

TECHNICAL MEMORANDUM

To: Nevada Environmental Response Trust

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

From: Carl Lenker and Eric Klink

Date: November 27, 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 October 2019 toward successfully implementing the Unit 4 Source Area In-Situ Bioremediation Treatability Study.

Task Progress Update: October 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 the bench-scale study results to date:
 - UNLV continued microcosm testing during the reporting period 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. The groundwater was diluted to three different total dissolved solids (TDS) concentrations (approximately 15,000 mg/L, 18,000 mg/L, and 21,000 mg/L) to evaluate the effect of TDS on the degradation of the chemicals of potential concern (COPCs).
 - **Molasses Microcosm Results:** On August 5, 2019 (day 347 of the microcosm testing), UNLV performed an evaluation of the remaining soil and water composition for the microcosms containing an initial TDS concentration of approximately 18,000 mg/L. The results confirmed almost complete degradation of the COPCs in soil and water. The final concentrations in water were less than 0.1 mg/L for hexavalent chromium, less than 4.43 mg/L for nitrate, less than 5 mg/L for chlorate, and 0.00096 mg/L for perchlorate. For comparison purposes, the initial concentrations of COPCs in these microcosms were 41.5 mg/L for hexavalent

chromium, 105 mg/L for nitrate, 8,519 mg/L for chlorate, and 1,646 mg/L for perchlorate. In addition, the soil remaining in the microcosms was rinsed three times and the rinsate analyzed to verify the COPCs in soil were also reduced. The rinsate contained very low concentrations of COPCs with hexavalent chromium concentrations less than 0.1 mg/L, nitrate concentrations less than 1.77 mg/L, chlorate concentrations less than 2 mg/L, and perchlorate concentrations less than 0.01 mg/L. On September 17, 2019 (day 390 of the microcosm testing), UNLV sampled the microcosms containing initial TDS concentrations of approximately 21,000 mg/L and 15,000 mg/L. In microcosms containing initial TDS concentrations of approximately 21,000 mg/L, the perchlorate concentration reduced from 1,878 mg/L to 18 mg/L in the sample from one microcosm, but only reduced from 1,878 mg/L to 1,700 mg/L in the sample from the replicate microcosm. In microcosms containing an initial TDS concentration of approximately 15,000 mg/L, the perchlorate concentrations reduced from approximately 1,500 mg/L to 1,100 mg/L.

- **Molasses and Acetate Microcosm Results:** The degradation of the COPCs is slower in the microcosms containing molasses and acetate than molasses alone. Hexavalent chromium, nitrate, and chlorate were degraded after 183 days in microcosms containing TDS concentrations of approximately 15,000 mg/L, after 267 days in microcosms containing TDS concentrations of approximately 18,000 mg/L, and after 337 days in microcosms containing TDS concentrations of approximately 21,000 mg/L. Perchlorate concentrations have not significantly degraded in any of the microcosms after 390 days.
- UNLV continued column testing during this reporting period with two intermediate columns (columns packed with a mixture of sand and soil collected from 75 to 85 feet bgs) and two deep columns (columns packed with a mixture of sand and soil collected from 95 to 105 feet bgs). The columns have been running for over 200 days. After day 156, UNLV stopped adding molasses and mixed microbial cultures to the columns for approximately 16 days, following the observed degradation of perchlorate. After day 172, the columns ran with a feed solution containing molasses, but not the mixed microbial cultures. Concentrations of COPCs in the effluent of the intermediate columns remained reduced and did not significantly rebound during the period when UNLV stopped adding molasses. Effluent perchlorate concentrations for the intermediate columns remained below 0.05 mg/L, compared to an influent concentration of approximately 550 mg/L. Concentrations of COPCs in the effluent of the deep columns rebounded during the period when UNLV stopped adding molasses and mixed microbial cultures. At day 200, chlorate is degrading again in the deep columns with effluent concentrations of approximately 800 to 1,300 mg/L compared to an influent concentration of approximately 2,600 mg/L.
- Schedule and Progress Updates
 - The following activities are scheduled to be conducted in November 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.
 - Development of the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum for Phase 2 at the completion of laboratory testing, provided the data support moving forward with a field test. The 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 October 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

**Not Individually, but Solely
as President of the 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

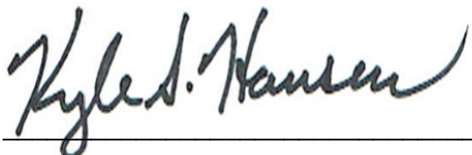
Company: Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Date: 11/27/19

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.



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

November 27, 2019

Date

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