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National Nuclear Security Administration
Sandia Field Office
P.O. Box 5400
Albuquerque, NM 87185

JUL 2 0 2021

Mr. Andrew Romero
Environmental Scientist, Pollution Prevention Section
New Mexico Environment Department
Ground Water Quality Bureau
1190 St. Francis Drive
Santa Fe, New Mexico 87502

Subject: Submittal of Discharge Permit (DP)-1845 Quarterly Report, July 2021, Referenced in the DP-1845, *Technical Area-V Treatability Study Injection Wells* for Sandia National Laboratories, New Mexico

Dear Mr. Romero:

The Department of Energy, National Nuclear Security Administration, Sandia Field Office, and National Technology and Engineering Solutions of Sandia, LLC submit the Subject document dated July 2021. This submittal is required by DP-1845 in accordance with Section IV.B, Terms and Conditions #11, and addresses quarterly reporting from January 1 through March 31, 2021. The full-scale operation for the Treatability Study at injection well TAV-INJ1 has completed the injection phase and is currently in the performance monitoring phase. All applicable terms and conditions specified in DP-1845 were met for this reporting period.

If you have any questions, please contact me at (505) 845-4262, or Dr. Adria Bodour of our staff at (505) 845-5349, or adria.bodour@nnsa.doe.gov.

Sincerely,

William V. Wechsler
Digitally signed by William V. Wechsler
Date: 2021.07.20 10:04:38 -06'00'

William V. Wechsler
Assistant Manager for Engineering

Enclosure

cc: See Page 2

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NNSA-2021-003429

Sandia National Laboratories, New Mexico

Environmental Restoration Operations

A U.S. Department of Energy Environmental Cleanup Program

Consolidated Quarterly Report

January – March 2021

July 2021

United States Department of Energy
Sandia Field Office

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525.

CONSOLIDATED QUARTERLY REPORT

July 2021

SANDIA NATIONAL LABORATORIES, NEW MEXICO

ENVIRONMENTAL RESTORATION OPERATIONS

U.S. DEPARTMENT OF ENERGY:	SANDIA FIELD OFFICE
CONTRACTOR:	NATIONAL TECHNOLOGY AND ENGINEERING SOLUTIONS OF SANDIA
PROJECT MANAGER:	Michael D. Barthel

NUMBER OF POTENTIAL RELEASE SITES SUBJECT TO CORRECTIVE ACTION: 6

SUSPECT WASTE: Radionuclides, metals, organic compounds, and explosives

REPORTING PERIOD: January – March 2021

OVERVIEW

This Sandia National Laboratories, New Mexico Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) fulfills all quarterly reporting requirements set forth in the Compliance Order on Consent. Table I-1 lists the six sites remaining in the corrective action process. This ER Quarterly Report presents activities and data as follows:

SECTION I: Environmental Restoration Operations Consolidated Quarterly Report, January – March 2021

SECTION II: Because there is no perchlorate sampling collection to report this quarter, this edition of the ER Quarterly Report does not include any analysis of data in Section II "Perchlorate Screening Quarterly Groundwater Monitoring Report."

SECTION III: Technical Area-V In-Situ Bioremediation Treatability Study Phase I Full-Scale Operation, January – March 2021

ABBREVIATIONS AND ACRONYMS

µg/L	microgram(s) per liter
µS/cm	microsiemen(s) per centimeter
AGMR	Annual Groundwater Monitoring Report
AOC	Area of Concern
BSG	Burn Site Groundwater
CCM	Current Conceptual Model
CME	Corrective Measures Evaluation
COC	constituent of concern
CY	Calendar Year
CYN	Canyons (acronym used for well identification only)
Dhc	*Dehalococcoides*
DO	dissolved oxygen
DOE	U.S. Department of Energy
DP	Discharge Permit
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration Operations
ER Quarterly Report	Environmental Restoration Operations Consolidated Quarterly Report
GWQB	Ground Water Quality Bureau
HWB	Hazardous Waste Bureau
INJ	injection (acronym used for well identification only)
ISB	in-situ bioremediation
LTS	Long-Term Stewardship
LWDS	liquid waste disposal system (acronym used for well identification only)
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligrams per liter
MW	monitoring well (acronym used for well identification only)
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NPN	nitrate plus nitrite
ORP	oxidation-reduction potential
pH	potential of hydrogen (negative logarithm of the hydrogen ion concentration)
SC	specific conductivity
SNL/NM	Sandia National Laboratories, New Mexico
SWMU	Solid Waste Management Unit
TA2-W	Technical Area-II (Well) (acronym used for well identification only)
TA2-SW	Technical Area-II (Southwest) (acronym used for well identification only)
TAG	Tijeras Arroyo Groundwater

TAV	Technical Area-V (acronym used for well identification only)
TA-V	Technical Area-V
TAVG	Technical Area-V Groundwater
TCE	trichloroethene
TJA	Tijeras Arroyo (acronym used for well identification only)
TOC	total organic carbon
TSWP	Treatability Study Work Plan
VOC	volatile organic compound
WYO	Wyoming (acronym used for well identification numbers in tables only)

SECTION I
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SECTION I
ENVIRONMENTAL RESTORATION OPERATIONS CONSOLIDATED QUARTERLY REPORT, January – March 2021

1.0 Introduction

This Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) provides the status of ongoing corrective action activities being implemented at Sandia National Laboratories, New Mexico (SNL/NM) during the January – March 2021 reporting period.

Table I-1 lists the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) currently identified for corrective action at SNL/NM. This section of the ER Quarterly Report summarizes the work completed during this reporting period at sites undergoing corrective action. Corrective action activities were conducted during this reporting period at the three groundwater AOCs:

- Burn Site Groundwater (BSG) AOC,
- Technical Area-V (TA-V) Groundwater (TAVG) AOC, and
- Tijeras Arroyo Groundwater (TAG) AOC.

Corrective action activities are deferred at the Long Sled Track (SWMU 83), the Gun Facilities (SWMU 84), and the Short Sled Track (SWMU 240) because these three sites are active mission facilities. These three active mission sites are located in Technical Area-III.

There were no SWMUs or AOCs in the corrective action complete regulatory process during this reporting period. Corrective action complete status has been approved for all SWMUs within the surface boundaries of each of the three groundwater AOCs.

2.0 Environmental Restoration Operations Work Completed

The following subsections identify the constituents of concern (COCs), summarize the corrective action milestones, and describe the ER work completed during the January – March 2021 reporting period at the three groundwater AOCs.

2.1 Sites Undergoing Corrective Action

In a letter dated April 14, 2016, the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) defined the scope and milestones for corrective action at three groundwater AOCs (BSG AOC, TAVG AOC, and TAG AOC) (NMED April 2016). Sections I.2.1.1 through I.2.1.3 discuss the specific milestones from this letter.

2.1.1 Burn Site Groundwater Area of Concern

Nitrate has been identified as a COC in groundwater at the BSG AOC based on detections above the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) in samples collected from monitoring wells. The EPA MCL and State of New Mexico groundwater standard for nitrate (as nitrogen) is 10 milligrams per liter (mg/L). The groundwater sampling and analysis program for the BSG AOC currently includes perchlorate analysis of water from groundwater monitoring well CYN-MW15, which is sampled semiannually.

The U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) and SNL/NM personnel met with the NMED HWB on July 20, 2015 to discuss the status of sites currently undergoing corrective action. For the BSG AOC, all parties agreed to a weight-of-evidence characterization program: (1) to conduct additional isotopic analyses/nitrate fingerprinting and age-dating of the groundwater; (2) to conduct a transducer study using existing wells to determine whether the groundwater is unconfined, semi-confined, or confined; and (3) to conduct an aquifer pumping test to help determine the origin of the elevated nitrates in the groundwater.

In January 2019, a Monitoring Well Installation Work Plan for the BSG AOC was submitted to NMED HWB (SNL/NM January 2019a) and subsequently approved by NMED HWB (NMED February 2019). The work plan proposed a minimum of four wells (CYN-MW16 through CYN-MW19) that will help define the extent of nitrate contamination in groundwater and refine the potentiometric surface in the BSG AOC. Long-term sampling from these new well locations, along with other BSG monitoring wells, will provide data to characterize the AOC and assist in evaluating potential remedial actions.

The following activities occurred at the BSG AOC during the January - March 2021 reporting period:

- Groundwater sampling was conducted at 4 groundwater monitoring wells in January 2021. Table I-2 presents the identification and the sampling frequency for BSG AOC monitoring wells. The complete analytical results for Calendar Year (CY) 2021 groundwater monitoring will be presented in the SNL/NM CY 2021 Annual Groundwater Monitoring Report (AGMR), which is anticipated to be submitted to the NMED HWB in the summer of 2022.
- This was the sixth sampling event conducted at the four groundwater monitoring wells installed in the fall of 2019 (CYN-MW16, CYN-MW17, CYN-MW18, and CYN-MW19). The concentrations of nitrate plus nitrite (NPN) during the January 2021 sampling event at well CYN-MW16 were 7.48 mg/L (environmental sample) and 7.37 mg/L (environmental duplicate sample), which did not exceed the EPA MCL of 10 mg/L for the fourth consecutive sampling event. The other three wells (CYN-MW17, CYN-MW18, and CYN-MW19) have consistently had NPN concentrations below the nitrate MCL.

2.1.2 Technical Area-V Groundwater Area of Concern

Trichloroethene (TCE) and nitrate have been identified as COCs in groundwater at the TAVG AOC based on detections above the EPA MCLs in samples collected from monitoring wells. The EPA MCLs and the State of New Mexico groundwater standards for TCE and nitrate (as nitrogen) are 5 micrograms per liter (µg/L) and 10 mg/L, respectively.

Personnel from the DOE/NNSA, DOE Headquarters Office of Environmental Management, SNL/NM, and NMED HWB worked together to address the groundwater contamination at the TAVG AOC. A meeting was held with the NMED HWB on July 20, 2015, and all parties agreed on a phased Treatability Study to evaluate the effectiveness of in-situ bioremediation (ISB) as a potential technology to treat groundwater contamination at the TAVG AOC.

To implement the ISB Treatability Study, SNL/NM personnel planned to install up to three injection wells (TAV-INJ1, TAV-INJ2, and TAV-INJ3) at TA-V near the highest contaminant concentrations in groundwater detected in monitoring wells TAV-MW6, TAV-MW10, and LWDS-MW1, respectively. The substrate solution containing essential food and nutrients for biostimulation was prepared in aboveground tanks. This substrate solution, along with the biodegradation bacteria, was gravity-injected to groundwater via the injection well.

The NMED HWB approved the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016) in May 2016 (NMED May 2016). In accordance with the Revised TSWP, the ISB Treatability Study is being conducted in two phases. Phase I included a pilot test, followed by full-scale operation at the first injection well (TAV-INJ1). Phase II of the ISB Treatability Study will include well installation and full-scale operation at the second and third injection wells (TAV-INJ2 and TAV-INJ3). The decision to install the Phase II injection wells will be dependent upon the findings of the Phase I full-scale operation.

The NMED Ground Water Quality Bureau (GWQB) required a groundwater Discharge Permit (DP) for operation of the injection wells. NMED GWQB issued DP-1845 to DOE/NNSA for the SNL/NM ISB Treatability Study injection wells on May 26, 2017 (NMED May 2017a). The DP-1845 term started on May 30, 2017 and will end on May 30, 2022. As required by DP-1845, DOE/NNSA and SNL/NM personnel submit separate quarterly reports to the NMED GWQB.

SNL/NM personnel have completed the Phase I pilot test at injection well TAV-INJ1. The operation and results of the pilot test were presented in Section III of the October 2018 ER Quarterly Report (SNL/NM October 2018). Based on the results of the pilot test, DOE/NNSA and SNL/NM personnel proposed eight modifications for the full-scale operation at well TAV-INJ1 (DOE July 2018). The NMED HWB subsequently approved the modifications on August 13, 2018 (NMED August 2018). Therefore, implementation of the Phase I full-scale operation at well TAV-INJ1 is governed by the Revised TSWP and where applicable, the approved modifications for full-scale operation.

SNL/NM personnel started the Phase I full-scale operation at well TAV-INJ1 in October 2018 and completed the six-month injection period in April 2019. Details on the six-month injection activities were presented in Section III of the October 2019 ER Quarterly Report (SNL/NM October 2019). The injection period is followed by two years of groundwater monitoring for performance of the ISB. The two-year performance monitoring includes three monthly sampling events followed by quarterly sampling events for the remainder of the two-year period, as planned in the Revised TSWP (SNL/NM March 2016). The three monthly sampling events were completed by July 2019. The Phase I ISB Treatability Study performance monitoring is currently on a quarterly schedule until May 2021.

The following activities occurred at TAVG AOC during the January - March 2021 reporting period:

- For performance monitoring of the Phase I ISB Treatability Study, groundwater sampling was conducted at the treatment zone (i.e., at injection well TAV-INJ1 and monitoring well TAV-MW6) in January 2021. Section III presents the groundwater monitoring results for the ISB Treatability Study for this quarter. Analytical results for DP-specific requirements are presented in DP quarterly reports that are submitted separately to the NMED GWQB.
- The TA-V groundwater monitoring network currently comprises 18 active monitoring wells. Of these 18 wells, well TAV-MW6 is designated as an ISB Treatability Study performance monitoring well and follows the sampling frequency and analytes specified for the ISB Treatability Study (see Section III). Well TAV-MW7, because of its proximity to the injection well TAV-INJ1, continues to serve as a monitoring well for the ISB Treatability Study, although no impact from the substrate solution injections has been observed at this deep well. Programmatically TAV-MW7 belongs to the TA-V groundwater monitoring network (SNL/NM January 2019b). Well TAV-MW7 will continue to be sampled and reported with wells TAV-INJ1 and TAV-MW6 in Section III of the ER Quarterly Reports for consistency and completeness.
- Table I-2 presents the CY 2021 sampling frequency for the monitoring wells at the TAVG AOC for the 17 wells in the TA-V groundwater monitoring network (18 wells minus well TAV-MW6). Groundwater sampling was conducted in February 2021. The complete analytical results for CY 2021 groundwater monitoring will be presented in the SNL/NM CY 2021 AGMR, which is anticipated to be submitted to the NMED HWB in the summer of 2022.

2.1.3 Tijeras Arroyo Groundwater Area of Concern

Nitrate has been identified as a COC in groundwater for the TAG AOC based on exceedances of the EPA MCL in samples collected from monitoring wells completed in the Perched Groundwater System and in the merging zone above the Regional Aquifer. TCE has been identified as a COC for the Perched Groundwater System (NMED April 2004). No TCE concentrations in Regional Aquifer samples have exceeded the EPA MCL. The EPA MCLs and State of New Mexico groundwater standards for TCE and nitrate (as nitrogen) are 5 µg/L and 10 mg/L, respectively.

In May 2017, NMED HWB completed its review of the Current Conceptual Model (CCM)/Corrective Measures Evaluation (CME) Report for the TAG AOC (SNL/NM December 2016), which was submitted to the NMED HWB on November 23, 2016 (DOE

November 2016). This report was submitted in accordance with NMED's "Summary of Agreements and Proposed Milestones…" letter of April 14, 2016 (NMED April 2016). The subsequent disapproval letter issued by the NMED HWB (NMED May 2017b) requested the inclusion of additional information in a revised report. The Revised TAG CCM/CME Report was submitted to the NMED HWB on February 13, 2018 (SNL/NM February 2018). Personnel from DOE/NNSA, SNL/NM, and NMED HWB met on September 23, 2020 to discuss NMED's ongoing review of the Revised TAG CCM/CME Report (SNL/NM February 2018). In the meeting, NMED HWB personnel stated that their selection of the remedial alternative concerning elevated nitrate concentrations in the Perched Groundwater System is likely to occur in mid-2021.

The following activities occurred at the TAG AOC during the January - March 2021 reporting period:

- Groundwater sampling was conducted at 11 monitoring wells in February and March 2021. Table I-2 presents the CY 2021 sampling frequency for the TAG monitoring wells.
- Analytical results for the samples were consistent with historical trends.
- The maximum NPN concentration in the Perched Groundwater System wells was 22.2 mg/L, which exceeds the EPA MCL and State of New Mexico groundwater standard of 10 mg/L.
- The maximum TCE concentration detected in Perched Groundwater System wells corresponded to well TA2-W-26. This well is routinely scheduled for quarterly sampling. The March 2021 TCE concentration for the environmental sample was 3.81 µg/L, which is less than the EPA MCL and State of New Mexico groundwater standard of 5 µg/L. However, the duplicate sample for TA2-W-26 was 13.8 µg/L, which exceeds the EPA MCL and State of New Mexico groundwater standard.
- The maximum NPN concentration in the Regional Aquifer wells was 2.70 mg/L.
- TCE was not detected (was less than 0.300 µg/L) in the Regional Aquifer wells.
- The maximum NPN concentration for merging zone well TJA-4 was 30.1 mg/L. TCE was not detected (was less than 0.300 µg/L) at well TJA-4. This well is located upgradient of the TAG AOC.
- The SNL/NM CY 2021 AGMR will present the analytical results for CY 2021 groundwater monitoring, and is scheduled for submittal to the NMED HWB in the summer of 2022

2.2 Sites in Corrective Action Complete Regulatory Process

There are currently no SWMUs or AOCs at SNL/NM in the corrective action complete regulatory process.

3.0 References

DOE, see U.S. Department of Energy.

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New Mexico Environment Department (NMED), April 2016. Letter to J.P. Harrell (U.S. Department of Energy, NNSA/Sandia Field Office) and M. W. Hazen (Sandia National Laboratories, New Mexico), "Summary of Agreements and Proposed Milestones Pursuant to the Meeting of July 20, 2015, March 30, 2016, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-16-MISC," NMED, Hazardous Waste Bureau, Santa Fe, New Mexico. April 14, 2016.

New Mexico Environment Department (NMED), May 2016. Letter to J. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and P. Davies (Sandia National Laboratories, New Mexico), "Approval Revised Treatability Study Work Plan for In-Situ Bioremediation at the Technical Area-V Groundwater Area of Concern, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-15-020," NMED, Hazardous Waste Bureau, Santa Fe, New Mexico. May 10, 2016.

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New Mexico Environment Department (NMED), February 2019. Letter to J.P. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and P. Shoemaker (Sandia National Laboratories), "Approval: Monitoring Well Installation Work Plan, Burn Site Groundwater Monitoring Wells CYN-MW16 Through CYN-MW23, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-19-003," NMED, Hazardous Waste Bureau, Santa Fe, New Mexico.February 12, 2019.

NMED, see New Mexico Environment Department.

Sandia National Laboratories, New Mexico (SNL/NM), March 2016. *Revised Treatability Study Work Plan for In-Situ Bioremediation at the Technical Area-V Groundwater Area of Concern, Sandia National Laboratories, Albuquerque, New Mexico,* Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), December 2016. *Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measures Evaluation Report*, Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), February 2018. *Revised Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measures Evaluation Report*, Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), October 2018. *Environmental Restoration Operations Consolidated Quarterly Report April – June 2018*, Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

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Sandia National Laboratories, New Mexico (SNL/NM), January 2019b. *Environmental Restoration Operations Consolidated Quarterly Report July – September 2018, Sandia National Laboratories, Albuquerque, New Mexico,* Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

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Tables

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Table I-1
Solid Waste Management Units and Areas of Concern
Where Corrective Action is Not Complete

Solid Waste Management Units and Areas of Concern	
Site Number	**Site Description**
83	Long Sled Track
84	Gun Facilities
240	Short Sled Track
NA	Tijeras Arroyo Groundwater Investigation (TAG AOC)
NA	TA-V Groundwater Investigation (TAVG AOC)
NA	Burn Site Groundwater Investigation (BSG AOC)

Notes:

AOC = Area of Concern.
BSG = Burn Site Groundwater.
NA = Not applicable. A site number was not assigned.
TAG = Tijeras Arroyo Groundwater.
TA-V = Technical Area-V.
TAVG = Technical Area-V Groundwater.

Table I-2
Groundwater Sampling and Analysis

Investigation Site	Sampling Frequency in CY 2021	Quarter of Sampling in CY 2021	Location of Analytical Results	Location of Perchlorate Analytical Results	Monitoring Wells in Network
TAVG AOC [a]	Quarterly	1,2,3,4	AGMR	NA	LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW7, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, TAV-MW14, TAV-MW15, TAV-MW16
	Annually	2	AGMR	NA	AVN-1, LWDS-MW2, TAV-MW3, TAV-MW5, TAV-MW9, TAV-MW13
BSG AOC	Semiannually	2,4	AGMR	NA	CYN-MW4, CYN-MW7, CYN-MW8, CYN-MW9, CYN-MW10, CYN-MW11, CYN-MW12, CYN-MW13, CYN-MW14A, CYN-MW15
	Quarterly	1,2,3,4	AGMR	NA	CYN-MW16, CYN-MW17, CYN-MW18, CYN-MW19
TAG AOC [b]	Quarterly	1,2,3,4	AGMR	NA	TA2-W-19, TA2-W-26, TA2-W-28, TJA-2, TJA-3, TJA-4, TJA-7
	Semiannually	1,3	AGMR	NA	TA1-W-06, TA2-W-01, TA2-W-27, TJA-6
	Annually	3	AGMR	NA	PGS-2, TA1-W-01, TA1-W-02, TA1-W-03, TA1-W-04, TA1-W-05, TA1-W-08, TA2-NW1-595, WYO-3
	Voluntarily	4	AGMR	NA	TA2-W-24, TA2-W-25, TJA-5

Notes:

[a] TAVG AOC monitoring network comprises 18 active wells: 17 wells are listed here; well TAV-MW6 currently is part of the ISB Treatability Study and follows a separate monitoring plan (see Section I.2.1.2).

[b] Monitoring well WYO-4 was removed from the TAG sampling schedule in response to the August 2017 meeting with NMED HWB personnel.

AGMR = Annual Groundwater Monitoring Report.
AOC = Area of Concern.
AVN = Area-V (North) (acronym used for well identification only).
BSG = Burn Site Groundwater (Area of Concern).
CY = Calendar Year.
CYN = Canyons (Burn Site Groundwater Area of Concern; acronym used for well identification only).
HWB = Hazardous Waste Bureau.
ISB = In-situ bioremediation.
LWDS = Liquid waste disposal system (acronym used for well identification only).
MW = Monitoring well (acronym used for well identification only).
NA = Not applicable. No wells in the site network are currently being sampled and analyzed for perchlorate or were not sampled during this reporting period.
NMED = New Mexico Environment Department.
PGS = Parade Ground South (acronym used for well identification only).
TA1-W = Technical Area-I (Well) (acronym used for well identification only).
TA2-NW = Technical Area-II (Northwest) (acronym used for well identification only).
TA2-W = Technical Area-II (Well) (acronym used for well identification only).
TAG = Tijeras Arroyo Groundwater (Area of Concern).
TAV = Technical Area-V (acronym used for well identification only).
TAVG = Technical Area-V Groundwater (Area of Concern).
TJA = Tijeras Arroyo (acronym used for well identification only).
WYO = Wyoming (acronym used for well identification only).

SECTION II
PERCHLORATE SCREENING QUARTERLY GROUNDWATER MONITORING REPORT, January– March 2021

The groundwater sampling and analysis program for the Burn Site Groundwater Area of Concern currently includes perchlorate analyses of water from one groundwater monitoring well (CYN-MW15). Due to the semiannual nature of the sampling, no groundwater samples were collected for perchlorate analysis during the January - March 2021 reporting period. Therefore, this edition of the Environmental Restoration Consolidated Quarterly Report does not include any analysis of data in Section II “Perchlorate Screening Quarterly Groundwater Monitoring Report.”

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APPENDIX

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SECTION III
TECHNICAL AREA-V IN-SITU BIOREMEDIATION TREATABILITY STUDY PHASE I FULL-SCALE OPERATION, January – March 2021

1.0 Background

Sandia National Laboratories, New Mexico (SNL/NM) personnel are conducting a Treatability Study of in-situ bioremediation (ISB) to address the groundwater contamination by nitrate and trichloroethene (TCE) at the Technical Area-V (TA-V) Groundwater (TAVG) Area of Concern (AOC). SNL/NM personnel planned to conduct the ISB Treatability Study in two phases. Phase I included a pilot test followed by full-scale operation at the first injection well (TAV-INJ1); Phase II will include well installation and full-scale operation at two additional injection wells (TAV-INJ2 and TAV-INJ3), contingent on the success of Phase I full-scale operation. The locations of the three injection wells TAV-INJ1, TAV-INJ2, and TAV-INJ3 are near monitoring wells TAV-MW6, TAV-MW10, and LWDS-MW1, respectively, where the highest contaminant concentrations in the TAVG AOC have historically been detected.

Table III-1 presents a timeline for the Phase I ISB Treatability Study at TAVG AOC. Phase I pilot test began in November 2017 with injections at well TAV-INJ1 completed in November 2017, followed by pilot test performance monitoring through June 2018. SNL/NM personnel began Phase I full-scale operation at the same injection well in October 2018 and completed the six-month injection period in April 2019. Currently, SNL/NM personnel are conducting the two-year performance monitoring in the Phase I ISB Treatability Study treatment zone, which is anticipated to conclude in May 2021. The implementation of the Phase I full-scale operation at well TAV-INJ1 is governed by the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016) and where applicable, the approved modifications for the full-scale operation at well TAV-INJ1 based on the pilot test results (U.S. Department of Energy [DOE] July 2018; New Mexico Environment Department [NMED] August 2018). Appendix A provides the NMED Hazardous Waste Bureau (HWB) approval letter and DOE's submittal of the proposed modifications.

This Section III of the Environmental Restoration Operations Consolidated Quarterly Report presents the monitoring results for the January – March 2021 reporting period for the ISB Treatability Study Phase I full-scale operation.

In accordance with the Revised TSWP (SNL/NM March 2016), a technical memorandum for the Phase I ISB Treatability Study will be produced after the performance monitoring period has concluded in May 2021 (Table III-1) and will include both the pilot test and the full-scale operation.

No field activities, other than groundwater monitoring to evaluate the performance of the ISB, occurred during this reporting period. The SNL/NM Long-Term Stewardship (LTS) personnel conduct groundwater monitoring for the entire TAVG AOC, including the Phase I ISB Treatability Study treatment zone. Groundwater monitoring includes groundwater elevation measurements, field water quality measurements, and groundwater sampling.

2.0 Groundwater Elevations at Technical Area-V

Figure III-1 shows the January 2021 groundwater elevation contour map (potentiometric surface) for the Regional Aquifer at TA-V. The groundwater elevation contours have not changed significantly since the October 2017 pre-Treatability Study baseline (SNL/NM January 2018). Groundwater flows generally to the west and southwest at TA-V. Overall the groundwater elevation at TA-V has been declining at a rate of 0.5 to 0.8 feet per year (SNL/NM June 2020). Approximately 530,000 gallons of substrate solution were injected over a six-month period (November 2018 – April 2019) during the Phase I full-scale operation, but did not create a noticeable effect on the potentiometric surface contours at TA-V.

3.0 Groundwater Monitoring for Phase I Treatability Study

The Phase I ISB Treatability Study treatment zone encompasses injection well TAV-INJ1 and two nearby monitoring wells (TAV-MW6 and TAV-MW7).

To collect field water quality data, In-Situ Incorporated Aqua TROLL® 600 multi-parameter sondes were installed in injection well TAV-INJ1 and monitoring well TAV-MW6. The parameters measured by the sonde included water column height (pressure) above the sonde, dissolved oxygen (DO), oxidation reduction potential (ORP), potential of hydrogen (pH), specific conductivity (SC), temperature, and turbidity. Pressure readings were converted to

groundwater elevation in feet above mean sea level. Sonde readings were collected every 15 minutes.

Injection well TAV-INJ1 and monitoring well TAV-MW6 are sampled to evaluate the performance of the ISB Treatability Study. Wells TAV-INJ1 and TAV-MW6 are screened across the water table; and the midpoint of the TAV-MW7 well screen is approximately 90 feet below the water table. Monitoring well TAV-MW7 was originally designated as a monitoring well to evaluate the performance of the ISB (SNL/NM March 2016). However, neither water level nor water quality in well TAV-MW7 were affected by the injections at well TAV-INJ1 due to the depth of the screen at well TAV-MW7. Therefore, well TAV-MW7 was reverted to the TAVG AOC monitoring network (Appendix A, Modification #7). In addition, using an Aqua TROLL® 600 multi-parameter sonde to collect field water quality data every 15 minutes in well TAV-MW7 was unnecessary and was therefore discontinued in December 2019, following SNL/NM's request (SNL/NM October 2019) and NMED's approval (NMED November 2019). Well TAV-MW7 continues to be sampled and reported with wells TAV-INJ1 and TAV-MW6 in Section III of this quarterly report for consistency and completeness.

The two-year performance monitoring includes three monthly sampling events followed by quarterly sampling events for the remainder of the two-year period, as described in the Revised TSWP (SNL/NM March 2016). The three monthly sampling events were completed by July 2019. The Phase I ISB Treatability Study performance monitoring is currently on a quarterly schedule until May 2021 (Table III-1).

Groundwater monitoring is also conducted at eight wells outside the Phase I ISB Treatability Study treatment zone on a quarterly schedule to monitor any lateral impact of the injected solution, as described in the Revised TSWP (SNL/NM March 2016).

Table III-2 lists the sampling dates for the January – March 2021 reporting period for all above-mentioned wells pertinent to the Phase I ISB Treatability Study. Before each well was sampled, field water quality data were collected using an aboveground Aqua TROLL® 600 multi-parameter sonde. Tables III-3 through III-6 present the analytical results. Table III-7 summarizes the stabilized field water quality parameters measured immediately before sample collection at each well.

3.1 Groundwater Monitoring inside the Treatment Zone

Groundwater monitoring inside the Phase I ISB Treatability Study treatment zone includes monitoring of the injection well TAV-INJ1 and monitoring wells TAV-MW6 and TAV-MW7.

3.1.1 Injection Well TAV-INJ1

Groundwater elevation at well TAV-INJ1 returned to the pre-injection static level after the injections were completed in April 2019 and remained unchanged through this reporting period.

With the influx of substrate solution, the water near well TAV-INJ1 has changed from aerobic conditions to anaerobic and reducing conditions since the completion of pilot test injections in November 2017 (Table III-1). Since then, DO, ORP, and pH have remained at optimal levels at well TAV-INJ1 for the biodegradation of nitrate and TCE to occur. During this reporting period, pH was steady around 7.0; DO was at 0.0 milligrams per liter (mg/L); and ORP stabilized around negative (-) 420 millivolts.

SC was approximately 850 microsiemens per centimeter (µS/cm) before the start of full-scale injections (SNL/NM January 2020, Table III-2). SC increased after the end of injections in April 2019, peaked at around 3,500 µS/cm in July 2019, and gradually decreased and stabilized around 2,000 µS/cm during this reporting period.

The baseline groundwater temperature in well TAV-INJ1 was approximately 21.1 degrees Celsius. The injected substrate solution, which was primarily potable water, was colder than groundwater because most of the injections occurred during the winter of 2018 – 2019. After injections were completed in April 2019, the water temperature in well TAV-INJ1 rose slowly and stabilized at 20.7 degrees Celsius since December 2020.

Turbidity varied daily between single digit and several tens of nephelometric turbidity units during this reporting period, likely due to the suspension of sediments and biological growth in the injection well. In general, turbidity has been much lower than the levels measured during injections, which were in the tens of thousands of nephelometric turbidity units.

During groundwater sampling at well TAV-INJ1, SNL/NM personnel discovered significant sediment accumulation in the well. This is probably due to the repeated disturbance of the geological formation by the 110 injections over the six-month period. As a result, the

sampling pump was placed at approximately mid-depth of the water column, higher than where the pump was previously set during the pre-full-scale operation sampling (approximately two feet above the bottom of the screen) when the well was relatively free of sediment. However, the pump was repeatedly clogged by the sediment during purging even after the pump was placed higher in the well. Beginning in January 2020, SNL/NM personnel used bailers to remove groundwater on the day before sampling to prevent pump failure, allowed the well to recover overnight, and collected samples the next day using the sampling pump. The overnight-recovery follows the standard practice of the SNL/NM LTS Program for sampling low-yield wells.

The analytical parameters for groundwater samples collected from well TAV-INJ1 include the following, in accordance with Modification #8 (Appendix A):

- Alkalinity (total, bicarbonate, and carbonate)
- Ammonia (as nitrogen)
- Anions (bromide and sulfate)
- *Dehalococcoides* (Dhc) and, if Dhc is present, vinyl chloride reductase
- Dissolved metals (arsenic, iron, and manganese)
- Methane/ethane/ethene
- Nitrate plus nitrite (NPN)
- Total organic carbon (TOC)
- Volatile organic compounds (VOCs)

Table III-3 provides the analytical results for the January – March 2021 sampling event at well TAV-INJ1.

Since the Phase I full-scale operation performance monitoring started in June 2019, a total of nine sampling events have occurred at well TAV-INJ1: the first and last week in June 2019, July 2019, October 2019, January 2020, April 2020, July 2020, November 2020, and January 2021.

The two constituents of concern at TAVG AOC are NPN and TCE. Since June 2019, NPN has not been detected at well TAV-INJ1. Since June 2019, TCE was detected at estimated values (J-qualified) of 0.4, 0.4, and 0.35 micrograms per liter (µg/L) in January (SNL/NM July 2020), April (SNL/NM October 2020), and July 2020 (SNL/NM January 2021), respectively, and in January 2021 at 0.39 (J) µg/L (Table III-3). TCE was not detected in the other five sampling events. Ethene, an intermediate TCE degradation indicator, had only two

detects since June 2019 and was not detected in January 2021. Concentration profiles were not generated for NPN, TCE, and ethene at well TAV-INJ1.

Figures III-2 through III-12 show the groundwater monitoring results for alkalinity, ammonia, bromide, sulfate, Dhc, arsenic, iron, manganese, methane, ethane, and TOC since June 2019 at well TAV-INJ1. Baseline concentrations from the November 13, 2017 sampling event (SNL/NM October 2018), which occurred prior to the ISB Treatability Study (i.e., before the pilot test), are shown in these figures, where applicable. Figures III-2 through III-12 show that:

- Alkalinity (as calcium carbonate, $CaCO_3$) remained relatively unchanged (Figure III-2).
- Ammonia (Figure III-3) and TOC (Figure III-12) serve as the nitrogen and carbon source for microbial activities, respectively. Both were being consumed over time, with TOC being consumed more rapidly than ammonia. The concentration of TOC appears to be stabilizing around 10 mg/L since April 2020.
- Bromide, the inert tracer, maintained a concentration at around 19 mg/L in the groundwater around the injection well (Figure III-4).
- Sulfate was consumed and maintained concentrations below the baseline since April 2020 (Figure III-5).
- The population of Dhc has decreased to non-detect since January 2020 (Figure III-6). Dhc did not establish a significant population in the groundwater around the injection well.
- Concentrations of dissolved arsenic have exceeded the U.S. Environmental Protection Agency maximum contaminant level of 0.01 mg/L since June 2019 (Figure III-7 and shown in **bold** in Table III-3 for this reporting period) but are gradually decreasing. Concentrations of dissolved iron were variable (Figure III-8); while concentrations of dissolved manganese have gradually increased since June 2019 (Figure III-9). Concentrations of the three dissolved metals all exceeded their baseline concentrations. Elevated dissolved metal concentrations are to be expected during bioremediation. During ISB, the substrate solution produces strongly anaerobic redox conditions in the aquifer that solubilize and mobilize naturally occurring metals and metalloids. The solubilization of these metals is a transient phenomenon and is limited to the Phase I ISB Treatability Study treatment zone. Solubilized metals and metalloids will precipitate into solid form once they leave the anaerobic treatment zone and enter the aerobic aquifer. This is verified by the fact that dissolved metal concentrations are all below MCLs at all other monitoring wells.
- The level of methane remained high (12,000 µg/L) in January 2021 and decreased from November 2020 (Figure III-10).
- Ethane is the product of complete dechlorination of TCE. Small amounts of ethane, between 0.1 and 0.31 µg/L, had been produced previously. The highest concentration of 1.1 µg/L was measured in January 2021, an increase from 0.31 µg/L in November 2020 (Figure III-11). Production of ethane will be further verified in future sampling events.

3.1.2 Monitoring Well TAV-MW6

Well TAV-MW6 is located approximately 50 feet east-southeast of well TAV-INJ1 and is screened across the water table as is well TAV-INJ1. The groundwater elevation in well TAV-MW6 remained at static levels during this reporting period. There were no significant changes in ORP, pH, SC, temperature, and turbidity in this well during this reporting period. The concentration of DO decreased from the baseline of approximately 7.0 mg/L to approximately 4.0 mg/L in October 2019. Since then, the DO concentration increased gradually and stabilized at approximately 4.8 mg/L since July 2020.

In accordance with the Revised TSWP (SNL/NM March 2016), well TAV-MW6 was sampled in September 2018 before full-scale operation, and then monthly during the six-month injection period (November 2018 – April 2019). After the injections, it is sampled at the same frequency as the injection well for the two-year performance monitoring (i.e., three monthly sampling events followed by quarterly sampling events for the remainder of the two-year period). The analytical parameters for groundwater samples collected from well TAV-MW6 are the same as those for well TAV-INJ1 in accordance with Modification #8 (Appendix A). Table III-4 provides the analytical results for January – March 2021 sampling event at well TAV-MW6.

Figure III-13 shows the concentration profiles of the two constituents of concern at the TAVG AOC (NPN and TCE) and Figure III-14 shows the concentration profiles of bromide and methane since September 2018 at well TAV-MW6. The concentrations for the other analytes (alkalinity, ammonia, sulfate, Dhc, arsenic, iron, manganese, ethane, ethene, and TOC) were consistent with the concentrations before the full-scale operation started in September 2018 (SNL/NM April 2019); therefore, concentration profiles were not generated for these analytes.

Figures III-13 and III-14 show that:

- There was no significant change in the concentrations of TCE from the level in September 2018 before full-scale operation; but overall, there was a slight decreasing trend for the concentrations of NPN (Figure III-13).
- Bromide (the inert tracer) was added to the substrate solution injected at well TAV-INJ1. Bromide concentrations are expected to increase in well TAV-MW6 as the substrate solution moves away from well TAV-INJ1. The bromide concentration at well TAV-MW6 before full-scale operation was 0.815 mg/L in September 2018 (SNL/NM April 2019). The bromide concentration at well TAV-MW6 reached its highest concentration of 4.12 mg/L in June 2019 and decreased to approximately 1.0 mg/L since April 2020 (Figure III-14).

- Methane was not detected at well TAV-MW6 before full-scale operation. Methane concentration increased to the highest of 360 µg/L in October 2019, has decreased since then, and was 84 µg/L in January 2021 (Figure III-14).

3.1.3 Monitoring Well TAV-MW7

Well TAV-MW7 is located approximately 27 feet east-southeast of well TAV-INJ1 and is screened approximately 90 feet below the water table.

The analytical parameters for groundwater samples collected from well TAV-MW7 include the following in accordance with Modification #7 (Appendix A):

- Bromide
- Dissolved metals (arsenic, iron, and manganese)
- Ethene
- NPN
- VOCs

Table III-5 provides the analytical results for the January – March 2021 sampling event at well TAV-MW7. Analytical results from this reporting period are consistent with the historical values at this well (SNL/NM June 2020).

3.2 Groundwater Monitoring outside the Treatment Zone

In accordance with Section 5.5 of the Revised TSWP (SNL/NM March 2016), eight wells are sampled quarterly for dissolved metals (arsenic, iron, and manganese) to evaluate the potential impact of the substrate solution on groundwater conditions outside the Phase I ISB Treatability Study treatment zone. The eight wells are: LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV-MW14 (see Figure III-1 for their locations). The analytical parameters for groundwater samples from these wells include:

- Dissolved metals (arsenic, iron, and manganese)
- NPN
- VOCs

These parameters are the same as those for the other monitoring wells in the TAVG AOC monitoring network (SNL/NM June 2020). Table III-6 provides the analytical results for the January – March 2021 sampling event at these wells. Environmental duplicate samples were collected from wells TAV-MW4 and TAV-MW12 per the monitoring requirement of the SNL/NM LTS Program for the TAVG AOC monitoring network. Analytical results from this reporting period are consistent with the historical values at these eight wells (SNL/NM June 2020).

3.3 Summary of Groundwater Monitoring Results for Phase I Treatability Study

The water quality and analytical results from injection well TAV-INJ1 show the following:

- The water temperature in the well has been slowly rising, indicating the injected solution is mixing with the native groundwater (the injected solution was colder than the local groundwater). On the other hand, the bromide concentration has remained relatively constant, indicating limited groundwater transport.
- The water quality data measured in the injection well indicate that optimal conditions for biodegradation of nitrate and TCE have been maintained, as reflected by the DO, ORP, and pH levels.
- NPN was not detected. Nitrate would have been biodegraded by native bacteria as being the most favorable electron acceptor after DO was depleted (see Section 3.0 of the Revised TSWP [SNL/NM March 2016]).
- TCE was detected at an estimated concentration (J-qualified) of 0.39 µg/L in January 2021.
- The dechlorination bacteria, Dhc, did not establish a significant population in the groundwater around the injection well. However, small but consistent amounts of ethane production suggest complete dechlorination is occurring at the injection well.
- The methane level remained high, indicating active methanogenic microbial activity.

Well TAV-MW6 serves as the monitoring well for evaluating the effectiveness of ISB inside the treatment zone. The water quality and analytical results from this well show the following:

- The DO concentration at well TAV-MW6 reached the lowest level of approximately 4 mg/L in October 2019 and stabilized at 4.8 mg/L during this reporting period. The overall NPN concentrations showed a slight decreasing trend with nitrate being the next favorable electron acceptor for microorganisms as DO was depleted.
- Bromide, the inert tracer, has migrated to well TAV-MW6. Its peak concentration (4.12 mg/L) was observed in June 2019 and was approximately 24 percent of the bromide concentration at the injection well. Bromide concentration decreased to approximately 1.0 mg/L since April 2020.

- The methane concentration at well TAV-MW6 reached the highest point of 360 µg/L in October 2019 and was 84 µg/L in January 2021. Methane was not produced at well TAV-MW6 as indicated by the water quality parameters measured at this well. Rather, methane migrated to well TAV-MW6 from the injection well.
- The Dhc have not reached well TAV-MW6.
- Dechlorination is not occurring at well TAV-MW6 and TCE concentrations remain unchanged.

The water quality and analytical results from well TAV-MW7 indicate that there is no impact on the deeper groundwater monitored by this well from the substrate solution injected at well TAV-INJ1.

For the eight wells located outside the Phase I ISB Treatability Study treatment zone, there is no impact on the groundwater chemistry at these wells from the substrate solution injected at well TAV-INJ1.

4.0 Deviation

No deviations were encountered with regards to the Revised TSWP (SNL/NM March 2016) and where applicable, the approved modifications for the full-scale operation at well TAV-INJ1 (DOE July 2018; NMED August 2018).

5.0 References

DOE, see U.S. Department of Energy.

New Mexico Environment Department (NMED), August 2018. Letter to J.P. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and R.O. Griffith (Sandia National Laboratories), "Approval: Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1, Sandia National Laboratory, EPA ID# NM5890110518, HWB-SNL-15-020," NMED Hazardous Waste Bureau, Santa Fe, NM, August 13, 2018.

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NMED, see New Mexico Environment Department.

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Sandia National Laboratories, New Mexico (SNL/NM), January 2021. *Environmental Restoration Operations Consolidated Quarterly Report July – September 2020*, Sandia National Laboratories, Albuquerque, New Mexico.

SNL/NM see Sandia National Laboratories, New Mexico.

U.S. Department of Energy (DOE), July 2018. Letter to J. E. Kieling (New Mexico Environment Department), "Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1," July 20, 2018.

Figures

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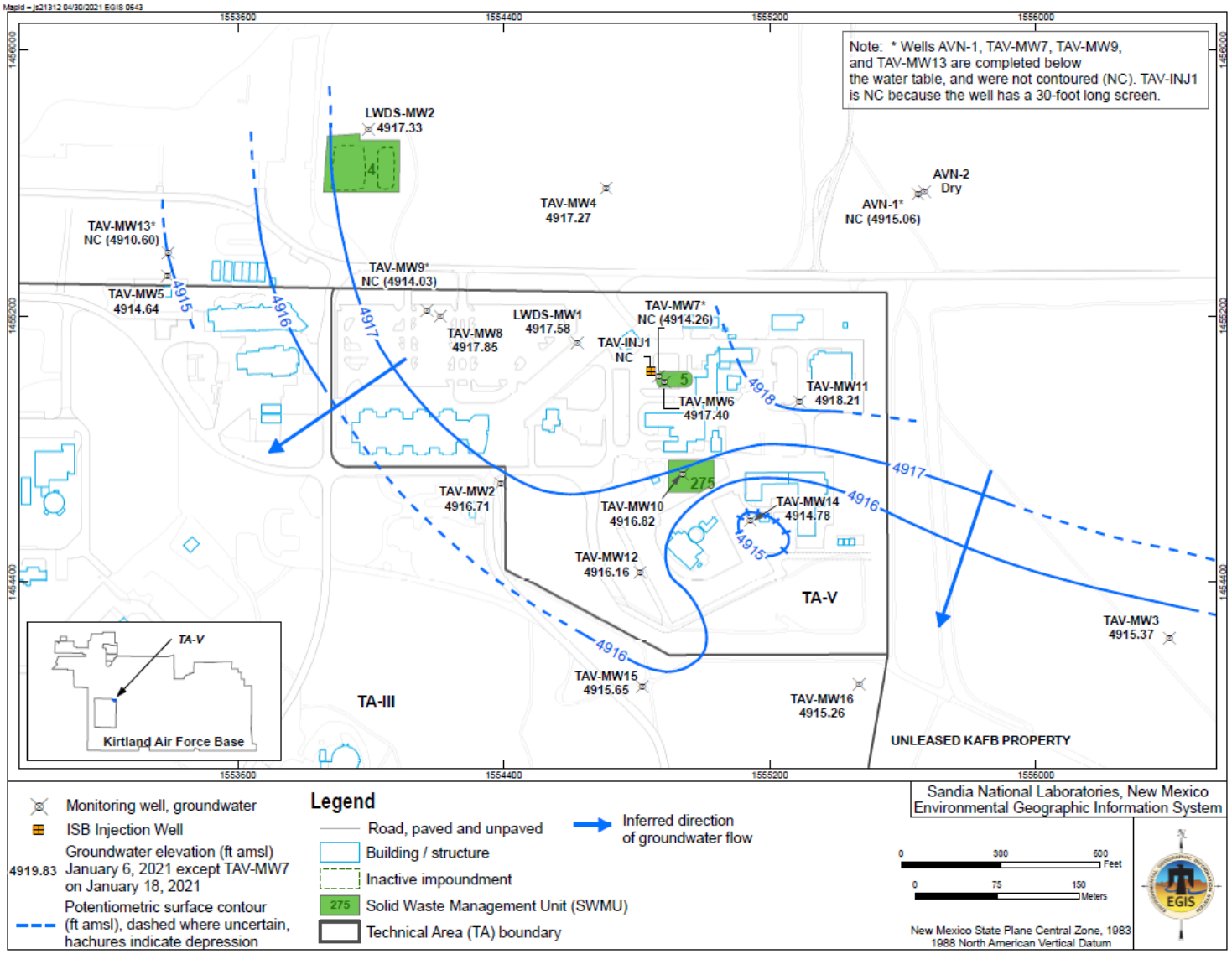

Figure III-1

Well Locations and Potentiometric Surface Contours for January 2021

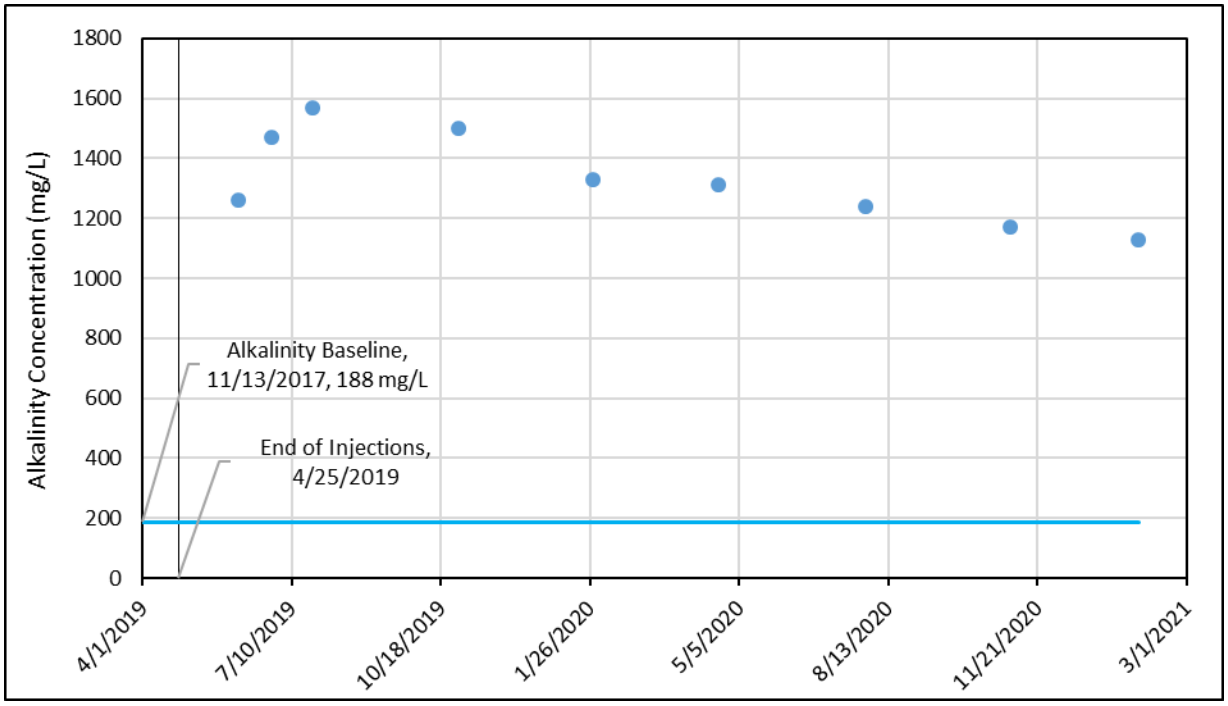

Figure III-2

Concentration of Alkalinity at Injection Well TAV-INJ1, June 2019 – January 2021

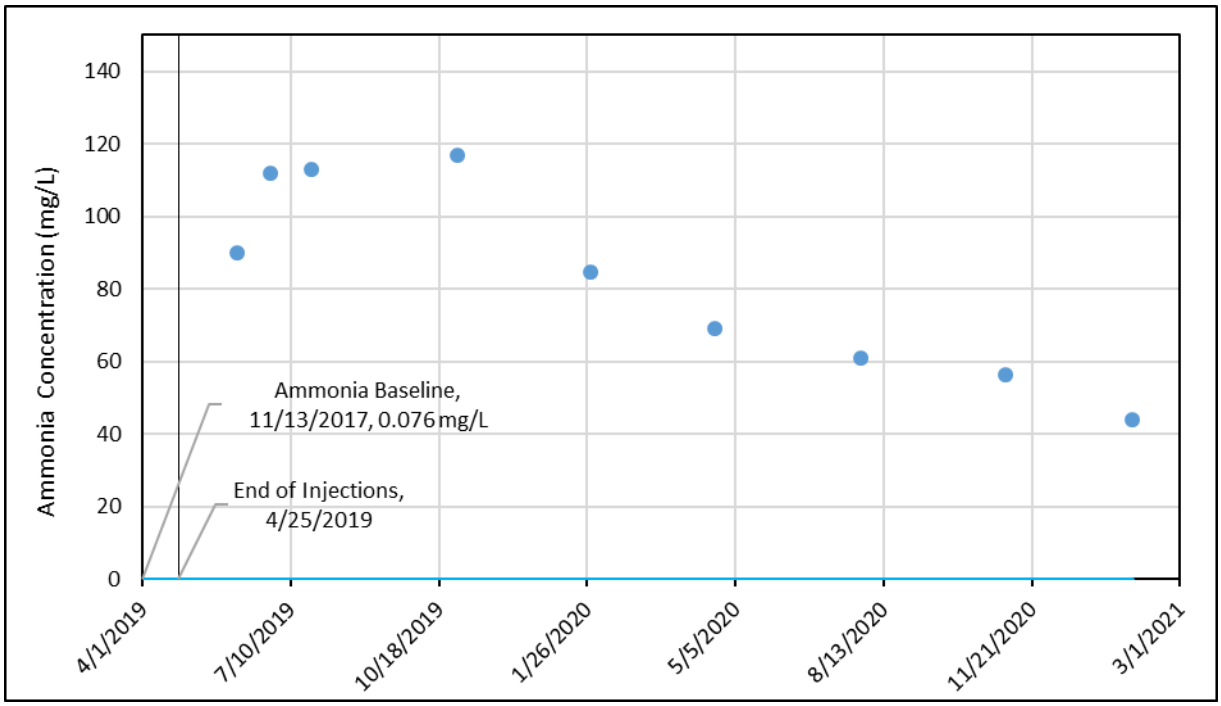

Figure III-3

Concentration of Ammonia at Injection Well TAV-INJ1, June 2019 – January 2021

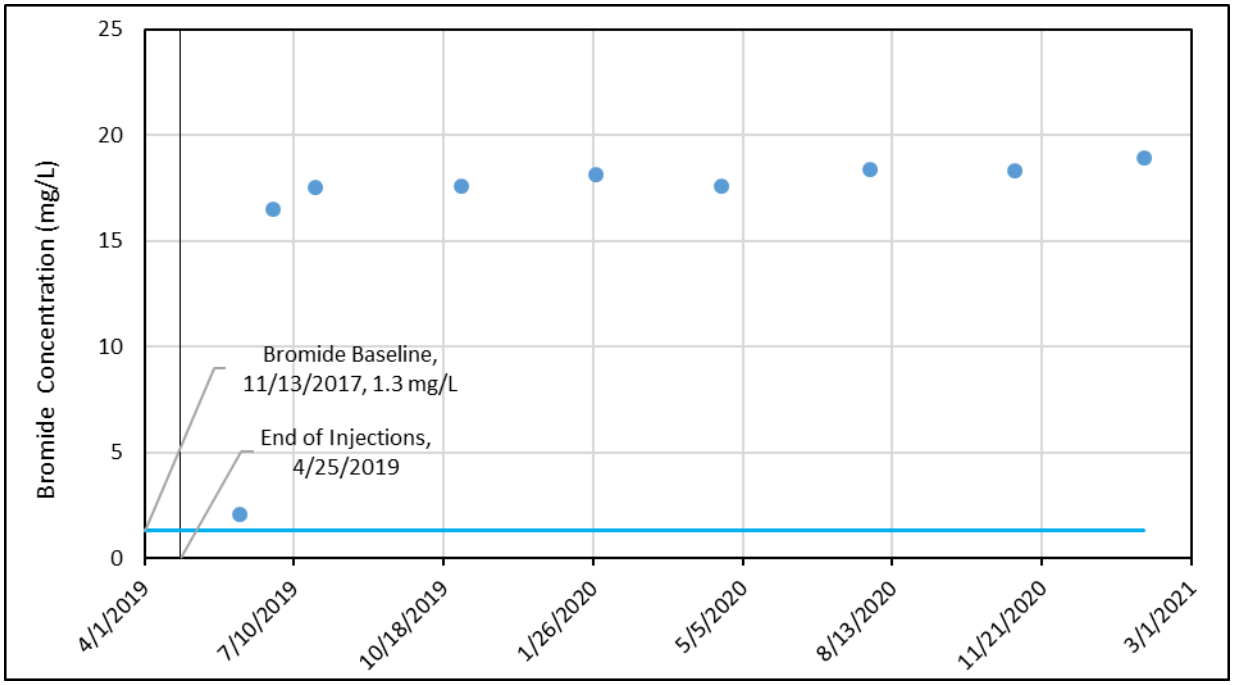

Figure III-4
Concentration of Bromide at Injection Well TAV-INJ1, June 2019 – January 2021

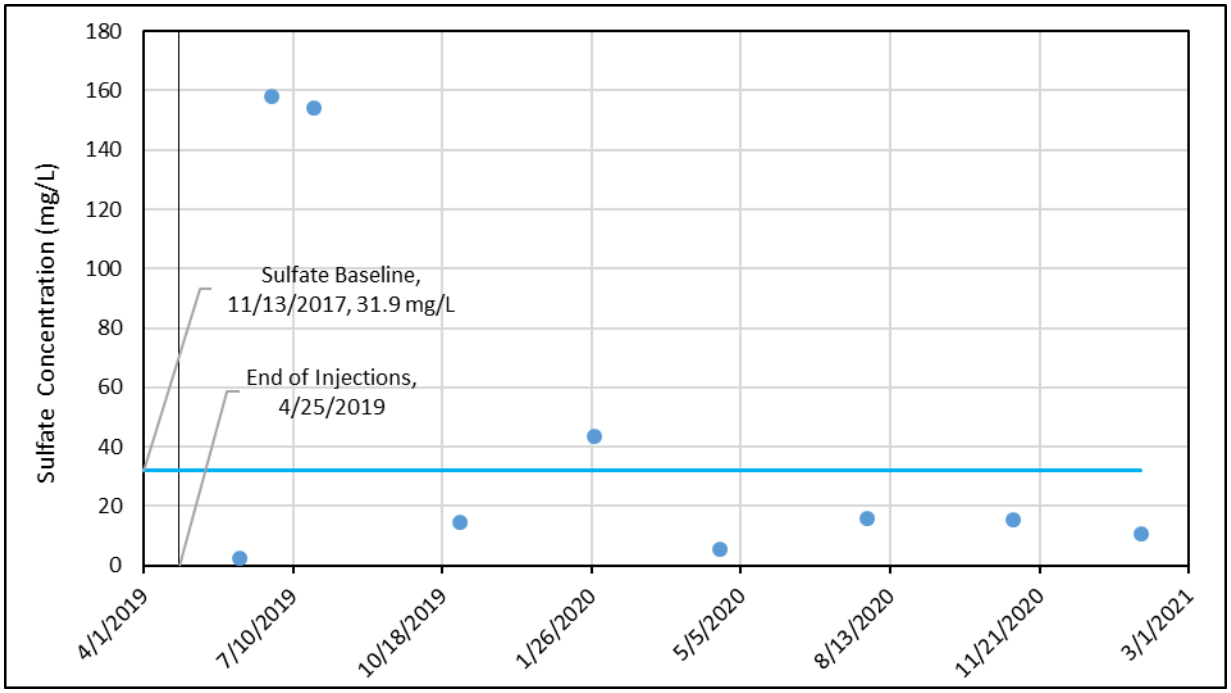

Figure III-5
Concentration of Sulfate at Injection Well TAV-INJ1, June 2019 – January 2021

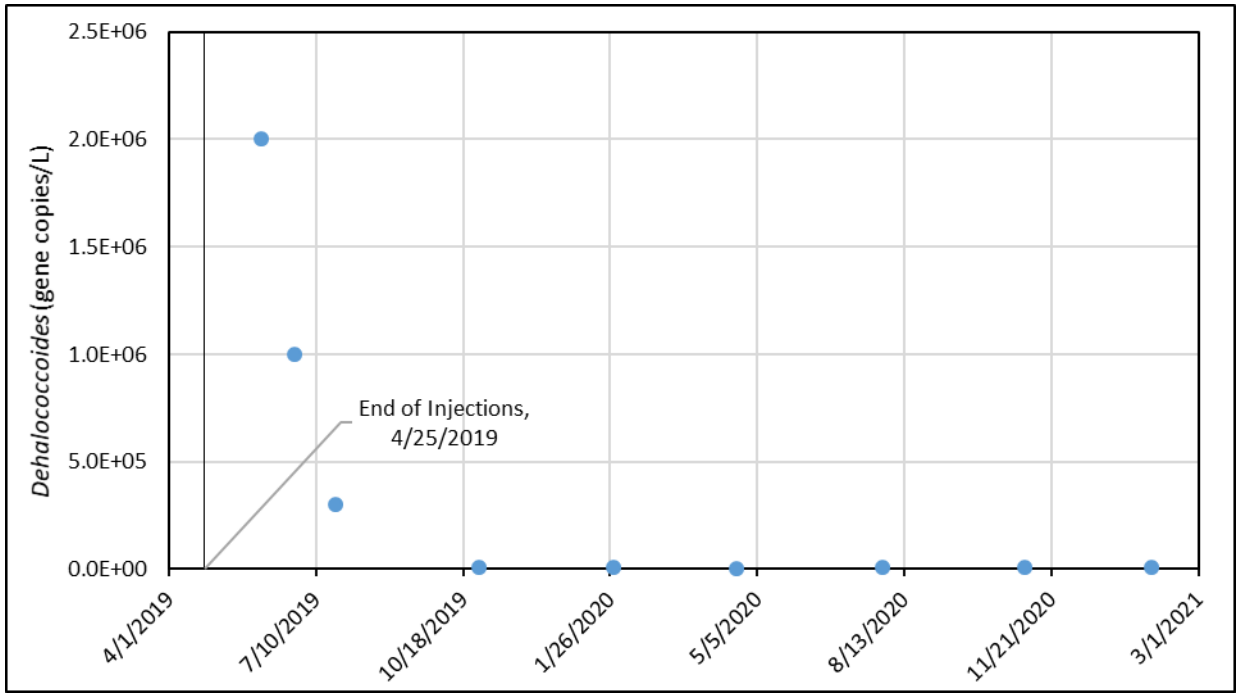

Figure III-6

Enumeration of *Dehalococcoides* at Injection Well TAV-INJ1, June 2019 – January 2021

Note: *Dehalococcoides* was not detected in baseline sample.

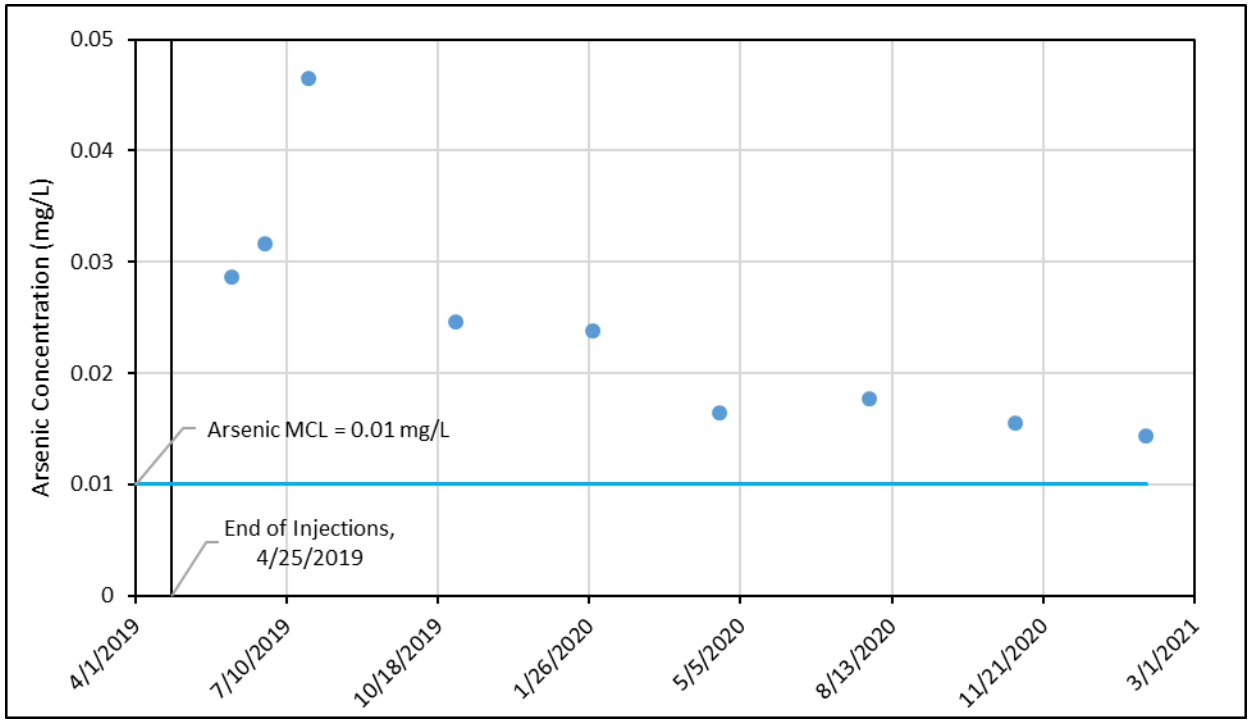

Figure III-7

Concentration of Arsenic at Injection Well TAV-INJ1, June 2019 – January 2021

Note: Arsenic was not detected in baseline sample.

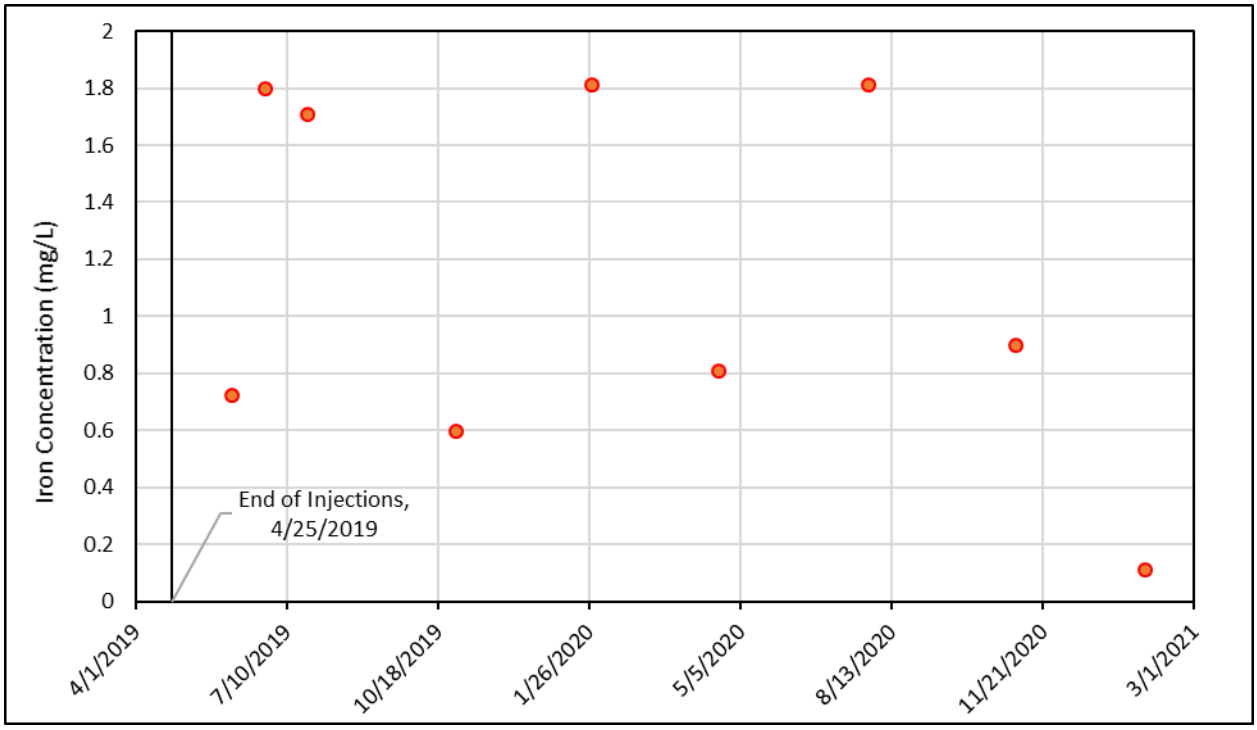

Figure III-8

Concentration of Iron at Injection Well TAV-INJ1, June 2019 – January 2021

Note: Iron was not detected in baseline sample.

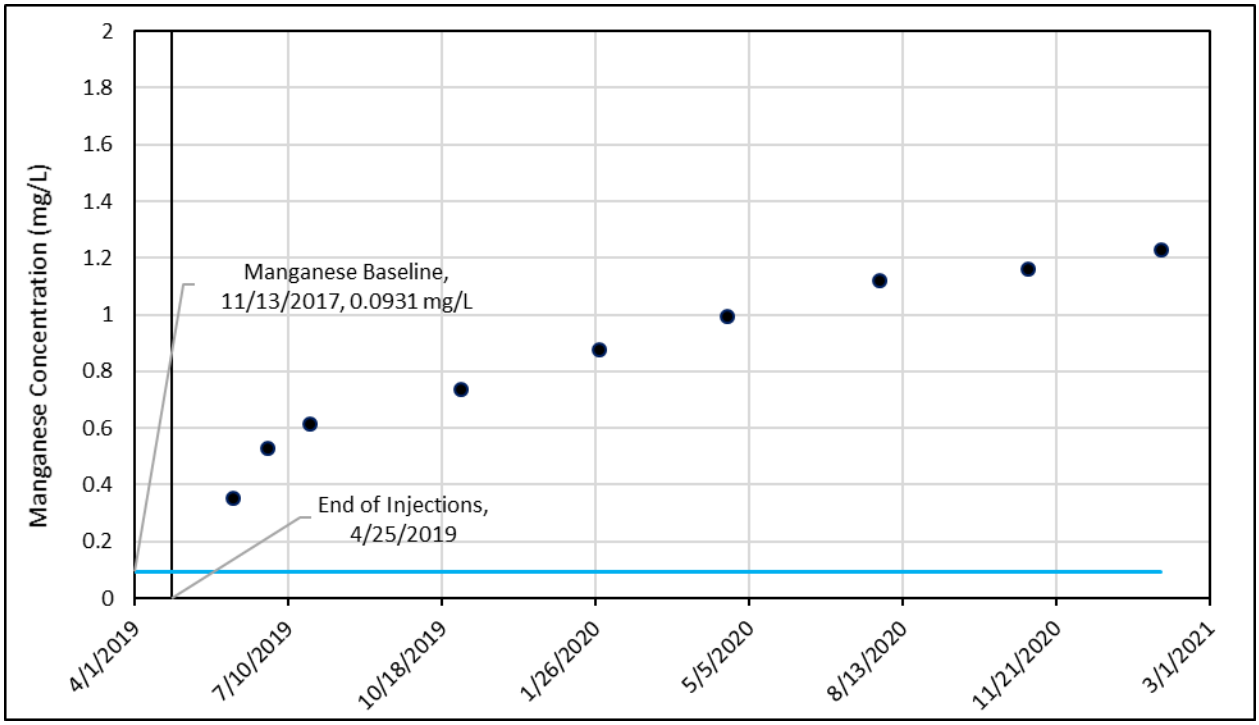

Figure III-9

Concentration of Manganese at Injection Well TAV-INJ1, June 2019 – January 2021

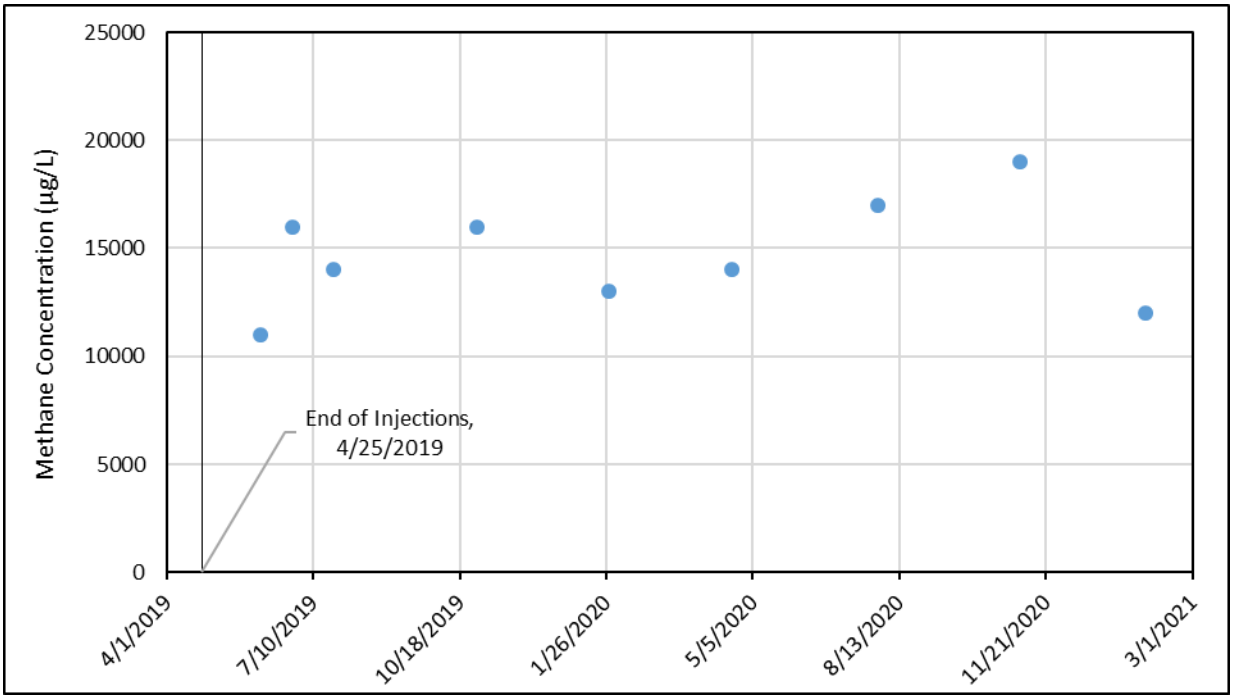

Figure III-10

Concentration of Methane at Injection Well TAV-INJ1, June 2019 – January 2021

Note: Methane was not detected in baseline sample.

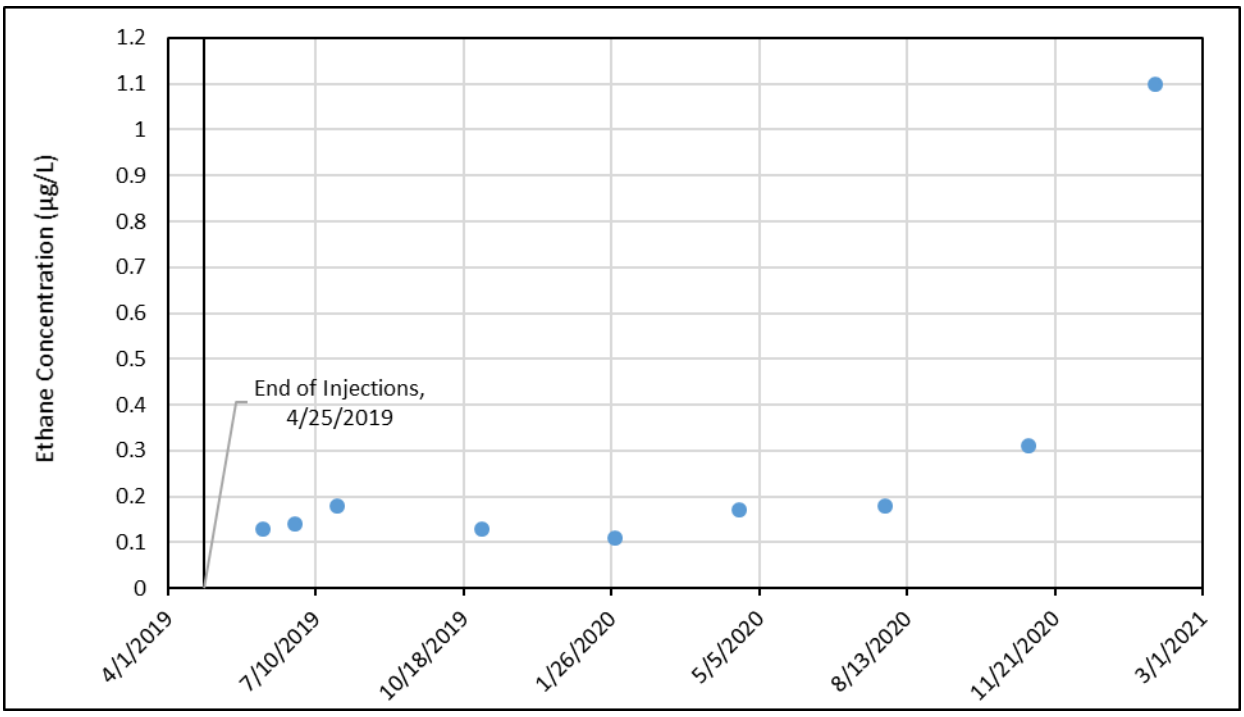

Figure III-11

Concentration of Ethane at Injection Well TAV-INJ1, June 2019 – January 2021

Note: Ethane was not detected in baseline sample.

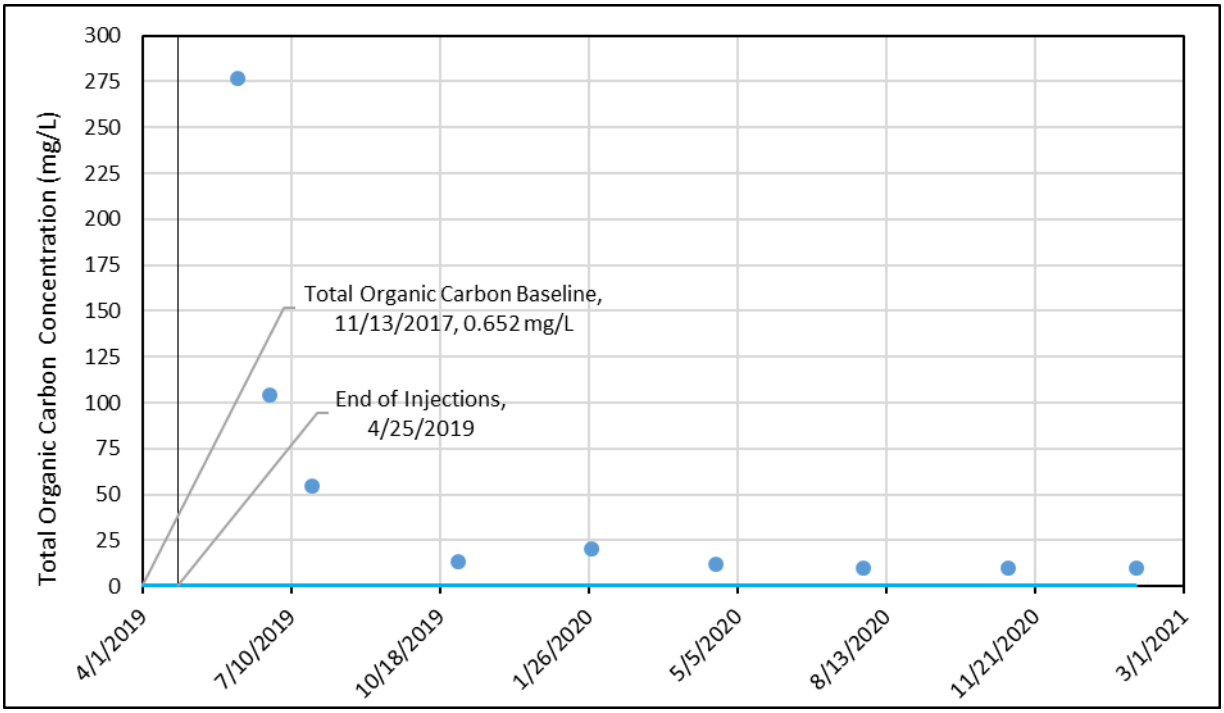

Figure III-12
Concentration of Total Organic Carbon at Injection Well TAV-INJ1, June 2019 – January 2021

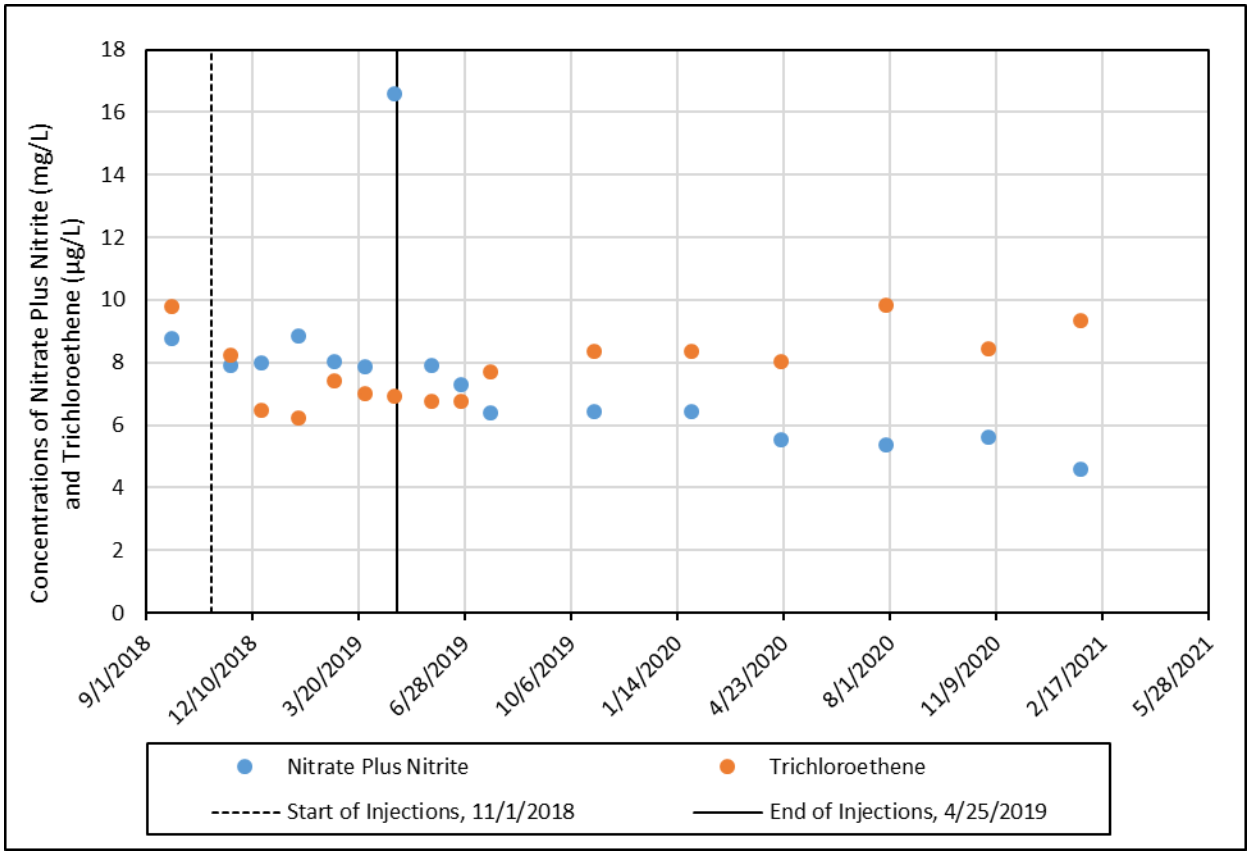

Figure III-13
Concentrations of Nitrate Plus Nitrite and Trichloroethene at Monitoring Well TAV-MW6, September 2018 – January 2021

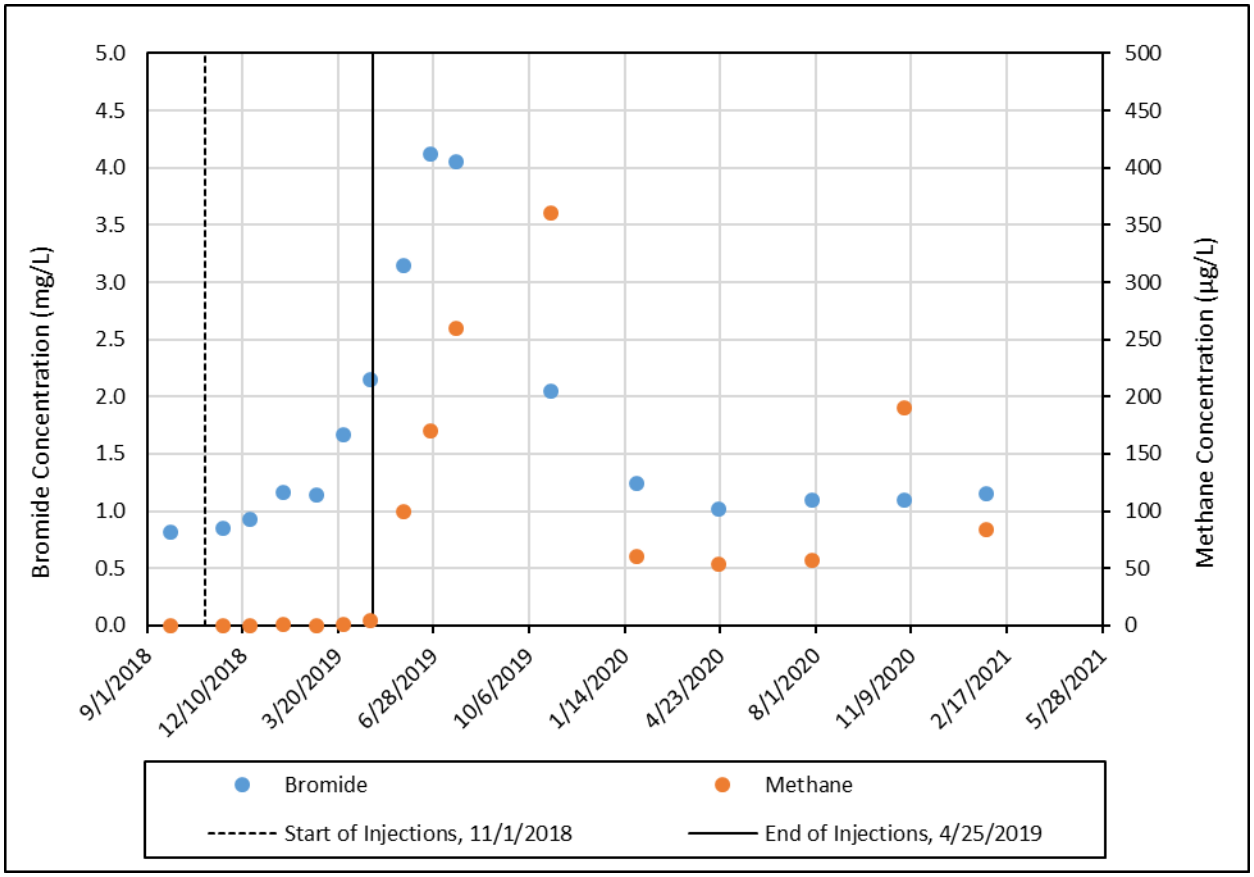

Figure III-14

Concentrations of Bromide and Methane at Monitoring Well TAV-MW6, September 2018 – January 2021

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Tables

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Table III-1
Timeline of Phase I In-Situ Bioremediation Treatability Study at TAVG AOC

Time	Event
July 2015	Personnel from DOE/NNSA, DOE Office of Environmental Management, SNL/NM, and NMED HWB agreed on a phased Treatability Study of ISB to evaluate if ISB is a viable technology to treat groundwater contamination at the TAVG AOC.
May 2016	NMED HWB approved the Revised Treatability Study Work Plan.
August 2016	NMOSE issued a Permit to Drill to install injection well TAV-INJ1.
May 2017	NMED GWQB issued Discharge Permit (DP)-1845 to DOE/NNSA for the TA-V Treatability Study injection wells.
September – November 2017	SNL/NM personnel installed injection well TAV-INJ1.
November 2017	Conducted Phase I pilot test injections at well TAV-INJ1. Began performance monitoring for Phase I pilot test injections.
June 2018	Completed performance monitoring of Phase I pilot test.
October 2018	SNL/NM personnel started Phase I full-scale operation of the ISB Treatability Study.
November 1, 2018 – April 25, 2019	Conducted the six-month injection period of the Phase I full-scale operation at well TAV-INJ1.
May 2019	Started the two-year performance monitoring of Phase I full-scale operation.
September 2020	Personnel from DOE/NNSA, SNL/NM, and NMED HWB met to discuss the path forward for the ISB Treatability Study.
May 2021	Anticipate completing the performance monitoring of the Phase I full-scale operation.

Notes:
AOC = Area of Concern.
DOE = U.S. Department of Energy.
GWQB = Ground Water Quality Bureau.
HWB = Hazardous Waste Bureau.
INJ = Injection (acronym used for well identification only).
ISB = In-Situ Bioremediation.
NMED = New Mexico Environment Department.
NMOSE = New Mexico Office of the State Engineer.
NNSA = National Nuclear Security Administration.
SNL/NM = Sandia National Laboratories, New Mexico.
TA-V = Technical Area-V.
TAV = Technical Area-V (acronym used for well identification only).
TAVG = Technical Area-V Groundwater.

Table III-2
Groundwater Sampling Conducted for Treatability Study, January – March 2021

Well Sampled	Sampling Date
Wells inside the Treatment Zone	
TAV-INJ1	28-Jan-21
TAV-MW6	27-Jan-21
TAV-MW7	3-Feb-21
Wells outside the Treatment Zone	
LWDS-MW1	23-Feb-21
TAV-MW2	8-Feb-21
TAV-MW4	9-Feb-21
TAV-MW8	15-Feb-21
TAV-MW10	18-Feb-21
TAV-MW11	10-Feb-21
TAV-MW12	12-Feb-21
TAV-MW14	17-Feb-21

Notes:

INJ = Injection well.
LWDS = Liquid waste disposal system.
MW = Monitoring well.
TAV = Technical Area-V.

Table III-3
Analytical Results for Groundwater Samples Collected at Injection Well TAV-INJ1, January – March 2021

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
28-Jan-21	Alkalinity	Alkalinity as $CaCO_3$	1,130	1.45	4.00	NE	mg/L			114254-005	SM 2320B	GEL
28-Jan-21	Alkalinity	Alkalinity, bicarb as $CaCO_3$	1,130	1.45	4.00	NE	mg/L			114254-005	SM 2320B	GEL
28-Jan-21	Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4.00	NE	mg/L	U		114254-005	SM 2320B	GEL
28-Jan-21	Ammonia	Ammonia	43.8	0.85	2.50	NE	mg/L			114254-001	EPA 350.1	GEL
28-Jan-21	Anions	Bromide	18.9	1.34	4.00	NE	mg/L			114254-003	SW846 9056A	GEL
28-Jan-21	Anions	Sulfate	10.8	0.133	0.400	NE	mg/L			114254-003	SW846 9056A	GEL
28-Jan-21	Microbial	Dehalococcoides	ND	100,000	100,000	NE	Enumeration/L	U		114258-001	Gene-Trac Dhc	SiREM
28-Jan-21	Dissolved Metals	Arsenic	**0.0144**	0.002	0.005	0.01	mg/L			114254-006	SW846 3005A/6020B	GEL
28-Jan-21	Dissolved Metals	Iron	0.109	0.033	0.100	NE	mg/L			114254-006	SW846 3005A/6020B	GEL
28-Jan-21	Dissolved Metals	Manganese	1.23	0.005	0.025	NE	mg/L		J	114254-006	SW846 3005A/6020B	GEL
28-Jan-21	MEE	Methane	12,000	4.90	10.0	NE	µg/L		J	114256-001	AM20GAX	PACE-GC
28-Jan-21	MEE	Ethane	1.10	0.075	1.00	NE	µg/L		J	114256-001	AM20GAX	PACE-GC
28-Jan-21	MEE	Ethene	ND	0.120	1.00	NE	µg/L	U	1.00UJ	114256-001	AM20GAX	PACE-GC
28-Jan-21	NPN	Nitrate plus nitrite as N	ND	0.085	0.250	10	mg/L	U		114254-004	EPA 353.2	GEL
28-Jan-21	TOC	Total Organic Carbon Average	9.74	1.65	5.00	NE	mg/L			114254-002	SW846 9060A	GEL
28-Jan-21	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114252-001	SW846 8260B	GEL
28-Jan-21	VOC	Trichloroethene	0.39	0.300	1.00	5	µg/L	J		114252-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-4
Analytical Results for Groundwater Samples Collected at Monitoring Well TAV-MW6, January – March 2021

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
27-Jan-21	Alkalinity	Alkalinity as $CaCO_3$	202	1.45	4.00	NE	mg/L			114250-006	SM 2320B	GEL
27-Jan-21	Alkalinity	Alkalinity, bicarb as $CaCO_3$	202	1.45	4.00	NE	mg/L			114250-006	SM 2320B	GEL
27-Jan-21	Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4.00	NE	mg/L	U		114250-006	SM 2320B	GEL
27-Jan-21	Ammonia	Ammonia	ND	0.017	0.050	NE	mg/L	U	0.050UJ	114250-002	EPA 350.1	GEL
27-Jan-21	Anions	Bromide	1.15	0.067	0.200	NE	mg/L		J	114250-004	SW846 9056A	GEL
27-Jan-21	Anions	Sulfate	41.2	0.665	2.00	NE	mg/L			114250-004	SW846 9056A	GEL
27-Jan-21	Microbial	Dehalococcoides	ND	2,000	2,000	NE	Enumeration/L	U		114257-001	Gene-Trac Dhc	SiREM
27-Jan-21	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		114250-007	SW846 3005A/6020B	GEL
27-Jan-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114250-007	SW846 3005A/6020B	GEL
27-Jan-21	Dissolved Metals	Manganese	0.00143	0.001	0.005	NE	mg/L	J	J	114250-007	SW846 3005A/6020B	GEL
27-Jan-21	MEE	Methane	84.0	2.50	5.00	NE	µg/L		J	114255-001	AM20GAX	PACE-GC
27-Jan-21	MEE	Ethane	0.650	0.075	1.00	NE	µg/L	J	J	114255-001	AM20GAX	PACE-GC
27-Jan-21	MEE	Ethene	ND	0.120	1.00	NE	µg/L	U	1.00UJ	114255-001	AM20GAX	PACE-GC
27-Jan-21	NPN	Nitrate plus nitrite as N	4.61	0.085	0.250	10	mg/L			114250-005	EPA 353.2	GEL
27-Jan-21	TOC	Total Organic Carbon Average	0.896	0.330	1.00	NE	mg/L	J		114250-003	SW846 9060A	GEL
27-Jan-21	VOC	Dichloroethene, cis-1,2-	1.25	0.300	1.00	70	µg/L			114250-001	SW846 8260B	GEL
27-Jan-21	VOC	Trichloroethene	**9.36**	0.300	1.00	5	µg/L			114250-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-5
Analytical Results for Groundwater Samples Collected at Monitoring Well TAV-MW7, January – March 2021

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
3-Feb-21	Anions	Bromide	0.272	0.067	0.200	NE	mg/L	N	J+	114270-001	SW846 9056A	GEL
3-Feb-21	Dissolved Metals	Arsenic	0.00235	0.002	0.005	0.01	mg/L	J		114268-003	SW846 3005A/6020B	GEL
3-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114268-003	SW846 3005A/6020B	GEL
3-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114268-003	SW846 3005A/6020B	GEL
3-Feb-21	MEE	Ethene	ND	0.12	1	NE	µg/L		UJ	114272-001	AM20GAX	PACE-GC
3-Feb-21	NPN	Nitrate plus nitrite as N	4.30	0.085	0.250	10	mg/L			114268-002	EPA 353.2	GEL
3-Feb-21	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114268-001	SW846 8260B	GEL
3-Feb-21	VOC	Trichloroethene	ND	0.300	1.00	5	µg/L	U		114268-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-6
Analytical Results for Groundwater Samples Collected at Monitoring Wells
LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV MW14, January – March 2021

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
LWDS-MW1												
23-Feb-21	Dissolved Metals	Arsenic	0.00315	0.002	0.005	0.01	mg/L	J		114307-003	SW846 3005A/6020B	GEL
23-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114307-003	SW846 3005A/6020B	GEL
23-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114307-003	SW846 3005A/6020B	GEL
23-Feb-21	NPN	Nitrate plus nitrite as N	**11.9**	0.170	0.500	10	mg/L			114307-002	EPA 353.2	GEL
23-Feb-21	VOC	Dichloroethene, cis-1,2-	3.13	0.300	1.00	70	µg/L			114307-001	SW846 8260B	GEL
23-Feb-21	VOC	Trichloroethene	**15.2**	0.300	1.00	5	µg/L			114307-001	SW846 8260B	GEL
TAV-MW2												
8-Feb-21	Dissolved Metals	Arsenic	0.00262	0.002	0.005	0.01	mg/L	J		114281-003	SW846 3005A/6020B	GEL
8-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114281-003	SW846 3005A/6020B	GEL
8-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114281-003	SW846 3005A/6020B	GEL
8-Feb-21	NPN	Nitrate plus nitrite as N	5.21	0.170	0.500	10	mg/L			114281-002	EPA 353.2	GEL
8-Feb-21	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114281-001	SW846 8260B	GEL
8-Feb-21	VOC	Trichloroethene	3.19	0.300	1.00	5	µg/L			114281-001	SW846 8260B	GEL
TAV-MW4												
9-Feb-21	Dissolved Metals	Arsenic	0.00269	0.002	0.005	0.01	mg/L	J		114285-003	SW846 3005A/6020B	GEL
9-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114285-003	SW846 3005A/6020B	GEL
9-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114285-003	SW846 3005A/6020B	GEL
9-Feb-21	NPN	Nitrate plus nitrite as N	4.50	0.170	0.500	10	mg/L			114285-002	EPA 353.2	GEL
9-Feb-21	VOC	Dichloroethene, cis-1,2-	0.48	0.300	1.00	70	µg/L	J		114285-001	SW846 8260B	GEL
9-Feb-21	VOC	Trichloroethene	**5.08**	0.300	1.00	5	µg/L			114285-001	SW846 8260B	GEL
9-Feb-21 (DUP)	Dissolved Metals	Arsenic	0.00277	0.002	0.005	0.01	mg/L	J		114286-003	SW846 3005A/6020B	GEL
9-Feb-21 (DUP)	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114286-003	SW846 3005A/6020B	GEL
9-Feb-21 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114286-003	SW846 3005A/6020B	GEL
9-Feb-21 (DUP)	NPN	Nitrate plus nitrite as N	4.51	0.170	0.500	10	mg/L			114286-002	EPA 353.2	GEL
9-Feb-21 (DUP)	VOC	Dichloroethene, cis-1,2-	0.51	0.300	1.00	70	µg/L	J		114286-001	SW846 8260B	GEL
9-Feb-21 (DUP)	VOC	Trichloroethene	**5.20**	0.300	1.00	5	µg/L			114286-001	SW846 8260B	GEL
TAV-MW8												
15-Feb-21	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		114298-003	SW846 3005A/6020B	GEL
15-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114298-003	SW846 3005A/6020B	GEL
15-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114298-003	SW846 3005A/6020B	GEL
15-Feb-21	NPN	Nitrate plus nitrite as N	6.35	0.170	0.500	10	mg/L			114298-002	EPA 353.2	GEL
15-Feb-21	VOC	Dichloroethene, cis-1,2-	0.44	0.300	1.00	70	µg/L	J		114298-001	SW846 8260B	GEL
15-Feb-21	VOC	Trichloroethene	4.36	0.300	1.00	5	µg/L			114298-001	SW846 8260B	GEL
TAV-MW10												
18-Feb-21	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		114302-003	SW846 3005A/6020B	GEL
18-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114302-003	SW846 3005A/6020B	GEL
18-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114302-003	SW846 3005A/6020B	GEL
18-Feb-21	NPN	Nitrate plus nitrite as N	**11.4**	0.170	0.500	10	mg/L			114302-002	EPA 353.2	GEL
18-Feb-21	VOC	Dichloroethene, cis-1,2-	2.07	0.300	1.00	70	µg/L			114302-001	SW846 8260B	GEL
18-Feb-21	VOC	Trichloroethene	**11.5**	0.300	1.00	5	µg/L			114302-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-6 (Concluded)
Analytical Results for Groundwater Samples Collected at Monitoring Wells
LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV MW14, January – March 2021 (concluded)

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
TAV-MW11												
10-Feb-21	Dissolved Metals	Arsenic	0.00247	0.002	0.005	0.01	mg/L	J		114288-003	SW846 3005A/6020B	GEL
10-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114288-003	SW846 3005A/6020B	GEL
10-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114288-003	SW846 3005A/6020B	GEL
10-Feb-21	NPN	Nitrate plus nitrite as N	6.72	0.170	0.500	10	mg/L			114288-002	EPA 353.2	GEL
10-Feb-21	VOC	Dichloroethene, cis-1,2-	0.60	0.300	1.00	70	µg/L	J		114288-001	SW846 8260B	GEL
10-Feb-21	VOC	Trichloroethene	4.93	0.300	1.00	5	µg/L			114288-001	SW846 8260B	GEL
TAV-MW12												
12-Feb-21	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		114294-003	SW846 3005A/6020B	GEL
12-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114294-003	SW846 3005A/6020B	GEL
12-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114294-003	SW846 3005A/6020B	GEL
12-Feb-21	NPN	Nitrate plus nitrite as N	4.42	0.170	0.500	10	mg/L			114294-002	EPA 353.2	GEL
12-Feb-21	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114294-001	SW846 8260B	GEL
12-Feb-21	VOC	Trichloroethene	1.91	0.300	1.00	5	µg/L			114294-001	SW846 8260B	GEL
12-Feb-21 (DUP)	Dissolved Metals	Arsenic	0.00203	0.002	0.005	0.01	mg/L	J		114295-003	SW846 3005A/6020B	GEL
12-Feb-21 (DUP)	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114295-003	SW846 3005A/6020B	GEL
12-Feb-21 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114295-003	SW846 3005A/6020B	GEL
12-Feb-21 (DUP)	NPN	Nitrate plus nitrite as N	4.38	0.170	0.500	10	mg/L			114295-002	EPA 353.2	GEL
12-Feb-21 (DUP)	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114295-001	SW846 8260B	GEL
12-Feb-21 (DUP)	VOC	Trichloroethene	1.99	0.300	1.00	5	µg/L			114295-001	SW846 8260B	GEL
TAV-MW14												
17-Feb-21	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		114300-003	SW846 3005A/6020B	GEL
17-Feb-21	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114300-003	SW846 3005A/6020B	GEL
17-Feb-21	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114300-003	SW846 3005A/6020B	GEL
17-Feb-21	NPN	Nitrate plus nitrite as N	7.46	0.170	0.500	10	mg/L			114300-002	EPA 353.2	GEL
17-Feb-21	VOC	Dichloroethene, cis-1,2-	0.40	0.300	1.00	70	µg/L	J		114300-001	SW846 8260B	GEL
17-Feb-21	VOC	Trichloroethene	4.28	0.300	1.00	5	µg/L			114300-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-7
Field Water Quality Measurements[i], January – March 2021

Well ID	Sample Date	Temperature (°C)	Specific Conductivity (µmho/cm)	Oxidation Reduction Potential (mV)	pH	Turbidity (NTU)	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)
TAV-INJ1	28-Jan-21	16.55	1684.51	-224.8	6.85	16.3	12.74	0.98
TAV-MW6	27-Jan-21	19.33	740.94	-45.6	7.43	1.93	33.31	2.39
TAV-MW7	3-Feb-21	20.43	602.13	141.1	7.51	1.19	2.70	0.21
LWDS-MW1	23-Feb-21	18.50	669.27	176.7	7.57	0.61	94.64	7.36
TAV-MW2	8-Feb-21	19.51	683.54	151.2	7.38	3.44	79.66	5.81
TAV-MW4	9-Feb-21	19.91	500.56	158.5	7.64	1.57	79.99	6.30
TAV-MW8	15-Feb-21	17.43	537.97	160.9	7.54	1.59	73.81	5.73
TAV-MW10	18-Feb-21	16.91	582.02	136.5	7.60	3.15	79.52	6.76
TAV-MW11	10-Feb-21	19.32	556.26	204.1	7.60	0.24	78.74	6.18
TAV-MW12	12-Feb-21	17.92	630.78	183.4	7.48	1.38	77.96	6.02
TAV-MW14	17-Feb-21	18.43	635.76	158.8	7.57	3.80	83.52	6.25

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Footnotes for Technical Area-V Analytical Results Tables

%	= Percent.
$CaCO_3$	= Calcium carbonate.
Dhc	= Dehalococcoides.
DUP	= Environmental duplicate sample.
Enumeration/L	= gene copies per liter.
EPA	= U.S. Environmental Protection Agency.
ID	= Identifier.
INJ	= Injection well (acronym used for well identification only).
LWDS	= Liquid waste disposal system (acronym used for well identification only).
µg/L	= Micrograms per liter.
mg/L	= Milligrams per liter.
MEE	= Methane, ethane, ethene.
MW	= Monitoring well (acronym used for well identification only).
No.	= Number.
NPN	= Nitrate plus nitrite.
TAV	= Technical Area-V (acronym used for well identification only).
TOC	= Total organic carbon.
VOC	= Volatile organic compound.

[a]Result

Detected VOCs are presented in the tables.

Bold	= Concentration exceeds the EPA MCL.
ND	= Not detected (at method detection limit).

[b]MDL

MDL	= Method detection limit. The minimum concentration or activity that can be measured and reported with 99% confidence that the analyte is greater than zero, analyte is matrix specific.

[c]PQL

PQL	= Practical quantitation limit. The lowest concentration of analytes in a sample that can be reliably determined within specified limits of precision and accuracy by that indicated method under routine laboratory operating conditions.

[d]MCL

MCL	= Maximum contaminant level. 2018 Edition of the Drinking Water Standards and Health Advisories Tables, EPA 822-F-18-001, Office of Water, U.S. Environmental Protection Agency, Washington, D.C., March 2018.
NE	= Not established.

[e]Lab Qualifier

If cell is blank, then all quality control samples met acceptance criteria with respect to submitted samples.

J	= Estimated value, the analyte concentration fell above the method detection limit and below the practical quantitation limit.
N	= Results associated with a spike analysis that was outside control limit.
U	= Analyte is absent or below the method detection limit.

Footnotes for Technical Area-V Analytical Results Tables *(Continued)*

[f]Validation Qualifier

If cell is blank, then all quality control samples met acceptance criteria with respect to submitted samples.

J	= The associated value is an estimated quantity.
J+	= The associated numerical value is an estimated quantity with a suspected positive bias.
UJ	= The analyte was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

[g]Analytical Method

AM20GAX	= Proprietary method of Pace Analytical Services, LLC.
Gene-Trac Dhc	= Proprietary method of SiREM.

Clesceri, Rice, Baird, and Eaton, 2012, *Standard Methods for the Examination of Water and Wastewater*, 22nd ed., Method 2320B, published jointly by American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

EPA, 1986, (and updates), "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 1984, "Methods for Chemical Analysis of Water and Wastes." EPA 600-4-79-020, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 1993, "Method 350.1, Determination of Ammonia Nitrogen by Semi-Automated Colorimetry." Revision 2.0.

EPA, 1993, "Method 353.2, Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry." Revision 2.0.

[h]Lab

GEL	= GEL Laboratories LLC, 2040 Savage Road, Charleston, South Carolina 29407.
PACE-GC	= Pace Analytical Gulf Coast, 7979 Innovation Park Drive, Baton Rouge, Louisiana 70820.
SiREM	= SiREM, 130 Stone Road. W, Guelph, Ontario, N1G 3Z2, Canada.

[i]Field Water Quality Measurements

Field measurements collected prior to sampling.

°C	= Degrees Celsius.
% Sat	= Percent saturation.
µmho/cm	= Micromhos per centimeter.
mg/L	= Milligrams per liter.
mV	= Millivolts.
pH	= Potential of hydrogen (negative logarithm of the hydrogen ion concentration).
NTU	= Nephelometric turbidity units.

Appendix A

NMED's Approval Letter and DOE's Submittal with the Enclosure Describing Full-Scale Operation Modifications

State of New Mexico
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6313
Phone (505) 476-6000 Fax (505) 476-6030
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SUSANA MARTINEZ
Governor
JOHN A. SANCHEZ
Lieutenant Governor

BUTCH TONGATE
Cabinet Secretary
J. C. BORREGO
Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

August 13, 2018

Jeffrey P. Harrell
Manager
U.S. Department of Energy
NNSA/Sandia Field Office
P.O. Box 5400, MS 0184
Albuquerque, NM 87185-5400

Richard O. Griffith
Senior Manager
Sandia National Laboratories
P.O. Box 5800, MS 0726
Albuquerque, NM 87185-5400

RE: APPROVAL
TECHNICAL AREA-V (TA-V) TREATABILITY STUDY NOTIFICATION OF FULL-SCALE OPERATION AT WELL TAV-INJ1
SANDIA NATIONAL LABORATORY
EPA ID#NM5890110518
HWB-SNL-15-020

Dear Mr. Harrell and Mr. Griffith:

The New Mexico Environment Department (NMED) received the letter titled *Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1,* dated July 20, 2018, submitted by the U.S. Department of Energy on behalf of itself and NTESS (collectively, the Permittees), on July 26, 2018. NMED has reviewed the letter and hereby issues this Approval of the proposed modifications to the Work Plan and concurs with the decision to proceed with full-scale operation at well TAV-INJ1 of the Treatability Study/Interim Measure at TA-V.

If you have any questions regarding this matter, please contact Naomi Davidson of my staff at (505) 222-9504.

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
B. Wear, NMED HWB
N. Davidson, NMED HWB
L. King, EPA Region 6 (6PD-N)
J. Todd, DOE/NNSA/SFO, MS-0184
D. Rast, DOE/NNSA/SFO, MS-0184
J. Cochran, SNL/NM, MS-0719
E. Boatman, SNL/NM, MS-0718

File: SNL 2018 and Reading, SNL-15-020

Department of Energy
National Nuclear Security Administration
Sandia Field Office
P.O. Box 5400
Albuquerque, NM 87185

JUL 20 2018

Mr. John E. Kieling
Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg. 1
Santa Fe, New Mexico 87505

Subject: Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1

Dear Mr. Kieling:

The Department of Energy/National Nuclear Security Administration/Sandia Field Office (DOE/NNSA/SFO) and its management and operating contractor, National Technology and Engineering Solutions of Sandia, LLC (NTESS) intend to proceed with full-scale operation at well TAV-INJ1 as part of the Treatability Study of in-situ bioremediation at TA-V Groundwater Area of Concern, Sandia National Laboratories/New Mexico (SNL/NM). Full-scale operation will not commence until at least 60 days after this notification is received at New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB), in accordance with the 2016 Revised Treatability Study Work Plan.

Associated modifications to the full-scale operation based on the experience and monitoring results of the pilot test at well TAV-INJ1 were discussed among personnel from DOE/NNSA/SFO, SNL/NM, and NMED HWB in a meeting held on June 20, 2018. The modifications and the rationale for the modifications to conduct full-scale operation at well TAV-INJ1 are provided in the enclosure.

If you have questions contact David Rast of our staff at (505) 845-5349.

Sincerely,

Jeffrey P. Harrell
Manager

Enclosure

cc: See Page 2

cc w/enclosure:
Naomi Davidson
NMED-HWB
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Albuquerque, New Mexico 87102-3400

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MSC05 3020
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cc w/o enclosure:
Amy Blumberg, SNL/NM
Paul Shoemaker, SNL/NM
Christi Leigh, SNL/NM
John Cochran, SNL/NM
Jun Li, SNL/NM
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Douglas Tonkay, DOE/EM-31
Thomas Longo, NNSA/NA-533
Jessica Arcidiacono, NNSA/NA-533
Cynthia Wimberly, SFO/OOM
James Todd, SFO/ENG
Susan Lacy, SFO/ENG
Steven Black, SFO/ENG
David Rast, SFO/ENG
NNSA-2018-001960

Technical Area-V (TA-V) Treatability Study
Notification of Full-Scale Operation at Well TAV-INJ1

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Paul E. Shoemaker
Signature

July 10, 2018
Date

Paul E. Shoemaker
Defense Waste Management Programs
Sandia National Laboratories/New Mexico
Albuquerque, New Mexico 87185
Operator

and

Signature

7/23/2018
Date

Jeffrey P. Harrell, Manager
U.S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
Owner

ENCLOSURE

The Department of Energy/National Nuclear Security Administration, Sandia Field Office and Sandia National Laboratories, New Mexico (SNL/NM) personnel (i.e., the project team) plan to implement the following modifications for the full-scale operation of the in-situ bioremediation (ISB) Treatability Study at the Technical Area-V (TA-V) Groundwater Area of Concern. The modifications were based on the experience and monitoring results of the pilot test conducted at well TAV-INJ1. The original proposal in the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016; NMED May 2016) is repeated verbatim, followed by the rationale for modification and a summary statement of the modification to be implemented in full-scale operation at well TAV-INJ1.

#1: Method for Deoxygenation in Aboveground Tanks

In Section 4.2.2, Page 4-9, the Revised TSWP states, "*One tank will be inoculated with a small amount of soil core/cuttings from the injection well screened interval and have KB-1® Primer added. The purposes of adding soil core/cuttings to the substrate solution are to (1) inoculate the solution with native microorganisms, (2) create a diverse microbial community that will more likely work synergistically with the bioaugmentation culture, and (3) reduce the lag time for initiating biostimulation associated with utilization of the substrate in the subsurface.*"

Rationale for Modification: Two injections of the substrate solution were conducted during the pilot test. The soil core/cuttings were not added to the substrate solution during the first injection, but were added during the second injection. The pilot test results showed that KB-1® Primer itself could produce favorable conditions – low dissolved oxygen (DO) and negative oxidation-reduction potential (ORP) – for safely injecting KB-1® Dechlorinator. KB-1® Dechlorinator are the dechlorinating bacteria that require anaerobic environment to survive.

Based on the experience gained during the pilot test, it is not necessary to rely on growing the microbial community in the aboveground tanks to produce low DO and negative ORP inside the tanks. In fact, the KB-1® Primer alone can sufficiently produce these conditions. Not relying on microbial growth in the aboveground tanks eliminates the biofouling concern for the water stored in the tanks.

During full-scale injection, we will bioaugment the aquifer with KB-1® Dechlorinator throughout the six-month injection; therefore, the three purposes stated above become unnecessary because of the long-term bioaugmentation in the aquifer.

Full-Scale Operation Modification #1: Use substrate components (i.e., chemicals) only to deoxygenate potable water in aboveground tanks.

#2: Number of Aboveground Deoxygenation Tanks for Full-Scale Operation

In Section 4.2.2, Pages 4-9 and 4-10, the Revised TSWP states "*A similar process will be applied to the full-scale injections. Two pairs of tanks will be used for full-scale injection (see section 4.3.2). Both pairs of tanks will be filled halfway with potable water, inoculated, and have KB-1® Primer added. After turning anaerobic, the tanks will be filled with potable water and*

mixed with proportional amounts of the substrate solution components. As with the push/pull test, deoxygenation of the entire tank volume is expected within one to two days. Once anaerobic conditions are restored, half of the tank contents (from each pair) will be injected. This pair of tanks will then be refilled with potable water and mixed with proportional amounts of the substrate solution components. Provided that approximately half a tank of the deoxygenated solution remains in each tank, this accelerated deoxygenation schedule is expected to continue without further use of KB-1® Primer during the remainder of the injection period. By alternating two pair of tanks, injection would not be interrupted while waiting for the substrate solution to turn anaerobic."

Rationale for Modification: Using substrate components (i.e., chemicals) to achieve low DO and negative ORP of the substrate solution for safely injecting KB-1® Dechlorinator, the injection operation can be simplified by alternating two deoxygenation tanks. Based on the experience from the pilot test, the chemicals can lower the DO and ORP to desired levels within a couple of hours. It takes about five and a half hours to inject approximately 5,000 gallons of substrate solution. Therefore, theoretically we can prepare a tank of substrate solution and empty it within a single day. In practice, we will prepare one tank and empty its content the next day. We will alternate using the two existing tanks used in the pilot test. With this modification, we do not need to install two more tanks as proposed in the Revised TSWP.

Full-Scale Operation Modification #2: Use two existing 5,000-gallon aboveground tanks for full-scale injection.

#3: Substitute for KB-1® Primer

In Section 4.2.2, Page 4-8, the Revised TSWP states "*KB-1® Primer is a proprietary mixture of amino acids, potassium bicarbonate, and sodium sulfite that is used to accelerate deoxygenation of water inorganically (sodium sulfite) while still providing an electron donor (amino acids) and buffer (potassium bicarbonate). It can therefore be used as a substitute for ethyl lactate, diammonium phosphate, and yeast extract, although it is significantly more costly and therefore, not suitable for the large volumes planned under full scale injection.*"

Rationale for Modification: With the goal of using chemical method for deoxygenation, the project team conducted bench-scale, 5-gallon bucket tests to evaluate the functionality of the key components of KB-1® Primer. The results of the bucket tests showed that by using the two key ingredients, potassium bicarbonate and sodium sulfite, combined with ethyl lactate and diammonium phosphate, we could achieve the same desired conditions as using the KB-1® Primer alone. The functionality of ethyl lactate as the electron donor and diammonium phosphate as the nutrient can effectively substitute for the amino acids in the KB-1® Primer.

Attachment A includes the Safety Data Sheets (SDS) for potassium bicarbonate and sodium sulfite.

Full-Scale Operation Modification #3: Eliminate KB-1® Primer. Use potassium bicarbonate and sodium sulfite. A Revised Table 4-1 is provided below for the substrate solution components in full-scale operation.

Minor adjustments to the quantities of the substrate components could be necessary during full-scale operation depending on the in-situ water quality measurements of the aboveground tanks content and the groundwater in well TAV-INJ1.

Revised Table 4-1
Substrate Solution Components

Substrate Solution Component	Function	Mixing Ratio (by weight)	Weight per 1,000 gal Water
Primary Components			
Ethyl lactate	Electron donor (substrate)	80.4%	5.64 lbs
Diammonium phosphate	Nutrient and pH buffer	9.0%	0.63 lbs
Accelerite® [a]	Nutrient	6.4%	0.45 lbs
Potassium Bicarbonate	Buffer and acid reducer	1.7%	0.11 lbs
Sodium Sulfite	Deoxygenation and reduction agent	2.5%	0.17 lbs
Primary Components per 1,000 gal Potable Water		**100%**	**7 lbs**
Additional Component Mixed with Substrate Solution			
Sodium bromide	Inert tracer (as bromide)	Not applicable; adjusted per field condition	0.2 lbs

[a] Accelerite® Bioremediation Nutrient is a product of JRW Bioremediation, LLC.
% = Percent.
gal = Gallon(s).
lbs = Pounds.

#4: Substitute for Yeast Extract

In Section 4.2.1, Page 4-7, the Revised TSWP states "*Diammonium phosphate and yeast extract will be added as nutrients to support microbial growth.*"

Rationale for Modification: Accelerite® Bioremediation Nutrient is a product of JRW Bioremediation, LLC (JRW). The composition of Accelerite® is a proprietary nutrient blend of yeast metabolites including B-vitamins and other soluble nutrients. Accelerite® was tested in the bench-scale bucket tests and proved to function the same as the yeast extract obtained from Sigma-Aldrich. There are two advantages of using Accelerite®. First, it is significantly more concentrated, requiring less material to achieve the desired effect. The overall cost for Accelerite® is less than the yeast extract because less material is required. Secondly, Accelerite® is received in liquid form and is much easier to handle in the field than the powder-form yeast extract. Therefore, Accelerite® Bioremediation Nutrient from JRW is chosen to substitute for yeast extract in the full-scale operation.

Attachment A includes the SDS for Accelerite® is Bioremediation Nutrient.

Full-Scale Operation Modification #4: Use Accelerite® Bioremediation Nutrient in place of yeast extract. The Revised Table 4-1 provides the quantity needed for Accelerite® in full-scale operation.

#5: Sampling for Laboratory Analysis of Tank Content

In Section 5.4.2, Pages 5-17 and 5-18 of the Revised TSWP do not state that samples of the injected substrate solution during full-scale injections will be collected for laboratory analysis. However, sampling is implied as we did during the pilot test injections, in accordance with Section 5.4.1, Page 5-15, which states, "*A sample of the injected substrate solution will be collected as it is being injected and analyzed for parameters listed in Table 5-4 and measured for field parameters specified in section 5.3.*"

Rationale for Modification: Samples of the substrate solution in aboveground tanks were collected for laboratory analysis during the pilot test injections. The objective of sampling the tank content was to confirm the ingredients of the substrate solution. However, significant matrix interferences were reported by the analytical laboratory, which resulted in high dilutions for most samples. While preparing the substrate solution, the daily dose, masses or volumes of the substrate components as well as the KB-1® Dechlorinator could be accurately measured before mixing. The volume of the potable water could be accurately measured by the flow meter connected to the fire hydrant. These records provided sufficient information on what was being injected. The laboratory analysis of the tank content did not add any value because the process knowledge of the injectate was sufficient. Therefore, laboratory analysis of the substrate solution is not necessary. In addition, an in-situ water quality sonde is used to monitor the turbidity, specific conductance, pH, ORP, DO, temperature, and pressure in each tank.

Full-Scale Operation Modification #5: No sampling of the aboveground tank content.

#6: Groundwater Sampling at Well TAV-INJ1 during Injection

In Section 5.2.2, Page 5-18, the Revised TSWP states, "*During injection, DO, ORP, and pH will be monitored in well TAV-INJ1 using downhole electronic probes and a data logger. Water levels will also be frequently monitored immediately prior and throughout each workday during injections. Additionally, wells TAV-INJ1, TAV-MW6, and TAV-MW7 will be monitored monthly during injection for the analyses (Table 5-4) and the field parameters listed in section 5.3.*"

Rationale for Modification: During the performance monitoring of the pilot test, it was apparent that we were dominantly sampling the substrate solution that was injected at well TAV-INJ1 instead of the native groundwater. Strong matrix interferences were reported by the analytical laboratory due to the various substrate ingredients. Because we know exactly how we prepare the substrate solution in aboveground tanks, it is not necessary to collect groundwater samples from the injection well during the six-month injection period.

However, we will collect groundwater samples from well TAV-MW6 during injection as planned in the Revised TSWP. In addition, in-situ water quality sondes will be installed in wells TAV-INJ1 and TAV-MW6 during injection. Turbidity, specific conductance, pH, ORP, DO, temperature, and pressure (correlates to water level) will be logged continuously at a frequency set by the project team.

Full-Scale Operation Modification #6: No groundwater sampling at injection well TAV-INJ1 during the six-month injection. Groundwater sampling at well TAV-INJ1 will start one month after the completion of full-scale injections, as proposed for the post-injection monitoring in the Revised TSWP.

#7: ISB Performance Monitoring at Well TAV-MW7

In Section 5.2.2, Page 5-17 (top of page), the Revised TSWP states "*Did results from deeper well TAV-MW7 support the conclusion that further injections will not adversely affect deeper groundwater?"*

Increases in nitrate or bromide concentrations and detections of TCE or associated daughter products in well TAV-MW7 would indicate further injection could drive contamination deeper."

Rationale for Modification: During the pilot test injections, an in-situ water quality sonde was installed in each of the three wells (TAV-INJ1, TAV-MW6, and TAV-MW7). The sonde has sensors for turbidity, specific conductance, pH, ORP, DO, temperature, and pressure. The pressure reading correlates to the height of the water column above the sonde. These seven parameters were logged continuously at a pre-specified interval (e.g., every minute). When injections occurred in well TAV-INJ1 (Figure 1a), we observed instantaneous response in well TAV-MW6 (Figure 1b). However, no response was observed in well TAV-MW7 (Figure 1c). These results indicate that wells TAV-INJ1 and TAV-MW6, both screened across the groundwater table, are **not** hydrogeologically connected with well TAV-MW7, which is screened 90 feet deeper.

The results from the four-month performance monitoring after the pilot test injections also show no indication of any injected ingredient in well TAV-MW7, even though well TAV-MW7 is laterally closer to well TAV-INJ1 than well TAV-MW6. The monitoring results of well TAV-MW7 have been similar to its baseline sampling results in the October – December 2017 Discharge Permit DP-1845 Quarterly Report submitted to the NMED GWQB. A copy of this report was also provided to the NMED HWB.

Well TAV-MW7 would not be useful for monitoring the ISB treatment zone surrounding wells TAV-INJ1 and TAV-MW6. Therefore, we propose to revert it back to the TA-V groundwater monitoring network, which is administered by the SNL Long-Term Stewardship (LTS) group. Under the LTS monitoring plan, well TAV-MW7 is sampled semiannually for nitrate plus nitrite (NPN), volatile organic compounds, and dissolved metals (arsenic, iron, and manganese).

Full-Scale Operation Modification #7: Revert well TAV-MW7 back to the LTS sampling plan with the following additions:

- Increase the sampling frequency from semiannually to quarterly.
- Include bromide in the current analysis suite.
- Include ethene in the current analysis suite, per requirement of the Discharge Permit DP-1845.
- Install an in-situ water quality sonde in well TAV-MW7 in full-scale operation.

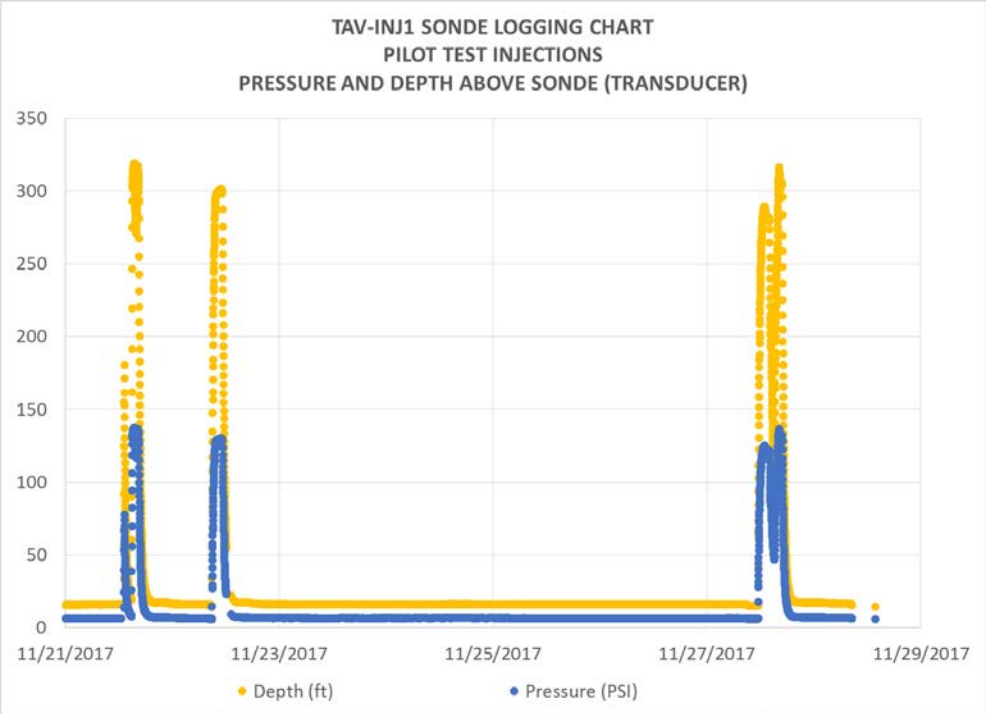

Figure 1a
Pressure and Water Column Height in well TAV-INJ1 during Injections

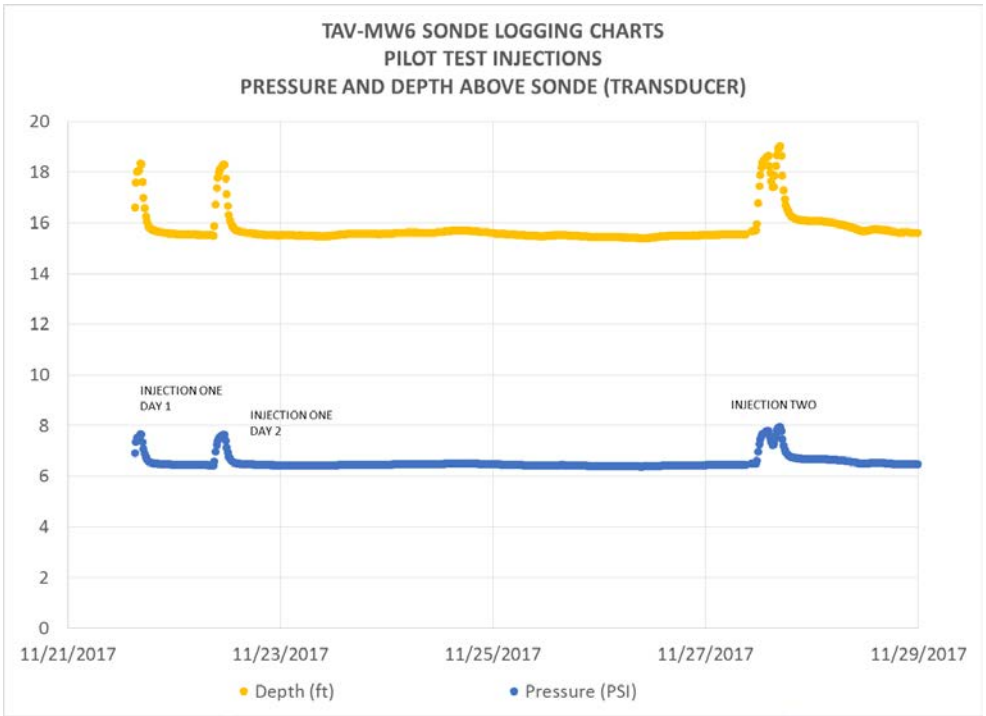

Figure 1b
Pressure and Water Column Height in well TAV-MW6 in
Response to Injections at well TAV-INJ1

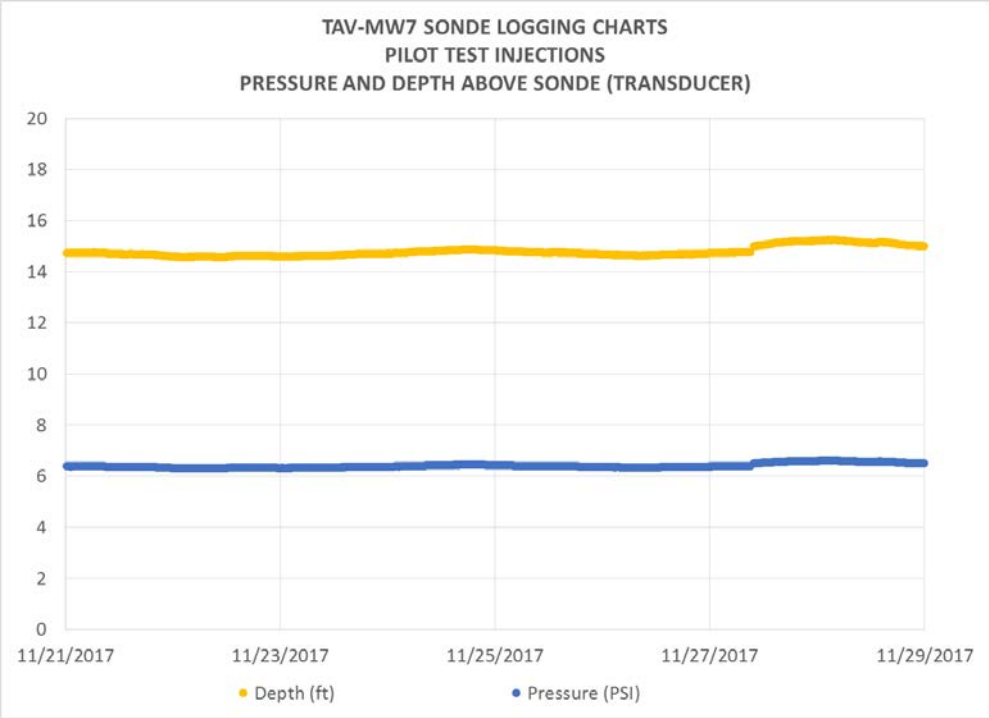

Figure 1c
Pressure and Water Column Height in well TAV-MW7 in
Response to Injections at well TAV-INJ1

In the unlikely event that the sonde readings or the analytical results from well TAV-MW7 show any variation from the baseline, it will be reinstated into the ISB performance monitoring campaign as soon as possible.

#8: Analytical Parameters for Groundwater Samples

In Section 5.3, Page 5-11, Table 5-4, the Revised TSWP provides the analytical parameters for groundwater samples to be collected during the Treatability Study.

Rationale for Modification: Table 5-4 is a comprehensive list that includes all potentially useful parameters identified in the **planning** stage. Based on the results from the pilot test performance monitoring, nine analytes will be eliminated for full-scale operation as explained below.

- Chloride and fluoride – These analytes are not indicative of the performance of the ISB; therefore, are not useful to monitor.

- Nitrite – Baseline samples were collected from injection well TAV-INJ1 and the two nearby monitoring wells TAV-MW6 and TAV-MW7 before the pilot test. Nitrite was either detected near the Practical Quantification Limit or was not detected in the baseline samples (see Table B-2 of the October – December 2017 DP-1845 Quarterly Report). During pilot test performance monitoring, nitrite was not

detected in any of the groundwater samples from wells TAV-INJ1, TAV-MW6, and TAV-MW7 (see Tables B-1 and B-4 of the October – December 2017 DP-1845 Quarterly Report).

Nitrite is highly reactive and is an intermediate compound formed during nitrification and denitrification. It can be oxidized to nitrate or reduced to ammonium in an aquifer. Results of the baseline sampling and the performance monitoring after pilot test injections (which generated reducing conditions in the aquifer) indicate that nitrite apparently does not exist at detectable concentrations during ISB at TA-V. Based on this understanding, nitrite will be eliminated from the analyte list in full-scale operation. Analyses for ammonia and NPN will remain.

- Calcium, magnesium, potassium, and sodium – These analytes are not indicative of the performance of the ISB; therefore, are not useful to monitor.

- Orthophosphate as P – Diammonium phosphate (DAP) is an ingredient of the substrate solution. It acts as a pH buffer and provides phosphorous to support microbial cell generation. Figure 2 presents the orthophosphate concentrations in well TAV-INJ1 during the pilot test performance monitoring. It shows that phosphorous was rapidly utilized by microbes. Figure 2 also presents the concentrations of Total Organic Carbon (TOC), which is the main source for microbial growth. Figure 2 shows the more gradual consumption of TOC compared to the exponential utilization of orthophosphate. It is expected that phosphorous will be completely consumed prior to the depletion of TOC. Therefore, TOC is a more robust and reliable indicator for microbial respiration and growth in the treatment zone. Based on this understanding, orthophosphate will be eliminated from the analyte list in full-scale operation. Analysis for TOC will remain.

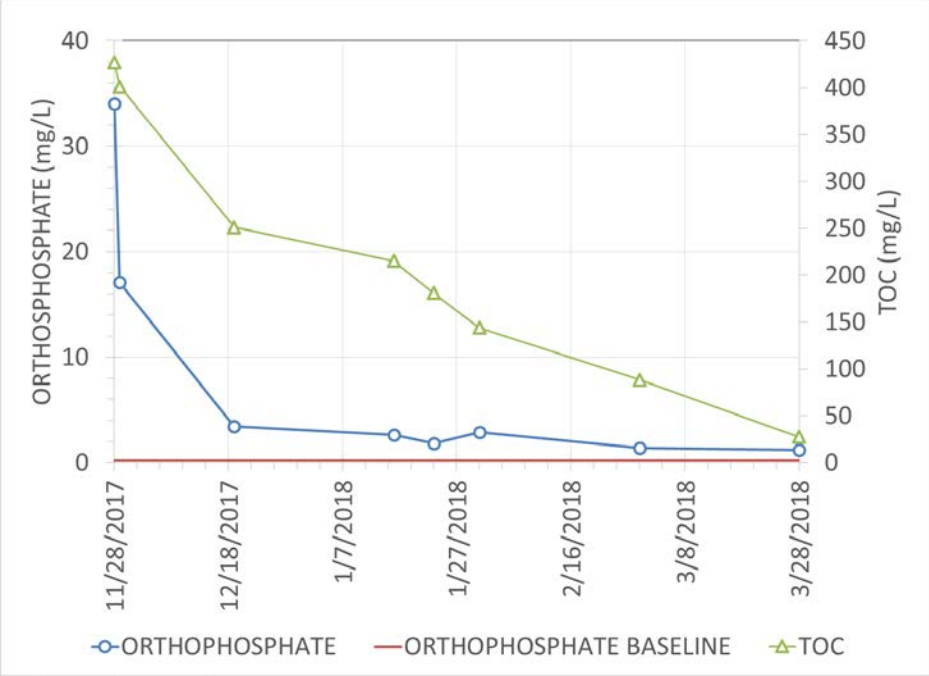

Figure 2
Orthophosphate and TOC Concentrations at TAV-INJ1 following Pilot Test Injections

- Sulfide – Similar to nitrite, sulfides generated during ISB are intermediate compounds and are not expected to persist in a dissolved state. Reactive sulfide was not detected in any of the groundwater samples from wells TAV-INJ1, TAV-MW6, and TAV-MW7 during the pilot test performance monitoring. Therefore, sampling for sulfides in the groundwater from the treatment zone is not warranted for the full-scale operation.

  However, due to the potential for hydrogen sulfide gas to accumulate in the well casing of the injection well, a handheld hydrogen sulfide gas meter will be used to monitor the hydrogen sulfide gas levels during the full-scale injections. The data may be useful to evaluate ISB performance and to address any worker safety concerns for conducting groundwater sampling.

Full-Scale Operation Modification #8: Eliminate unnecessary analytical parameters when wells TAV-INJ1 and TAV-MW6 are sampled. The Revised Table 5-4 is provided below for the analytical parameters for full-scale operation.

Revised Table 5-4
Analytical Parameters for Groundwater Samples

Analytical Group/Analyte in Table 5-4 of the Revised TSWP	Analyte in Table 5-4 of the Revised TSWP	Revised Analyte List for Full-Scale Operation
Alkalinity (total, bicarbonate, and carbonate)	Alkalinity	Yes
Ammonia (as Nitrogen)	Ammonia	Yes
Anions	Bromide	Yes
Anions	Chloride	No
Anions	Fluoride	No
Anions	Nitrite	No
Anions	Sulfate	Yes
Dehalococcoides (Dhc) and, if Dhc is present, vinyl chloride reductase (vcrA).	Dhc and vcrA	Yes
Dissolved Metals	Arsenic	Yes
Dissolved Metals	Calcium	No
Dissolved Metals	Iron	Yes
Dissolved Metals	Magnesium	No
Dissolved Metals	Manganese	Yes
Dissolved Metals	Potassium	No
Dissolved Metals	Sodium	No
Methane/Ethane/Ethene (MEE)	MEE	Yes
Nitrate plus Nitrite (NPN)	NPN	Yes
Orthophosphate (as P)	Orthophosphate (as P)	No
Total Organic Carbon (TOC)	TOC	Yes
Sulfide	Sulfide	No
Volatile Organic Compounds (VOCs)	VOCs	Yes

References

New Mexico Environment Department (NMED), May 2016. Letter to J. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and P. Davies (Sandia National Laboratories, New Mexico), “Approval Revised Treatability Study Work Plan for In-Situ Bioremediation at the Technical Area-V Groundwater Area of Concern, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-15-020,” NMED, Hazardous Waste Bureau, Santa Fe, New Mexico, May 10, 2016.

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