EMID-701818
Rec'd 12/20/21

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December 20, 2021

Arturo Duran, Designated Agency Manager
Environmental Management, U.S. Department of Energy
Los Alamos Field Office
1200 Trinity Drive, Suite #400
New Mexico 87544

RE: REVIEW – ASSESSMENT REPORT FOR THE EVALUATION OF CONDITIONS IN THE REGIONAL AQUIFER AROUND WELL R-70
LOS ALAMOS NATIONAL LABORATORY
EPA ID#NM0890010515
HWB-LANL-21-034

Dear Mr. Duran,

The New Mexico Environment Department (NMED) received the United States Department of Energy's (DOE) *Assessment Report for the Evaluation of Conditions in the Regional Aquifer Around Well R-70* (Report) on June 30, 2021. The Report is dated June 2021 and referenced as EM2021-0321. The basis for the Report is to assess the anomalously deep high chromium concentration in monitoring well R-70 that prompted NMED to issue the July 12, 2019 response letter[1], which directed DOE to install monitoring wells R-35c and R-73 in the northeast portion of the chromium plume. DOE negotiated with NMED's designated agency manager to first allow DOE to evaluate the regional aquifer conditions in this area to determine if there is a need for these two wells.

These negotiations resulted in the submittal of a workplan that constituted Milestone #1 for Fiscal Year 2020 in Appendix B of the 2016 Compliance Order on Consent (Consent Order) and was titled *Assessment Work Plan for the Evaluation of Conditions in the Regional Aquifer Around Well R-70* (Workplan). The Workplan, submitted on December 16, 2019, and referenced as EM2019-0458, committed DOE to provide the following:

- A detailed review of the hydrostratigraphy relating to the chromium distribution in the eastern portion of the plume.
- A geochemical data analysis to evaluate whether a geochemical stratification is present in the regional aquifer that explains the vertical distribution of chromium at regional monitoring well R-70.
- An analysis of observations of the interim measures' extraction and injection on the chromium concentration at the monitoring wells.
- A groundwater model that provides insights into how the chromium concentrations around R-70 may respond to the interim measures.

NMED approved the Workplan on April 14, 2020, which included a June 17, 2020 submittal date for the Report.

[1] Letter 39047, J.E. Kieling to D. Hintze, "Results from Regional Groundwater Monitoring Well R-70," July 12, 2019.

On June 4, 2020 DOE sent an extension request letter[2] (Extension Request) to NMED due to electrical pump issues and the March 23, 2020 interruption of the interim measures system operation due to the Essential Mission Critical Activities (EMCA) in response to the COVID-19 pandemic. DOE's justification for the Extension Request included the need to collect at least three consecutive monthly groundwater quality samples from monitoring well R-70, which could not be accomplished due to the mechanical and EMCA issues. NMED approved the Extension Request on June 10, 2020[3] with a revised Report due date of June 30, 2021. The Report was listed as a Milestone in the Appendix B Milestones and Targets for fiscal year 2021 in the Consent Order. However, this Milestone was never finalized because the fiscal year 2021 Appendix B Milestones and Targets were in dispute resolution between NMED and DOE and were never resolved.

NMED's technical review of the Report generated several comments because of DOE not adhering to the Workplan and the commitments made in the Extension Request. NMED concurs with DOE regarding the need for an additional monitoring well, R-73. NMED notes that the Report presents no tenable reason to reconsider installing R-35c. Some of the notable issues with the Report are:

- The Report lacks the groundwater model required by the Workplan.
- DOE has not fulfilled its commitment to meet and confer with NMED regarding the need for R-35c per the Extension Request.
- DOE did not follow NMED directions to not use the data and results of the R-70 pumping tests in the Report due to numerous technical deficiencies on DOE's part in conducting the test.
- The Report lacks viable scientific data and information to formulate mutually-derived decisions upon which the recommendations in the Report were to be based.
- The Report lacks key LANL/DOE references, identifying specific sections documenting sources and variable release volumes and chemical composition of TA-03 cooling tower outfall and industrial and wastewater releases since the early 1950s to Sandia Canyon.
- The Report lacks binary and ternary mixing calculations using chromium, chloride, nitrate, bromide, perchlorate, and other conservative solutes to quantify volumetric mixing of effluents released from LANL (primarily to Sandia Canyon) since the early 1950s and native regional aquifer groundwater relevant to R-70 screen(S) 1 and screen(S) 2 groundwater. Mixing calculations should also include dual isotopes of oxygen and nitrogen in nitrate and oxygen and sulfur in sulfate for LANL-derived effluents and native regional aquifer groundwater.
- The Report lacks detailed discussion and quantitative analysis of contaminant mass flux, solute residence times and geochemical transients observed at R-11, R-43 S1 and S2, CrEX-5, R-45 S1 and S2, and R-28 and R-42, prior to the addition of chemical tracers and amendments.
- The Report lacks geochemical and reactive transport modeling to quantify solid phase (aquifer material) and solute interactions occurring during groundwater mixing between LANL-derived effluents and native regional aquifer groundwater near well R-70 S1 and S2.

[2] Letter EMLA-2020-1471-02-001, A.Q. Duran to K. Pierard, "Request for Extension of Assessment Report for the Evaluation of Conditions in the Regional Aquifer around Well R-70," June 4, 2020.

[3] Letter EMID-700938, K. Pierard to A.Q. Duran, "Approval, Request for Extension of Assessment Report for the Evaluation of Conditions in the Regional Aquifer Around Well R-70," June 10, 2020.

NMED required the groundwater model for DOE to evaluate the effectiveness of the existing monitoring well network to detect the migrating chromium plume and the interim measures to control the downgradient migration of the chromium plume. The model would have provided a critical data gap analysis that could evaluate whether additional monitoring wells such as R-35c are needed and, if so, where to locate the new wells. NMED does not accept the reasons provided in the Report for omitting the groundwater model. Additionally, DOE claimed in the Report that forgoing the model requirement was discussed with NMED during an April 22, 2021 pre-submittal meeting. However, a pre-submittal meeting between NMED and DOE specific to the Report was never held. There was an April 22, 2021 technical team meeting, which focused on other issues, in which DOE briefly discussed some of the conclusions of the Report, but never mentioned that the required groundwater modeling would be omitted. NMED was not formally informed, nor did NMED approve DOE's decision to not include the Workplan requirement for a groundwater model in the Report.

DOE did not meet with NMED to discuss the viability of regional aquifer monitoring well R-35c as it committed itself to do in the Extension Request. Additionally, DOE disregarded an NMED directive to not use the pumping data to draw conclusions due to the reasons outlined in NMED's notice of disapproval letter[4]. As such, the assessment lacks the viable scientific data and information as established in the Extension Request that DOE would provide in the Report to derive at mutual agreements and decisions. NMED does not concur with DOE's conclusion that regional aquifer monitoring well R-35c is not necessary.

The fiscal year 2022 Consent Order Appendix B Milestones and Targets negotiations have included the installation of R-35c as a target for fiscal year 2023. NMED has determined that R-35c is necessary and must be installed in accordance with the principles outlined in the July 12, 2019 response letter[1].

The Enclosure includes two Exhibits: NMED's review comments in Exhibit 1 and an independent third-party review in Exhibit 2 that contain technical comments and supporting evidence that contend DOE's conclusions. NMED is not requiring DOE to respond to these comments or to revise the Report. NMED is providing the comments and supporting evidence to support NMED's position that R-35c must be installed in accordance with the July 12, 2019 response letter[1].

In summary, NMED finds the work described in the Report to be subjective, opinion-based, relying on information that is not relevant to the northeast portion of the chromium plume.

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[4] Letter EMID-701439, K. Pierard to A.Q. Duran, "Notice of Disapproval, Completion Report for the Regional Aquifer Well R-70, Revision 1, and the Response to the New Mexico Environment Department's Draft Comments on the Completion Report for Regional Aquifer Well R-70," May 25, 2021.

Should you have any questions regarding this correspondence, please contact Christopher Krambis of my staff at (505) 231-5423.

Sincerely,

Rick Shean Digitally signed by Rick Shean Date: 2021.12.20 10:58:32 -07'00'

Rick Shean
Chief
Hazardous Waste Bureau

cc with Attachment:

N. Dhawan, NMED HWB
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File: 2021 LANL, Evaluation of Conditions in The Regional Aquifer Around Well R-70
HWB LANL-21-034

ENCLOSURES

EXHIBIT 1

NMED TECHNICAL COMMENTS ON ASSESSMENT REPORT FOR THE EVALUATION OF CONDITIONS IN THE REGIONAL AQUIFER AROUND WELL R-70, JUNE 30, 2021

General Comments

1. Any comprehensive aquifer characterization study should include preparation of potentiometric surface contour maps interpolated from synoptic site-specific head data collected across the study aquifer and calculations of the average groundwater flow velocity and direction based on those maps. NMED notes such aquifer characterization is missing from the Report. No aquifer characterization study can be complete without such analyses. Consequently, the study is incomplete, and the conclusions are not valid without these basic tenants of aquifer characterization.

2. NMED notes that DOE presents the pumping rate at PM-3 in several figures, including Figure 4.1-1, -2, -3, -4, -6, -9, -10, -11, -13, -15 to be variable. NMED observed the flow rate at PM-3 to be constant at 1,425 gallons per minute. In addition, NMED confirmed with Los Alamos County Utilities that all the production well pumps operate as either being on or off and that the pumping rates are not altered as indicated by DOE in the figures.

3. The Report does not fulfil the requirements of the Workplan and is incomplete. For example, the Report does not present the groundwater model and a detailed stratigraphic study in the relevant northeast portion of the chromium plume as required by the Workplan. In addition, DOE did not follow NMED's directive to not use the pumping test data from R-70 due to improper test methods and analyses presented by DOE and concurred by the U.S. EPA[4]. As such, the conclusions and recommendations presented in the Report are not backed up by information that was agreed upon by both NMED and DOE to conduct this study.

4. Section 3 of the Report provides confusingly mixed conceptual models regarding the geochemical stratification at regional aquifer monitoring well R-70 that contradict one another and are not based on any new geochemical data. Most of the Report appears to be prepared using old information that does not specifically address the requirements of the Workplan.

Specific Comments

1. Section 1.0 Introduction, Page 1.

A. DOE Statement: "*The R-70 assessment work plan indicated that numerical modeling would also be incorporated into the assessment report as one of the methods used to evaluate data gaps in the monitoring network and to predict IM performance in the northeastern portion of the plume. However, the relatively short data set and high variability in chromium concentrations in R-70 screen 1 made its model validation very challenging, with the likelihood of producing unreliable and highly uncertain results, and therefore not supportive of meeting the objective of the report.*"

NMED Comment: NMED does not agree with DOE's decision to not include the model in the Report. The reason provided by DOE appears to be the same reason DOE provided to NMED when requesting the Extension Request in June 2020, i.e., not enough data is available to reliably calibrate the model[2]. The object of the Report is to provide a better understanding of the aquifer conditions around newly installed regional aquifer monitoring well R-70 and to assess whether the existing monitoring well network and interim measures effectiveness are sufficient. NMED granted the Extension Request for

DOE to acquire sufficient information to meet the objectives of the Report[3]. DOE should have contacted NMED before submitting the Report to work out such issues.

B. **DOE Statement:** "*As presented to NMED in a pre-submission meeting held on April 22, 2021, numerical modeling will not be included in this report, and the conclusions and recommendations derived from the other assessment lines of inquiry will not be affected.*"

NMED Comment: NMED does not agree with this statement. DOE may have mentioned it in a meeting, but NMED never approved not including the model in the Report. No official notification was sent to NMED seeking approval of DOE's decision. Any such agreement would require DOE provide NMED a formal written request and to obtain NMED approval from the designated agency manager because such a change would require amending an approved workplan. NMED does not accept DOE's position that the Report conclusions and recommendations were not affected by the elimination of the groundwater model.

2. Section 2.0 High-Resolution Stratigraphy in The Chromium Investigation Area, Pages 1 to 6.

DOE Statement: "*This section presents an analysis of the aquifer based on core collected during sonic drilling of core holes CrCH-1 through CrCH-5 in 2014 and 2015 to collect sediments from the regional aquifer for tests including bench-scale tests for natural attenuation (LANL 2018, 602964). Figure 2.0-1 shows the locations of the core holes."*

NMED Comment: The coreholes are not germane to the area around and east (toward PM-3) of regional aquifer monitoring well R-70. The information from the coreholes are between 2,000 feet to 5,000 feet west of R-70 and do not necessarily represent aquifer conditions in the northeast portion of the regional aquifer considering the high anisotropy and heterogeneity of the regional aquifer. In addition, the hydraulic conductivity values derived from the cores are not reflective of plume scale aquifer conditions. In allowing for and approving the Workplan, NMED allowed DOE to specifically study the conditions of the regional aquifer at the northeast portion of the chromium plume to determine the effectiveness of the monitoring well network downgradient of the plume, to study the geochemical stratification of the northeast portion of the chromium plume, and to study the effectiveness of the interim measures to stop the migration of the northeast portion of the chromium plume to migrate downgradient of R-70. Instead, DOE has used old data presented in several unrelated reports that date from four to six years ago that was designed to study the chromium plume centroid, not the hydrogeology of the northeast portion of the plume. NMED does not accept the corehole information as a fulfilment of the detailed hydrostratigraphic review that was required by the Workplan to evaluate the vertical chromium distribution in the eastern portion of the plume.

3. Section 3.2 Comparison of R-70 Screen 1 and Screen 2 Geochemistry with That of Nearby Wells, Page 8.

DOE Statement: *"The geochemical signatures at R-70 screen 2 likely reflect plume migration from the R-28, R-42, and CrEX-4 area where contaminants are relatively deep beneath the water-table."*

NMED Comment: A potentiometric surface contour map interpolated from site-specific synoptic water level data in the area described in this section should have been provided to support whether the postulated plume migration pathway is plausible. The lack of such a basic component to this study makes such statements difficult to verify (see General Comment 1).

4. Section 3.3 Conceptual Models that Describe the Vertical Chromium Distributions at Well R-70, Pages 9 and 10.

DOE Statement: *"Nevertheless, there remain uncertainties in terms of the depth of the contaminant plume in the R-70 region. These uncertainties are important to resolve in order to design an effective remediation plan for this portion of the plume. A deeper well (R-73) is proposed to provide additional information on the geochemistry and vertical extent of contamination in the R-70 area."*

NMED Comment: NMED concurs.

5. Section 4.1.1 Effect of PM-3 on R-70, Page 11.

A. **DOE Statement:** *"The Theis analysis presented in the "Evaluation of Chromium Plume Control Interim Measure Operational Alternatives for Injection Well CrIN-6" (LANL 2018, 603032) showed estimated drawdowns from water-supply pumping, with the largest influences typically coming from O-4, PM-2, PM-4, and PM-5, and not PM-3. (Faint influences of PM-3 were possibly detected at R-35a, R-35b, and R-44 screen 2, but even at these locations, the effect was dwarfed by the influence of PM-2 and PM-4, particularly, and in some cases may be of questionable significance.)"*

   NMED Comment: NMED finds DOE's interpretation to be unsupported, specifically "*(Faint influences of PM-3 were possibly detected at R-35a, R-35b, and R-44 screen 2, but even at these locations, the effect was dwarfed by the influence of PM-2 and PM-4…)*". The influence from PM-3 pumping on R-35a is not dwarfed by PM-2, PM-4, and O-4. To present a more plausible aquifer assessment, NMED performed tenable analyses on the effects that the July 27, 2019 PM-3 pumping operations had on the hydraulic head measured at regional aquifer monitoring well R-35a. NMED concludes that a substantial measured influence is consistently present and in a pronounced manner to perform an effective and tenable aquifer performance test between PM-3 and R-35a. The pumping is sufficient to be representative of the regional aquifer between PM-3 and R-35a, specifically the Chamita formation (Tcar) hydraulic properties.

   NMED's analyses was performed using HydroSOLVE, Inc.'s AQTESOLV Professional version 4.5 aquifer test analysis software and is provided in Attachment 1 to Exhibit 1. NMED has determined that the aquifer transmissivity of the Tcar is about 18,500 square feet per day, a storativity of 0.0015 and hydraulic conductivity of 78 feet per day when modeled as an unconfined system. NMED also considered a confined model due to the lack of a similar hydraulic response at R-35b, certain unconfined solution parameter limits being reached during convergence of the unconfined model, and a potential localized unsaturated/confining layer at a depth of 929 feet at PM-3. In the confined analysis, NMED used a thickness of 176 feet (thickness of Tcar between 929-foot anomaly and the top of the Miocene basalt) to derive appropriate aquifer parameters. The confined model analysis resulted in a transmissivity of 17,500 square feet per day, a storativity of 0.0009, and a hydraulic conductivity of 99 feet per day for the Tcar portion of the regional aquifer, which is more than an order of magnitude greater than the analysis shown in Figures 2.2-1 through 2.3-3 of the Report.

   Unfortunately, the Tcar pathway was not analyzed by DOE in the Report, yet it represents the most likely potential pathway between R-70 and PM-3. DOE did not present an accurate or complete pathway analysis from R-70 to PM-3 in the Report because DOE did not consider the possibility that the chromium contamination is deeper than that detected at screen 2 at R-70 and that PM-3 operations could draw the chromium from the R-70 screen 2 area downward into the Tcar.

In addition, the PM-2, PM-4, and O-4 pumping operations that DOE does attribute to affecting the recorded heads at monitoring wells R-35a, R-35b, R-44 S2 are located 1.5 to 2 miles south (PM-2), 1 to 1.5 miles southwest (PM-4), and 1.2 miles north (O-4) to these monitoring wells. To the contrary, DOE states that the pumping effects of PM-3 on these monitoring wells is faint. However, the proximity of PM-3 to these same monitoring wells ranges from only 360 feet northeast of R-35a/b and 3,500 feet northeast of R-44 S2. If DOE's statement on page 2 of the Report that "…*the three subunits are effectively a single hydrogeologic unit*" is valid, then DOE's conclusion here conflicts with that on page 2 of the Report. DOE has not adequately characterized the conditions of the regional aquifer in the northeast portion of the chromium plume as required by the Workplan.

6. Section 4.1.1 Effect of PM-3 on R-70, Page 13
DOE Statement: (1) *"Chromium-area monitoring wells are apparently isolated from pressure responses generated by PM-3 pumping because most water production at PM-3 is likely from Miocene sedimentary deposits beneath the basalts." …* **(2)** *"At PM-3, Miocene sedimentary rocks (Tcar) above the Miocene basalts make up only 75 ft (~5%) of the well screen, so it is reasonable to assume that most of the water production comes from Miocene sedimentary rocks in the lower part of the well (79% of the well screen)."*
(3) "*The relatively high stratigraphic position of the Miocene basalts at PM-3 largely isolates shallow portions of the regional aquifer from pressure responses due to pumping of productive sedimentary deposits in the lower part of the well." …* **(4)** *"Like PM-3, Miocene basalts occupy high positions in these wells (Figure 4.1-7), and most of the water production comes from sediments beneath the basalts."*

NMED Comment: DOE provides no facts to support the first statement. While a hydraulic response to pumping proves a hydraulic connection exits between two points, a lack of a response does not necessary demonstrate there is no hydraulic connection. To draw the conclusion that DOE has in the first statement, an obvious no flow boundary must be present, such as that identified from aquifer testing and a hydrostratigraphic analysis. In the hydrogeologic setting of the Tcar, the lack of a hydraulic response can be attributed to the high aquifer storativity and transmissivity of the Tcar that are sufficient to meet pumping demands without contribution from the hydraulically connected overlying strata. It is conceivable that a measurable response in the Tcar at the area around R-70 occurs when PM-3 operates and draws in water laterally along the Tcar preferential pathway. The issue is the lack of monitoring wells at this location in the Tcar. Proposed regional aquifer monitoring well R-73 should be screened in the Tcar.

In the case of PM-3, the lack of pressure responses is likely attributed to the high transmissivity of the Tcar (see Specific Comment 5) and not hydrologic isolation of PM-3 to the rest of the regional aquifer including the chromium plume. DOE's conceptual model that PM-3 is isolated from the rest of the regional aquifer contrasts with its own statement on page 2 of the Report that despite the regional aquifer consisting of various strata, they behave "effectively a single hydrogeologic unit." Multiple lines of evidence are presented below that negate DOE's statements that sedimentary rocks below the Miocene basalt are the source of water available to PM-3:

- the thickness of Tcar above the Miocene basalt at PM-3 is 360 feet[5] not 75 feet.

[5] Weston Solutions, Inc., November 2019, WC18 Update to the Los Alamos National Laboratory Geologic Framework Model: West Chester, PA 19380; Contract No.: 1158835, Work Order No: 12923.116.001

- the saturated portion of the 360-foot thick Tcar above the Miocene basalt that could provide available water to PM-3 is 310 feet based on the depth to water at R-35b (795 feet) and the top of the Miocene basalt at PM-3 (1105 feet).
- The length of PM-3's 14-inch diameter 3/32-inch louver screen in the Tcar above the Miocene basalt is 149 feet based on the PM-3 well construction and geologic log[6] and DOE's Figure 4.1-7.
- Publications and flowmeter logs demonstrate that the municipal wells downdip relative to the Miocene basalt obtain most of their yields from above the Miocene basalt.
- NMED demonstrated in Specific Comment 5 that the Tcar above the Miocene basalt is sufficiently transmissive to meet the pump capacity of PM-3.
- The pump inlet in PM-3 is at a depth of 830 feet[7], 123 feet above the well screen and would draw water from the first highly transmissive zone immediately below the casing bottom. Consequently, it would not be physically possible for the pumping to bypass the more proximal high transmissivity zone demonstrated in Specific Comment 5 and lift water from greater depths below the Miocene basalt.
- Regarding DOE's third statement, predictions from a published groundwater model that simulated pumping from PM-2, PM-3 and PM-4 predicted that pumping from each of these well, including PM-3 will influence groundwater levels at R-11, R-28, and R-15[8]. It should be noted that the published study was conducted by the Los Alamos National Laboratory and should have been used by DOE in the Report.

Regarding DOE's fourth statement, municipal wells O-1, O-2 and PM-1 are far more updip than PM-3 regarding the Miocene basalt as shown in DOE's Figure 4.1-8, and unlike PM-3 the saturated portion of Tcar lies below the Miocene basalt in these wells. As such, PM-3 may not be protected from the chromium plume because production is from Tcar above the Miocene basalt, unlike at O-1, O-2, and PM-1. Additionally, several constituents including pharmaceuticals have been detected in samples collected from PM-3 at low concentrations, indicating that anthropogenic contaminants travel to PM-3 along preferential pathways from surface discharge points and, as such, PM-3 is not protected from the chromium plume migration.

7. Section 4.1.3 Effect of Pumping Tests at R-70 on Other Monitoring Wells Modeling, Page 16
DOE statement: *"Figure 4.1-25 illustrates the approximate hydraulic zone of influence at surrounding locations due to pumping at R-70 screen 1 and screen 2. Notably, the influence of pumping is felt a significant distance from R-70, but not at R-35a or R-35b, indicating that R-70 is either isolated from or too distant from PM-3 to be hydraulically connected. In all cases with an apparent drawdown caused by the R-70 screen 2 test is greater."*

NMED Comment: DOE included the R-70 pumping tests in the Report despite NMED's disapproval of the methods employed by DOE to conduct and analyze those tests[4]. DOE improperly conducted all the pumping tests at R-70 because standard methods were not used to maintain a true constant rate in favor of operating the pump at full capacity to avoid "*striving for perfection by constantly fiddling with the discharge valve … will*

[6] Purtyman, William D., 1967, Record of Water-supply Well PM-3; Los Alamos, New Mexico: U.S. Geological Survey Open-file Report 67-181, Santa Fe, New Mexico.
[7] Los Alamos County Utilities, Water Wells Fact Sheet.
[8] Harp, Dylan R. and Velimir V. Vesselinov, 2010, Identification of Pumping Influences in Long-Term Water Level Fluctuations: Groundwater, doi: 10.1111/j.1745-6584.2010.00725.x

always cause more noise, chaos, variation, and/or erratic pumping rates."[9] This supports NMED's position that the R-70 pumping tests are not suitable to evaluate whether distant wells, such as R-35a, are hydraulically connected because the radius of influence of the pumping at R-70 was restricted due to the pumping method DOE used to conduct the tests.

Figure 4.1-25 is inexplicably asymmetric with respect to the R-70 pumping center. This implies a significant anisotropy that is not supported by the geologic cross-section shown in Figure 4.1-8 or in any of the relevant cross-section shown in the Geologic Framework[5], and conflicts with the supposed responses at distance well R-13 but not at nearby R-44 or CrIN-2. It is more likely that the observation at R-13 is due to other pumping such as PM-3, which was operating at the same time, or it is evidence of sinuous preferential pathways as postulated by DOE in Section 2.4 of the Report. If the later scenario is correct, it is likely that the screened intervals at R-35a and R-35b are not in the preferential pathway as R-70 S2. This demonstrates the need for a screen in the R-35/PM-3 area in the same strata as the chromium plume at R-70 S2 as postulated by NMED's July 12, 2019 response letter[1]. Additionally, inclusion of R-28 in the analysis and Figure 4.1-20 is questionable considering DOE has concluded that R-28 is unlikely to provide representative data and has agreed to replace the well due to the 2017 molasses injection pilot study[10].

8. Section 5.0 Modeling, Page 17
DOE statement: "*In order for the model calibration to recognize and connect concentration targets to real processes, there needs to be enough data to correlate chromium concentration variability to physical processes such as IM pumping and injection or source-term characteristics*."

NMED Comment: NMED approved DOE's Extension Request[3] for the express purpose of having DOE collect enough information to complete the study including calibrating the groundwater model. Since NMED approved the Extension Request on June 10, 2020[3], DOE collected groundwater quality data from R-70 S1 and R-70 S2 over the nine subsequent months as indicated by Figure 3.1-2 of the Report. This is three times the minimum amount of data DOE stated in the Extension Request was necessary to complete the study. Additionally, Figure 4.1-1 indicates that six months of groundwater level data are available for the study following NMED's Extension Request approval for a total of about one year of water level data to calibrate the groundwater flow model. Consequently, NMED does not concur with DOE that there is not enough data to sufficiently calibrate the model.

9. Figure 4.1-25 Approximate hydraulic zone of influence of pumping at R-70 S1 and S2, Page 56

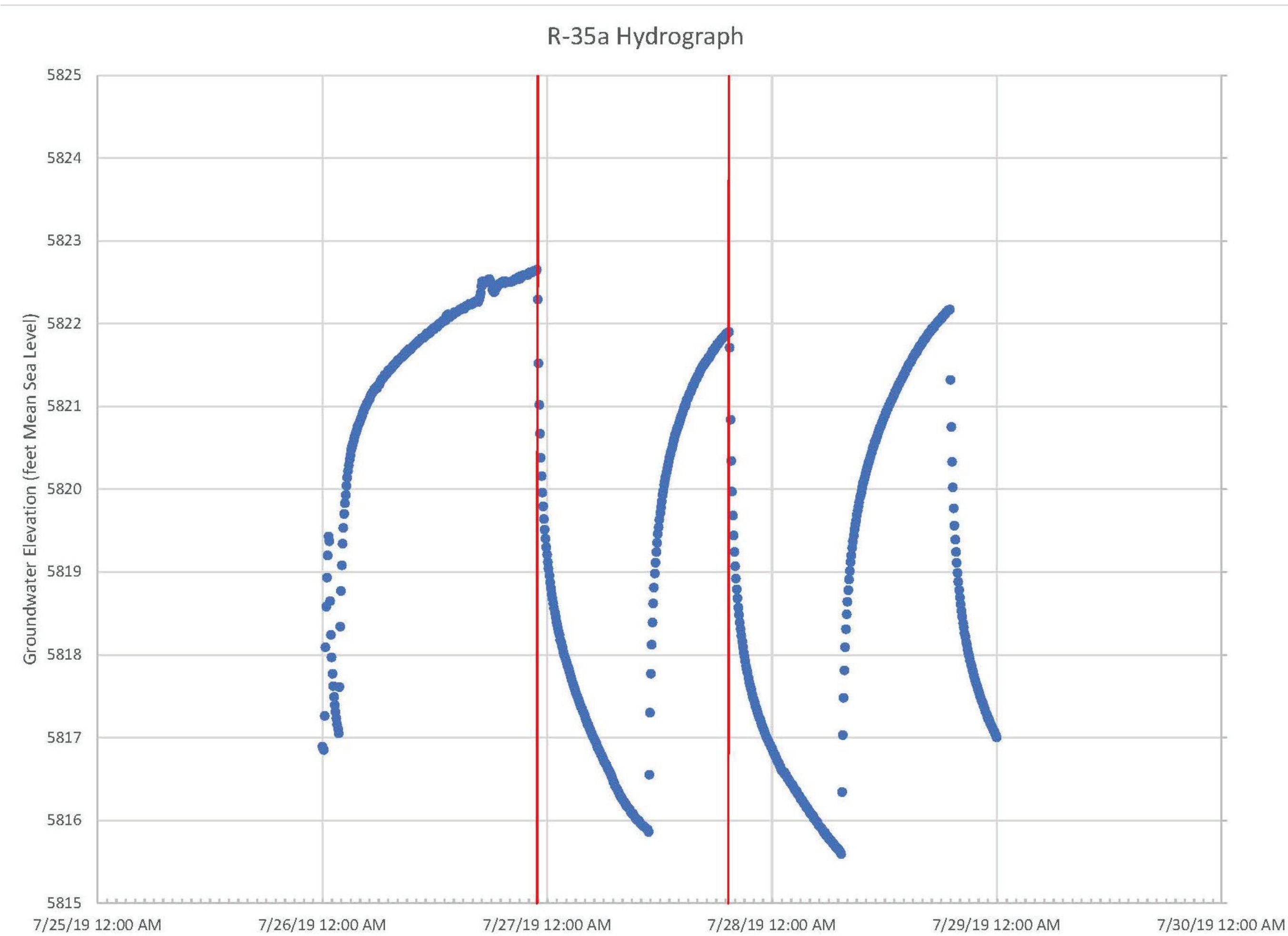
NMED Comment: In this figure, DOE shows an approximate hydraulic zone of influence from R-70 pumping as an elongated oval with the major axis trending north-south and the minor axis trending east-west. However, R-70 is not at the center of the oval but is offset to show that R-35a/b and PM-3 do not lie within the zone of influence of R-70 pumping. The issue is that CrIN-2 and R-44 do not respond to the R-70 pumping as shown in Figures 4.1-21 and 4.1-22, respectively, but are inexplicably included within the zone of influence depicted in Figure 4.1-25. NMED notes that if the perimeter of the zone of influence depicted by the oval was correctly shifted east to exclude R-44 and CrIN-2 as it should, R-35a/b would be closer to R-70's zone of influence.

Review of this figure with the conceptual model postulated in Section 2.4 (that preferentially pathways would

[9] DOE, September 3, 2020, Response to the New Mexico Environment Department's Draft Comments on the Completion Report for Regional Aquifer Well R-70, December 2019, Dated May 7, 2020.
[10] DOE, October 2021, Results from Extended Purging of Monitoring Wells R-42 and R-28: EM2021-0715.

follow interconnected beds of high hydraulic conductivity that cross formational contacts), a case can be made that preferential pathways exist as fingers or sinuous pathways along these beds between R-70 S2 and PM-3. In this scenario, DOE has made the case for installation of R-35c considering that it has been demonstrated that R-13 may be hydraulically connected to R-70 whereas CrIN-2 and R-44, which are closer to R-70 than R-13, are apparently not hydraulically connected. Additionally, R-70 S2 is not in the same strata as either R-35a or R-35b. A potential sinuous preferential pathway, whether along the base of the Puye or not, may exist between these two points in high hydraulic conductivity Tcar. This is a valid assessment as the vertical extent of the chromium concentration is unknown at R-70 and PM-3 pumping of the high transmissive Tcar (see Specific Comment 5) is likely to pull water in all directions within the Tcar to the well including R-70.

ATTACHMENT 1


R-35a Hydrograph
Groundwater Elevation (feet Mean Sea Level)
5825
5824
5823
5822
5821
5820
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5817
5816
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7/25/19 12:00 AM
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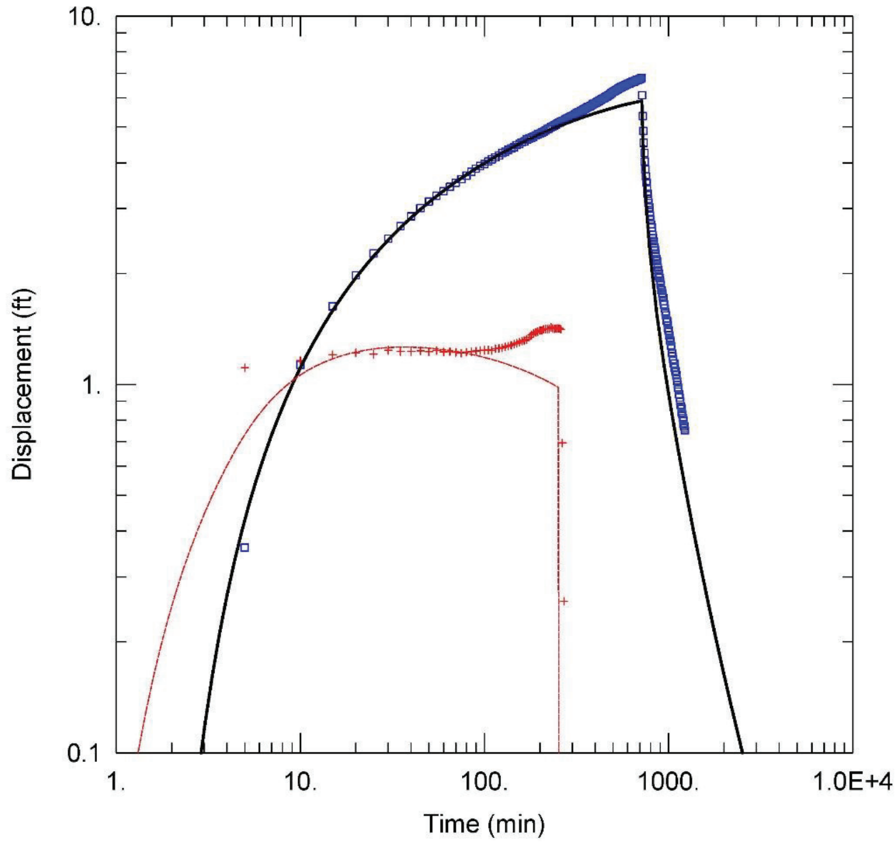
7/27/19 12:00 AM
7/28/19 12:00 AM
7/29/19 12:00 AM
7/30/19 12:00 AM

Aquifer Parameters Between PM-3 and R-35a

Prepared By: NM Environment Department	Prepared For: None
Project: HWB-21-034	Location: Los Alamos, NM



SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 1.85E+4 ft^2/day
S = 0.001492
Sy = 0.25
ß = 0.001

AQUIFER DATA

Saturated Thickness: 236. ft

WELL DATA

Pumping Wells

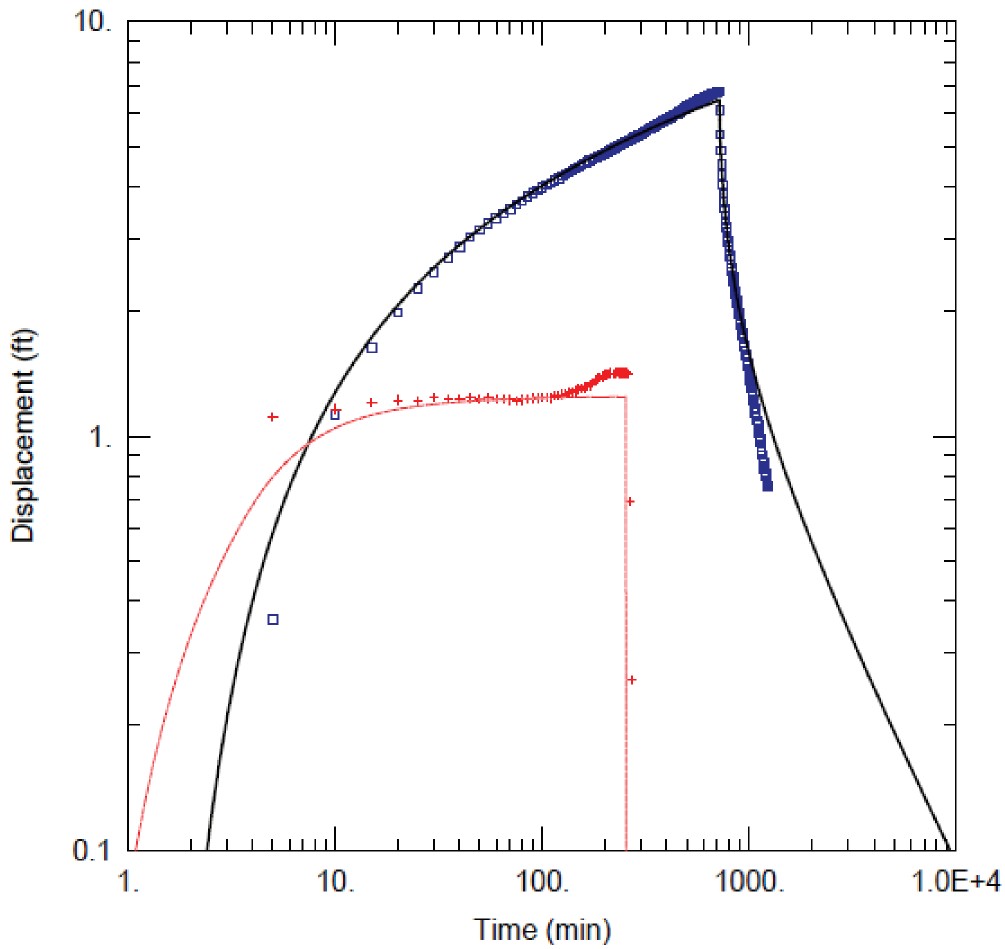
Well Name	X (ft)	Y (ft)
PM-3	1642590	1769530

Observation Wells

Well Name	X (ft)	Y (ft)
□ R-35a	1642330	1769310

Aquifer Parameters Between PM-3 and R-35a

Prepared By: NM Environment Department	Prepared For: Department of Energy
Project: HWB-21-034	Location: Los Alamos, NM



SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 1.75E+4 ft^2/day
S = 0.0009
Kz/Kr = 0.1
b = 176. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PM-3	1642590	1769530

Observation Wells

Well Name	X (ft)	Y (ft)
▫ R-35a	1642330	1769310

EXHIBIT 2
ADDITIONAL TECHNICAL COMMENTS

Paige Walton, P.G.
AQS, Inc.
Phone: (435) 830-7730

September 13, 2021

Subject: Submittal of deliverable for review of contractor's report titled: *Assessment Report for the Evaluation of Conditions in the Regional Aquifer Around Well R-70*, at Los Alamos National Laboratory, in support of New Mexico Environment Department.

Dear Paige:

Semper Environmental (Semper) has completed our review and assessment of the N3B report titled *The Assessment Report for the Evaluation of Conditions in the Regional Aquifer Around Well R-70*, submitted to the New Mexico Environment Department (NMED) on June 30, 2021. The report and associated work plan (*Assessment Work Plan for the Evaluation of Conditions in the Regional Aquifer Around Well R-70*; submitted to NMED on December 19, 2019) were provided to us by NMED as part of their regulatory oversight at Los Alamos National Laboratory (LANL) and the United States Department of Energy (DOE). Semper's scope, as defined by NMED, was to perform an independent review the LANL report, including a comparison to the work plan, and provide native comments on the report based on industry standards and technically-sound reasoning.

Our review comments follow the comment format used by NMED on previous LANL reports, and are given below.

Comments:

1. **Executive Summary, page vi**

   LANL Statement: "*The deep contamination at R-70 possibly originates as far upgradient as the CrEX-4 area and remains at that approximate depth in the R-70 area.*"

   Comment: While it may or may not be true that deep Cr contamination at R-70 originates in upgradient regions, the last part of this statement ("…and remains at that approximate depth in the R-70 area.") has no basis from any data collected in the R-70 area. The vertical extent of contamination at R-70 has not yet been determined. This portion of the statement should be revised accordingly.

2. **Section 2.0, High-Resolution Stratigraphy in the Chromium Investigation Area, page 1**

   LANL Statement: "*This section presents an analysis of the aquifer based on core collected during sonic drilling of core holes CrCH-1 through CrCH-5 in 2014 and 2015 to collect sediments from the regional aquifer for tests including bench-scale tests for natural attenuation (LANL 2018, 602964). Figure 2.0-1 shows the locations of the core holes.*"

Comment:

a.) Presumably, the choice of borings to use for the particle-size analyses of hydraulic conductivity (K) values was made because each of the various geologic units within the Cr plume were sampled as part of this well set. However, relative to the location of R-70 and the northeast portion of the plume, which is the subject of this document, the nearest boring used in the particle-size analyses is CrCH-2, located over 2.300 feet away (upgradient) from R-70, and the farthest, CrCH-5 is over 4,800 feet away from R-70. Explain why these wells, with CrCH-1, 3, and 4, were used for the particle-size analyses and why they are considered representative of the R-70 area. Why is it not a better representation of subsurface conditions in the R-70 area to use drill cuttings from R-70 and other wells in the immediate vicinity of R-70, for the same type of analyses, or to at least include wells from the northeast portion of the Cr plume as part of the overall data set?

b.) Related to the comment above, Section 2.1.1 of the assessment work plan for the regional aquifer around well R-70 stated that the hydrostratigraphy assessment would involve *"…a detailed review of the hydrostratigraphy in the chromium plume, specifically as it relates to the spatial distribution of chromium in the eastern portion of the plume downgradient of R-70."* However, the findings presented in Section 2.0 of the Assessment Report (High-Resolution Stratigraphy in the Chromium Investigation Area) is based on core samples taken from borings that are thousands of feet upgradient and west of R-70. Please explain why data from borings closer to R-70 and the eastern plume region was not used in the analyses and how the data that was used is related to R-70 and areas downgradient as specified in the Work Plan.

3. Section 2.2, Estimated Hydraulic Conductivity from Particle Size Data, page 4

LANL Statement: "*The overlap in Ks suggests there is little difference in the bulk hydraulic properties at the scale of geologic units, and the regional aquifer where the chromium plume is located is effectively a single heterogeneous hydrogeologic unit.*"

Comment: If this statement is meant to be representative of the R-70 area, rectify how this can be true when the Aquifer Testing Report for R-70 found that K values in R-70 screen 2 were over twice the K value determined for R-70 screen 1.

4. Section 2.2, page 4

LANL Statement: "*All three geologic units are characterized by hydraulic heterogeneity, and high-K beds are widely distributed throughout the stratigraphic sequence regardless of geologic unit (Figure 2.2-3).*"

Comment: It is not clear how Figure 2.2-3 supports the last part of the statement above. By far, most of the 15 graphs (methods) presented on Figure 2.2-3 show a significantly elevated K value in CrCH-2 for beds of the Pumiceous Subunit of the Puye Formation [Tpf(p)] compared to the other two geologic units. Similarly, at least half of the graphs on Figure 2.2-3 indicate relatively similar K values for most of the thickness of the Miocene Pumiceous Unit (Tjfp) and high-K beds do not appear to be widely distributed based on these methods. Please clarify or revise the statement accordingly.

5. **Section 2.4, Flow Networks that Cross Stratigraphic Boundaries, page 6**

LANL Statement: "*In this interpretation, high concentrations of chromium in R-70 screen 2 are not due to the pumiceous Puye subunit being a preferential pathway. Instead, flow is controlled by networks of interconnected high-K beds that cross the primary geologic unit contacts and form complete lateral pathways between Miocene aquifer sediments in the vicinity of CrEX-4 to Pliocene aquifer sediments in the R-70 area***."**

Comment:

a.) As described in this paragraph, the alternative interpretation of elevated Cr flowing from CrEX-4 to R-70 screen 2 laterally across stratigraphic boundaries along interconnected high-K beds is questionable. The lateral flow distance between these two points is approximately 3,000 feet. When compared to other reasonable explanations, this interpretation is unlikely, especially across these distances in an alluvial fan environment where high-K units are typically truncated and of limited extent. The interpretation also seems to contradict an earlier statement in Section 2.3, page 5, which states, regarding the U.S. Bureau of Reclamation estimation method "*This method would be expected to yield representative results in systems in which well-connected, high-K pathways exist over significant distances, which is not likely to be the case in these units because alluvial fan deposits are largely made up of beds with limited lateral extent.*" Further, significantly high-K beds of the pumiceous Puye subunit are clearly seen in Figure 2.2-3, and these are based on data from CrCH-2, the boring from the particle-size analyses dataset that is closest to R-70 (see previous comment). Based on this, it seems highly likely that the pumiceous Puye subunit could in fact be a preferential pathway in the R-70 area.

b.) Nowhere in the report is there a discussion or even an acknowledgment of the potential for downward-directed vertical flow gradients to be an explanation for the higher Cr concentrations in the deeper well screen at R-70. Substantial downward vertical gradients have been documented in other LANL wells (e.g., R-69 in the RDX plume area) and downward-directed vertical gradients may have been induced in some wells due to IM pumping (e.g. R-45). It is acknowledged that an upward-directed vertical gradient may be present between S2 and S1 at R-70, however, if present, it is likely not substantial and determinations are confounded due to this being an angled well. In an unconfined, mountain-front groundwater recharge environment, a downward-directed vertical hydraulic gradient is common and needs to be addressed. Please add a discussion acknowledging this potential.

6. **Section 3.0, Hydrogeochemistry, page 6**

LANL Statement: "*This section presents data collected from wells in the R-70 area to develop one or more conceptual models for the observed geochemical structure near the northeast portion of the chromium plume.*"

Comment: Under Section 2.1.2 Hydrogeochemistry, the Assessment Work Plan stated "*A review of zonal sampling that was conducted during drilling of R-35a will also be conducted.*" The Assessment Work Plan went on to describe 18 screening samples taken from numerous depth intervals in R-35a and R-35b. However, the Assessment Report contains no such review of R-35a or R-35b samples. Please provide a review of these samples as stated in the Assessment Work Plan as they are pertinent to the discussion presented in the Assessment Report and will represent a vertical sampling profile from an area downgradient of R-70.

7. **Section 3.1, Groundwater Geochemistry at Well R-70 Screen 1 and R-70 Screen 2, page 7**

LANL Statement: "*The geochemical signature in R-70 screen 1 reflects a mixture of sewage and cooling-tower effluent. Evidence for the sewage signature includes elevated nitrate as nitrogen (NO3 as N) at 2.65 mg/L with a slightly enriched 15N (NO3) isotope composition at 4.99 and 6.60 per mil, and chloride at 6.03 mg/L.*"

Comment:

a.) Provide the basis, from published sources, whereby the R-70 screen 1 isotopic compositions stated above are indicative of sewage or mixing of sewage and cooling tower effluent.

b.) No description has been provided of the procedures and methods used to analyze and evaluate the various isotopic signatures discussed in this section, nor were they provided in the Assessment Work Plan. Please provide a general description of the type(s) of isotopic analyses performed and how the results were interpreted and attributed to different sources.

8. **Section 3.3, Conceptual Models that Describe the Vertical Chromium Distributions at Well R-70, page 9**

LANL Statement: "*The contrast in chromium concentrations in the two screens at well R-70 and the presence of significantly higher concentrations in the deeper of paired screens is unique to the chromium plume.*"

Comment: Explain how this statement is accurate considering well CrEX-4. In the cross section shown in Figure 2.4-2, well CrEX-4 is shown to also have higher Cr concentrations in the deeper of paired screens. Revise statement as needed.

9. **Section 3.3, page 9**

LANL Statement: "*Despite the uncertainty concerning a conceptual model, vertical distribution of chromium at R-70 does not appear to be driven by vertical spreading due to pumping at PM-3 or local downward gradients.*"

Comment: This statement is made without providing a sufficient basis for making it. Downward-directed vertical gradients from areas upgradient of the plume centroid could also explain the vertical contaminant profile seen at R-70 and other wells. Provide additional explanation with site well water-level data, that specifically addresses the potential for downward-directed gradients to cause the deeper contamination at R-70, and why this does or does not provide a more likely explanation for the vertical contamination profile observed.

10. **Section 3.3, page 9-10**

    LANL Statement: "*Nevertheless, there remain uncertainties in terms of the depth of the contaminant plume in the R-70 region. These uncertainties are important to resolve in order to design an effective remediation plan for this portion of the plume. A deeper well (R-73) is proposed to provide additional information on the geochemistry and vertical extent of contamination in the R-70 area*."

    Comment: Provide additional general information and rationale about the newly proposed deep well R-73, such as approximate location and depth of screen. Indicate whether an industry-standard (e.g., at least 72-hour) aquifer pumping test will be performed on the new well.

11. **Section 4.1.1, Effect of PM-3 on R-70, page 12**

    LANL Statement: "*R-70 is an angled well, so the small horizontal hydraulic head gradients in the area introduce some uncertainty into the physical vertical gradient at that location. However, upward vertical gradients are also present in several other dual-screened chromium-area wells that are not angled (e.g., R-61 and R-44), particularly during ambient periods in pumping (N3B 2021, 701366).*"

    Comment: It appears that upward-directed vertical gradients may be present at some dual-screened wells in the Cr plume. But are there also downward-directed vertical gradients observed in any wells? An accounting of vertical gradients from all applicable nested/dual-screen wells in the Cr plume is needed in order to better understand the hydrogeological environment and validate conceptual models of flow. Please provide a table of all dual-screened wells within the Cr plume and in locations upgradient and downgradient of the plume area. In the table, provide the direction (downward or upward) of the vertical gradient and its magnitude for each well. Evaluate the effect of IM pumping for each of the dual-screen wells and indicate if the determination of vertical gradient is based on ambient or pumping conditions. Lastly, show the results on a map or multiple maps if needed, that displays the direction of the vertical gradient (e.g. "D" or "U") at each applicable well point.

12. **Section 4.1.1, page 12**

    LANL Statement: "*The effect of IM pumping (discussed in section 4.1.2) is to reduce the magnitude of the vertical gradient, although it is still typically slightly upward. Figure 4.1-6 shows a time period during IM pumping, along with PM well activity, to further evaluate the question of whether PM-3 effects are apparent at R-70. A period of "reversal" of the gradient (to slightly downward) is shown in Figure 4.1-6, period E; while the timing of the reversal suggests that PM-3 could have been responsible, evidence against this hypothesis is that a slight reversal occurs again in period F, while PM-3 is not pumping. These two events do not have a clear explanation based on changes in IM pumping, as the IM pumping during that time was consistent, until the end of period F.*"

    Comment: If there is not a clear explanation for changes in direction of the vertical gradient (upward-directed to downward-directed) at R-70, from either pumping at PM-3 or IM pumping, does this preclude making the statement that upward vertical gradients are the ambient condition at R-70? For example, in Figure 4.1-6, it appears there are several time periods after period F where there are changes in the direction of the vertical gradient that are not all attributable to changes in IM pumping rates. Please revise the discussion in Section 4.1.1 to address this. It is acknowledged that the changes in Figure 4.1-6 occur over a period of a few days and not over weeks or months, but these changes to downward-directed gradients are important to the discussion as they represent periods when contamination may migrate to deeper levels.

13. **Section 5.0, Modeling, page 17**

LANL Statement: "*In order to produce reliable modeling results useful for the objectives of this report, relatively steady-state chromium concentrations or a clear trend for chromium and water-level data from R-70 were necessary for robust calibration.*

However, the data collected between August 2020 and March 2021 at R-70 screen 1 show significant variability in chromium concentrations, which may be related to the transient nature of IM operations in the area (e.g., pumping at CrEX-5) (Figure 4.1-14), plume variability, or the continued settling of geochemical conditions in the relatively new well."

Comment: The significant variability of Cr concentrations in R-70 S1 between August 2020 and March 2021 are not shown in Figure 4.1-14. The figure seems to show generally standard levels of variability and a somewhat consistent trend in S1 Cr values for the stated time period. Modeling needs to be performed as agreed to in the approved Assessment Work Plan. Preliminary calibrations can be built on a range of Cr concentrations expected based on the variability seen in the current data set. Revise the report to include numerical modeling results as approved in the Assessment Work Plan.

14. **Section 6.0, Summary of Observations, page 17**

LANL Statement: "*Permeable beds are distributed throughout the stratigraphic sequence regardless of geologic unit, and the regional aquifer where the plume is located is effectively a single highly heterogeneous hydrogeologic unit*." AND "*Preferential flow paths do not appear to be associated with particular geologic units, but rather regimes of higher groundwater flow likely occur where networks of interconnected high-K beds form in heterogeneous alluvial deposits*."

Comment: See Comment No. 4 above.

15. **Section 6.0, Summary of Observations, page 18**

LANL Statement: "*The R-70 screen 2 geochemical signature is similar to upgradient wells CrEX-4, CrEX-5, R-28, and R-42. The contrast in chromium distribution between the two screens is significant, and could be related to the timing of effluent releases, and mixing of plume groundwater with clean ambient groundwater*."

Comment: See Comment No. 5b above. Downward migration of contaminants in the region between CrEX-4 and R-70 also needs to be addressed as a potential explanation for the vertical geochemical profile seen at R-70.

16. Figure 2.4-1, page 32

Comment: The conceptual geologic block diagram in this figure is showing potential flow paths in heterogenous alluvial fan deposits. The block diagram shows upward-directed vertical flow paths in shallow to moderate-depth Q90 strata. The block diagram shows no downward-directed flow paths, which are generally understood to be present in mountain front alluvial fan deposits and have been observed in some wells in the Cr Investigation area. See Comment #11 above and modify the conceptual geologic block diagram if needed based on the results of the evaluation requested in Comment #11.