# OFFICE OF THE NEVADA ENVIRONMENTAL RESPONSE TRUST TRUSTEE

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August 16, 2024

Mr. Chad Schoop, P.E.
Bureau of Industrial Site Cleanup
Nevada Division of Environmental Protection
375 E. Warm Springs Road, Suite 200
Las Vegas, Nevada 89119

RE: Seep Well Field Area Bioremediation Treatability Study
2022 Annual Progress Report
Nevada Environmental Response Trust
Henderson, Nevada

Dear Mr. Schoop:

The Nevada Environmental Response Trust (NERT) is pleased to present the 2022 Annual Progress Report for the Seep Well Field Area Bioremediation Treatability Study for Nevada Division of Environmental Protection (NDEP) review. In addition, an annotated response-to-comments is provided addressing NDEP's comments dated September 30, 2022 on the 2021 Annual Progress Report.

If you have any questions or concerns regarding this matter, feel to contact me at (702) 960-4309 or at steve.clough@nert-trust.com.

Office of the Nevada Environmental Response Trust

Stephen R. Clough

Stephen R. Clough, P.G., CEM
Remediation Director
CEM Certification Number: 2399, exp. 3/24/25

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| NDEP Comment | Response to Comment |
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| **General Comments** | |
| *General Comment 1: NDEP asks a project summary report beyond the annual progress reports after the project completion. Please provide the criteria used to determine when an additional injection is required in the project summary report. The criteria should be both quantitative and qualitative. Please analyze the relationship among injection frequency, injection EOS concentration, chase water, biofouling, and injection well maintenance for all events that were completed. NDEP suggest a table of metrics how the in-situ bioremediation of the groundwater perchlorate in the study area can be optimized in the full-scale project. Please provide the response to the following comments in the summary report.* | NERT will prepare a comprehensive project summary report upon receipt of comments on the Seep Well Field Area Bioremediation Treatability Study 2022 Annual Progress Report that will summarize all data collected since treatability study inception and evaluate the overall treatability study results with respect to perchlorate and chlorate biodegradation, injection frequency, injectate quantities and concentration, and injection well maintenance. |
| *General Comment 2: This is a well-planned and executed long-term study that has investigated many aspects of the treatment process very thoroughly. The data from this study show clearly the relationship between higher total organic carbon (TOC) and better removal of perchlorate and chlorate. Recognizing no further injections will be performed as part of this pilot study, injection of a larger quantity of emulsified vegetable oil (EVO) is recommended for any future full-scale application of this technology to increase TOC and enhance treatment.* | Comment noted. An evaluation of EVO dosing will be discussed in the forthcoming comprehensive project summary report. |
| *General Comment 3: As previously commented on November 17, 2021, the amount of carbon substrate (EOS) added is low however it is injected at a high concentration which contributes to the clogging of the wells and then dispersed by a large quantity of distribution water resulting in a low concentration or organic carbon in the treatment area. The 2021 comments recommended more EOS in less distribution water but injected at a lower concentration to prevent clogging of wells. Additional 2021 comments make recommendations for well maintenance. It is recommended that these 2021 comments are considered if and when the full-scale application of this technology is designed.* | Both remediation experience and literature have demonstrated that with injections of EVO, the total quantity of water added during injections is more of a significant factor in remediation success rather than the EVO:water dilution ratio. Secondly, injection well maintenance is often a routine component of ISB operations (with EVO as well as other carbon substrates). This long-term treatability study indicated that the majority of injection wells required no maintenance throughout the five-year treatability study that included eight injection events. Injection wells that did periodically indicate reduced injection rates and/or increased injection pressures were easily rehabilitated and were able to accept injectate in subsequent injection events.<br><br>For full-scale design, components related to dosing requirements, combined with staging area size, EVO and amendments transportation/storage, and equipment selection, will be carefully considered to allow flexibility in EVO dilution ratios. |

| NDEP Comment | Response to Comment |
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| **Essential Corrections** | |
| *Essential Correction 1: Section 2.1 Designed Injection Quantities Page 4: There is a discussion of nutrient addition, however Appendix E shows that nitrogen and phosphorus have not been analyzed in the pilot study wells in some time. It is suggested that nitrogen and phosphorus are monitored in order to verify the nutrient levels in the aquifer.* | Generally, there is sufficient nitrogen in native groundwater because of the relatively high nitrate concentrations in groundwater in the treatability study area. Bench-scale studies performed at UNLV indicated that neither nitrogen nor phosphorus would be required as a nutrient for ISB. However, small quantities of phosphorus were included in the injectate solution primarily because this nutrient is not naturally present in groundwater and to maintain a carbon to phosphorous ratio consistent with what is required for anaerobic systems. Additionally, the EVO product selected for the treatability study (EOS® PRO) contains nominal amounts of phosphorus.<br><br>With respect to the treatability study monitoring program, both phosphorous and total nitrogen were sampled as part of the effectiveness monitoring program from 2017 through 2018 following the first three injection events. Because the data collected during this time period provided a sufficient understanding of the ISB effects with respect to these parameters, both nitrogen and phosphorous were eliminated from the effectiveness monitoring program as part of the NDEP-approved Treatability/Pilot Study Modification No. 6. Additionally, the NDEP-approved 2020 Annual Progress Report recommended removal of phosphate from the injectate solution during the seventh and eighth injection events because phosphorus was unlikely to be a limiting nutrient for microorganisms, as phosphorus was included in the injectate solution for the first six injection events. |

| NDEP Comment | Response to Comment |
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| *Essential Correction 2: Section 2.4 Evaluation of Injection Frequency Page 6: Table 1 in this section shows that the number of months between injections have increased. Please provide the metrics used to determine when an additional injection is required.* | Primarily, the overall plume-wide changes in perchlorate and chlorate concentrations, combined with evaluation of secondary parameters indicating general aquifer conditions (i.e., lack of dissolved oxygen, presence of total organic carbon, etc.), were used to evaluate the timing of additional injections. Data collected over time has also indicated that injection frequency could vary due to a wide range of groundwater flow rates observed in the treatability study area. For example, portions of the subsurface containing paleochannels, which are typically comprised of relatively coarse, poorly graded materials resulting in faster groundwater flow rates, may require more frequent injections to sustain perchlorate biodegradation.<br><br>An evaluation of injection frequency for full-scale implementation will be discussed in the forthcoming comprehensive project summary report. |
| *Essential Correction 3: Figures 5A,5B, 6A, 6B, and 7A, 7B: In these figures the "baseline conditions" figure is from June 2021. Understanding that this is a report on the 2021 data, it may, nevertheless, be helpful to include a figure showing the true baseline conditions (prior to any injections) to demonstrate the extent to which the pilot study has affected overall chemical concentrations.* | Note 2 on the referenced figures indicates that the baseline image depicts conditions from July 2017, which are representative of pre-injection conditions. The date will be added to the heading of the baseline conditions image in the forthcoming comprehensive project summary report for clarity. |
| *Essential Correction 4: Table 2: Injection Well Maintenance Methods Page 10: Table 2 suggests that hydrojetting with chemical addition as currently performed may not offer any improved performance over hydrojetting alone. This should be considered when planning well maintenance for any full-scale application.* | Comment noted. The benefits of chemical addition to the hydrojetting process likely varies by location based on the composition and quantity of the accumulated solids within a particular injection well. Therefore, full-scale application will consider the composition/quantity of the accumulated solids during selection of the appropriate injection well maintenance technique. |
| *Essential Correction 5: Section 4.2: Hydrogeological Evaluation Page 13: This section discusses a significant change in groundwater levels occurring in December 2021. The trend graphs in Appendix F do show changes in trends in the December 2021 data. It is suggested that a note of some type is included in these graphs to indicate that the December 2021 data may not be indicative of true trends due to the water level change.* | Comment noted. This recommendation will be considered in the forthcoming comprehensive project summary report based on the water level trends observed over time. |

| NDEP Comment | Response to Comment |
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| *Essential Correction 6: Section 4.3.4: Total Organic Carbon Page 24: This section states that increases in TOC were "marginal" at best and the reason for this was that the carbon is thought to be consumed closer to the injection wells and does not reach the monitoring wells. However, some monitoring wells are within 30 feet of the closest injection well and if carbon is not observed within 30 feet of the injection well, it may be an indication that insufficient carbon is being added.* | As outlined in the responses to General Comments 2 and 3 above, an evaluation of carbon dosing will be included in the forthcoming comprehensive project summary report. |
| *Essential Correction 7: Section 4.4: Microbial Evaluation Page 29: The microbial data show clearly the effectiveness of higher organic carbon on microbial numbers and the composition of bacteria. This supports the recommendation that organic carbon be injected at a higher concentration.* | Comment noted. It is generally true that microbial populations, diversity, and overall composition in terms of robustness are likely to be enhanced in the presence of elevated concentrations of organic carbon. This was demonstrated in the microbial data collected from the injection well SWFTS-IW02A and monitoring well SWFTS-MW14 (located in the general vicinity of the injection wells). However, because this is not a continuous trench-like biobarrier and the treatability study area is heterogeneous, some downgradient areas will likely receive more organic carbon while other downgradient vicinities may receive less organic carbon from the injections. Even with increased concentrations of organic carbon, the microbial populations will vary from location to location. Additionally, as noted in Section 4.4, the screened interval for monitoring well SWFTS-MW09, which is the downgradient monitoring well that was included in the microbial evaluation during this reporting period, is only 5 feet in length and extends below the maximum depth treated within the upgradient injection well transect. Therefore, lower microbial cell numbers are not unexpected at this location.<br><br>Carbon substrate concentrations, injection frequency, and making provisions for additional injection points in between existing injection wells will be discussed in more detail in the comprehensive project summary report. |