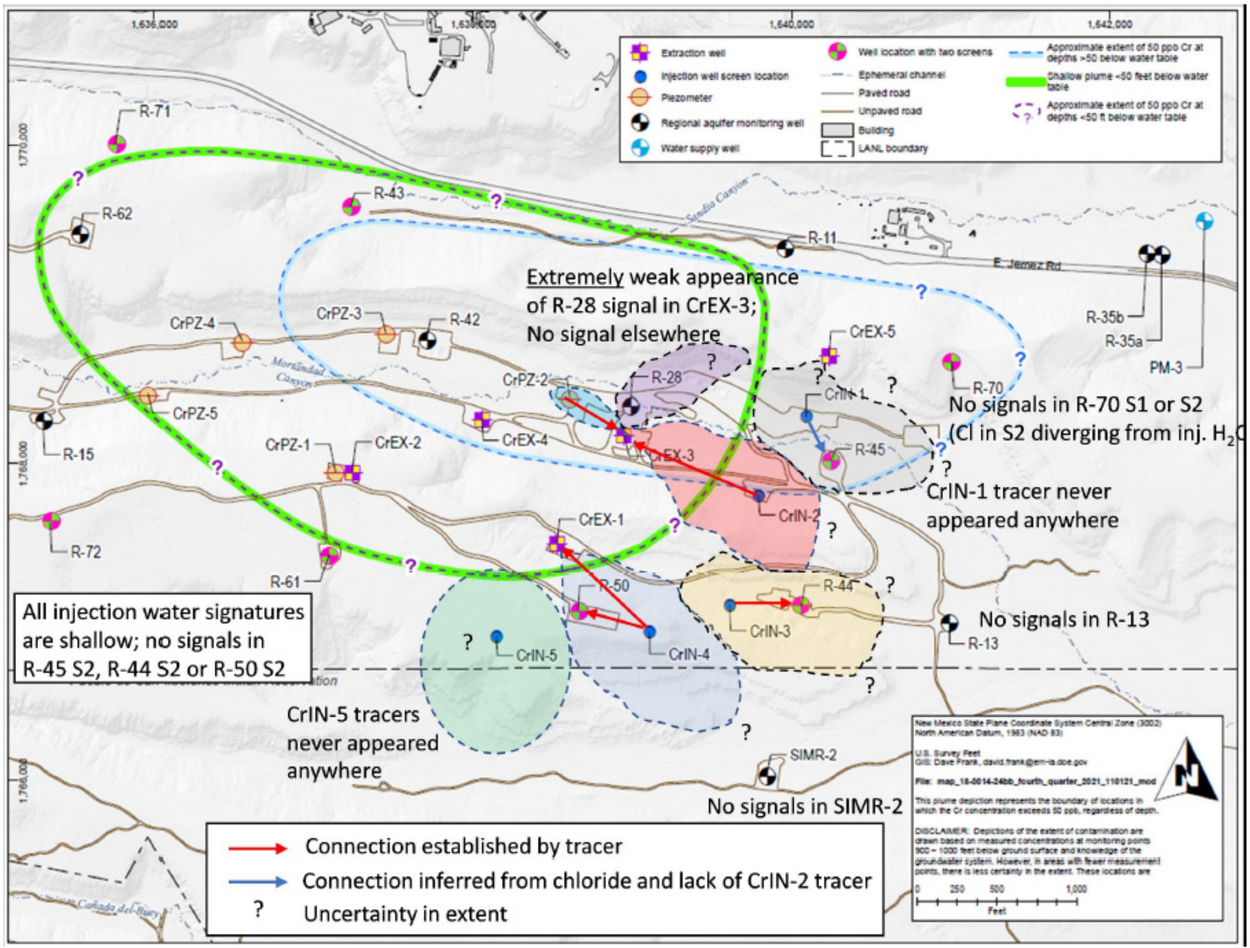
Figure 3.2-13 Time-series plots for R-70 screen 2





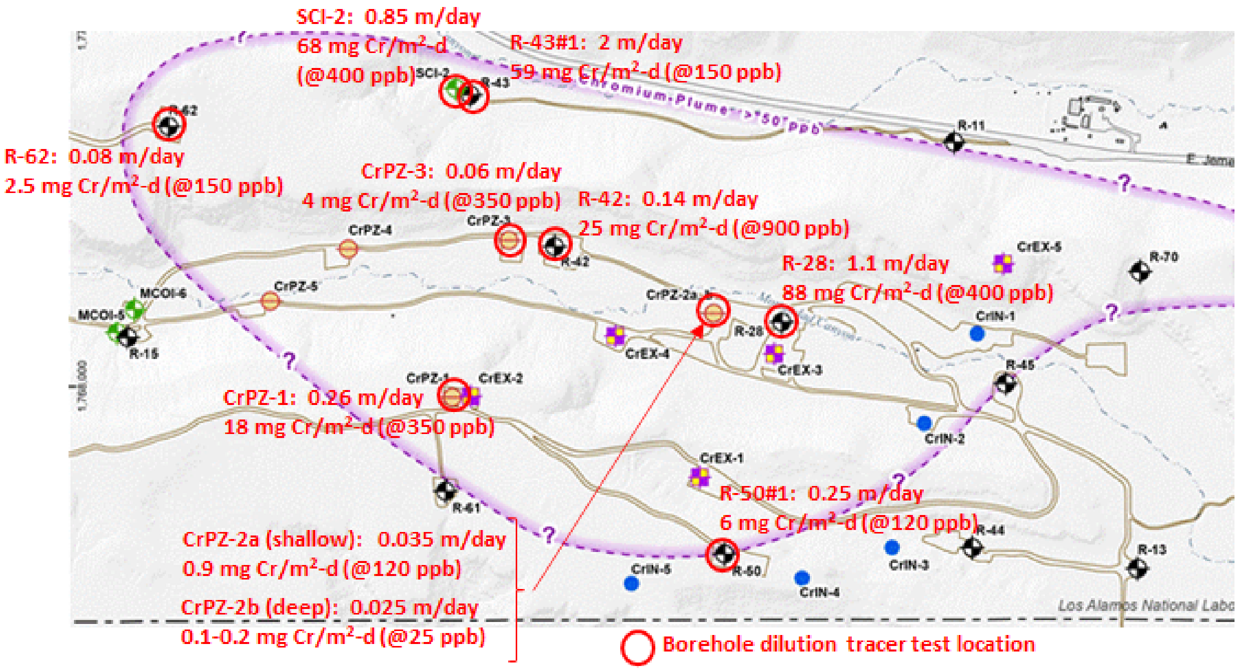
Notes: Open symbols represent nondetection results and solid symbols represent detection results at the plotted value. The background for chromium is 7.48 µg/L. Groundwater elevations represent raw data (without barometric adjustment). S1 = Screen 1.

Figure 3.2-12 Time-series plots for R-70 screen 1



Notes: Depiction of IM injection flows and summary of other inferences from tracer and geochemical signatures; S1 = Screen 1; S2 = Screen 2.

Figure 3.5-5 Tracer footprints



Note: Estimates assume a flow porosity of 0.2. SCI-2 is in a perched water zone above the water table.

Figure 2 Groundwater flow rates and Cr(VI) fluxes estimated in borehole dilution tracer tests (copied from Reimus et al. 2021, 701331).

Table 1
Frequency of Analytical Suites Collected at
Performance Monitoring Locations, Piezometers, Addressed in the 2022 Report

Location	Metals	Low-Level Tritium	General Inorganics[a]	Naphthalene Sulfonate Tracers	Sodium Bromide Tracer	Sodium Perrhenate Tracer	Deuterated Water Tracer
Performance Monitoring Locations							
R-11	M[b]	S[c]	M	M	M	M	M
R-35a	M	S	M	M	M	M	M
R-35b	M	S	M	M	M	M	M
R-44 S1[d]	M	Q[e]	M	M	M	M	—[f]
R-44 S2[g]	M	Q	M	M	M	M	—
R-45 S1	M	Q	M	M	M	M	M
R-45 S2	M	Q	M	M	M	M	M
R-50 S1	M	Q	M	M	M	—	—
R-50 S2	M	Q	M	M	M	—	—
R-61 S1	M	Q	M	M	M	—	—
SIMR-2	M	S	M	M	M	—	—
Piezometers							
CrPZ-1	Q	Q	Q	—	Q	—	—
CrPZ-2a	Q	Q	Q	—	Q	—	—
CrPZ-3	Q	Q	Q	—	Q	—	—
CrPZ-4	Q	Q	Q	—	Q	—	—
CrPZ-5	Q	Q	Q	—	Q	—	—

Note: This table is excerpted from Table 3.1-1 of the 2022 Annual Progress Report.

[a] Includes nitrate, sulfate, and perchlorate.

[b] M = Monthly.

[c] S = Semiannually.

[d] S1= Screen 1.

[e] Q = Quarterly.

[f] — = Not analyzed at the noted location.

[g] S2 = Screen 2.

Table 2
Estimates of Flow Porosities
Associated with First and Mean Arrival Times
of the 1,5-NDS Tracer at CrEX-1 and of Chloride at
R-50 Screen 1, R-44 Screen 1 and R-45 Screen 1

Well	Porosity from First Arrival	Porosity from Mean Arrival
CrEX-1	0.06	0.12
R-50 s1	0.08	0.14
R-44 s1	0.05	0.09
R-45 s1	0.05	0.115

Note: This table was copied from Reimus et al. (2021, 701331)