MICHELLE LUJAN GRISHAM
GOVERNOR

JAMES C. KENNEY
CABINET SECRETARY

August 26, 2021

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

Re: Notice of Disapproval
Semiannual Progress Report on Chromium Plume Control Interim Measure Performance,
July through December 2020
Los Alamos National Laboratory
EPA ID#NM0890010515
HWB-LANL-21-019

Dear Arturo Duran,

The New Mexico Environment Department (NMED) received the United States Department of Energy's (DOE) *Semiannual Progress Report on Chromium Plume Control Interim Measure Performance, July through December 2020* (Report) on March 31, 2021. The Report is dated March 2021 and referenced by EM2021-0110. The Report constitutes one submittal in a series of semi-annual reports that are subject to reporting and interim measure (IM) operational requirements provided in Paragraphs C and D of Section XV of the 2016 Compliance Order on Consent (Consent Order). Those Paragraphs reference Section XXIII of the Consent Order, which provides the process for NMED review and approval of these submittals. NMED issues this Notice of Disapproval with disapproval comments in accord with Paragraph F of Section XXIII of the Consent Order. NMED also sent a Notice of Disapproval on July 8, 2021, for the *Semiannual Progress Report on Chromium Plume Control Interim Measure Performance, January through June 2020*. Some of the comments in this letter are similar in nature but must be addressed separately for each report, per Paragraph F of Section XXIII of the Consent Order.

Paragraph C of Section XXIII of the Consent Order requires DOE to involve NMED in chromium technical team and pre-submittal meetings to discuss the contents of the Report before its submittal and for NMED to provide input to direct and adjust the IM operations. In 2020, DOE did not hold these required meetings. This failure has resulted in a substantial disparity between the two parties' approach on how best to assess and manage the IM performance. Additionally, subsequent semi-annual reports are propagating unresolved issues from previous submittals.

On December 31, 2020, NMED issued informal comments based on the review of DOE's *"Semiannual Progress Report on Chromium Plume Control Interim Measure Performance, January through June 2020"* (Previous Report). DOE did not address NMED's informal comments through a resolution process as required by Section XXIII of the Consent Order. Instead, DOE appears to be addressing NMED's informal comments on the Previous Report in the Report. As a result, the issues identified in the Previous Report remain unresolved.

NMED issues this Notice of Disapproval because DOE has not addressed the majority of NMED's informal comments on the Previous Report before submitting this Report, which has resulted in the persistence of crucial unresolved issues. As a result, there are multiple disapproval comments that parallel the unresolved December 31, 2020, informal comments. DOE must also remove their responses to NMED's December 31, 2020, informal comments from this Report and address them in the proper context.

DOE must satisfactorily resolve all the disapproval comments provided herein and must not add to, delete from, or introduce other modifications that do not pertain to the enclosed comments. If DOE notes other issues in the Report that may need modification, DOE must contact NMED to discuss the matter before making any modifications to the revision. The revision of the Report is due within 60 days of the date of this letter.

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

Sincerely,

Ricardo Maestas Digitally signed by Ricardo Maestas Date: 2021.08.26 11:00:51 -06'00'

Ricardo Maestas
Acting Chief
Hazardous Waste Bureau

Cc with Attachment:

N. Dhawan, NMED HWB
C. Krambis, NMED HWB
M. Petersen, NMED HWB
R. Greiner, NMED
C. Catechis, NMED
M. Hunter, NMED GWQB
P. Longmire, NMED GWQB
S. Yanicak, NMED-DOE-OB
L. King, US EPA Region 6
R. Martinez, San Ildefonso Pueblo, NM
D. Chavarria, Santa Clara Pueblo, NM
C. Rodriguez, EM-LA
H. Shen, EM-LA
D. Katzman, N3B
J. Murdock, N3B

S. Veenis, N3B
E. Day, N3B
C. Maupin, N3B
P. Maestas, N3B
W. Alexander, N3B
emla.docs@em.doe.gov

File: LANL 2021 and Reading, Semiannual Progress Report on Chromium Plume Control Interim Measure Performance, July through December 2020
HWB-LANL-21-019

ENCLOSURE
NMED DISAPPROVAL COMMENTS ON THE SEMIANNUAL PROGRESS REPORT ON CHROMIUM PLUME CONTROL INTERIM MEASURE PERFORMANCE, JULY THROUGH DECEMBER 2020, MARCH 2021
LOS ALAMOS NATIONAL LABORATORY, EPA ID #NM0890010515
LANL-21-019

General Comment No. 1

The April 2018 *Chromium Plume Control Interim Measure Performance Monitoring Work Plan* (Work Plan)[1] states that a secondary objective of the interim measures (IM) *"is to hydraulically control plume migration in the eastern downgradient portion of the plume"* and that the *"objective of the performance monitoring and associated reporting is to collect, evaluate, and report on the performance of the IM... to guide adjustments in the distribution and rates of extraction and injection."* Unlike the IM extraction operation that has demonstrated the rapid development of a sustained cone of depression that serves to control plume migration, the activation of CrIN-3, CrIN-4, and CrIN-5 in 2018 has not produced similar evidence of hydraulic control via injection such as the manifestation of a defined hydraulic mound along the Los Alamos National Laboratory – Pueblo de San Ildefonso boundary.

NMED's potentiometric surface mapping shows that the IM injection and extraction operations do not affect groundwater levels in the deeper screened wells where chromium contaminated groundwater is known to be present at R-28, CrEX-4, and R-70 S2 (see Specific Comments Nos. 7 and 8 below). The fact that the IM is not fulfilling all work plan objectives, and that NMED has identified unfavorable responses at R-45 S2, requires that DOE adjust the distribution and rates of IM extraction and injection. It is essential for DOE to hold technical team meetings with NMED to implement the needed changes to the IM system to achieve all objectives formulated since 2013[2,3]. The following general and specific comments provide substantial insights that support adjustment of the IM operation.

General Comment No. 2

Section XXIII of the Consent Order requires pre-submittal meetings be held for IM reports for NMED and DOE to review and discuss the content, technical approach, and/or results to be presented in the document. During the pre-submittal review, NMED is to identify issues or concerns with the technical approach and/or results that would preclude NMED approval.

Following review of the first IM progress report submitted in 2018, NMED sent DOE a letter with the subject *"Approval, Annual Progress Report on Chromium Plume Control Interim Measure Performance"* (2019 Letter)[4]. NMED's general comment 1 attached to the 2019 Letter stated, *"numerical groundwater model and capture/flooding zone width calculations must be included in future IM performance reports to sufficiently assess the IM performance."* DOE's response to this comment was *"Applicability and incorporation of numerical modeling for semiannual reporting might be appropriate to guide IM operational strategies if performance monitoring wells are not responding favorably. The use of modeling for the chromium project should be further discussed with NMED in pre-submission meetings for future semiannual progress reports."* NMED's approval of DOE's response is for the numerical groundwater modeling requirement only, and the capture/flooding zone width calculations requirement set by NMED must be included in each report. The approval of this statement does not relieve DOE from conducting the modeling requirement, especially considering that NMED has

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[1] LANL, April 2018, Chromium Plume Control Interim Measures Performance Monitoring Work Plan (LA-UR-18-23082). 38423.

[2] LANL, April 30, 2013, IM Work Plan for the Evaluation of Chromium Mass Removal. 35819

[3] LANL, May 26, 2015, Interim Measures Work Plan for Chromium Plume Control (LA-UR-15-23126). 37125.

[4] NMED, October 3, 2019, Approval Letter to the Semiannual Progress Report on Chromium Plume Control Interim Measure Performance. 39134

identified an unfavorable response in R-45 S2 (see Specific Comment No. 3 below). This unfavorable response constitutes the type of technical issue both DOE and NMED are required to discuss in pre-submittal meetings. DOE needs to revise the Report to include the required numerical modeling and capture zone and flood zone analyses to better assess the IM performance. This work is to be conducted under the strict technical direction of NMED.

Specific Comments

1. Section 2.1.3 Chromium Mass Removal, Page 3.
DOE Statement: *"Although specific rates and efficiencies of chromium mass removal from extraction wells are not explicit IM objectives, they may provide insights into observed plume response. Table 2.1-3 presents estimates for chromium mass removal for the IM to date."*

NMED Comment:
Table 2.1-3 indicates that the hexavalent chromium concentrations upon which the mass removal estimates have been based are derived from use of a HACH colorimetric field meter. NMED operates two such field meters and has found results from both agree with one another but provide an overestimate of actual hexavalent chromium concentration compared to laboratory analytical results of the same sample. To provide accurate chromium mass removal estimates via sampling, DOE should collect and submit groundwater samples to a NELAP-accredited commercial laboratory that employs defensible U.S. EPA Methods for total dissolved chromium. Details shall be discussed in a technical team meeting prior to the next semi-annual IM progress report is submitted (see General Comment Nos. 1 and 2).

2. Section 3.2.1 Water-Quality and Tracer Results, Page 4.

A. DOE Statement: *"This timeline is indicated as January 2017, representing the approximate beginning of consistent operations along the southern portion of the plume."*

NMED Comment: Based on previous chromium plume control IM reports, the timeline for actual continuous extraction and injection IM operations at the southern area began in May 2018. In addition, the Work Plan states that the initial operational phase of the IM that involves pumping at CrEX-1, CrEX-2, and CrEX-3 and injection into CrIN-3, CrIN-4, and CrIN-5 was to start in 2018. In the revision, correct this statement to reflect the accurate date when continuous IM injection and extraction operations began (i.e., May 23, 2018).

B. DOE Statement: *"The decreasing trend in chromium concentrations in extraction well CrEX-1 shown in Figure 3.2-20 is attributable to mixing with treated water primarily from CrIN-4 which is supported by the tracer results presented later in this section. The decreasing trend in chromium concentrations in CrEX-2 shown in Figure 3.2-21 is likely associated with capture of groundwater with lower chromium concentrations."*

NMED Comment: DOE must support this statement using the required capture zone and flood zone mapping, and numerical groundwater modeling (see General Comment 2 and Specific Comments Nos. 3 and 5).

C. **DOE Statement:** *"The decreasing and current chromium concentrations at R-50 S1 provide the basis for the estimated plume extent at the 50 µg/L concentration as depicted in the various plume maps in this report (e.g., Figure 1.0-1)."*

NMED Comment: While this conforms with the Work Plan, one monitoring point (R-50) does not necessarily constitute the basis to state that the plume has been effectively "pushed" in a favorable direction, i.e., toward the extraction wells. Actual measured recovery of the chromium mass in CrEX-1 is not evident and could suggest that DOE's statement is not supported. DOE must model this scenario to determine where the chromium plume edge likely migrated and/or why the mass has not manifested at CrEX-1 due to the IM injection operations. DOE must support this statement with the required capture zone/flood zone mapping and groundwater modeling (see General Comment 2 and Specific Comments Nos. 3 and 5).

D. **DOE Statement:** *"Monitoring well SIMR-2 has consistently shown background chromium concentrations, with no increase in chromium concentrations that might have occurred because of either migration of chromium downgradient of the area affected by the IM or a hydraulic push caused by any of the upgradient injection wells."*

NMED Comment: The fact that chromium concentrations have not increased in a downgradient well from IM injection operations at CrIN-3, CrIN-4, and CrIN-5 in over a three-year period illustrates that the assertion DOE makes on page 6 is unsupported. As such, the injection operations likely have little, if anything, to do with the chromium plume extent being pushed upgradient. If the injection operations were effective at moving the chromium plume front upgradient to CrEX-1, it would also have moved it in all directions from the point of injection, especially downgradient. Consequently, one would expect to see chromium and tracer concentrations increase at a downgradient monitoring location from an effective injection operation front. This statement suggests it is the extraction operations, not the injection operations, that are the cause of the reversal in the hydraulic gradient and for the movement, if any, of the chromium plume extent at the R-50/SIMR-2 south boundary area (see Specific Comment No. 4). DOE must perform the required capture zone/flood zone mapping and groundwater modeling (see General Comment 2 and Specific Comments Nos. 3 and 5) to provide a more substantial line of evidence than water quality observations.

3. Section 3.2.1 Water-Quality and Tracer Results, Pages 4 and 5.
DOE Statement: *"Although the chromium concentrations in R-45 S1 had begun to drop before IM operations began in the eastern area, injection may have already increased the rate of decline in chromium concentrations. R-45 S2 did not show similar responses for the same period; chromium concentrations in this well screen have continued to increase. The increase in chromium concentrations predates eastern area IM operations (CrIN-1, CrIN-2, and CrEX-5) and is therefore likely unrelated to IM operations. Two working hypotheses for the presence of the deeper contamination in the R-45 and R-70 areas are being evaluated. One hypothesis is that the concentrations of chromium and related constituents observed in R-45 S2 reflect a deeper pathway that may originate further upgradient in the plume, possibly as far upgradient as the CrEX-4 area where a very similar geochemical signature is observed. Under that case, the increase in chromium in R-45 S2 simply represents plume variability. Other wells have historically shown similar patterns. A second hypothesis is that localized downward gradients caused by infiltration of young post-Cr-release effluent at locations further downgradient from locations where chromium originally infiltrated are at least partially responsible for the observed trend in R-45 S2."*

NMED Comment: The data illustrated in the plot in the Attachment show that the decrease in the chromium concentrations at R-45 S1 correlate exactly with the startup of injection wells CrIN-3, CrIN-4, and CrIN-5 in May 2018 and was later accelerated by the startup of injection wells CrIN-1 and CrIN-2 in November 2019. Conversely, these data also show two distinct and pronounced increases in the chromium concentration at the deeper R-45 S2 that also correlate exactly with the commencement of both IM injection operations. Consequently, DOE's assertion that the chromium concentration in R-45 began to decrease before IM operations began appears to be incorrect. In that statement, DOE only considers the eastern area IM, not the south area IM, which is the obvious cause of the first response shown in the Attachment. In the revision, DOE must provide a less biased discussion on this topic to include the southern area IM injection operations as the cause of the chromium responses observed at R-45 and to delete the "two working hypotheses" from the Report based on the following.

The "two working hypotheses" DOE provided in the Report to explain these responses are unsupported by hydraulic and chemical data. The plot in the Attachment shows a very high goodness of fit in the Excel-generated coefficient of determination R-squared value for the chromium detections measured in R-45 S2 in over 10 years of monitoring before IM began. This trendline represents the natural increase in the chromium concentration and, if extrapolated into the future, the chromium concentration should not have reached a concentration of 50 µg/L until February 2035, not December 2020. This contrasts with DOE's first hypothesis that it is the result of an upgradient preferential pathway unless DOE can substantiate that a new release of chromium has occurred. The second hypothesis is also unsupported because there are no significant vertical hydraulic gradients in this portion of the regional aquifer as shown by the hydrographs in the Attachment, and infiltration to the regional aquifer at this location has no substantial source to be a factor in the downward movement of the chromium at R-45 (see Specific Comment No. 9).

Considering the screened zones of the injection wells and R-45 S1 are similar, it is obvious that injection water from the 2018 southern IM system startup either diluted or pushed the chromium concentration at R-45 S1 away from the point of injection. As a result, the chromium previously detected there can no longer be detected with the limited monitoring well network in this area, nor can it be recovered by the IM extraction wells. Additionally, the pressure exerted on deeper groundwater by the same injection operation appears to be the cause of the sudden increase at R-45 S2 over the same timeframe. Subsequent injection at CrIN-1 and CrIN-2 resulted in chromium now exceeding the New Mexico Water Quality Control Commission (WQCC) groundwater quality standard at R-45 S2. The response at R-45 S2 constitutes an unfavorable response in an interim measure performance monitoring well and indicates chromium is present at depth between R-45 and CrIN-1 through CrIN-4 above regulatory limits. This condition merits adjustments to the IM system[1].

In accordance with the Work Plan, NMED's concern of this unfavorable response requires readjustment of the entire IM injection operations. As part of the readjustment to the IM system, NMED requires DOE to conduct the required capture zone and flooding zone analyses and numerical groundwater modeling. This work must be conducted with NMED's input. The plan for the necessary adjustments must be included in the revision of the Report (see General Comment No. 2 above) and/or discussed with NMED in technical meetings. Cessation of all injection operations shall be part of the plan and consist of at least one semi-annual monitoring period to evaluate whether these trends reverse. Technical details must be discussed in a technical team meeting prior to the next semi-annual IM progress report is submitted (see General Comment Nos. 1 and 2).

4. Section 3.2.1 Water-Quality and Tracer Results, Page 6.
DOE Statement: *"Injected water is assumed to be spreading out from CrIN-4 in all directions, but the tracer arrivals at CrEX-1 and R-50 S1 are significant in that they demonstrate that injected water has moved significant distances against the natural gradient in this area of the plume when aided by pumping at CrEX-1."*

NMED Comment: The reversal of the natural hydraulic gradient and the arrival of injected water and tracers from CrIN-4 to R-50 S1 and CrEX-1 is due solely to the pumping at CrEX-1 and not the injection operation at CrIN-4 (see specific comment no. 2D). Groundwater level data at R-50 indicate CrEX-1 pumping creates observable drawdown at R-50 located 450 feet away, but that no discernable rise in the water level occurs from CrIN-4 injection, also 450 feet away. (NMED's analysis of R-50 groundwater levels can be shared with DOE in technical team meetings). It is a physical impossibility that injection can reverse the natural hydraulic gradient enough to push water and tracers upgradient without the development of a mound sufficient to reverse the natural hydraulic gradient. In over three years of operation, the monitoring well network installed around the injection wells indicate that injection operations create no observable hydraulic mound. In contrast, the same monitoring well network shows that a large cone of depression is evident from IM extraction operations. Consequently, there is no evidence that the IM injection operations have been effective at achieving hydraulic plume control and reversing the hydraulic gradient. In accordance with the Work Plan, the effectiveness of the IM activities should be apparent following a three-year period. Based on the data collected by DOE, NMED concludes that injection operations at CrIN-3 through CrIN-5 do not provide plume control along the southern boundary and that adjustments should be made to the IM system (see General Comment Nos. 1 and 2 above). The revision shall strike out the phrase *"when aided by pumping at CrEX-1"* and replace it with *"due to pumping at CrEX-1"*.

5. Section 3.2.1 Water-Quality and Tracer Results, Pages 6 – 8.

A. DOE Statement (pages 6 and 7): *"Additional discussion of tracer and geochemical signature responses associated with IM system performance is presented in the pending Proceedings of the 2021 Waste Management Symposium (Reimus et al. 2021, 701331). This paper also summarizes effective/flowing porosity estimates and flow distribution estimates (i.e., cumulative fractions of flow occurring in cumulative fractions of total porosity) that have been derived from the tracer and geochemical signature responses to date. The relation of the tracer detections at R-50 S1 and R-44 S1, and the corresponding steady decrease in chromium concentrations, indicate that the effective flooding radius from injection at CrIN-4 and CrIN-3 has established the 50 µg/L edge of the plume close to and upgradient of R-50 and upgradient of R-44 (Figure 3.2-30)."*

NMED Comment: Information from tracer test breakthrough, such as travel times, groundwater flow velocity, and effective porosity should have been provided in the Report in accordance with the Work Plan. It is unacceptable for DOE to not include required data in the Report, and in lieu of this requirement, cite its own published work in the Report. In addition, NMED requires DOE to support this statement through capture/flood zone analyses and numerical groundwater flow modeling to evaluate the IM performance, specifically the alleged effective flooding radius from CrIN-3 and CrIN-4 injection operations to have established the 50 µg/L chromium plume edge (see General Comment Nos. 1 and 2 above). In the revision DOE must include the tracer test results presented in the referenced paper, specifically the aquifer porosity and flow estimates and the flooding radius. Inclusion of this information is a requirement of the Work Plan and subsequent agreements between NMED and DOE.

B. **DOE Statement (page 8):** *"Some relatively simple calculations show that it is reasonable to expect that aquifer water would not drift back into the injection wells during the 98 days of the EMCA pause prior to sampling. In these calculations, it is assumed that flow into the injection wells is radial over the thickness of the screened intervals (using a flow porosity less than total porosity to account for preferential flow in more conductive layers), with a superimposed natural gradient flow that serves to limit the upgradient distance that injected water can travel before a stagnation point is encountered. The calculations depend on the assumed flow porosity and the natural gradient flow in the aquifer at the specific locations."*

   NMED Comment: DOE must perform the required capture zone/flood zone calculations and groundwater modeling (see General Comment 2 and Specific Comments Nos. 3 and 5A) to provide a more substantial line of evidence than the *"simple calculations"* and assumptions provided to support this statement.

C. **DOE Statement (page 8):** *"If a natural flow velocity of 0.27 m/day—which is consistent with the results of the borehole dilution tracer test in R-50 S1 in 2015 after assuming a flow porosity of 0.15—is superimposed on the radial injection flow, a stagnation point is predicted at about 70 m upgradient of the injection well. During the 135 days of injection, the leading edge of the injection water would therefore have moved approximately 32 m upgradient. In the subsequent 98 days of IM shutdown, the natural flow would move this leading edge about 26 m back downgradient (i.e., 98 × 0.27 m/day) toward the injection wells, leaving the untreated aquifer water about 6 m short of the injection wells at the time they were sampled."*

   NMED Comment: The 0.27 m/day natural flow velocity provided in DOE's calculations is twice the value cited in a previous report concerning this parameter[5] and does not pertain to the flow velocity that would result from the injection operations in the upgradient direction against the natural flow velocity. To conduct a proper analysis of this scenario, DOE must perform the required capture zone/flood zone calculations and groundwater modeling (see General Comment 2 and Specific Comments Nos. 3 and 5A) as it is more likely that the CrIN-1 and CrIN-2 injection operations moved the chromium mass downgradient and vertically downward based on the response at R-45 S2 and that no discernable mound formed to reverse the natural hydraulic gradient prior to the shutdown. In addition, DOE's statement, if true, that chromium rebound was observed at R-50 (discussed on page 8) suggests that the IM performance there has not been as successful as DOE indicates because the IM had been operating much longer at the southern IM area than at the eastern area. The entire IM operation needs to be simulated in a groundwater model to address this issue. If DOE's calculation and narrative cannot be substantiated by the model, the narrative must be removed from the revision.

D. **DOE Statement (page 8):** *"The relatively quick rebound in chromium concentrations observed in R-50 S1 also provides some indication that the current extent of the injection signal is near the R-50 area, meaning that there is likely a stagnation point not far upgradient of R-50 S1"*.

   NMED Comment: Figure 3.2-8 does not support this statement because the chromium concentration that immediately precedes and follows the "EMCA pause" timeline are about the same (specifically 26.4 µg/L on 3/4/2020 11:58 AM and 30.3 µg/L on 6/26/2020 12:44 PM). DOE must perform the required capture zone and flood zone calculations and numerical groundwater modeling (see General Comment 2 and Specific Comments Nos. 3 and 5A) to support this statement or delete it from the revision.

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[5] LANL, September 2012, Phase II Investigation Report for Sandia Canyon (LA-UR-12-24593). 35521.

6. Section 3.2.2 Water-Level Data, Page 11.

A. DOE Statement: *"R-45 S1 and S2 are shown in Figure 3.2-38a. Some of the early data, particularly at R-45 S2 but S1 as well, are unreliable, leading to poor corrections and unclear trends, e.g., beginning in 2012 and persisting until around 2018."*

NMED Comment: In the revision DOE shall provide multiple lines of evidence that support the claim that the data from 2012 to 2018 are unreliable. The assumption that insufficient barometric compensation employed by DOE on these data does not constitute a valid line of evidence.

B. DOE Statement: *"The chromium IM infrastructure wells nearest to R-45 are CrIN-1, CrIN-2, CrEX-5, and CrEX-3 (Figure 1.0-1). Figure 3.2-38b shows the hydrograph for 2018–2020, highlighting the recent effects of the IM. As expected, R-45 is strongly affected by CrIN-1 and -2. Figure 3.2-38c shows a period from March to December 2020. At point A, the IM, which had been operating at most wells (CrEX-1, -2, and -5; CrIN-1, -2, -4, and -5), shutdown and water levels immediately declined at both R-45 S1 and S2 but substantially more at S1. It appears the combined effect of injection and extraction results in a greater water-level rise at S1 than at S2. This is likely due to two effects: (1) the combined effect of injection at CrIN-1 and -2 is greater at R-45 S1 (see Figure 3.2-38d, period C, where CrEX-5 is not operational but CrIN-1 and -2 turn on and off at the end of period C); and (2) the effect of extraction at CrEX-5 is greater on R-45 S2 (see Figure 3.2-38e, point D). Note that period B in Figure 3.2-38c does not have CrIN-2 pumping, suggesting that the dominance of injection over extraction at R-45 S1 is driven primarily by CrIN-1, not CrIN-2. Given the distances between R 45 and these wells, this is expected."*

NMED Comment: DOE discusses each chromium IM infrastructure well near R-45 except CrIN-3 in this narrative. The omission of CrIN-3 from this narrative is unacceptable, especially considering it was a comment made by NMED on the Previous Report. In the revision, DOE must include the influences of CrIN-3 operation on R-45 S1 and S2 and consider its obvious effects on chromium concentrations there as attested by the plot in the Attachment and to the similar and simultaneous hydrograph responses discussed in Specific Comment No. 11 and noted by "period B in Figure 3.2-38c". DOE must include the required capture zone and flood zone and numerical groundwater flow modeling analyses to substantiate this statement.

7. Section 3.3 Water-Table Map, Page 13

DOE Statement: *"Water-table maps are presented as an additional line of evidence in evaluating long-term changes in the water-table structure and associated with IM performance and interpreting potential changes in concentrations of key constituents in performance monitoring wells and piezometers. Long-term pumping and injection at IM infrastructure wells may affect the structure of the water table over time in the form of drawdown around extraction wells and mounding around injection wells. The changes in the water table, chromium concentrations, and tracer breakthrough provide insights into overall IM performance."*

NMED Comment: The water table maps presented in the Report are not sufficient to evaluate the changes in the water table from the IM extraction and injection operations because of the use of the automated kriging computer algorithm, incomplete dataset, and use of monthly averages in lieu of synoptic data (see Specific Comment Nos. 8, 9 and 10 below). Consequently, the mapping shown as Figures 3.3-1 and 4.0-2 in the Report are not representative of the IM performance and do not provide an accurate assessment of the effectiveness of the IM or impact to the structure of the water table. Using the three-point problem (see Specific Comment No. 8) and synoptic data of all the chromium group wells, NMED easily produced much more robust results that reveal the IM extraction operations impact on the water table configuration but not the IM injection operations. NMED's mapping also indicates that none of the IM operations affect the deeper heads recorded in the "S2" screened interval. Hence, DOE's IM does not affect the deeper portions of the chromium groundwater contamination (NMED's maps and the three-point problem triangulation technique can be shared with DOE in technical team meetings).

Section 3.2 (page 11) of the Report indicates that the screen 2 heads are affected by pumping differently than the screen 1 heads at some locations. Mapping the deeper heads in the chromium plume provides insights into IM effects, preferential pathways, the occurrence of contamination, and contamination migration at depth. NMED's mapping of the deeper heads show the IM operations do not impact the deeper heads and that a clear plume-scale preferential pathway is identifiable. DOE must revise Figures 3.3-1 and 4.0-2 to also show the potentiometric surface contours of the heads measured at depth as recorded from screen 2 wells superimposed with the water table contours recorded by screen 1 wells and include them in the revision. DOE must use the three-point problem using synoptic data of all wells in the chromium group and recontour Figures 3.3-1 and 4.0-2 and include them in the revision. The mapping shall be undertaken with NMED involvement and approval before both figures are included in the revision.

8. Section 3.3 Water-Table Map, Page 13

DOE Statement: *"The method used for water table mapping utilizes kriging and provides a degree of automation that allows for consistency in the maps over time. The use of monthly averages of water-level data ensures that any given water-table depiction is not driven by one or more anomalous values in any given well.*

The extremely low gradient in the plume area supports use of periodic monthly averages to represent long-term changes specifically associated with the IM. Various short-duration perturbations, such as monthly groundwater monitoring for the Interim Facility-Wide Groundwater Monitoring Plan and daily and longer variations in pumping rates from nearby Los Alamos County water-supply wells, could have a local effect at one or more locations, resulting in non-representative water-table depictions if a more synoptic approach were to be used."

NMED Comment: DOE's assertions in this section are incorrect, specifically DOE's justifications for the use of kriging and the use of monthly averages in lieu of actual water level data. Kriging does not necessarily align with industry standards. Kriging does not provide any more consistency over time than other method of interpolation and is prone to misrepresent surfaces if improperly used. Use of synoptic data does not result in non-representative water table depictions but constitutes the only information upon which a representative water table configuration can be based. Additionally, use of synoptic data is the industry standard[6].

While kriging honors the data at the measurement locations and is commonly used in industry for interpolating datasets, by default it is a poor choice to provide a representative groundwater flow interpolation because it assumes the dataset has a normal distribution, has no trend, and has no significant data gaps. Kriging is highly prone to interpolation artifacts that cause overemphasis of isolated observations, excessive smoothing and/or abrupt changes in the interpolated surface and data gaps. The gridding resolution, drift and the semivariogram model must be appropriately applied to each dataset, otherwise kriging is prone to misrepresent the groundwater flow system. Hence, kriging and other automated geostatistical interpolation methods must be

[6] ASTM-D6000-15 Standard Guide for Presentation of Water-Level Information from Groundwater Sites.

used with caution. The flat hydraulic gradient requires a very low interpolation error to provide a representative water table map. However, DOE did not provide the error in the predicted surface for each map in the Report to validate their application of kriging. DOE's reason for using kriging shows a lack of understanding in what constitutes formulation of tenable representative maps because automation should not be an overriding factor when choosing a method of interpolation. The commonly accepted, unbiased, and tenable method in mapping the water table surface is triangulation of the three-point problem. The three-point problem is a mathematically based method used in geology and hydrogeology to determine the true dip and hydraulic gradient. NMED's application of the three-point problem using synoptic data produced a series of tenable potentiometric surface maps that provide a far more representative water table configurations that contrasts with DOE's interpretation during periods of IM operations and during periods without IM operations.

DOE's statement that the low hydraulic gradient requires the use of monthly averages is unsupported by hydraulic data and information. DOE's use of monthly averages instead of actual synoptic data is not consistent with the industry standard[6], does not comply with discharge permit requirements[7], and does not provide better understanding of the long-term changes in the water table caused by the IM activities. The use of monthly average water levels to map the water table incorporates undesirable water table fluctuations caused by barometric pressure changes, drawdown from sampling purges and earth tides, which all skew the interpolating and contouring results. Conversely, use of synoptic data obtained from continuously recording pressure transducers at low activity times (e.g., early mornings, weekends, and holidays) negates these undesired effects on groundwater levels because all measurements are from the same time and under the same influence. Consequently, compensation of barometric and tidal influences are not required; unlike monthly averages, which incorporate such influence, and thus result in a nonrepresentative potentiometric surface. DOE must provide multiple standards (e.g., U.S. EPA, ASTM) and studies in peer reviewed journals or textbooks to support the use of monthly averages over synoptic data when synoptic data are available for mapping the water table surface. In addition, detecting effects from pumping from the IM extraction wells and County production wells is a prime objective in preparing these maps in the semi-annual reports and should not be circumvented by using monthly averages.

9. Section 3.3 Water-Table Map, Page 13 and 14.

DOE Statement: *"In addition to being potentially caused by pumping, subtle mounds and adjacent apparent depressions in the water table can also be caused by local areas of present-day recharge from the vadose zone. For example, although the water table generally dips gently from west to east across the chromium plume area, a suspected recharge window causing slight mounding in the water table to the east of CrPZ-2 could cause the appearance of a lower point to the west, even in the May 2018 baseline map."*

NMED Comment: NMED does not concur that *"subtle mounds and adjacent apparent depressions in the water table can also be caused by local areas of present-day recharge from the vadose zone."* The suggestion that a subtle, but measurable, depression or low point in the water table can occur from a mound is unlikely. The prevailing cause for a depression in a water table surface is pumping. However, the use of monthly averages, conflicting reference well surveys, data gaps, and incorporation of different zones (i.e., deeper, or shallower) can create errant closed contours when automated computer algorithms like kriging are used.

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[7] NMED, August 31, 2016, Ground Water Discharge Permit, Los Alamos National Laboratory Underground Injection Control Wells Discharge Permit-1835. 37680.

NMED contoured the same data (which is synoptic) for the May 1, 2018, baseline water table map presented by DOE in Figure 3.3-2 of the Report, but using the three-point problem, and was not able to reproduce the depression. DOE must recontour the baseline water table map using the three-point problem for inclusion into the revision. Figures 3.3-1 and 4.0-2 in the Report also show a closed contour at an equal elevation of 5830 feet that forms an apparent depression in the water table in the same area. However, no data support these closed contours, and the closed contours are not centered around an operating extraction well. These errant closed contours are a recurring problem in many previous semi-annual reports and it is obvious they are due to artifacts that result from the application of automated software, data gaps, questionable reference surveys, and use of monthly averages in lieu of actual synoptic data. Piezometers paired adjacent to CrEX-1, CrEX-3 and CrEX-4, like CrPZ-1 is paired with CrEX-2, will be required to help fill in the data gaps if DOE continues to use computer algorithms in formulating water table maps in future submittals. In addition, DOE states in Section 3.3 of the Report that *"slight mounding in the water table to the east CrPZ-2 could cause the appearance of a lower point to the west, even in the May 2018 baseline map."* This *"mound"* east of CrPZ-2a/b may be attributed to a false high at R-28 in the baseline map that is due to the loss of hydraulic connectivity in R-28 with the aquifer due to the August 2017 molasses amendment injection. Conversely, it could be due to survey issues among the piezometer and the monitoring well. DOE must investigate this as a possibility, as well as the pressure transducer settings and the wellhead reference surveys, as potential underlying causes of the apparent water level anomalies in this area that affect mapping of the water table. DOE should perform a well resurvey, if necessary, at each chromium group installation due to the high sensitivity the flat hydraulic gradient is to aberrations in reference data. Results of such investigations (e.g., well resurvey, R-28 water level representativeness...) should be included in the revision.

Another potential source of error in mapping of the water table is DOE not including all data points available in the chromium group when preparing these maps. While the mapping requirements include only 14 wells[7], it excludes key wells such as R-28, R-48, R-70, R-35b and R-15 from formulation these maps. Data from these wells and SIMR-2 (one of the 14 required wells that DOE typically omits from the water table maps) are as instrumental in understanding long-term changes to the water table from IM activities as the locations listed in the discharge permit[7]. NMED does not understand why DOE omits groundwater level data from several local chromium group monitoring wells but includes the statement that *"Monitoring wells within and surrounding the plume are used, including wells not presented on the map (i.e., R-21, R-31, R-32, R-37, and R-40). Water levels in wells surrounding the plume provide useful control points for contouring along the edges of the area of interest for this report."*[8] The use of data closest to the subject matter is especially important when using automated computer algorithms to interpolate data because the algorithm stresses reliance on the nearest data over more distant data. Accurate representation of the water table requires inclusion of all chromium group well data regardless of the permit requirements. DOE must include synoptic data from each chromium group installation and revise Figures 3.3-1 and 4.0-2 in the revision and in all future submittals using three-point problem manual interpolation method to minimize the impacts the existing data gaps have on automated computer interpolation methods.

Drilling records demonstrate that no perched aquifer or other vadose saturation is present in the area to provide the *"present-day recharge"* to the water table as surmised by DOE. Additionally, the documented decline in the perched water levels at the upgradient chromium group area counters DOE's statement (e.g., MCOI-4, MCOI-5,

[8] Newport News Nuclear BWXT-Los Alamos, LLC, March 2021, Quarterly Report for the Discharge of Treated Groundwater to the Regional Aquifer under Discharge Permit 1835, Calendar Year 2020 Quarter 4. EM2021-0056.

SCI-1). Sustained engineered injection operations from the plume control IM have shown that mounding does not occur along the water table, or at least not at detectable magnitudes by the existing monitoring well network. It is implausible that the natural recharge in a desert environment such as Los Alamos would provide more flux to the water table than the IM injection operations. DOE must remove this narrative in the revision or support it by identifying the source with recent drilling data, quantifying the recharge flux to the water table from the source, and comparing the "present-day recharge" flux to the IM injection operation flux through calculations and groundwater modeling. More realistic scenarios that explain the errant closed contours include well survey issues, mis-contouring of the water table due to errant use of monthly water level averages, inclusion of R-28 and R-42 and different hydrostratigraphic zones, data gaps and use of the automated kriging interpolation method.

10. Section 3.3 Water-Table Map, Page 14.
DOE Statement: *"The water table in the chromium area is relatively flat. Therefore, even relatively small localized variations in hydraulic conductivity may be linked to discernible changes in pressure measurements."*

NMED's Comment: On page 13 of the Report DOE states *"The use of monthly averages of water-level data ensures that any given water-table depiction is not driven by one or more anomalous values at any given well."* If this statement is true, explain in the revision how the anomalous low at CrPZ-2 is consistently an issue in mapping the water table. Knowing that hydraulic conductivity is a tensor, explain how *"...relatively small localized variations in hydraulic conductivity may be linked to discernible changes in pressure measurements."* If true, one would expect it to be a common problem in mapping of potentiometric surface elsewhere in the chromium site, and in hydrogeology in general, considering the stated geologic conditions at CrPZ-2 are not unique. In the revision, provide peer-reviewed literature (e.g., journal articles, university textbooks...) and a numerical groundwater model run that simulates the mechanics of the flow field in such hydrogeologic conditions (e.g., flat water table and small localized variations in hydraulic conductivity) to support this statement. Otherwise, remove the statement from the revision and pursue a different approach to solve the cause of this anomaly (Specific Comment No. 9).

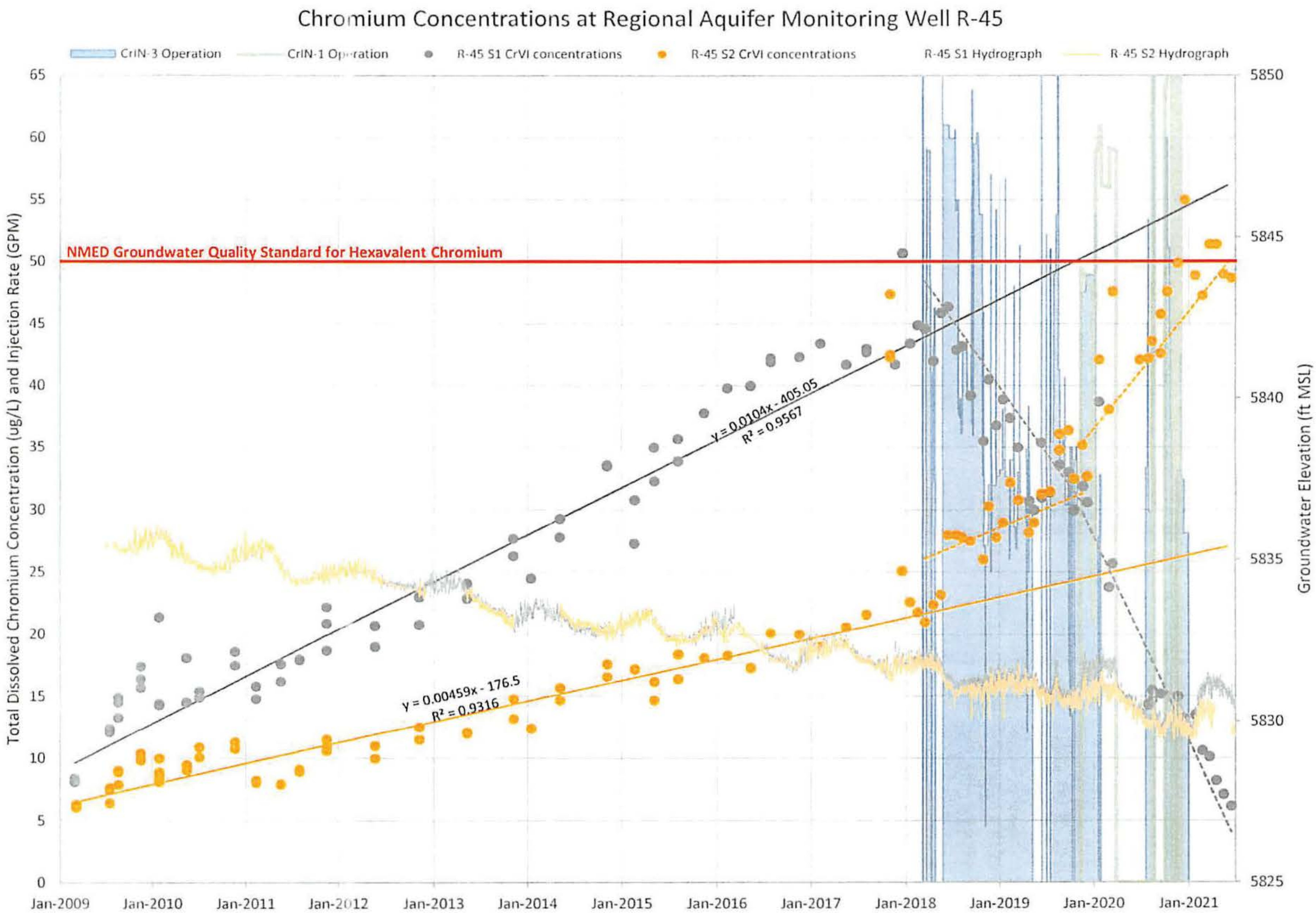
11. Figure 2.1-2 - Injection well flow rates and water levels for CrIN-1, CrIN-2, CrIN-3, CrIN-4, and CrIN-5 from July 1 through December 31, 2020, page 23.

NMED Comment: In this figure, there is a unique pattern to the sudden near 80-foot water level rise recorded in CrIN-3 during October 2020 as it contrasts with concurrent patterns of water level changes recorded in the other injection wells. Figure 3.2-38c on page 65 of the Report shows a very similar pattern recorded in the hydrograph for R-45 S1 during the timeframe denoted by "period B", also in October 2020 (see specific comment 6B). In Section 3.2.2 on page 11 of the Report, the 1-foot rise noted by "period B" is attributed to CrIN-1 because CrIN-2 was not operating. However, there was little increase in the CrIN-1 water level rise in October compared to that shown in CrIN-3 and the pattern resembles that of the near 80-foot water level rise in CrIN-3 not CrIN-1. In the revision, explain these unique patterns and comment on whether the large injection recorded in CrIN-3 is the cause of the similar pattern recorded in R-45 S1 and how DOE will include this response in the pending groundwater model as this cause and response indicates a definite hydraulic connection between CrIN-3 and R-45 S1 (see Specific Comment No. 6B). This hydraulic connection is also noted by the groundwater chemistry trend changes shown in the Attachment.

The Work Plan requires DOE to provide key data that support its evaluation of IM performance including water level data[1]. DOE has not provided the water level data from the 10 IM infrastructure wells in the Report. Within five business days of the date of this Notice of Disapproval, DOE must submit the raw pressure transducer data from the 10 IM infrastructure wells shown in Figure 2.1-1 and 2.1-2, and barometric pressure changes used to compensate the raw water levels, if performed. E-mail these data directly to Christopher.krambis@state.nm.us.

12. Figures 3.2-37a through 3.2-42, pages 60 through 77.

NMED Comment: Many of these figures are too busy, specifically Figures 3.2-37a, -38a, -38b, -38c, -39a, -39d, -40a, - 40c, -41a, and -42, due to the excessively long timeframes shown by the x-axis scale compared to the less busy figures that have much more concise timeframes. In the revision, provide a second set of figures for each well that show only the timeframe of concern by the Report (i.e., July 2020 through December 2020).



Chromium Concentrations at Regional Aquifer Monitoring Well R-45
CrIN-3 Operation
CrIN-1 Operation
R-45 S1 CrVI concentrations
R-45 S2 CrVI concentrations
R-45 S1 Hydrograph
R-45 S2 Hydrograph
NMED Groundwater Quality Standard for Hexavalent Chromium
y = 0.0104x - 405.05
R² = 0.9567
y = 0.00459x - 176.5
R² = 0.9316
Total Dissolved Chromium Concentration (ug/L) and Injection Rate (GPM)
Groundwater Elevation (ft MSL)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
5850
5845
5840
5835
5830
5825
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