

# TECHNICAL MEMORANDUM

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**To:** Nevada Environmental Response Trust

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**Cc:** Nevada Division of Environmental Protection  
United States Environmental Protection Agency

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**From:** Arul Ayyaswami and Dan Pastor

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**Date:** May 9, 2019

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**Subject:** Unit 4 Source Area In-Situ Bioremediation Treatability Study Monthly Progress Report

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At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this memorandum that summarizes Tetra Tech's progress made during March 2019 toward successfully implementing the Unit 4 Source Area In-Situ Bioremediation Treatability Study. The location of the treatability study is depicted on Figure 1 and the well locations are depicted on Figure 2.

## Task Progress Update: March 2019

### Task M21 – Unit 4 Source Area In-Situ Bioremediation (ISB) Treatability Study

- Task Leader – Arul Ayyaswami
- Current Status
  - The University of Nevada – Las Vegas (UNLV) continued microcosm and column testing in accordance with the Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Work Plan and Treatability Study Modification No. 1. The following is a brief summary of results of the microcosm and column testing through March 2019:
    - UNLV performed microcosm tests with a combination of molasses, molasses with acetate, mixed microbial cultures, and soil and groundwater collected from boring and well locations near the Unit 4 Building. Hexavalent chromium, nitrate, and chlorate concentrations have degraded in all microcosms, including the microcosms containing total dissolved solids (TDS) concentrations as high as 21,000 mg/L; the highest TDS concentration present in this set of microcosms. Perchlorate has started to degrade in all the microcosms based on the analytical results from samples collected from the microcosms on March 22, 2019. Perchlorate concentrations reduced from approximately 1,900 mg/L to 1,400 mg/L in microcosms containing molasses and TDS concentrations of approximately 21,000 mg/L. Perchlorate concentrations have reduced from approximately 1,600 mg/L to 600 mg/L in microcosms containing molasses and TDS concentrations of approximately 17,000 mg/L. Due to the limited available material volumes associated with the microcosms, sample frequency is determined based on degradation rates and remaining materials for sampling. The next microcosm sampling event is planned for mid-May 2019 based on the current

- degradation rates observed. It is anticipated that this will be the final microcosm sampling event based on the limited volume of material that remains available for sampling.
- UNLV performed additional microcosm testing using nano-scale zero valence iron (nZVI). The microcosm tests evaluated the effectiveness of nZVI to treat groundwater collected from the Unit 4 area and in various combinations with mixed microbial cultures, molasses, nutrients, groundwater, and soil. Based on the additional testing results, hexavalent chromium reduced from approximately 22 mg/L to less than 1 mg/L within 4 hours using the stoichiometric requirement of nZVI. Some nitrate, chloroform, chlorate, and perchlorate reductions were also observed after 27 days in the microcosms. Additional microcosm testing will be performed using a larger dosing of nZVI.
  - On March 24, 2019, UNLV converted the columns from recirculation mode to flow-through mode. The columns use a feed solution consisting of molasses, diluted groundwater from wells U4-E-02I and U4-E-05D, sodium bicarbonate, mixed microbial cultures, and nutrients. After 7 days, hexavalent chromium concentrations reduced from approximately 10 mg/L to 3 mg/L in the intermediate columns (columns packed with a mixture of sand and soil collected from 75 to 85 feet bgs) and from approximately 9.5 mg/L to 2 mg/L in the deep columns (columns packed with a mixture of sand and soil collected from 95 to 105 feet bgs). Column tests are continuing.
- The extended groundwater extraction test started on December 5, 2018 and continued through February 28, 2019, a total of 86 days, as outlined in the NDEP-approved Treatability / Pilot Study Modification No. 4 for the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan. The following is a brief summary of the activities and preliminary results associated with the extended groundwater extraction test through March 2019:
    - Equipment used for the extended groundwater extraction test was either demobilized or stored for further use during the full-scale treatability study. The frac tank and associated secondary containment was cleaned and removed from the Site on March 1, 2019.
    - Recovery monitoring for the extended groundwater extraction test was conducted after the extraction period ended on February 28, 2019 and continued through March 14, 2019. During the recovery period, groundwater levels were monitored at the extraction wells and observation wells and samples were collected at the conclusion of the recovery period on March 14, 2019.
    - Groundwater was extracted from well U4-E-01I from December 5, 2018 through January 11, 2019 at an average flow rate of 2.9 gallons per minute (gpm). TDS concentrations declined from 31,000 milligrams per liter (mg/L) to 5,000 mg/L after 1 day of pumping and were consistently low for all subsequent sampling. The TDS concentration at U4-E-01I at the conclusion of the recovery period (62 days after ending groundwater extraction at this well) was 6,300 mg/L (Figure 3).
    - Groundwater was extracted from well U4-E-01D from January 18, 2019 through February 28, 2019 at an average flow rate of 0.29 gallons per minute (gpm). Prior to active pumping, well U4-E-01D served as an observation well during pumping of the near by intermediate zone. During the observation period, TDS concentrations at U4-E-01D reduced from 46,000 mg/L on November 29, 2018 to 8,900 mg/L on December 12, 2018 when groundwater was being extracted from U4-E-01I and then increased to 49,000 mg/L on January 2, 2019. When active pumping of well U4-E-01D was started on January 18, 2019, the TDS concentration at U4-E-01D, after approximately 35 minutes of groundwater extraction, was 22,000 mg/L. On January 19, 2019, after approximately 23 hours of groundwater extraction, the TDS concentrations at U4-E-01D increased to 52,000 mg/L and then slowly declined to 39,000 mg/L on February 28, 2019 (41 days after starting

groundwater extraction at U4-E-01D). After extraction ended, the TDS concentration at U4-E-01D increased to 41,000 mg/L on March 14, 2019, at the conclusion of the recovery period. TDS concentration trends for this well are depicted on Figure 4.

- Groundwater was extracted from well U4-E-05D from December 5, 2018 through February 28, 2019 at an average flow rate of approximately 1.9 gpm. TDS concentrations at extraction well U4-E-05D declined from 36,000 mg/L on December 5, 2018 to 24,000 mg/L on February 28, 2019. The TDS concentration on March 14, 2019 at U4-E-05D further decreased to 16,000 mg/L two weeks after extraction ended at U4-E-05D. TDS concentration trends for this well are depicted on Figure 5.
- Schedule and Progress Updates
  - The following activities are scheduled to be conducted in April 2019:
    - Continued UNLV microcosm and column testing in accordance with the Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Work Plan and Treatability Study Modification No. 1.
    - A Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum for Phase 2 will be prepared at the completion of laboratory testing provided the data support moving forward with a field test. The actual submittal timeline of the Addendum will be dependant on the duration of the microcosm and column studies.
- Health and Safety
  - There were no health and safety incidents related to Task M21 during March 2019.

## CERTIFICATION

### Unit 4 Source Area Bioremediation Treatability Study Monthly Progress Report

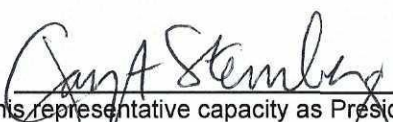
Nevada Environmental Response Trust Site  
(Former Tronox LLC Site)  
Henderson, Nevada

#### Nevada Environmental Response Trust (NERT) Representative Certification

I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the systems(s) or those directly responsible for gathering the information or preparing the document, or the immediate supervisor of such person(s), the information submitted and provided herein is, to the best of my knowledge and belief, true, accurate, and complete in all material respects.

Office of the Nevada Environmental Response Trust

Le Petomane XXVII, not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

**Signature:**  \_\_\_\_\_, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Not Individually, but Solely  
as President of the Trustee

**Name:** Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

**Title:** Solely as President and not individually

**Company:** Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

**Date:** 5/9/19

## CERTIFICATION

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I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been prepared in a manner consistent with the current standards of the profession, and to the best of my knowledge, comply with all applicable federal, state, and local statutes, regulations, and ordinances. I hereby certify that all laboratory analytical data was generated by a laboratory certified by the NDEP for each constituent and media presented herein.

**Description of Services Provided:** Prepared Unit 4 Source Area Bioremediation Treatability Study Monthly Progress Report, Nevada Environmental Response Trust Site, Henderson, Nevada.



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**Kyle Hansen, CEM**  
Field Operations Manager/Geologist  
Tetra Tech, Inc.

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May 9, 2019

Date

Nevada CEM Certificate Number: 2167  
Nevada CEM Expiration Date: September 18, 2020

# Figures

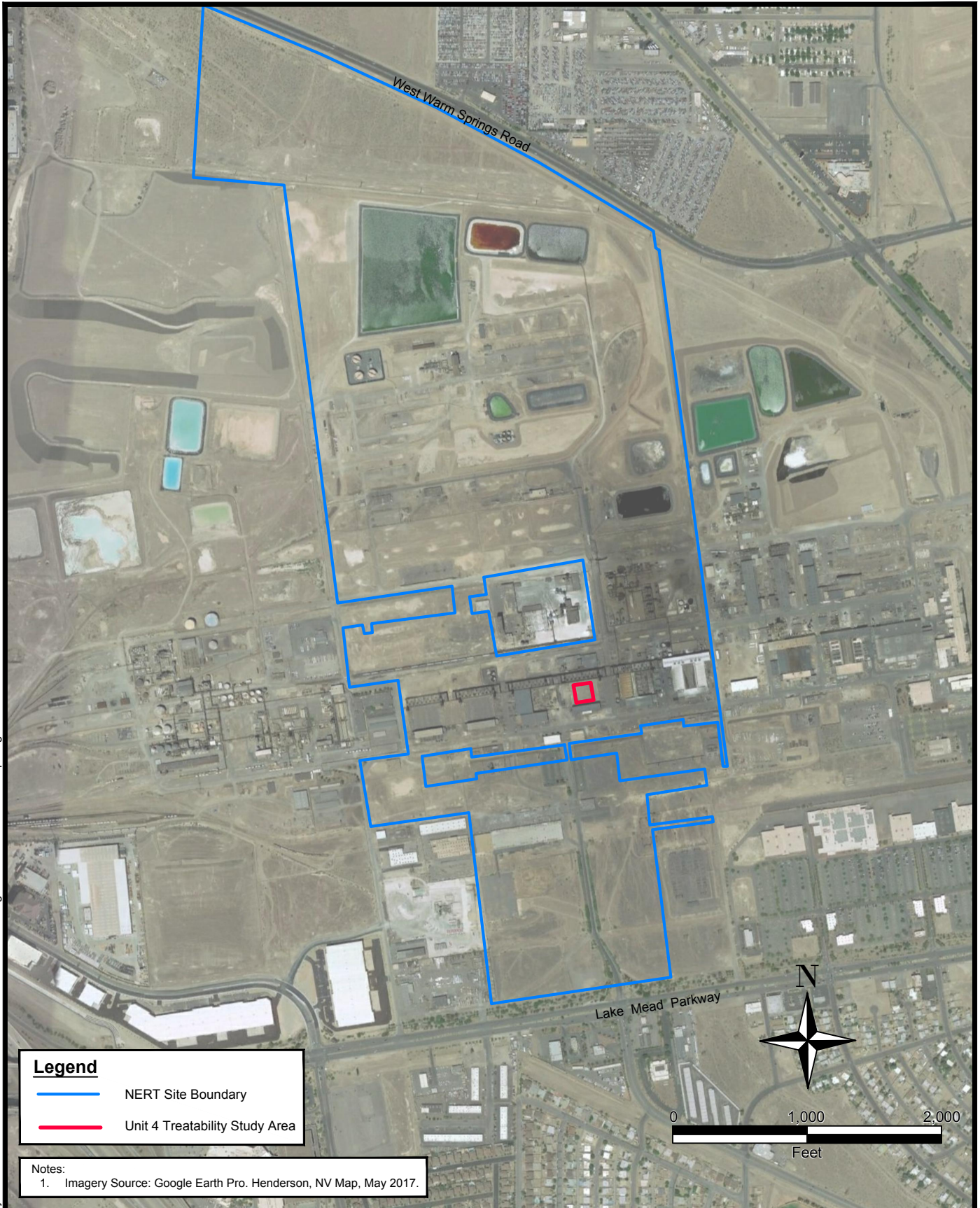




Figure 1 - Site Location Map.dwg

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### Legend

-  NERT Site Boundary
-  Unit 4 Treatability Study Area

### Notes:

1. Imagery Source: Google Earth Pro. Henderson, NV Map, May 2017.



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NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

UNIT 4 SOURCE AREA IN-SITU BIOREMEDIATION TREATABILITY STUDY

### SITE LOCATION MAP

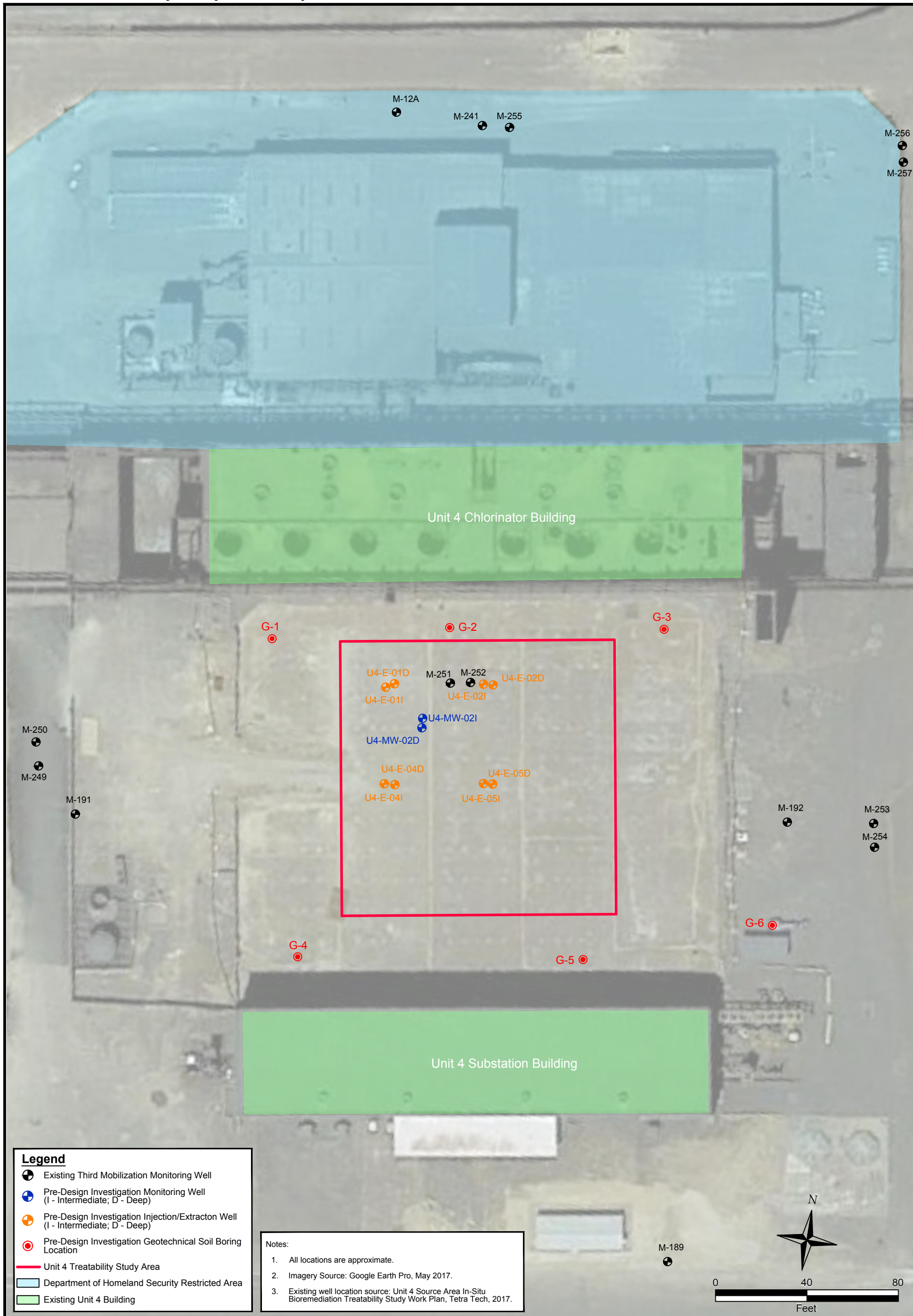
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Date: MARCH 5, 2019








Designed By: KB

Figure No.

1




**Legend**

-  Existing Third Mobilization Monitoring Well
-  Pre-Design Investigation Monitoring Well (I - Intermediate; D - Deep)
-  Pre-Design Investigation Injection/Extracton Well (I - Intermediate; D - Deep)
-  Pre-Design Investigation Geotechnical Soil Boring Location
-  Unit 4 Treatability Study Area
-  Department of Homeland Security Restricted Area
-  Existing Unit 4 Building

**Notes:**

1. All locations are approximate.
2. Imagery Source: Google Earth Pro, May 2017.
3. Existing well location source: Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan, Tetra Tech, 2017.

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Feet



**TETRA TECH**

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NEVADA ENVIRONMENTAL RESPONSE TRUST SITE  
 UNIT 4 SOURCE AREA IN-SITU BIOREMEDIATION TREATABILITY STUDY

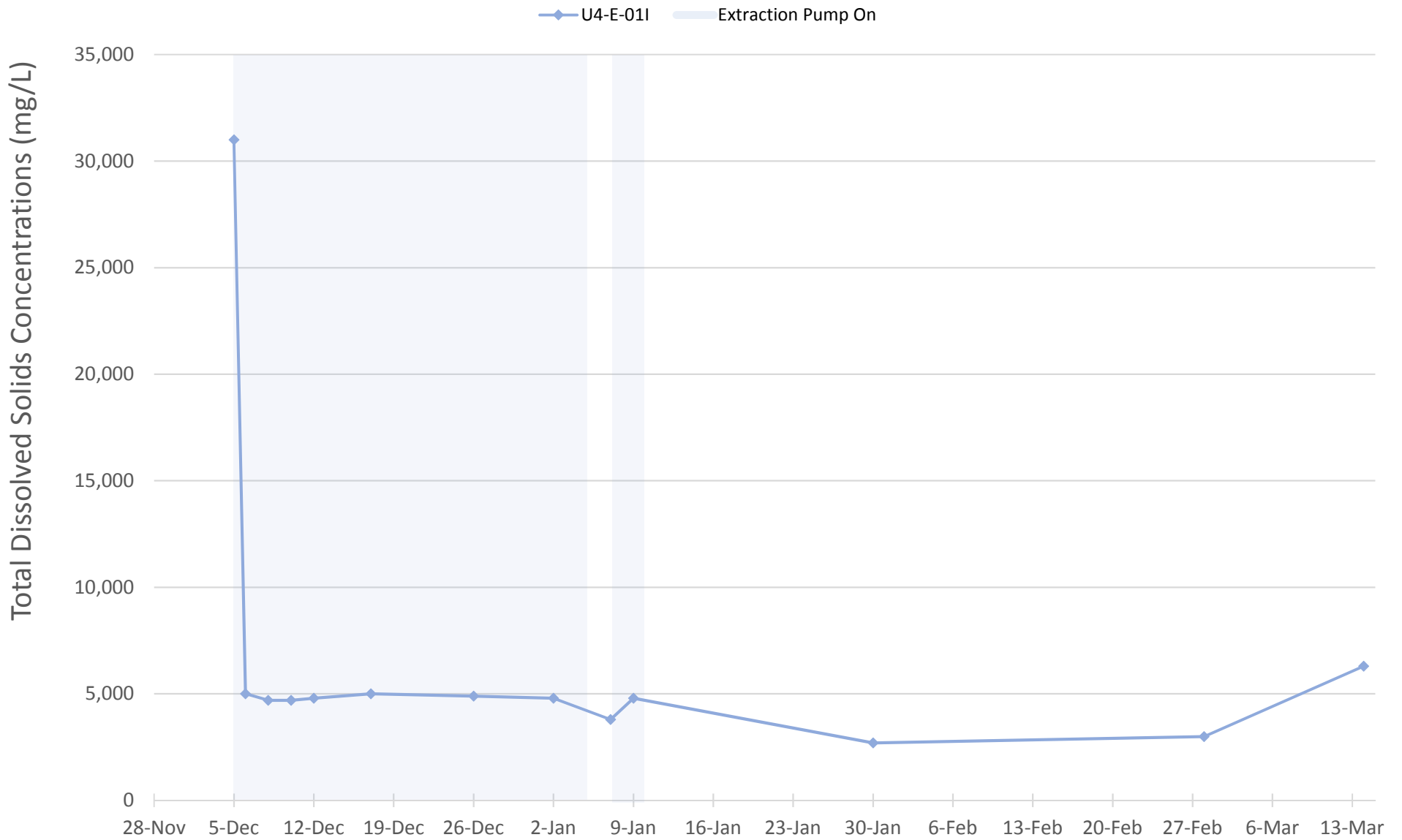
**BORING AND WELL LOCATIONS**

Project No:	117-7502019
Date:	APRIL 5, 2019
Designed By:	KB
Figure No.	<b>2</b>



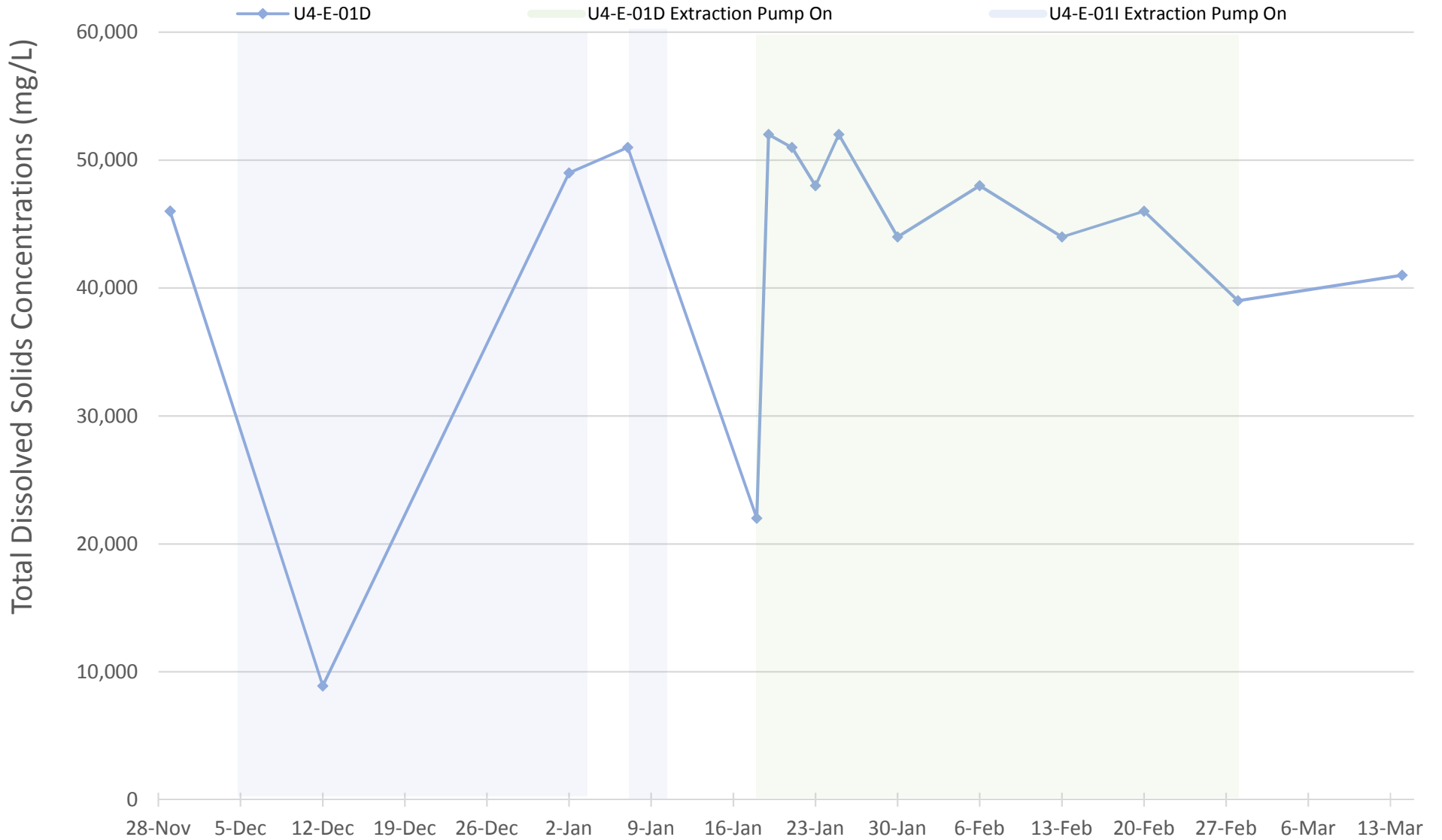
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**Figure 3**  
**TDS Concentrations at Extraction Well U4-E-01I**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Modification 4



**DRAFT**

**Figure 4**  
**TDS Concentrations at Extraction Well U4-E-01D**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Modification 4



**DRAFT**

**Figure 5**  
**TDS Concentrations at Extraction Well U4-E-05D**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Modification 4

