

TECHNICAL MEMORANDUM

To: Nevada Environmental Response Trust

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

From: Arul Ayyaswami and Dan Pastor

Date: April 7, 2019

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

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 January 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: January 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 testing 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. Preliminary results from the microcosm testing, as previously reported, are summarized below with additional updates regarding the chlorate and perchlorate degradation:
 - Hexavalent chromium concentrations reduced from approximately 38 milligrams per liter (mg/L) to 0.6 mg/L within 15 days and to less than 0.1 mg/L within 35 days in microcosms containing molasses and total dissolved solids (TDS) concentrations as high as 21,000 mg/L.
 - Hexavalent chromium concentrations reduced from approximately 38 mg/L to less than 0.1 mg/L within 84 days in microcosms containing molasses and acetate and TDS concentrations as high as 21,000 mg/L, significantly slower than molasses alone (15 days).
 - Nitrate concentrations reduced from 100 mg/L to less than 0.1 mg/L within 49 days in all the microcosms, with only slightly slower degradation rates observed with microcosms containing higher TDS concentrations.
 - Chlorate concentrations for two of the microcosms were below the detection limit of 2 mg/L after 141 days. Perchlorate degradation, which typically occurs following chlorate degradation, has not yet been observed in any of the microcosms regardless of the TDS

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concentrations based on the samples collected for analysis in January 2019. Additional sampling will be conducted as microcosm testing continues, and the results will be summarized in future progress reports.

- UNLV performed initial microcosm tests using nano-scale zero valence iron (nZVI). The microcosm tests evaluated the effectiveness of nZVI to treat groundwater collected from the Unit 4 area alone and in various combinations with mixed microbial cultures, molasses, and nutrients. Hexavalent chromium reduced from 125 mg/L to less than 1 mg/L in all of the scenarios within three days. Sample results for chlorate, nitrate, perchlorate, and chloroform have not been received and will be summarized in future progress reports.
- UNLV packed four columns for testing. Two columns were packed with a mixture of sand and soil collected from 75 to 85 feet bgs within the former Unit 4 Building to represent the intermediate treatment zone and two columns were packed with a mixture of sand and soil collected from 95 to 105 feet bgs within the former Unit 4 Building to represent the deep treatment zone. The soil was mixed with sand to achieve flow conditions similar to what is observed within the Unit 4 treatability study area. The columns were flushed with water collected from wells within the former Unit 4 Building along with mixed microbial cultures to allow the microorganisms to acclimatize prior to the addition of carbon substrate.
- The extended groundwater extraction test started on December 5, 2018, and continued through January 2019 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 progress through January 2019:
 - TDS concentrations in groundwater from extraction well U4-E-01I 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 with a reported TDS concentration of 4,800 mg/L after 28 days of extraction with an approximate flow rate of 2.9 gallons per minute (gpm). After conducting a rebound test of just over 2 days, the TDS concentration at U4-E-01I remained low with a concentration of 3,800 mg/L.
 - After concurrence from the Trust and in accordance with the NDEP-approved Treatability / Pilot Study Modification No. 4 for the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan, Tetra Tech transferred the extraction pump from U4-E-01I to U4-E-01D and began extracting groundwater from U4-E-01D at a rate of approximately 0.3 gpm on January 18, 2019. The baseline TDS concentration at U4-E-01D was 58,000 mg/L; however, the TDS concentrations at U4-E-01D during the first day of groundwater extraction was 22,000 mg/L. After one day of groundwater extraction, the TDS concentrations at U4-E-01D increased to 52,000 mg/L and remained at approximately 50,000 mg/L for 7 days until declining to a concentration of 44,000 mg/L as of January 30, 2019 (12 days after starting groundwater extraction at U4-E-01D).
 - Tetra Tech continued operation of U4-E-05D and increased the pumping rate from approximately 1.3 gpm to 1.9 gpm on January 4, 2019. TDS concentrations at extraction well U4-E-05D have slightly declined from 36,000 mg/L to 31,000 mg/L after 49 days of extraction.
- Schedule and Progress Updates
 - The following activities are scheduled to be conducted in February 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.

- Continued operation of the groundwater extraction test as part of the NDEP-approved Treatability / Pilot Study Modification No. 4.
- Preparation of the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum that is currently anticipated to be submitted in the Second Quarter of 2019.
- Health and Safety
 - There were no health and safety incidents related to Task M21 during January 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: Jay A Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust 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: 4/7/19

CERTIFICATION

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.



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

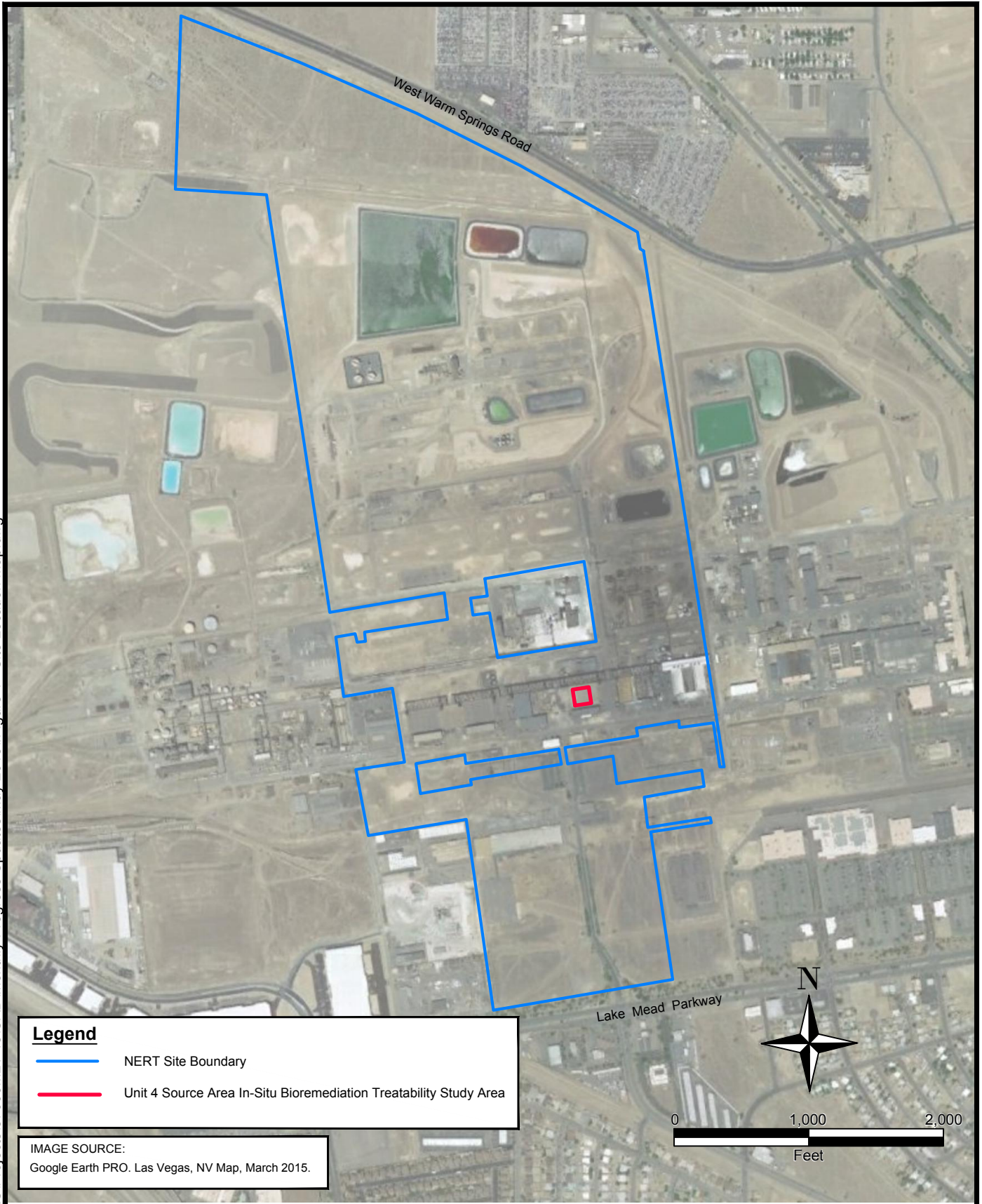
April 7, 2019

Date

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

Figures

tts318fs3.tt.local\CES\Projects\87600M21-18\CAD\Monthly Progress Updates\May 2018\Figure 1 - Site Location Map.dwg



Legend

- NERT Site Boundary
- Unit 4 Source Area In-Situ Bioremediation Treatability Study Area

IMAGE SOURCE:
Google Earth PRO. Las Vegas, NV Map, March 2015.

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NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

UNIT 4 SOURCE AREA IN-SITU BIOREMEDIATION TREATABILITY STUDY

SITE LOCATION MAP

Project No: 117-7502018
Date: JUNE 13, 2018
Designed By: PK

Figure No.
1

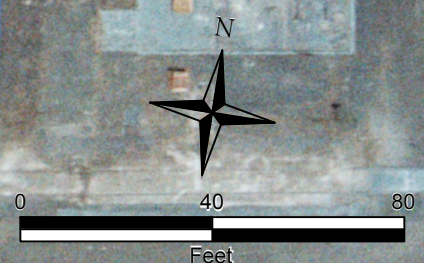


Legend

- Geotechnical Soil Boring Location
- ⊕ Existing Third Mobilization Monitoring Well
- ⊕ Nested Monitoring Well (I - Intermediate; D - Deep)
- ⊕ UMCf Injection/Extraction Well Cluster (2 Screen Intervals; I - Intermediate; D - Deep)
- Unit 4 Treatability Study Area
- Department of Homeland Security Restricted Area
- Existing Unit 4 Building

Notes:

1. All locations are approximate.
2. Imagery Source: Aerotech Mapping, August 2016.
3. Well location source: Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan, Tetra Tech, 2017.




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

BORING AND WELL LOCATIONS

Project No:	117-7502018
Date:	JULY 10, 2018
Designed By:	CL
Figure No.	2