

MEMO

Date **April 8, 2019**
To **Nevada Environmental Response Trust**
From **John Pekala, Scott Warner, and Chris Ritchie**
Copy to **Nevada Division of Environmental Protection**
United States Environmental Protection Agency
Subject **Galleria Drive ZVI-Enhanced Bioremediation Treatability**
Study Monthly Progress Report

TASK PROGRESS UPDATE: JANUARY 2018

At the direction of the Nevada Environmental Response Trust (NERT or Trust), Ramboll US Corporation (Ramboll) has prepared this memorandum which summarizes Ramboll's progress during January 2019 toward successfully implementing the Galleria Drive Zero-Valent Iron (ZVI)-Enhanced Bioremediation Treatability Study.

TASK M18 – GALLERIA DRIVE ZVI-ENHANCED BIOREMEDIATION TREATABILITY STUDY.

- Task Leaders – Scott Warner / Chris Ritchie
- Current Status
 - Phase 1 of the treatability study is on-going. The pre-design field investigation as specified in the work plan is complete; bench-scale testing is in progress and described more in the following sections. Phase 2 (design and implementation of a field test) is anticipated to be proposed in Q2 2019 as part of a forthcoming Work Plan Addendum.
 - Column testing of two initial test columns remain in operation. The columns were started in October 2018 to evaluate the reduction of nitrate, chlorate, and perchlorate under dynamic, site-simulated conditions. As previously reported, one column was filled with ZVI only as the reactive media; the second column was composed of ZVI with added organic carbon ("ZVI+oc"). Also as previously reported, results to-date demonstrate that nitrate and chlorate are rapidly removed in both columns, corroborating previous batch test results. Perchlorate removal is observed in the ZVI+oc column but has not been observed in the ZVI-only column. In February 2019, the column containing ZVI-only will be sampled and analyzed for perchlorate-reducing bacteria and amended with nutrients (diammonium phosphate, or DAP) and vitamin B-12. DAP has a formula of $(\text{NH}_4)_2\text{HPO}_4$ and is a common nutrient for biomass. If insignificant perchlorate reduction is observed in the nutrient-amended column and perchlorate-reducing bacteria levels are low, bioaugmentation may be considered.

- Subsequent to startup of the above mentioned columns, three longer columns (five feet long) have been operating for approximately 50 days. The columns are used to evaluate the degradation of varying concentrations of contaminants. The column conditions are:
 - o ZVI only
 - o ZVI+oc
 - o Peroxychem EHC® (commercially-available mixture of ZVI + organics)

These columns were operated for approximately a week before adding DAP and vitamin B-12 to all three columns. Once DAP and B-12 were added to the columns (as noted by the vertical dashed line in Figures 1-3), all columns demonstrated rapid reduction of nitrate, chlorate, and perchlorate including the ZVI-only column (no added carbon source). This would be the first demonstrated reduction of perchlorate by ZVI with no added carbon source; confirmation testing is presently underway. The columns using the Peroxychem EHC® solution, though initially effective at removing contaminants, experienced breakthrough of perchlorate in the effluent after approximately 25 days. Breakthrough of chlorate and nitrate followed in succession as would be expected based on expected electron acceptor utilization. This breakthrough likely reflects the exhaustion of Peroxychem EHC® dosed in the column. The dose was not calculated to study longevity. Based on these results, for Peroxychem EHC® to be considered, additional testing would be needed to determine its longevity and maximum electron donor potential. The column tests continue to operate; sampling is anticipated to continue for approximately two more months. Following completion, degradation rate evaluations will be used to estimate the rate/order for the degradation.

- Testing is being performed to evaluate hydrogen gas production rates using headspace pressure in a closed flask instrumented with a pressure sensor. The objective of this testing is to develop a method to measure hydrogen generation from the ZVI material. If successful, the method could be used to estimate the life of the ZVI. Preliminary results are anticipated to be discussed in subsequent updates.
- The Trust continues to evaluate the applicability of this technology as additional data become available. Because the application of ZVI for in-situ treatment of perchlorate and chlorate is a novel technology, the testing involves some experimental trial and error. However, based on current information, the application of ZVI for treatment of site contaminants appears feasible. Moreover, the application of ZVI has multiple potential applications across the NERT Study Area either as a standalone technology or in tandem with other technologies.
- Schedule and Progress Updates
 - Field work related to the pre-design field investigation as specified in the work plan is complete. Additional deeper investigation was conducted in January in accordance with Treatability/Pilot Study Modification No. 5 dated November 5, 2018 (approved by NDEP on November 14, 2018). Preliminary findings from the deeper investigation are expected to be provided in the February update.
 - A work plan addendum is anticipated to be submitted in Q2 2019 provided that the data continue to support moving forward with a field test.

- Health and Safety
 - There were no safety incidents during January 2019.

ATTACHMENTS

Figure 1: Influent and effluent concentrations of nitrate, chlorate, and perchlorate in column containing ZVI only - January 2019 (Preliminary Information)

Figure 2: Influent and effluent concentrations of nitrate, chlorate, and perchlorate in column containing ZVI and organic carbon - January 2019 (Preliminary Information)

Figure 3: Influent and effluent concentrations of nitrate, chlorate, and perchlorate in column containing PeroxyChem EHC[®] - January 2019 (Preliminary Information)

Galleria Drive ZVI-Enhanced Bioremediation Treatability Study Progress Update

**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 as President*, 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

Galleria Drive ZVI-Enhanced Bioremediation Treatability Study Progress Update

**Nevada Environmental Response Trust Site
(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 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 Galleria Drive ZVI-Enhanced Bioremediation Treatability Study Progress Update, Nevada Environmental Response Trust Site, Henderson, Nevada

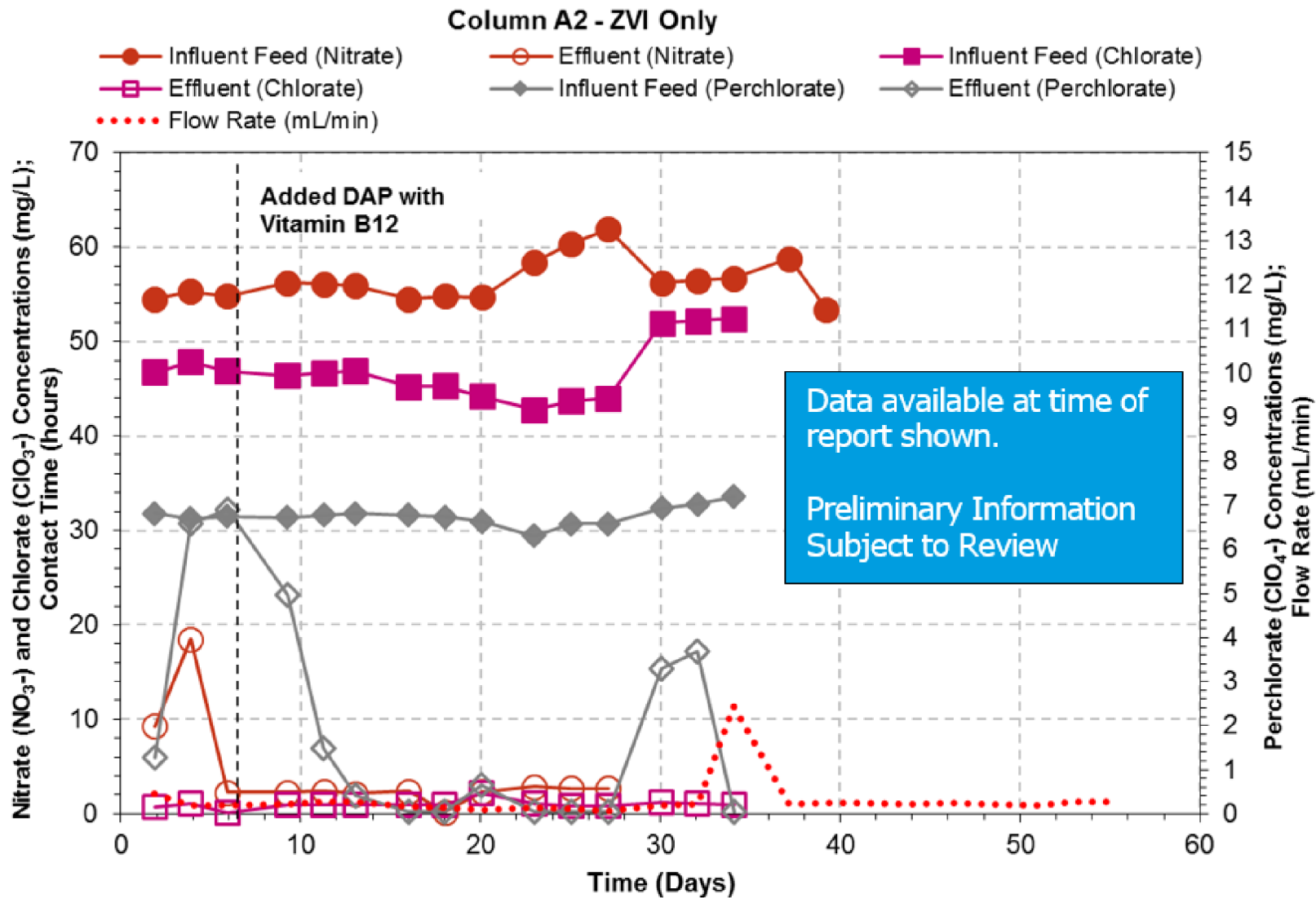


April 8, 2019

John M. Pekala, PG
Principal

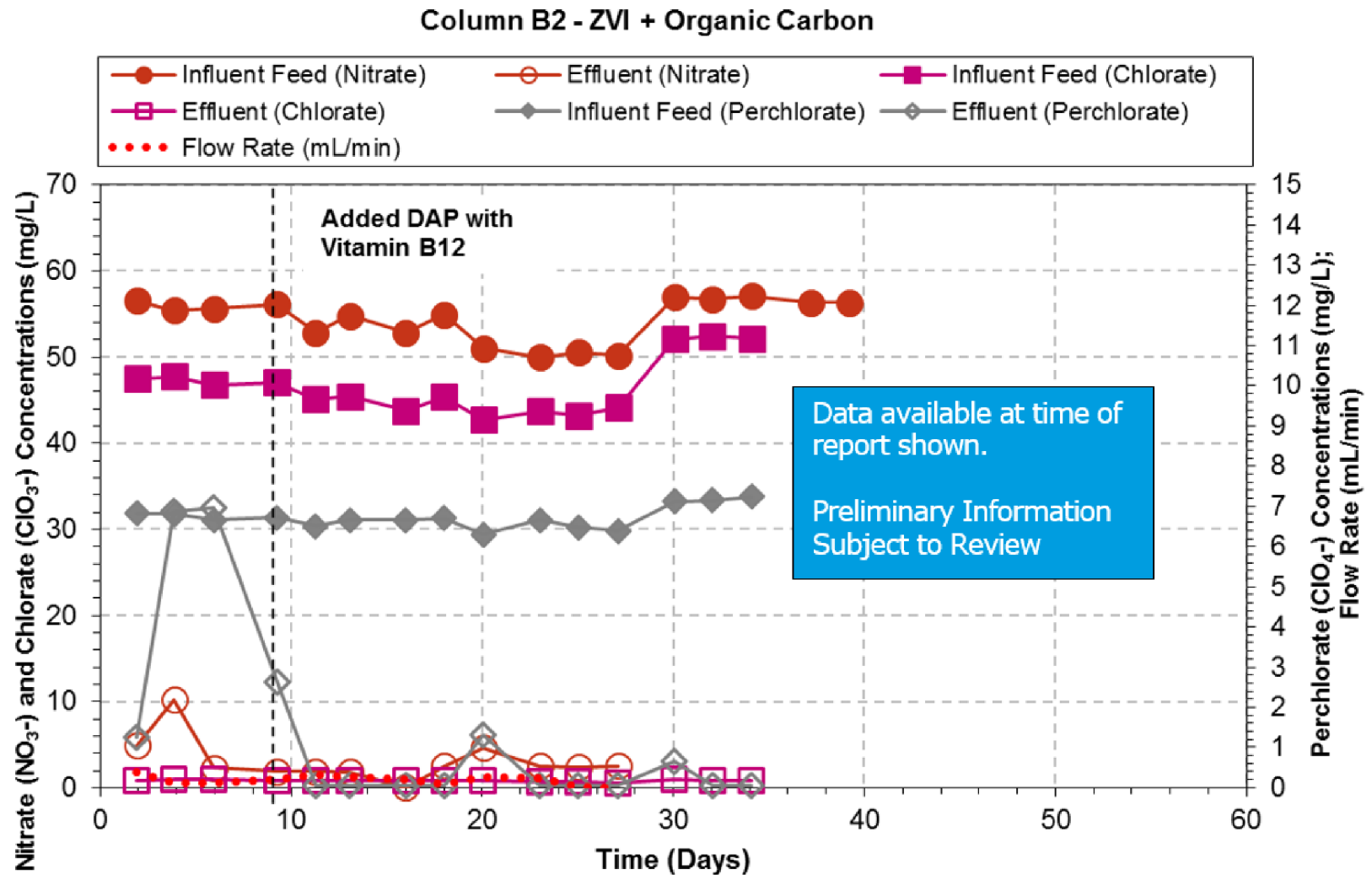
Date

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



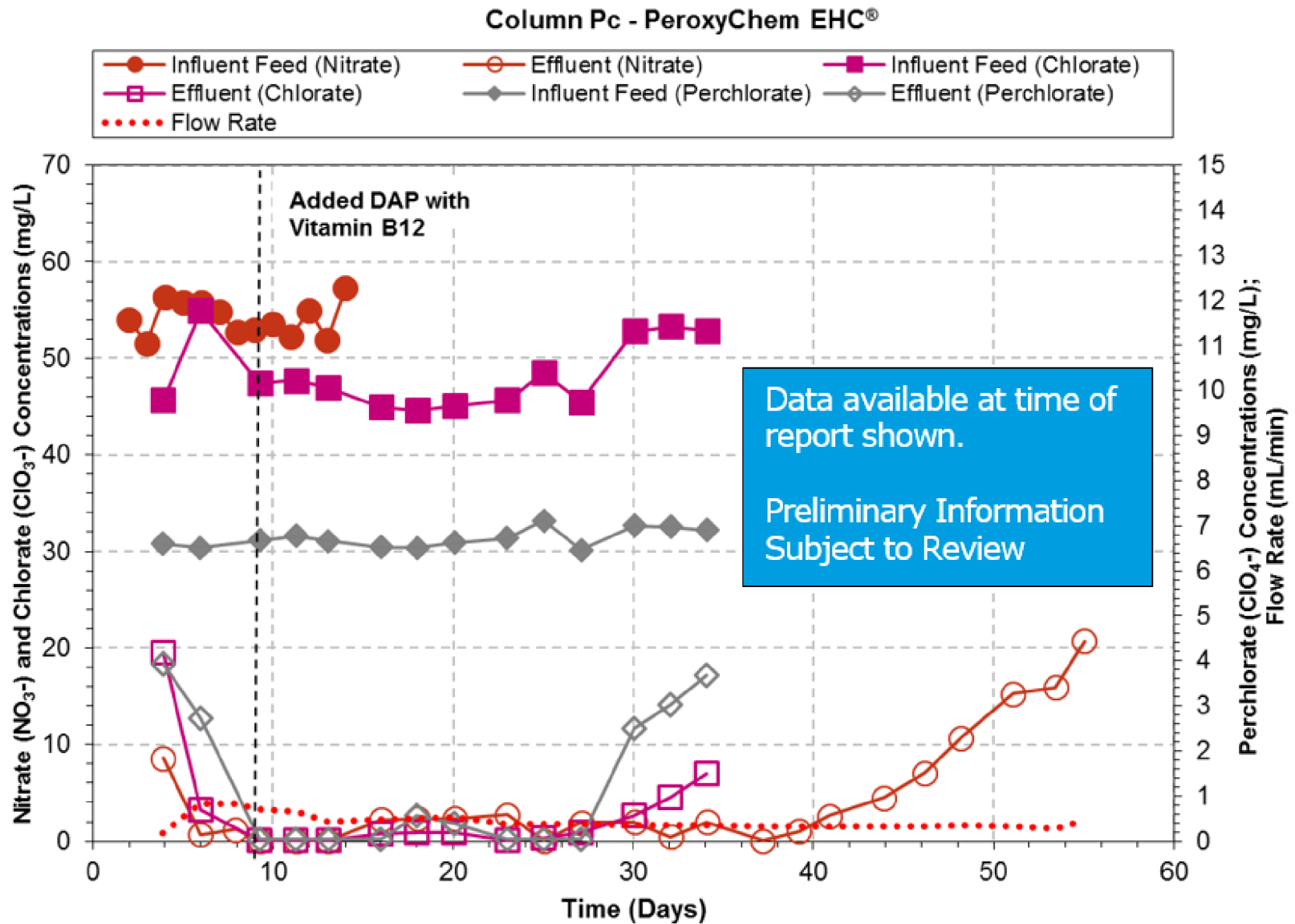
Influent and effluent concentrations of nitrate, chlorate, and perchlorate in column containing ZVI only - January 2019 (Preliminary Information)

Nevada Environmental Response Trust
Henderson, Nevada



Influent and effluent concentrations of nitrate, chlorate, and perchlorate in column containing ZVI and organic carbon - January 2019 (Preliminary Information)

Nevada Environmental Response Trust
Henderson, Nevada



Influent and effluent concentrations of nitrate, chlorate, and perchlorate in column containing PeroxyChem EHC® - January 2019 (Preliminary Information)

Nevada Environmental Response Trust
Henderson, Nevada