TETRA TECH

TECHNICAL MEMORANDUM

To:	**Nevada Environmental Response Trust**
From:	Ronnie Britto, Dana Grady and Dan Pastor – Tetra Tech
Date:	May 26, 2017
Subject:	Seep Well Field Bioremediation Treatability Study – Notification of Field Implementation Modification

1.0 BACKGROUND

As requested by the Nevada Environmental Response Trust (NERT), Tetra Tech has prepared this detailed technical memorandum to document modifications to the Seep Well Field Bioremediation Treatability Study Work Plan. The Treatability Study modifications discussed herein describe changes to injection well layout and water source during the upcoming injections. These modifications are based on initial drilling results and cost saving measures developed as the work has progressed.

2.0 INJECTION WELL LAYOUT

The Seep Well Field Area Bioremediation Treatability Study Work Plan presented a conceptual injection and monitoring well layout and states that the final quantity and location of the injection wells would be finalized after completion of the preliminary field activities. Tetra Tech recently completed several preliminary field activities, including geophysics, initial borehole and monitoring well installation, soil and groundwater sampling, and initial hydraulic testing. Based on these activities, additional potentiometric contouring was performed that revealed a slight shift from the previously presented potentiometric contours. As a result of this shift, Tetra Tech plans to slightly reposition the injection well transects to more appropriately intersect perchlorate-contaminated groundwater migrating towards the Las Vegas Wash. This reconfiguration of the flow regime results in the following:

- Approximate 15-degree rotation of the injection well transects;
- Shortens the length of transects (reduction from 25 to 20 injection wells, which is a reduction of two to three wells in each injection well transect) to remain within the access agreement boundary to the southeast and to minimize potential influence of substrate injection on the existing SWF extraction wells;
- Select injection well locations may still consist of paired wells to optimize carbon distribution (as stated in the Work Plan) with the need for paired wells based on field observations during drilling;
- Transect separation has been reduced from 150 feet to 100 feet following evaluation of soil analyses and results of borehole dilution and slug tests. Spacing between injection wells of 75 feet remains the same; and

- Monitoring well network adjusted accordingly to effectively monitor the treatability study based on the revised injection well layout.

The revised location of the injection well transects, monitoring wells, and updated potentiometric contouring is presented in Figure 1, which also contains an inset of the original conceptual design presented in the Work Plan for comparison purposes.

3.0 DISTRIBUTION WATER

As explained in the work plan, distribution water is a key component of the injection process to promote an even subsurface distribution of the injectants within the injection well transects. This feature of the bioremediation design is important because it improves the distribution of the carbon donor laterally along the injection rows and creates a more complete treatment zone. Based on a review of the available water sources, Tetra Tech plans to utilize purge water from new and/or existing monitoring wells in the immediate vicinity of the treatability study injection wells for use as distribution water. Tetra Tech included this approach in the Underground Injection Control (UIC) permit application recently submitted to Nevada Division of Environmental Protection (NDEP) – Bureau of Water Pollution Control (BWPC). This is contingent upon NDEP – BWPC approval (via UIC permit issuance). If this provision of the permit application is not approved, Tetra Tech will use City of Henderson water. This process would be accomplished by extracting water from the nearby monitoring wells (screened in the alluvium) and transferring the water to on-site frac tanks for use during the injection process. Water extracted from these monitoring wells will be injected only within the barrier (also only in the alluvium) and will undergo the same level of treatment as the groundwater that flows past the barrier. Using the groundwater in this manner does not add contamination or relocate the groundwater outside of the current formation and general location. The number of monitoring wells used in this operation will be dependent on the final hydraulic properties of the wells and pumping rates that can be achieved. Based on initial hydraulic testing (borehole dilution and slug tests), it is anticipated that six monitoring wells may be needed for this operation. Locations of these wells are presented in Figure 1.

There are multiple advantages to using existing groundwater from nearby monitoring wells, which are described in more detail below:

- Using existing groundwater for distribution, rather than an outside source of water (such as City of Henderson hydrant water) will enhance the mixing of the carbon substrate within the barrier, which should result in more rapid mixing and distribution of native water.
- Even though using off-site water for distribution water will result in minimal dilution, the approach of using site groundwater from within the same area as injections will remove any such minor effects when determining treatment effectiveness.
- The amount of water that would be extracted from monitoring wells to support the injection wells is expected to be a minor fraction (approximately 1 to 2 percent) of the actual groundwater that normally flows through the Seep Well Field area, where initial testing indicates that flow velocities are on the order of 10 to 30 feet per day.
- This process would assist in overall water conservation by using groundwater as distribution water. Using groundwater from within the treatability study location avoids the need to procure and/or purchase water from an outside source, which renders the remediation more green and economical, and reduces truck traffic and dust generation.
- Most importantly, the re-use of extracted groundwater will provide useful information regarding remediation costs of a full-scale system for the feasibility study.

4.0 PERMITTING

Based on general discussions with the NDEP, BWPC on May 12, 2016, BWPC is expected to be receptive to using groundwater as a source of distribution water, provided that the appropriate details regarding the distribution water are submitted within the UIC Permit application. The UIC permit application was submitted to NDEP, BWPC on May 9, 2017.

Although water will only be extracted from monitoring wells during the injection events, the extraction of this water will require a water appropriations permit. The "Application for Permit to Appropriate the Public Water of the State of Nevada for Environmental Purposes" is currently underway.

5.0 ANTICIPATED SCHEDULE

The installation of injection wells and supplemental monitoring wells is scheduled to begin May 22, 2017. Following installation and development of the injection and monitoring wells, a comprehensive groundwater sampling event will be performed within the treatability study area to determine baseline conditions prior to injections. Based on this schedule, the first injection event is proposed for August/September 2017. The frequency of the injections is proposed for once every three months. However, results from the effectiveness monitoring program may indicate that a less frequent injection schedule is required to sustain the appropriate conditions necessary for biodegradation of perchlorate.

\\TTS100FS1\PROJECTS\NERT\MXD\GIS FIGURE DATABASE\MXD\FIGURE 1-REVISED INJECTION WELL LAYOUT_11X17.MXD

LEGEND

- MONITORING WELL
- RECOVERY WELL
- PLANNED INJECTION WELL
- PLANNED MONITORING WELL
- PLANNED MW TO BE USED FOR EXTRACTION
- MONITORING WELL TO BE USED FOR EXTRACTION
- PROPOSED WEIR DEWATERING TREATMENT SYSTEM
- PROPOSED INFLUENT LINE
- PROPOSED EFFLUENT LINE
- SWF BURIED CONDUIT
- UNDERGROUND PIPELINE
- STREET
- DOWNGRADIENT PLUME

PERCHLORATE CONCENTRATION

- 1-9.9 mg/L
- 10-24.9 mg/L

PARCEL BOUNDARY

10 mg/L

PC-97 PC-117 PC-116 PC-116R PC-115R PC-99R3 PC-99R2 PC-133 PC-91 PC-92 PC-94 MW04 MW06B MW06A MW02 MW10A MW10C MW09A MW09B MW03 MW01 MW07A MW07B MW05A MW05B MW08A MW08C PC-58

1536 1537 1538 1539 1540 1541 1542 1543 1544 1545 1546 1547 1548 1549 1550 1551 1552 1553 1554 1555

ROAD RIGHT OF WAY

AGUILA ROAD

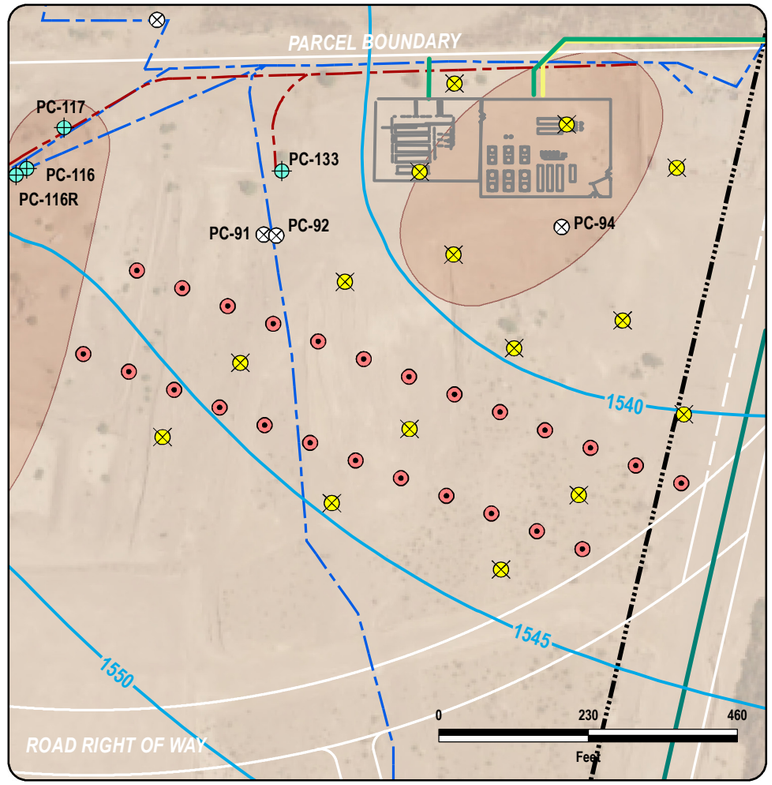
N

0 165 330 Feet

NOTES:

1. FIELD TEST AREA LOCATED WITHIN PARCEL 161-31-101-002
2. PERCHLORATE CONCENTRATION SOURCED FROM THE RAMBOLL ENVIRON ANNUAL REMEDIAL PERFORMANCE REPORT FOR CHROMIUM AND PERCHLORATE (2016)

ORIGINAL PROPOSED LAYOUT FROM THE SEEP WELL FIELD AREA BIOREMEDIATION TREATABILITY STUDY WORK PLAN (TETRA TECH, SEPTEMBER 2016)



PERCHLORATE CONCENTRATIONS AND POTENTIOMETRIC CONTOURS SOURCED FROM THE RAMBOLL ENVIRON ANNUAL REMEDIAL PERFORMANCE REPORT FOR CHROMIUM AND PERCHLORATE (2015)

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NEVADA ENVIRONMENTAL RESPONSE TRUST

REVISED INJECTION WELL LAYOUT BASED ON APRIL 2017 POTENTIOMETRIC CONTOURS

Project No.:	114-520225
Date:	MAY 18, 2017
Designed By:	SRA
Figure No.	1