November 5, 2018

TECHNICAL MEMORANDUM

To: Steve Clough, Brian Loffman, Andrew Steinberg
Nevada Environmental Response Trust

From: Scott Warner, Ramboll
Chris Ritchie, Ramboll
John Pekala, CEM#2347, Expires 9/20/2020, Ramboll

Re: Treatability/Pilot Study Modification No. 5
Nevada Environmental Response Trust Site
Henderson, Nevada
Ramboll Project No. 1690006943-032

This Technical Memorandum presents Ramboll's recommended modification to the scope of work for the Galleria Drive[1] ZVI-Enhanced Bioremediation Treatability Study Phase I activities currently in progress at the Nevada Environmental Response Trust Site (the "Site") located in Henderson, Nevada. As presented in the approved Galleria Drive ZVI Bioremediation Treatability Study Work Plan (Work Plan) dated September 29, 2017, a treatability study will be performed to evaluate the feasibility and effectiveness of implementing ZVI-enhanced bioremediation to reduce the contaminant mass flux at the mid-plume containment and mass removal boundary, which has been established as a Remedial Action Objective (RAO) for Operable Unit 2. The location of this treatability study is shown in Figure 1. A geologic cross-section is presented in Figure 2.

This recommended modification proposes the installation of four deeper monitoring wells and one additional shallow monitoring well with corresponding soil sampling, water sampling, and aquifer testing. All monitoring wells will be installed at the ZVI treatability study area along Galleria Drive. The deeper monitoring wells will be installed to further investigate perchlorate contamination in the deeper Upper Muddy Creek Formation (UMCf) that was encountered during the field investigation activities performed by Tetra Tech as part of their Galleria Drive treatability study located northeast of the ZVI treatability study area. The shallow monitoring well will be installed to target a coarser-grained deposit within the UMCf to better understand the hydrogeological significance of this unit. The results obtained from the additional data collection effort described herein will be used to design the Phase 2 field scale treatability study and will be summarized within the forthcoming addendum to the Work Plan (Work Plan Addendum).

[1] As of September 2018, all references to Galleria Road were updated to be Galleria Drive.

OBJECTIVE

As presented in the previously approved Work Plan, the overall objective of the pre-design activities is to collect key data for the implementation of laboratory bench-scale tests and the design of an appropriate field scale treatability study to best address perchlorate migration in the vicinity of the proposed mid-plume RAO boundary. As shown on Figure 1, seven groundwater monitoring wells (ES-33 through ES-39) and five soil borings (ESB-19 through ESB-23) have been installed at the ZVI treatability study area for this purpose. From these wells and borings a geologic cross-section has been developed and is presented as Figure 2. Two potentially significant geologic features within the UMCf were identified during the investigation and are displayed on Figure 2: a silty sand/sandy silt unit encountered between 40 and 50 feet bgs and an organically-rich clayey silt unit encountered between 65 and 80 feet bgs. Additional investigation is recommended within these units to better understand how they may impact a potential field test of ZVI-enhanced bioremediation.

Moreover, during comparison of preliminary findings from Tetra Tech's companion Galleria Drive treatability study, it was learned that Tetra Tech identified perchlorate in groundwater wells installed within a deeper interval (approximately 90-110 feet bgs). Additional investigation is recommended within and below this interval to better understand the extent of perchlorate in the deeper UMCf.

The specific objectives of the additional investigation proposed within this modification are as follows:

- Evaluate the nature and extent of perchlorate, chlorate, and other parameters within a silty sand/sandy silt unit previously encountered between 40 and 50 feet bgs through the collection of soil and groundwater samples.
- Evaluate the nature and extent of perchlorate, chlorate, organic content, and other parameters within an organically-rich clayey silt unit previously encountered between 65 and 80 feet bgs through the collection of soil and groundwater samples.
- Evaluate the nature and extent of perchlorate and chlorate in the deeper UMCf at four locations (paired with existing shallow groundwater well) through the collection of soil and groundwater samples.
- Evaluate the hydrogeological significance the shallow coarser-grained deposit in the upper UMCf and the deeper UMCf through slug testing and single-borehole dilution testing.

New monitoring wells ES-40, ES-41, ES-42, ES-43, and ES-44. As shown on Figures 1 and 2, five additional monitoring wells will be installed in the UMCf adjacent to existing wells ES-33, ES-34, ES-36, and ES-38, respectively. The borings for ES-40 to ES-43 will be advanced to a planned total depth of 150 feet bgs. These planned wells are anticipated to be screened from approximately 90-110 feet bgs to better understand the nature and extent of perchlorate contamination in the deeper UMCf; actual screen intervals may differ based on evaluation of lithology at the time of drilling. Soil sampling will take place during the installation of each well. Soil sampling will begin at 40 feet bgs with samples being collected at approximately 10-foot intervals. Beginning at 90 feet bgs and continuing until 120 feet bgs samples will be collected at approximately 5-foot intervals. Beginning at 120 feet bgs the soil sampling intervals will revert to 10-foot intervals. ES-44 will be advanced to a planned total depth of 55 feet bgs. The anticipated screened interval will be approximately 40-55 feet bgs to better understand the significance of this coarser-grained unit within the UMCf; the actual screened interval may differ based on evaluation of

lithology at the time of drilling. One to two soil samples will be collected from the desired zone of interest (approximately 45 to 52 feet bgs).

Soil samples will be analyzed for perchlorate, chlorate, nitrate, total chromium, total organic carbon, and moisture content. Groundwater samples will be collected once development of the monitoring wells is completed. Groundwater samples will be analyzed for perchlorate, chlorate, chloride, sulfate, nitrate, metals [calcium, magnesium, potassium, sodium, and iron], alkalinity, total dissolved solids, total organic carbon, dissolved organic carbon, iron [ferrous and ferric], and total and hexavalent chromium. Once groundwater sampling is completed, hydraulic well testing (i.e., slug and single-borehole dilution tests) will be conducted at each new monitoring well. Each new well will be logged using a Nuclear Magnetic Resonance (NMR) instrument. All soil sampling, monitoring well installations, monitoring well development, analytical testing, aquifer testing, etc. will be consistent with the methodologies presented in the approved Work Plan. Additionally, data collected during this additional investigation along with the prior field investigation data will be presented in accordance with the approved Work Plan.

EVALUATION OF RESULTS

The results of the Phase I field efforts (e.g., initial field investigation results, the proposed additional field investigation results), laboratory bench-scale testing being performed at University of Nevada Las Vegas, and the geochemical and reactive transport modeling will be incorporated into the forthcoming Work Plan Addendum. The Work Plan Addendum will also include Trust recommendations for the Phase 2 approach for potential field testing of ZVI-enhanced bioremediation.

SCHEDULE

Upon approval of this modification and authorization to proceed, the additional field investigation activities, as described herein, can begin within two weeks. Field activities are anticipated to be performed during November-December 2018. Validated analytical results from this additional investigation are anticipated to be available between December 2018 and January 2019. All data (initial investigation data and the additional field investigation data) will be evaluated and used in the preparation of the Work Plan Addendum. The anticipated completion date of the Work Plan Addendum is first quarter 2019.

Please contact us should you have any questions about the recommended additional investigation.

Attachments

Table 1 Planned Additional Investigation Locations

Figure 1 Proposed Additional Well Locations

Figure 2 Schematic Subsurface Cross-Section A-A’

RAMBOLL

Treatability/Pilot Study
Modification No. 5

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

Nevada Environmental Response Trust (Trust) 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 the Trust. Based on my own involvement and/or my inquiry of the person or persons who manage the system(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, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Signature: Jay A Steinberg, not individually, but solely as Pres, 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: 11/5/18

Treatability/Pilot Study
Modification No. 5

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

Responsible Certified Environmental Manager (CEM) for this project
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 provided 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.

November 5, 2018

John M. Pekala, PG
Principal

Date

Certified Environmental Manager
Ramboll US Corporation
CEM Certificate Number: 2347
CEM Expiration Date: September 20, 2020

TABLE 1. PLANNED ADDITIONAL INVESTIGATION LOCATIONS
Treatability/Pilot Study Modification No. 5
Nevada Environmental Response Trust Site; Henderson, Nevada

Planned Monitoring Well ID	Galleria Drive[1] ZVI Treatability Study Area Location	Initial Planned Well Construction Details					
		Well Pilot Boring Depth (ft bgs)	Casing Diameter and Type	Screen Size (inches)	Screened Interval (ft bgs)	Sand Pack Interval (ft bgs)	Sand Pack Size
ES-40	Adjacent to Well ES-33	150	4" PVC	0.01	90-110	88-110	No. 2/12
ES-41	Adjacent to Well ES-34	150	4" PVC	0.01	90-110	88-110	No. 2/12
ES-42	Adjacent to Well ES-36	150	4" PVC	0.01	90-110	88-110	No. 2/12
ES-43	Adjacent to Well ES-38	150	4" PVC	0.01	90-110	88-110	No. 2/12
ES-44	Adjacent to Well ES-34	55	4" PVC	0.01	40-55	38-55	No. 2/12

Notes:

See Figure 1 for planned additional investigation locations.

See Figure 2 for planned monitoring well depths in relation to adjacent monitoring wells.

ft bgs: feet below ground surface

[1] As of September 2018, all references to Galleria Road were updated to be Galleria Drive.

Credits: Aerial imagery provided by Ramboll UAV, February 2018 and Southern Nevada Water Authority, 2016.

A

A'

ES-40

ES-33*

ES-41

ES-44

ES-34*

ES-35*

ESB-23

ES-36*

ES-42

ESB-21

ES-38

ES-43

ESB-20

ESB-22

ES-39

ESB-19

ES-37

Legend

- Proposed Monitoring Well
- Monitoring Well
- Soil Boring Location (June 2018)
- Proposed Field Test Area
- Cross-Section A-A' Line (see Figure 2)

Note:
*Pilot borings were drilled to 120 feet below ground surface approximately five feet down gradient (north) of the monitoring well location.

N

0 100 200 Feet

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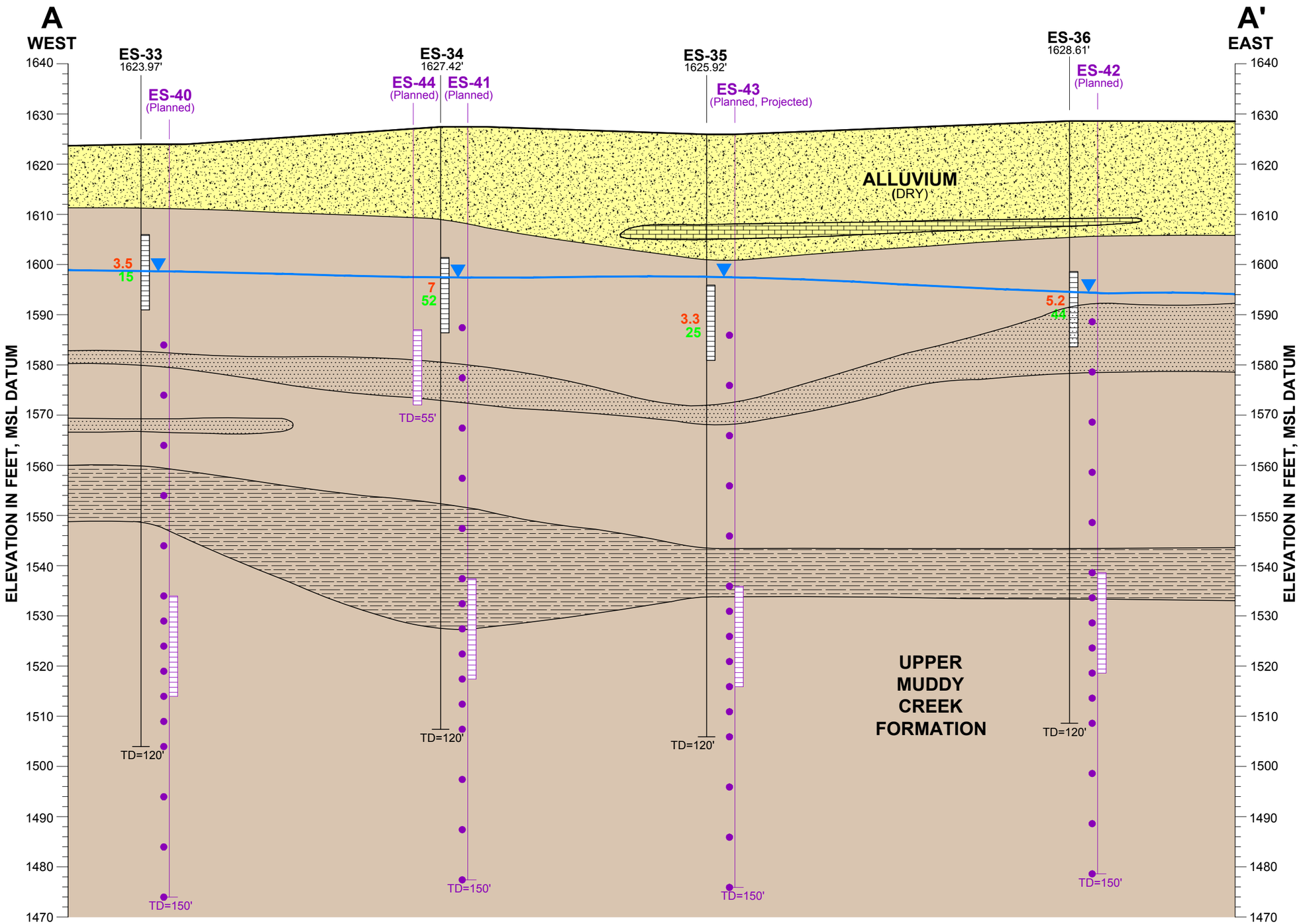
Proposed Additional Well Locations
Treatability/Pilot Study Modification No. 5
Galleria Drive ZVI-Enhanced Bioremediation Treatability Study
Nevada Environmental Response Trust Site; Henderson, Nevada

Figure
1

Drafter: JK/RS | Date: 10/5/2018 | Contract Number: 1690006943-032 | Approved by: | Revised:



Explanation:

ES-33 Well name
3.5 Perchlorate, mg/L
15 Chlorate, mg/L

Planned Soil Sample Depths

Groundwater Elevation (May 2018)

Notes:

1. Perchlorate concentrations above 1.0 mg/L are shown in **red**. The screening level for perchlorate is 0.015 mg/L.
2. Planned investigation locations are shown in purple.
3. TD = total depth.
4. MSL Datum = Mean Sea Level Datum.
5. Subsurface interpretation is preliminary; subject to change.

CALICHE	ALLUVIUM (Qal)
CALICHE	SILTY SAND / SAND WITH GRAVEL

UPPER MUDDY CREEK FORMATION (UMCf)		
SILT/ CLAYEY SILT	SILTY SAND / SANDY SILT	ORGANIC-RICH CLAYEY SILT

VERTICAL SCALE IN FEET
20'
10'
0'
0' 100' 200'
HORIZONTAL SCALE IN FEET
10X VERTICAL EXAGGERATION

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Schematic Subsurface Cross-Section A - A'

Treatability/Pilot Study Modification No. 5
Galleria Drive ZVI-Enhanced Bioremediation Treatability Study
Nevada Environmental Response Trust Site; Henderson, Nevada

Figure **2**

Drafter: RS | Date: 10/3/18 | Contract Number: 169000 6943 | Approved by: | Revised:

RMSO 10/5/18 Q:\DRAWINGS\1690006943 < 1690006943-MOD 5 A-A' CROSSECTION >