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Date: June 25, 2021
Refer To: N3B-2021-0215

Michelle Hunter, Chief
Ground Water Quality Bureau
New Mexico Environment Department
1190 S. St. Francis Drive
Santa Fe, NM 87502-5469

Subject: Submittal of the Work Plan for Groundwater Modeling for Contaminant Migration from Wells R-42 and R-28

Dear Ms. Hunter:

Enclosed please find the submittal of the "Work Plan for Groundwater Modeling for Contaminant Migration from Wells R-42 and R-28." This work plan is submitted in response to the New Mexico Environment Department's (NMED's) "Notice of Non-Compliance, Los Alamos National Laboratory (LANL), Regional Aquifer Wells R-28 And R-42" letter, dated May 27, 2021. The letter requests that the U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office (EM LA) submit a workplan for NMED's approval, within 30 days of the date of the letter, "detailing DOE's proposed initial modeling, both conceptual and computer simulation, of the contaminant migration."

If you have questions, please contact Christian Maupin at (505) 695-4281 (christian.maupin@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Troy Thomson
Acting Program Manager
Environmental Remediation
N3B-Los Alamos

Sincerely,

Stephen G. Hoffman
Digitally signed by Stephen G. Hoffman
Date: 2021.06.25 12:37:52 -06'00'

Arturo Q. Duran
Compliance and Permitting Manager
Environmental Management
Los Alamos Field Office

Enclosure(s): One hard copy with electronic files:

1. Work Plan for Groundwater Modeling for Contaminant Migration from Wells R-42 and R-28 (EM2021-0348)

cc (letter and enclosure[s] emailed):
Laurie King, EPA Region 6, Dallas, TX
Chris Catechis, NMED-DOE-OB/-RPD
Steve Yanicak, NMED-DOE-OB
Patrick Longmire, NMED-GWQB
Steve Pullen, NMED-GWQB
Andrew Romero, NMED-GWQB
Neelam Dhawan, NMED-HWB
Christopher Krambis, NMED-HWB
Ricardo Maestas, NMED-HWB
Peter Maggiore, NA-LA
Arturo Duran, EM-LA
John Evans, EM-LA
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Cheryl Rodriguez, EM-LA
Thomas McCrory, EM-LA
Kenneth Ocker, EM-LA
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Dana Lindsay, N3B
Pamela Maestas, N3B
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PRS website

Pamela T. Maestas

From: Pullen, Steve, NMENV <steve.pullen@state.nm.us>
Sent: Friday, June 25, 2021 4:32 PM
To: Pamela T. Maestas
Cc: Romero, Andrew C, NMENV; Longmire, Patrick, NMENV; Emily M. Day; Regulatory Documentation; cheryl.rodriguez@em.doe.gov; Christian T. Maupin; Kenneth Ocker; Danny Katzman; Bruce A. Robinson; Hunter, Michelle, NMENV
Subject: RE: Submittal to NMED on 6/25/2021 of WP for GW Modeling R-42 and R-28

Hi Pam,

The NMED GWQB acknowledges receipt.

Have a nice weekend.

sp

From: Pamela T. Maestas <pamela.maestas@em-la.doe.gov>
Sent: Friday, June 25, 2021 4:25 PM
To: Hunter, Michelle, NMENV <Michelle.Hunter@state.nm.us>
Cc: Pullen, Steve, NMENV <steve.pullen@state.nm.us>; Romero, Andrew C, NMENV <AndrewC.Romero@state.nm.us>; Longmire, Patrick, NMENV <Patrick.Longmire@state.nm.us>; Emily M. Day <Emily.Day@em-la.doe.gov>; Regulatory Documentation <RegDocs@EM-LA.DOE.GOV>; cheryl.rodriguez@em.doe.gov; Christian T. Maupin <Christian.Maupin@em-la.doe.gov>; Kenneth Ocker <kenneth.ocker@em.doe.gov>; Danny Katzman <danny.katzman@em-la.doe.gov>; Bruce A. Robinson <bruce.robinson@em-la.doe.gov>
Subject: [EXT] Submittal to NMED on 6/25/2021 of WP for GW Modeling R-42 and R-28

Ms. Hunter,
Attached for submittal is a pdf of the following:

- Submittal of the Work Plan for Groundwater Modeling for Contaminant Migration from Wells R-42 and R-28 (N3B-2021-0215, letter and enclosure)

Please acknowledge receipt of this submittal by responding to this email. Hard copies of the submittal will be taken to your office next week.
Let me know if you have any questions.
Thank you.

Pamela T. Maestas
Regulatory Documentation Manager
Newport News Nuclear BWXT-Los Alamos, LLC
c. 505-927-7882
regdocs@em-la.doe.gov

1200 Trinity Drive, Suite 150
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WORK PLAN FOR GROUNDWATER MODELING FOR CONTAMINANT MIGRATION FROM WELLS R-42 AND R-28

1.0 INTRODUCTION

This work plan is submitted in response to the New Mexico Environment Department's (NMED's) "Notice of Non-Compliance, Los Alamos National Laboratory (LANL), Regional Aquifer Wells R-28 And R-42" letter (Notice of Non-Compliance), dated May 27, 2021 (NMED 2021). The letter requests that the U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office (EM-LA) submit a workplan for NMED's approval, within 30 days of the date of the letter, "detailing DOE's proposed initial modeling, both conceptual and computer simulation, of the contaminant migration." The contaminants referred to in NMED's May 27, 2021, letter are naturally occurring iron and manganese that have been liberated from the aquifer sediments near the wells (R-42 and R-28) where a pilot-scale study is underway to evaluate the technical feasibility of using amendments (sodium dithionite and molasses, respectively) added directly into areas within the hexavalent chromium plume as part of a potential groundwater remediation strategy (Figure 1.0-1). The geochemically reducing conditions around R-42 and R-28 were intentionally induced in a small, pilot-scale, footprint within the regional aquifer. The pilot-scale study described above is being implemented in accordance with the "Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon" (Pilot-Scale WP; LANL 2017a) which was submitted to NMED on July 11, 2017, and subsequently approved by NMED on July 31, 2017 (NMED 2017). A supplement to the pilot-scale study titled "Supplemental Work Plan for Pilot-Scale Amendments Testing for Chromium in Groundwater beneath Mortandad Canyon" (N3B 2019a) was submitted to NMED on September 24, 2019, and subsequently approved by NMED on July 29, 2020 (NMED 2020).

2.0 BACKGROUND

As noted above, the pilot-scale study involved the deployment of a sodium dithionite solution into R-42 and a molasses solution into R-28 in the fall of 2017. EM-LA submitted two notices of intent to discharge (NOIs), one for each proposed amendment deployment, to the NMED Ground Water Quality Bureau (GWQB) on May 22, 2017 (LANL 2017b,c). The amendments were subsequently deployed into these two wells in accordance with no-permit-required determinations made by the NMED-GWQB and received on June 27, 2017, for R-28 and July 18, 2017, for R-42. The Pilot-Scale WP and the NOIs noted the possibility of iron, manganese, and other constituents being liberated from aquifer sediments as a result of the conditions induced by deployment of the amendments. Accordingly, monitoring at R-42 and R-28 has included these and other constituents since deployment of the amendments in the fall of 2017.

The results of the sampling conducted at R-42 and R-28 as part of the pilot-scale study have been included in a series of periodic reports submitted to NMED over several years (LANL 2018a; LANL 2018b; N3B 2018a; N3B 2018b; N3B 2019b; N3B 2019c; N3B 2019d; N3B 2020). These reports provide the data in the context of tracking the progress of the study, and evaluation of the principle geochemical indicators that provide insights into how conditions around these wells are evolving as part of the study.

Additionally, modifications were made to EM-LA's discharge permit 1835 (DP-1835) to include monitoring for iron and manganese for compliance monitoring of the effluent from the ion-exchange treatment system. The monitoring occurs weekly and is included in quarterly reports submitted as a requirement under DP-1835 (e.g., N3B 2021). Sampling and analysis are also being conducted at extraction wells and nearby monitoring wells on a monthly basis for a wide range of constituents, including iron and manganese. Those data indicate no apparent increases in iron or manganese at those locations with the

exception of extraction well CrEX-3, which shows elevated manganese. However, the data remain inconclusive with regards to whether the elevated manganese at CrEX-3 is directly related to the elevated manganese at R-28.

3.0 PROPOSED MODELING APPROACH

The Notice of Non-Compliance directed EM-LA to develop a work plan for the development of both conceptual and numerical models for the fate and transport of iron and manganese. The following two subsections outline EM-LA's proposed approach for the conceptual (section 3.1) and numerical (section 3.2) models.

3.1 Conceptual Model

The conceptual model for fate and transport of iron and manganese as a result of amendments deployment in R-42 and R-28 will be developed to enable representation of the behavior of these constituents from the time of amendments deployment, to the present-day condition, to potential future behavior. The components of the conceptual model include the behavior of the amendments during deployment, and the subsequent hydrogeochemical processes acting on the amendments, breakdown products, and the reduced iron and manganese species. The hydrologic elements consist of the displacement of native groundwater with amendment solutions, and the subsequent drift of dissolved species as the natural flow conditions were re-established after the hydrologic impact of deployments subsided. Numerous geochemical processes will also be included in the conceptual model, including:

- reduction-oxidation (redox) processes,
- fate of the sodium dithionite and molasses upon injection into the formation,
- solubility of iron and manganese species as a function of redox conditions,
- sorption of reduced iron and manganese aqueous species via ion exchange processes, and
- potential re-oxidation of iron and manganese species as they are introduced into oxidizing groundwater.

The conceptual model will be described using a combination of field observations at the site and general hydrogeochemical principles. Assumptions and system-scale simplifications will be identified and justified, and the accompanying numerical model will be based on these assumptions and simplifications.

3.2 Modeling

This work plan discusses two modeling approaches for providing estimations of the fate and transport of reduced iron and manganese in the regional aquifer liberated from aquifer sediments during the pilot-scale study. Two alternative approaches to the modeling are discussed below.

Modeling approach 1 would involve development of a three-dimensional reactive transport model, including the full effects of the hydrologic and geochemical behavior of the system through the various operational phases. One attribute of this modeling approach is that the complete history of transport, generation of reduced iron and manganese species, and their subsequent migration away from the borehole can be incorporated, which might have the benefit of reducing the number of simplifying assumptions, since in principle, the evolution of the transport system can be directly simulated, including the effects of interim measure operation. The main drawback of the approach is the long model development process and computational times.

Modeling approach 2 would utilize a one-dimensional geochemical transport model, with inputs such as flow direction and velocity informed by the three-dimensional model. In this approach, modeled estimates of the migration of the dissolved species in three dimensions are sacrificed in favor of representing the important geochemical processes in greater detail. Computational times would be substantially reduced, enabling more complete sensitivity and uncertainty analysis. Model development time is expected to be considerably reduced as well.

The recommendation is to use approach 2 for pragmatic reasons. The level of uncertainty in the geochemical processes is expected to dominate the analysis of this system, making a full three-dimensional representation presented as approach 1 less useful than approach 2, which would fully evaluate the redox, solubility, and sorption processes. These geochemical processes are much more readily accomplished in a simple one-dimensional flow model in which computational time is devoted to the geochemical processes rather than the hydrologic processes. The Finite Element Heat and Mass (FEHM) model for the chromium project would still be used to inform the one-dimensional model by providing the flow direction and transport velocity within which the geochemical processes take place. The one-dimensional transport processes that would be incorporated in approach 2 would be conducted using either the FEHM code or possibly the PHREEQC [PH (pH), RE (redox), EQ (equilibrium), C (programming language)] code, which has provisions for performing reactive transport calculations along a one-dimensional flow path. This approach would allow for the efficient prediction and quantification of uncertainty of iron and manganese transport distances along any flow path predicted in the three-dimensional hydrologic model.

Although, in principle, the same calculations could be performed in full three-dimensions (i.e., approach 1), the development time for such a model would be considerably longer in comparison to the more practical approach 2. Given the goal of the modeling, which is to estimate the area in the aquifer with elevated iron and manganese concentrations, approach 2 is recommended as the most efficient means of achieving the modeling objective in NMED's Notice of Non-Compliance.

4.0 REFERENCES

LANL (Los Alamos National Laboratory), July 2017. "Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon," Los Alamos National Laboratory document LA-UR-17-25406, Los Alamos, New Mexico. (LANL 2017a)

LANL (Los Alamos National Laboratory), May 2017. "Notice of Intent to Conduct a Pilot-Scale Amendment Study at Los Alamos National Laboratory Regional Aquifer Monitoring Well R-42," Los Alamos National Laboratory letter number EPC-DO: 17-188, Los Alamos, New Mexico. (LANL 2017b)

LANL (Los Alamos National Laboratory), May 2017. "Notice of Intent to Conduct a Pilot-Scale Amendment Study at Los Alamos National Laboratory Regional Aquifer Monitoring Well R-28," Los Alamos National Laboratory letter number EPC-DO: 17-190, Los Alamos, New Mexico. (LANL 2017c)

LANL (Los Alamos National Laboratory), January 2018. "Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater beneath Mortandad Canyon," Los Alamos National Laboratory document LA-UR-18-20467, Los Alamos, New Mexico. (LANL 2018a)

LANL (Los Alamos National Laboratory), April 2018. "Second Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon," Los Alamos National Laboratory document LA-UR-18-23418, Los Alamos, New Mexico. (LANL 2018b)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), July 2018. “Third Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2018-0019, Los Alamos, New Mexico. (N3B 2018a)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), October 2018. “Fourth Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2018-0069, Los Alamos, New Mexico. (N3B 2018b)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), December 2019. “Supplemental Work Plan for Pilot-Scale Amendments Testing for Chromium in Groundwater beneath Mortandad Canyon, Revision 1,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0455, Los Alamos, New Mexico. (N3B 2019a)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), January 2019. “Fifth Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0011, Los Alamos, New Mexico. (N3B 2019b)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), April 2019. “Sixth Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0133, Los Alamos, New Mexico. (N3B 2019c)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), December 2019. “Seventh Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon, April to September 2019” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0427, Los Alamos, New Mexico. (N3B 2019d)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), June 2020. “Eighth Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon, October 2019 to March 2020” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2020-0253, Los Alamos, New Mexico. (N3B 2020)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), June 2021. “Quarterly Report for the Discharge of Treated Groundwater to the Regional Aquifer under Discharge Permit 1835, Calendar Year 2021 Quarter 1” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2021-0264, Los Alamos, New Mexico. (N3B 2021)

NMED (New Mexico Environment Department), July 31, 2017. “Approval, Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon,” New Mexico Environment Department letter to D. Hintze (DOE-EM) and B. Robinson (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2017)

NMED (New Mexico Environment Department), January 14, 2020. “Approval with Modification, Supplemental Work Plan for Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon Revision 1,” New Mexico Environment Department letter to D. Hintze (EM-LA) from K. Pierard (NMED-HWB), Santa Fe, New Mexico. (NMED 2020)

NMED (New Mexico Environment Department) 2021. “Notice of Non-Compliance, Los Alamos National Laboratory (LANL), Regional Aquifer Wells R-28 And R-42,” New Mexico Environment Department letter to A. Duran (EM-LA) from M. Hunter (NMED-GWQB), Santa Fe, New Mexico, dated May 27, 2021. (NMED 2021)

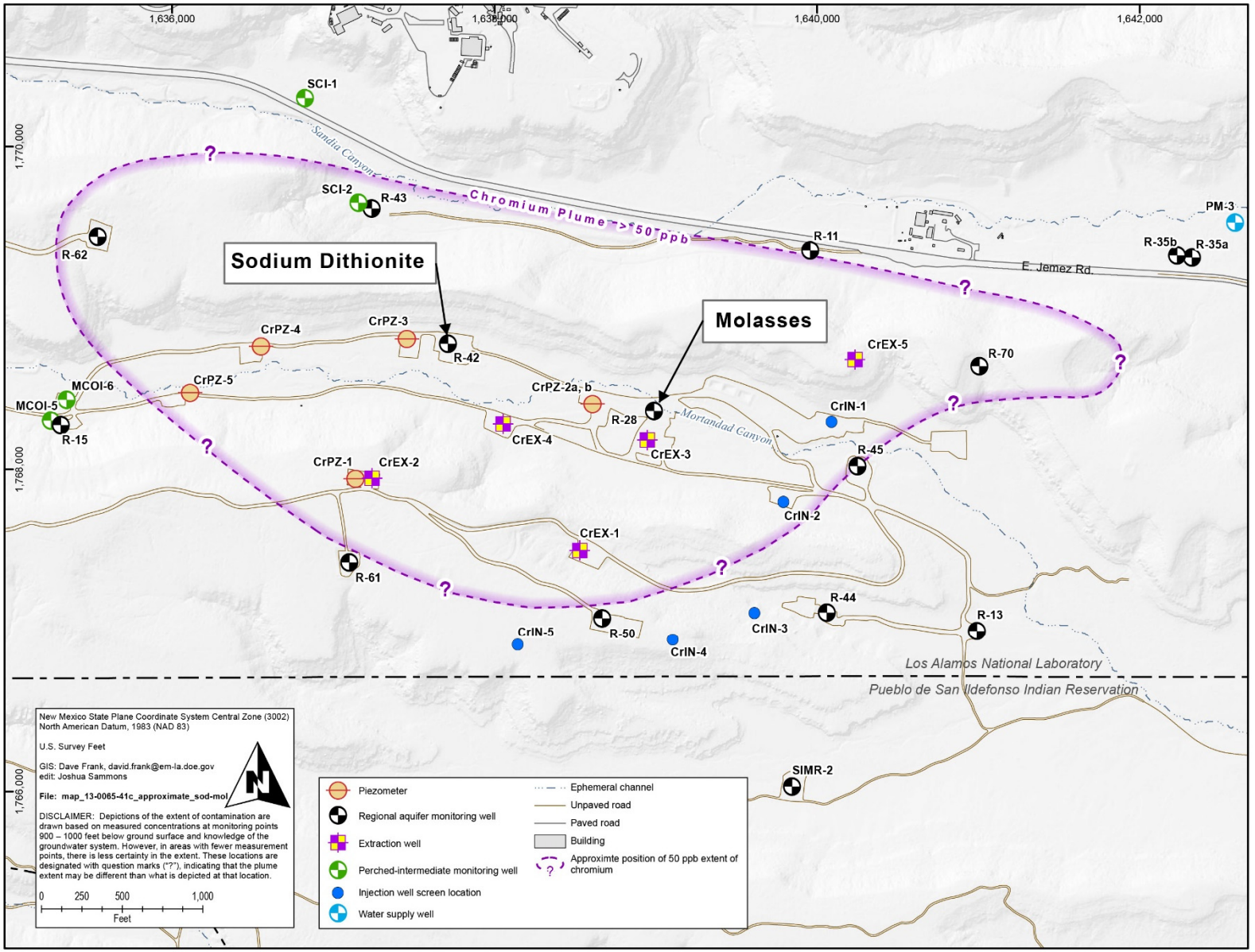

Figure 1.0-1 Chromium plume area and the locations where the sodium dithionite and molasses pilot-scale study is being conducted