Galleria Drive Bioremediation Treatability Study Work Plan Addendum

Nevada Environmental Response Trust Site Henderson, Nevada

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Acronyms/Abbreviations	Definition
ASTM	ASTM International
AWF	Athens Road Well Field
BEC	Basic Environmental Company, LLC
BRC	Basic Remediation Company
bgs	below ground surface
COH	City of Henderson
DO	dissolved oxygen
EC	electrical conductivity
EVO	emulsified vegetable oil
FS	Feasibility Study
ft/day	feet per day
ft/ft	feet per foot
gpm	gallons per minute
GWETS	groundwater extraction and treatment system
IDW	investigation-derived waste
ISB	in-situ bioremediation
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAC	Nevada Administrative Code
NDEP	Nevada Division of Environmental Protection
NDWR	Nevada Division of Water Resources
NERT or Trust	Nevada Environmental Response Trust
NMR	nuclear magnetic resonance
ORP	oxidation-reduction potential
PLFA	phospholipid fatty acids
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
Site	Nevada Environmental Response Trust site, Clark County, Nevada
SRB	sulfate reducing bacteria

Acronyms/Abbreviations	Definition
SWF	Seep Well Field
TDEM	time domain electromagnetic
TDS	total dissolved solids
Tetra Tech	Tetra Tech, Inc.
TOC	total organic compound
USEPA	United States Environmental Protection Agency
UIC	Underground Injection Control
UMCf	Upper Muddy Creek formation
UNLV	University of Nevada at Las Vegas
VFAs	volatile fatty acids
Work Plan Addendum	Galleria Drive Bioremediation Treatability Study Work Plan Addendum
ZVI	zero valent iron

CERTIFICATION

Galleria Drive Bioremediation Treatability Study Work Plan Addendum

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

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

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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 Galleria Drive Bioremediation Treatability Study Work Plan Addendum, Nevada Environmental Response Trust Site, Henderson, Nevada

March 29, 2019

Kyle Hansen, CEM
Field Operations Manager/Geologist
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Date

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

1.0 INTRODUCTION

On behalf of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this Galleria Drive Bioremediation Treatability Study Work Plan Addendum (Work Plan Addendum) for implementation of an in-situ bioremediation (ISB) treatability study in the Upper Muddy Creek formation (UMCf) at a location within the Eastside Study Area, which is northeast of the NERT site (Site), located in Clark County, Nevada (Figure 1). This Work Plan Addendum is being submitted to the Nevada Division of Environmental Protection (NDEP) under the Interim Consent Agreement effective February 14, 2011. The Work Plan Addendum presents the results of the pre-design field and laboratory activities described in the *Galleria Road Bioremediation Treatability Study Work Plan* (Work Plan) (Tetra Tech, 2017), which was approved by NDEP on October 31, 2017, as amended by *Treatability/Pilot Study Modification No. 3 – Galleria Road Bioremediation Treatability Study* (Tetra Tech, 2018) (referred to as Modification No. 3), which was approved by NDEP on August 30, 2018. The Work Plan Addendum provides information on the final design for Phase 2 implementation of the ISB treatability study based on the Phase 1 pre-design results.

1.1 PROJECT OBJECTIVES

The activities in this Work Plan Addendum are being conducted to support remedy selection as part of a Remedial Investigation and Feasibility Study (RI/FS) process. Currently, the remedial investigation (RI) is being conducted in four investigation sub-areas: the On-Site NERT RI Study Area; the Off-Site NERT RI Study Area; the NDEP Downgradient Study Area; and the Eastside Study Area. These investigation sub-areas are collectively referred to as the NERT RI Study Area (Figure 1).

Additional technical evaluation of location-specific remedial options is necessary to support remedy selection in the Eastside Study Area. The Eastside Study Area has unique hydrogeologic conditions and a distinct distribution of contaminants compared to other areas within the NERT RI Study Area due, in part, to different mechanisms of contaminant release from the historic eastside infiltration ponds. Two separate, coordinated in-situ treatability studies are being performed along the northern portion of the Eastside Study Area along Galleria Drive to evaluate the feasibility and effectiveness of different technologies to reduce contaminant mass flux at the mid-plume containment and mass removal boundary, which has been established as a remedial action objective (RAO). These studies are being performed in support of the RAO to mitigate contaminant migration at the mid-plume boundary and to provide essential input for the Feasibility Study (FS). These treatability studies consist of application of ISB by Tetra Tech and application of Zero-Valent Iron (ZVI) Enhanced Bioremediation by Ramboll. The two treatability study locations are presented in Figure 1. Due to the proximity of the treatability study locations, Tetra Tech and Ramboll regularly coordinate and share data obtained during the pre-design activities to support each of the study's initiatives.

The overall objective of the ISB treatability study is to demonstrate and evaluate the effectiveness of implementing ISB to reduce the contaminants present in the shallow UMCf and migrating through the vicinity of Galleria Drive in the Eastside Study Area. This treatability study will build on the results of the previous ISB treatability study performed downgradient of the Athens Well Field (AWF) near the City of Henderson (COH) Bird Viewing Ponds (Tetra Tech, 2016a) and the on-going Seep Well Field (SWF) Area Bioremediation Treatability Study (Tetra Tech 2016b). However, unlike those studies that focused on the alluvium and more transmissive paleochannel deposits, this treatability study primarily focuses on the UMCf underlying the study location.

A summary of site background information prior to the pre-design field activities and ISB technology description can be found in the Work Plan. The site background is described in Section 1.3 of the Work Plan. Similarly, a description of the planned ISB technology and previous and on-going treatability studies appears in Section 2.0 of the Work Plan.

1.2 WORK PLAN ADDENDUM ORGANIZATION

This Work Plan Addendum is organized as follows:

- **Introduction (Section 1.0):** Provides the primary objectives of this work plan addendum and field treatability study.
- **Phase 1 Pre-Design Field and Laboratory Activities (Section 2.0):** Provides a description and results summary of the field and laboratory activities that have been completed to date.
- **Phase 2 Treatability Study Design (Section 3.0):** Describes the treatability study design including objectives, study location, injection and monitoring well layout, and injection design.
- **Phase 2 Effectiveness Monitoring Plan (Section 4.0)**: Presents the effectiveness monitoring program for the treatability study, including the field, analytical, and microbial groundwater monitoring and data validation requirements, as well as mass flux evaluations.
- **Phase 2 Permitting Requirements (Section 5.0):** Summarizes permitting requirements for treatability study implementation.
- **Phase 2 Reporting (Section 6.0):** Summarizes reporting related to design, execution, and evaluation of the treatability study.
- **Phase 2 Schedule (Section 7.0):** Summarizes the schedule for conducting the treatability study and associated reporting.
- **References (Section 8.0):** Lists the documents referenced in this Work Plan Addendum.

2.0 PHASE 1 PRE-DESIGN FIELD AND LABORATORY ACTIVITIES

This section describes the various pre-design field and laboratory activities that have been completed to-date during Phase 1 of the treatability study and the associated results that were used to optimize the Phase 2 location and design of the study.

The objectives of the pre-design activities, as described in the Work Plan were to accomplish the following:

- Characterize the lithology in sufficient detail to refine the conceptual injection well spacing.
- Identify preferential flow pathways in order to better target injections.
- Assess localized vertical and horizontal distribution of perchlorate to appropriately target the treatability study.
- Accurately identify groundwater flow directions and rates to design the injection wells and perform injections to best address perchlorate migration in the vicinity of the mid-plume RAO boundary.

Two additional objectives were added as the Phase 1 pre-design field and laboratory investigations progressed as described in Modification No. 3:

- Evaluate the effectiveness of ISB for the very high sulfate and TDS zone in a laboratory setting using soil and groundwater from 90 -110 feet bgs.
- Evaluate the feasibility of performing injections into the low conductivity 90 – 110 feet bgs treatment interval.

To gather the appropriate data to meet these objectives, Phase 1 pre-design field and laboratory activities were performed from March to June 2018 in accordance with the Work Plan. The pre-design activities that were conducted included: geophysical surveys, soil boring and monitoring well installation, soil and groundwater sampling, aquifer testing (including slug tests, single-borehole dilution tests, and nuclear magnetic resonance [NMR] logging), and laboratory bench-scale studies. Based on the results of the initial pre-design activities, additional pre-design work was recommended in the approved Modification No. 3. The pre-design field and laboratory activities associated with Modification No. 3 were performed from September to December 2018 and included performing step-rate injection tests and additional laboratory bench-scale studies.

A summary of these activities, their purpose, and the respective results are presented in this section. All field work described was conducted in general accordance with the existing *Field Sampling Plan, Revision 1* (ENVIRON, 2014), the Work Plan, and Modification No. 3. A data validation summary report will be provided for all data presented in this report at the conclusion of the treatability study in the final Galleria Drive Bioremediation Treatability Study Results Report.

2.1 GEOPHYSICS

Geophysical surveys were performed as a cost-effective method to improve the identification and definition of preferential flow pathways and paleochannel morphology, as well as to characterize the top of the UMCf. The time domain electromagnetic (TDEM) method was selected due to its historical use at the site to successfully identify paleochannels in the UMCf at the Black Mountain Industrial Complex property southeast of the study area (GEOVision, 2003). Geophysical surveys were performed by GEOVision with Tetra Tech oversight on March 28, 2018 followed by a subsequent field effort on April 9, 2018. TDEM sounding data were collected along two transect lines, each consisting of four individual soundings, that crossed through the treatability study area, as illustrated in Figure 2.

As expected based on review of historical information, the geophysical survey results did not indicate the presence of a paleochannel within the treatability study area. The geophysical survey did identify the alluvial/UMCf contact and the top of the saturated UMCf; these depths were subsequently confirmed during drilling of nearby monitoring wells. GEOVision's geophysical survey report is provided in Appendix A.

2.2 INSTALLATION OF SOIL BORINGS AND MONITORING WELLS

Soil borings and monitoring wells were installed within the treatability study area to provide information on the lithology, hydrogeology, and contaminant distribution within the treatability study area. This section presents details of the installation activities, including a description of the geology within the treatability study area and summary of the soil results.

2.2.1 Installation Activities

Field work associated with the installation of Phase 1 pre-design soil borings and monitoring wells was conducted from April 9 to April 27, 2018. Locations of soil borings/monitoring wells are presented in Figure 2.

2.2.1.1 Pre-Drilling Activities

Tetra Tech, on behalf of NERT, prepared and submitted all required applications and obtained required permits prior to the installation of soil borings and monitoring wells. A Monitor Well Drilling Waiver (Nevada Administrative Code [NAC] 534.441) and a Notice of Intent to Drill Card (NAC 534.320) were submitted to the Nevada Division of Water Resources (NDWR). The Monitoring Well Drilling Waiver also included a completed, signed, and notarized Affidavit of Intent to Plug a Monitoring Well as a required attachment.

Prior to the start of drilling activities, Tetra Tech contacted USA North Utility Locating Services, reviewed available utility maps, and retained the services of a geophysical locator to check for underground utility lines. Each drilling location was also cleared to a depth of 10 feet below ground surface (bgs) by air knife operations to ensure the area was clear of utilities.

2.2.1.2 Soil Boring Installation

Five soil borings were installed within the treatability study footprint to provide area-specific lithological information and contaminant concentration data to incorporate into the development of the final treatability study design. Drilling and well installation activities were conducted by Cascade Drilling, LP using rotosonic drilling methods. Each of the five soil borings was advanced to approximately 120 feet bgs. The continuous soil cores were logged from ground surface to total depth using the Unified Soil Classification System. Photographs of soil cores were also collected during drilling activities. Copies of the soil boring logs and core photographs are provided in Appendix B.

During drilling activities, soil samples were collected at approximately 10-foot intervals from the top of the water table to the base of the boring. All soil samples were analyzed for perchlorate. Six soil samples were also analyzed for a suite of analytes to provide additional characterization of the subsurface in accordance with the Work Plan. Soil samples for laboratory analysis were collected in laboratory-supplied containers, labeled, placed in plastic bags, and stored in a cooler on ice for transport under chain-of-custody documentation to the appropriate laboratory, either TestAmerica Laboratories, Inc. or Microbial Insights Inc.

The Work Plan specified that two undisturbed soil samples would be collected from each borehole in representative lithological units upon reaching groundwater using a Shelby tube, or similar collection device for physical parameter analysis including moisture content, porosity, and soil density. An attempt was made to collect such samples. However, the UMCf in the Galleria Drive Bioremediation Treatability Study area was compacted and cemented such that samples could not be collected using direct-push devices such as a Shelby tube.

Depth-discrete groundwater samples were also planned to be collected from select boreholes within the alluvium, just above the top of the UMCf, and within the UMCf to vertically profile the perchlorate distribution. Because no saturated alluvium was present within the study area, depth-discrete groundwater samples were not collected from within the alluvium or from the interval above the UMCf. Depth-discrete groundwater samples were attempted within the UMCf, but in many cases there was insufficient water to collect the groundwater sample due

to the low hydraulic conductivity. As a result, only two depth-discrete groundwater samples were collected from the UMCf (Results are discussed in Section 2.3.2.3).

Finally, during boring installation, representative soil was collected from the UMCf over the depth intervals of approximately 60 – 85 feet bgs and 90 – 110 feet bgs from location GRTS-MW03A/B and transported to the University of Nevada at Las Vegas (UNLV) for use in the laboratory bench tests (described in Section 2.7).

2.2.1.3 Monitoring Well Installation

A set of paired monitoring wells was installed at each soil boring location to evaluate the horizontal and vertical extent of perchlorate concentrations and hydraulic gradient changes with depth throughout the UMCf to help optimize the design and effectiveness of the treatability study. Each soil boring was converted to a permanent monitoring well and screened within the UMCf to serve as the deeper well of the well pair. The additional paired monitoring well was then installed at each location with a separate shallower screened interval in the upper portion of the UMCf. Due to its proximity to the 120-foot bgs soil boring, the paired monitoring well location was not lithologically logged. In general, the shallow UMCf wells are screened within the 60 – 85 feet bgs interval and the deeper UMCf wells are screened from 90 – 110 feet bgs. At one location (GRTS-MW05B), the deeper well of the well pair, was screened in the more gypsum-rich portion of the borehole to provide characterization of that zone from 75 – 85 feet bgs. Because saturated alluvium was not present within the treatability study area, monitoring wells were only installed within the UMCf.

In general, monitoring wells were constructed using 2-inch schedule 40 polyvinyl chloride (PVC) casing and screened with 2-inch diameter, 0.010-inch slotted PVC well screen. One set of paired monitoring wells was constructed with 4-inch diameter schedule 40 PVC casing and screened with 4-inch diameter, 0.010-inch slotted PVC well screen, which is required for single-borehole dilution testing (Section 2.5.2). All wells were completed with flush-mounted, traffic-rated well boxes, at an elevation approximately 0.5-inch above grade. Following well construction, but no sooner than 48 hours after well construction was compete, the newly installed monitoring wells were developed using a surge block and bailer to swab and surge the filter pack and remove sediment. This process was followed by pumping with a submersible pump to purge the well of fine-grained sediment. Well development was considered complete when three to ten casing volumes of water had been removed from the well and index parameters (consisting of pH, specific conductivity, turbidity and temperature) were stable over three consecutive measurements.

Once all monitoring well installation activities were complete, a licensed land surveyor surveyed the horizontal coordinates of each well relative to North American Datum 83 with an accuracy of 0.1 foot. The elevation of the ground surface and top of well casing measuring point relative to North American Vertical Datum 88 was surveyed with accuracies of 0.1 foot and 0.01 foot, respectively.

A summary table of well construction details and well construction diagrams is provided in Appendix B.

2.2.1.4 Management of Investigation-Derived Waste

Investigation-derived waste (IDW) generated was managed in accordance with applicable state, federal, and local regulations and as described in *Field Sampling Plan, Revision 1* (ENVIRON, 2014). During the Phase 1 pre-design investigation of the treatability study area, IDW included soil cuttings, personal protective equipment, general field consumables (such as plastic sheeting beneath soil cores during logging), equipment decontamination water, and groundwater generated during depth-discrete groundwater sampling and well development.

Investigation-derived soil waste was containerized onsite in plastic lined, 10-cubic yard roll-off bins. The roll-offs were labeled to indicate contents, source, and date when accumulation began. Soil cuttings contained in each of the roll-off bins were sampled for profiling purposes, with one composite soil sample collected from each bin. The samples were analyzed for the following: volatile organic compounds by United States Environmental Protection

Agency (USEPA) Method 8260B; Resource Conservation and Recovery Act (RCRA) 8 Metals by USEPA Method 6010B; flashpoint ignitability by USEPA Method SW846 7.1.2; pH by USEPA Method 9045C; perchlorate by USEPA Method 314.0; and toxicity characteristic leaching procedure – Metals by USEPA Method 1311 extraction/USEPA Method 6010B. Results indicated that the soil cuttings were non-hazardous waste. All IDW was disposed of at Apex Landfill, Las Vegas, Nevada.

Waste water generated during purging or decontamination activities was temporarily stored in 55-gallon drums and/or 500-gallon totes and transferred into the GW-11 Pond for onsite treatment in the NERT groundwater extraction and treatment system (GWETS).

2.2.2 Results

Data from the soil boring and monitoring well installation activities were compiled to provide a description of the geology of the bioremediation treatability study area and a summary of the soil analytical results.

2.2.2.1 Bioremediation Treatability Study Area Geology

Geologic cross-sections of the treatability study area are presented in Figures 3a and 3b. A review of the lithology indicates that the uppermost 25 to 43 feet are comprised of unsaturated alluvium ranging from silty sands to sandy gravel. There was no evidence of a distinct paleochannel located within the bioremediation treatability study area.

The UMCf within the bioremediation treatability study area generally consisted of silt and clay layers, with more silt toward the top of the UMCf and more clay toward the bottom of the borehole (depth of 120 feet), which is generally consistent with lithology observed in nearby Phase 3 RI soil borings. Gypsum was present throughout the UMCf, which included powdery white gypsum layers (comprised almost entirely of gypsum) that were generally less than 1-foot thick. Distinct individual gypsum crystals were also present in abundance. In some cases, the gypsum crystals were so numerous that they comprised a large percentage of the core. The amount of gypsum and cementation generally increased with depth to approximately 90 feet bgs. Between 90 and 110 feet bgs, the amount of gypsum decreased, and then increased again to the total depth of 120 feet bgs. Hence, the shallow monitoring in each well pair was screened in the less cemented zone of the UMCf from 60 – 80 feet bgs, and the deeper monitoring well was screened in the more cemented zone of the UMCf from 90 – 110 feet bgs (lower UMCf). At one location, the deeper monitoring well of the well pair, well GRTS-MW05B, was screened from 75 – 85 feet bgs, which was located within the more gypsum-rich portion of the borehole to provide characterization of that zone.

Within the treatability study area, the UMCf was more consolidated and cemented than expected. The transition from unconsolidated to semi-consolidated UMCf is identified on geologic cross sections in Figures 3a and 3b. This transition represents the shallowest depth in which the available data indicated more consolidated material based on the observed level of cementation (moderately to strongly cemented) and consistency (stiff, very stiff, or hard). In addition to numerous gypsum layers, there were two organic-rich layers that correlated across the study area. These layers are identified on Figures 3a and 3b and contained increased (commonly black colored) organic matter. They are suspected of representing decayed plant matter deposited as part of the UMCf.

2.2.2.2 Soil Analytical Results

As described in Section 2.3.1.2, soil samples were collected at approximately 10-foot intervals from the top of the water table to the base of the boring. Soil analytical results are presented in Appendix C, Table C.1. Perchlorate was detected in soil samples at concentrations ranging from 0.072 to 2.4 milligrams per kilogram (mg/kg). In general, perchlorate was primarily detected in soil at depths less than 90 feet bgs. However, soil samples collected from 90 – 110 feet bgs at location GRTS-MW03B had perchlorate detections ranging from 0.072 to 0.20 mg/kg. Perchlorate was not detected above the laboratory detection limit in any soil samples collected from the bottom of the soil borings at 120 feet bgs.

As described in Section 2.3.1.2, six soil samples were also analyzed for a suite of analytes to provide additional characterization of the subsurface. Chlorate results ranged from less than 0.33 J mg/kg to 2.7 J mg/kg. Chlorate was not detected above the laboratory detection limit of 0.37 mg/kg in the deepest sample collected at 109 feet bgs. Results from the soluble cation analysis performed on the water extract indicate that calcium and sulfate concentrations are relatively high (up to 640 and 1,900 milligrams per liter [mg/L], respectively), which was expected based on the observation of gypsum during drilling activities. Concentrations of total kjeldahl nitrogen concentrations (ranging from 11 to 88 mg/kg) indicate that there is likely sufficient nitrogen to serve as a micronutrient for native microorganisms during bioremediation at the low concentrations of perchlorate. Current and previous field treatability studies as well as UNLV bench-scale studies have also indicated that the addition of nitrogen as a microbial micronutrient is not required for groundwater perchlorate bioremediation (Tetra Tech, 2016a).

Two soil samples were sent to Microbial Insights for analysis of phospholipid fatty acids (PLFA) and the perchlorate-reductase gene. Samples were collected from GRTS-MW01B at 75 feet bgs and from GRTS-MW03B at 63 feet bgs. Soil microbial results are presented in Appendix C, Table C.2. The key findings of the microbial analysis indicate that the soil is microbially active with populations in the range of 10^5 – 10^6 cells/gram of soil. Ratios for slowed growth and decreased permeability of the cell membrane provide information on the “health” of the gram negative microbial community and how this population is responding to the conditions present in the environment. Higher ratios (greater than 1.0) could be reflective of a community that is stressed and an environment that may not be as supportive of the microbial community, often due to the lack of available carbon substrate. The ratios of slowed growth and decreased permeability for the Galleria Drive soil samples indicate an environment that is generally not toxic to microorganisms and would likely be supportive of perchlorate bioremediation upon the addition of a carbon substrate. Results also indicate that there appear to be sufficient proteobacteria, which are important for biodegradation of perchlorate and other electron acceptors (such as nitrate) once the carbon substrate has been injected. Finally, perchlorate reductase was not detected above the laboratory detection limit of 1.67×10^4 cells/gram in either sample, which is not unexpected considering this enzyme is specific to perchlorate reduction processes and the fact that perchlorate is persisting, organic carbon is lacking, and ISB has yet to be implemented within the treatability study area.

2.2.2.3 Discrete-Groundwater Analytical Results

As described in Section 2.3.1.2, depth-discrete groundwater samples were collected at two locations, GRTS-MW01B at 74.5 feet bgs and GRTS-MW04B at 79 feet bgs. These samples were analyzed for perchlorate, nitrate, and chlorate. Perchlorate concentrations ranged from 1.8 to 6.0 mg/L. Chlorate concentrations ranged from 1.8 to 7.7 mg/L. Nitrate was detected in the groundwater sample collected from location GRTS-MW01B at a concentration of 4.5 J mg/L. Depth-discrete groundwater results are presented in Appendix C, Table C.3.

2.3 GROUNDWATER SAMPLING

Following completion of well development activities, a comprehensive groundwater sampling event was performed in May 2018 on all wells within the bioremediation treatability study area. This event included measurement of water levels in the 10 newly installed wells and 6 existing monitoring wells (ES-13, MCF-6B, MCF-6C, DBMW-6, DBMW-7, and DBMW-8). Groundwater samples were collected from the 10 newly installed wells and 3 existing wells (ES-13, MCF-6B, and MCF-6C) and analyzed for a variety of field and laboratory parameters in accordance with the Work Plan to establish baseline conditions for the final treatability study design. In addition, groundwater was collected from monitoring well GRTS-MW03A and transported to UNLV for use in the bench-scale studies described in Section 2.7. Finally, Bio-traps® were installed in monitoring wells GRTS-MW04A and GRTS-MW04B on May 17, 2018 and retrieved on June 12, 2018. The Bio-traps® were sent to Microbial Insights, Inc. for analysis of the perchlorate reductase gene and PLFA, as described in section 2.3.2.

2.3.1 Bioremediation Treatability Study Area Hydrogeology

Based on data collected during the installation of soil borings and monitoring wells, groundwater was first encountered in the UMCf; there was no saturated alluvium. The May groundwater level gauging event indicated that the depth to groundwater in monitoring wells within the bioremediation treatability study area ranges from about 47 to 64 feet bgs. Figures 4a and 4b present groundwater potentiometric surface maps of the bioremediation treatability study area for the UMCf wells screened from 60 – 85 feet bgs and 90 – 110 feet bgs, respectively. Depth to water measurements are provided in Table D.1, in Appendix D.

Groundwater in the monitoring wells screened within the 60 – 85 feet bgs interval generally flows north-northeast, while groundwater in the deeper monitoring wells screened within the 90 – 110 feet bgs interval generally flows to the east. These flow directions tend to confirm data collected by Basic Remediation Company (BRC) in 2009, which show northeastern to eastern flow in the study area (Daniel B. Stephens & Associates, Inc., 2010). It is suspected that the paleochannel immediately east of the bioremediation treatability study area acts as a drain affecting both screened zones in the study area. However, this paleochannel is not expected to affect the Galleria Drive Bioremediation Treatability Study. The calculated average hydraulic gradient in the bioremediation treatability study area for wells screened in the 60 – 85 feet bgs interval was 0.035 feet per foot (ft/ft). The calculated average hydraulic gradient in the bioremediation treatability study area for wells screened in the 90 – 110 feet bgs interval was 0.028 ft/ft.

The vertical gradient is downward throughout the study area and ranges from 0.16 to 0.32 ft/ft. The strong vertical gradient implies that there are significant barriers to vertical flow in the study area, which is typical in a laminated, partially cemented, fine-grained formation such as the UMCf. The downward vertical gradient is consistent with that observed at the MCF-06 well cluster during the vertical gradient assessment performed by BRC in 2008 (BRC, 2008).

2.3.2 Groundwater Analytical Results

A summary of the groundwater concentration ranges of perchlorate and chlorate, as well as other noteworthy parameters with respect to the bioremediation process, is presented in ***Table 1***. Complete analytical results are provided in Appendix C, Tables C.4 and C.5. Groundwater sampling field logs are provided in Appendix D.

Table 1 Concentration Ranges in Groundwater (mg/L)

Analyte	Concentrations in the Upper UMCf (60 – 85 ft bgs)	Concentrations in the Lower UMCf (90 – 110 ft bgs)
Perchlorate	3.3 – 14	< 0.05 – 3.2
Chlorate	3.7 – 19	< 0.1 – 1.6
Nitrate	< 5.5 – 38	< 5.5
Sulfate	2,800 – 19,000	26,000 – 34,000
TDS	7,600 – 43,000	50,000 – 64,000

Notes:
mg/L – milligrams per liter
UMCf – Upper Muddy Creek formation
ft bgs – feet below ground surface
TDS – total dissolved solids

Perchlorate was detected above the laboratory detection limit in groundwater samples collected from all monitoring wells within the bioremediation treatability study area, with the exception of GRTS-MW02B and GRTS-MW04B (both of which are screened from 90 – 110 feet bgs). Perchlorate concentrations were greater in groundwater samples collected from the shallower UMCf wells screened from approximately 60 – 85 feet bgs than the monitoring wells screened from 90 – 110 feet bgs. It should be noted that the two groundwater samples from the 90 – 110 feet bgs zone that did not have detections of perchlorate had an elevated sample detection limit of 0.05 mg/L. The analytical laboratory reported that sample dilutions were necessary due to interferences caused by chloride, sulfate, and TDS. Specifically, high anion and TDS concentrations like those encountered in groundwater from the 90 – 110 feet bgs interval in the treatability study area may interfere with the instrumentation used in perchlorate analysis. As a result, the analytical laboratory must run an initial dilution on the groundwater sample, which elevates the laboratory detection and reporting limits. Chlorate concentrations followed a similar pattern with respect to vertical distribution and also had elevated sample detection limits of 0.1 and 0.25 mg/L for the deep groundwater samples that did not have detections of chlorate.

Nitrate, which is the most likely competing electron acceptor and carbon substrate consumer during bioremediation, was detected at concentrations up to 38 mg/L in groundwater samples collected from wells screened in the 60 – 85 feet bgs interval and was not detected above the laboratory detection limit of 5.5 mg/L (which is also an elevated detection limit due to initial dilutions required as described above) in groundwater samples collected from the deeper wells screened from 90 – 110 feet bgs. Concentrations at the levels present within the 60 – 85 feet bgs interval could delay the onset of contaminant degradation because nitrate is often a preferred electron acceptor during bioremediation.

Sulfate and total dissolved solids (TDS) were detected at concentrations up to 19,000 and 43,000 mg/L, respectively, in groundwater samples collected from the upper UMCf (60 – 85 feet bgs). Sulfate and TDS were detected at concentrations up to 34,000 and 64,000 mg/L, respectively, in groundwater samples collected from the UMCf (90 – 110 feet bgs). The high TDS concentrations are attributed to the sulfate concentrations and associated cations, rather than the chlorate and perchlorate concentrations. High levels of sulfate and TDS could pose a challenge to the microbial community. Often, high TDS may cause a lag to the onset of perchlorate biodegradation or may sometimes even prevent contaminant biodegradation (Gingras and Batista, 2002).

Specialized microbial analyses, namely, PLFA analyses and the presence of the perchlorate reductase gene, were determined via the use of Bio-Traps®, which are patented devices available through a specialized microbial firm, Microbial Insights in Knoxville, Tennessee. The objective was to obtain specialized microbial data to gauge the likely response of the microbial community to the addition of carbon substrate into groundwater and to evaluate perchlorate biodegradation potential. Microbial biomass results were 3.73×10^5 cells/gram in GRTS-MW04A (screened from 70 – 85 feet bgs) and 5.82×10^4 cells/gram in GRTS-MW04B (screened from 89.5 – 109.5 feet bgs) well. These numbers are indicative of sufficient microbial populations in groundwater that could possess the ability to biodegrade perchlorate and other inorganic electron acceptors such as chlorate and nitrate, upon the addition of an external source of organic carbon. A sizable proportion of proteobacteria (greater than 50% in both wells) was observed which indicates a proliferation of the appropriate bacterial community that is gram negative, has the ability to utilize a variety of carbon sources, has adapted easily to the groundwater environment, and is representative of both aerobic and anaerobic bacteria. On the other hand, the low proportions (less than 10%) of observed metal reducing bacteria and sulfate reducing bacteria (SRB)/actinomycetes reveal redox conditions that are not overly reducing. Eukaryotes percentages are also relatively low, indicating that these scavengers of valuable contaminant-reducing bacteria do not pose a significant threat in this groundwater. As explained in Section 2.2.2.2, ratios for slowed growth and for decreased permeability of the cell membrane provide information on the “health” of the gram-negative microbial community and how this population is responding to the conditions present in the environment. In general, ratios for slow growth and decreased permeability are less than 1.0 with the exception of a slowed growth ratio of 3.32 observed in GRTS-MW04A (screened from 70 – 85 feet bgs). This ratio of slowed growth indicates a stressed environment, likely due to the lack of organic carbon present in the subsurface. However, the decreased permeability ratio for both these

samples is zero, indicating that the toxicity is not at levels which cannot be overcome, upon the addition of a carbon substrate. Finally, the perchlorate reductase enzyme was not detected in either sample above the laboratory detection limit of 2.5 x 10^2 cells/gram, which was expected as indicated in Section 2.2.2.2..

In general, microbial results are similar to results from the on-going SWF Area Bioremediation Treatability Study, in which perchlorate biodegradation in groundwater is occurring quite successfully upon the addition of a carbon substrate. Therefore, a similar strong microbial response can be expected in groundwater during the Galleria Drive Bioremediation Treatability Study as well.

2.4 AQUIFER TESTING

The objective of the aquifer testing program was to obtain information regarding aquifer hydraulic conductivity, groundwater flow velocity, and total and mobile porosity in the area where the treatability study is planned. Aquifer testing activities, including slug testing, borehole dilution, and NMR logging, were performed in May/June 2018. This section summarizes the aquifer testing activities and associated results. The supporting summary memo for slug testing and borehole dilution testing, including borehole dilution test plots and AQTESOLV (HydroSOLVE, 2007) interpretation plots, is provided in Appendix E. NMR logs are presented in Appendix F.

2.4.1 Slug Tests

Slug tests were performed in all ten newly installed monitoring wells and two existing monitoring wells (ES-13 and MCF-06B) to obtain location-specific aquifer hydraulic conductivity in the screened interval of wells within the bioremediation treatability study area. Although the Work Plan included slug testing in monitoring wells DBMW-7 and MCF-06C, these wells were ultimately not tested. Monitoring well ES-13, which was installed in January 2018 as part of the NERT Phase 3 RI, was substituted instead due to its proximity to the bioremediation treatability study area. Monitoring well MCF-06C had insufficient water to perform the proposed slug test. Although monitoring well MCF-06C was not tested, sufficient slug testing data was collected during the pre-design phase to determine the range of hydraulic conductivities present within the treatability study area.

The slug tests were performed in general accordance with ASTM Internationals (ASTM) Standard D4044-96 (ASTM International, 2008). Prior to conducting each slug test, the water level in the well was measured manually with an electronic water level probe to determine the static groundwater level. An electronic pressure transducer/data logger was suspended in the well and water levels were monitored manually until static conditions were reestablished. A falling-head test was then conducted by smoothly lowering a length of weighted and sealed PVC pipe (slug) into the well, securing it in place above the transducer, and recording the rate of water level decline. Once static conditions were reestablished, a rising-head test was conducted by removing the slug and allowing the water level to again recover to static conditions while recording the rate of recovery. Barometric pressure changes during testing were monitored and recorded using a pressure transducer placed above the water table.

At the end of each test, the pressure transducer was removed from the well and the water level displacement data were downloaded to a laptop computer and corrected for barometric pressure effects, if necessary. The corrected data were interpreted using AQTESOLV for Windows (Duffield, 2014). Where possible, both the falling-head and rising-head data were analyzed to cross-check the interpretation results.

Results support the field observation that the UMCf becomes more compacted and cemented with depth. The average hydraulic conductivity in the 60 – 85 feet bgs zone was approximately 0.5 feet per day (ft/day), while the hydraulic conductivity in the 90 – 110 feet bgs zone was several orders of magnitude lower at 0.002 ft/day. The decrease in hydraulic conductivity with depth is expected, but it is also associated with slower flow rates. The supporting summary memo, including AQTESOLV (HydroSOLVE, 2007) interpretation plots, is provided in Appendix E.

2.4.2 Single-Borehole Dilution Test

Single-borehole dilution tests were performed in wells GRTS-MW03A and GRTS-MW03B (locations shown on Figure 2), to evaluate groundwater flow velocities in the UMCf within the bioremediation treatability study area. A summary of the field procedures, data analyses, and borehole dilution test plots is provided in Appendix E. Results indicate that the average flow velocity in well GRTS-MW03A is about 3 ft/day, and the average flow velocity in well GRTS-MW03B is about 0.003 ft/day, depending on hydraulic conditions.

2.4.3 Nuclear Magnetic Resonance Logging

NMR logging was performed in the deeper well of the five paired well configurations (namely GRTS-MW01B, GRTS-MW02B, GRTS-MW03B, GRTS-MW04B, and GRTS-MW05B) to further delineate any localized preferential flow pathways within the treatability study area. Although the Work Plan optionally proposed NMR logging for existing wells, this was deemed not required due to the more comprehensive NMR logging that was conducted as part of the Phase 3 RI, which included RI monitoring well ES-13 that is located within the treatability study area. As a result, only the five, deeper new wells were logged as part of Phase I activities. The reduced number of NMR surveys will not negatively affect this treatability study, as the NMR results received for this effort provided the information needed for final treatability study design.

NMR logging was previously used successfully at the SWF Area Bioremediation Treatability Study to identify higher-transmissivity zones within each well. This technology can be used in open or PVC-cased wells to provide high-resolution downhole estimates of hydraulic conductivity, total water content, total and mobile porosity, and relative pore-size distributions below the water table (Walsh et al, 2013). Above the water table, NMR provides volumetric water content measurements. The specific tool used depended on the diameter of the well, because larger diameter wells require a larger tool that has a larger radius of investigation. All tools provided a measurement approximately every 1.5 to 2 feet of depth. The high-resolution estimates of hydraulic conductivity were compared to the lithologic logs and aquifer testing results for each well to assess the possibility of preferential flow. The final NMR report is provided in Appendix F.

Because the translation of NMR data to hydraulic conductivity requires the use of an empirical relationship, the correct model for the degree of consolidation of the formation must be selected in order to yield accurate estimates of hydraulic conductivity. The boreholes examined at the Galleria Drive bioremediation treatability study area using NMR transitioned from unconsolidated to semi-consolidated UMCf, so the unconsolidated model was used for the upper portion of each borehole, and the semi-consolidated model was used for the lower portion. The transition to the semi-consolidated model was identified based on the observed level of cementation (moderately to strongly cemented) and consistency (stiff, very stiff, or hard). If neither of these data types was available, UMCf lithology was used to determine the dividing line, with clays indicating a more consolidated region. The dividing line between unconsolidated and semi-consolidated materials was located at the shallowest depth in which the available data indicated an increase in consolidation.

NMR estimates of hydraulic conductivity generally agreed with estimates derived using slug testing within an order of magnitude, particularly higher in the borehole. However, the drilling-related disturbance zone surrounding the borehole appears to have been larger in the deepest portion of each hole. For the four-inch well (GRTS-MW03B), the larger NMR tool clearly reached beyond the damage zone around the borehole. However, in the two-inch wells, the smaller NMR tool did not consistently penetrate the formation past the damage zone around the borehole. This is observable in the logs as sporadic large increases in the hydraulic conductivity, particularly in the sand-packed interval where the damage zone was not grouted. These irregularities will not affect the treatability study because aquifer properties were estimated using several aquifer testing methods, with the expectation that site-specific conditions might render one method less reliable.

The water content log was particularly useful as it indicated that the water content of the UMCf in the Galleria Drive bioremediation treatability study area was not as high as observed at the SWF Area Bioremediation Treatability Study. These data correlated with field observations that the area had significantly more cementation

than previously encountered during field work for the SWF Area Treatability Study. Furthermore, the mobile porosity, which is approximately equivalent to effective porosity and provides a distinction between "more bound" water from "more mobile" water, is very low, often below 1% in this study area. This corresponds well with the observed groundwater flow velocities, which in spite of low hydraulic conductivities are faster than anticipated because of the low effective porosity.

2.5 STEP-RATE INJECTION TESTS

The original treatability study conceptual design presented in the Work Plan focused on ISB in the upper portion of the UMCf from 60 – 85 feet bgs, which was based on site knowledge of the likely extent of contamination at the time the original work plan was prepared. However, initial Phase 1 pre-design activities performed within the 90 – 110 feet bgs interval identified both perchlorate groundwater concentrations as high as 3.2 mg/L and a complex hydrogeologic and geochemical environment. As a result, additional technical evaluation to assess the feasibility of ISB in this deeper, impacted zone of the UMCf was recommended in Modification No. 3.

As part of this additional technical evaluation, a field screening step-rate injection test was included to evaluate the practicability of injection into the 90 – 110 feet bgs interval in this study area. This evaluation was critical since the ability to inject carbon substrate-laden fluids into the subsurface is one of the cornerstones of successful ISB application. The subsurface material within the 90 – 110 feet bgs interval within the Galleria Drive Bioremediation Treatability Study area is semi-consolidated and more cemented than has been encountered in the UMCf at other treatability study locations. Secondly, the groundwater may be migrating through fractured networks or more transmissive zones within the cemented material. As presented in Section 2.5, this 90 – 110 feet bgs interval has an extremely low hydraulic conductivity (estimated at 0.002 ft/day from slug tests) and, therefore, it is important to examine the engineering viability of injecting fluids prior to embarking on a larger scale field treatability test.

Prior to performing the step-rate injection test, an Underground Injection Control (UIC) permit amendment was submitted to request permission to inject water from a nearby City of Henderson fire hydrant at pressures of up to 60 pounds per square inch (psi). Following approval of the UIC permit amendment request, the step-rate injection tests were performed the week of September 17 – 21, 2018, by Cascade Technical Services with Tetra Tech oversight. To gauge the variability within the subsurface, step-rate injection tests were performed in all four of the newly installed pre-design monitoring wells that are screened from 90 – 110 feet bgs, namely GRTS-MW01B, GRTS-MW02B, GRTS-MW03B, and GRTS-MW04B (shown in Figure 2). Because the monitoring well construction does not differ significantly from the proposed injection well construction, using the monitoring wells installed as part of pre-design activities to assess possible injection rates and effects was deemed appropriate.

During the field test, water obtained from a nearby City of Henderson fire hydrant was injected into a single monitoring well, typically increasing the injection pressure in approximately 10 psi increments to a maximum pressure of 60 psi. Injections occurred for approximately 20 minutes for each 10-psi increment. During the test, injection flow rates, total volume injected, and injection pressures were monitored at the injection well. Manual water levels were collected from surrounding monitoring wells before the start of each test, during each step-rate injection/pressure increase, and during recovery after testing to determine if the injections induced changes in water levels in the vicinity of the treatability study area. Select monitoring wells were also instrumented with In-Situ Rugged TROLL 100 pressure transducers, which were programmed to collect data at 15-minute intervals, to evaluate the areal extent of pressure response to injections. Field parameter measurements, including TDS and conductivity, were also collected with a downhole probe to evaluate whether actual injected water entered any of the surrounding monitoring wells. Once the test completed the injection step at 60 psi, the test was discontinued and equipment was moved to the next monitoring well to repeat the process.

The results of the test indicated that limited water could be injected into the subsurface. Total injection quantities for each well ranged from 5.6 to 15.1 gallons. The maximum injection rate achieved at the highest tested injection pressure of 60 psi was only 0.4 gallons per minute (gpm) and this injection rate was only attained in one of the four wells that were tested. ***Table 2*** presents a summary of the injection quantities on a per well basis during each

injection pressure interval. A complete report of step-rate injection tests by Cascade Technical Services is provided in Appendix G.

Table 2 Step-Rate Injection Test – Injection Summary

Injection Well	Injection Date and Time[1]	Targeted Pressure (psi)	Sustained Pressure (psi)	Average flow (gpm)	Volume of Water Injected (gal)[2]
GRTS-MW01B	9/19/2018 11:33	-	-	-	14.2
		0	0.0	0.0	0.0
		10	10.2	0.0	0.0
		20	20.5	0.1	1.1
		30	31.1	0.0	0.3
		40	40.9	0.0	0.1
		50	50.8	0.1	1.4
		60	60.1	0.2	4.6
		Total volume of water injected			**7.5**
GRTS-MW02B	9/19/2018 08:51	-	-	-	15.2
		0	0.6	0.0	0.0
		10	10.9	0.0	0.0
		20	20.3	0.1	1.2
		30	31.2	0.0	0.5
		40	41.1	0.0	0.4
		50	50.6	0.2	4.4
		60	59.9	0.4	8.6
		Total volume of water injected			**15.1**
GRTS-MW03B	9/18/2018 14:09	-	-	-	27.9
		0	0.0	0.0	0.0
		10	10.9	0.0	0.0
		20	20.1	0.1	1.2
		30	30.8	0.1	0.9
		40	40.6	0.1	2.7
		50	50.7	0.2	3.2
		60	60.5	0.2	2.3
		Total volume of water injected			**10.3**

Injection Well	Injection Date and Time[1]	Targeted Pressure (psi)	Sustained Pressure (psi)	Average flow (gpm)	Volume of Water Injected (gal)[2]
GRTS-MW04B	9/18/2018 12:45	-	-	-	15.0
		0	0.0	0.0	0.0
		10	12.5	0.0	0.0
		20	20.5	0.1	0.6
		30	33.1	0.0	0.2
		40	40.3	0.0	0.3
		50	51.9	0.0	0.3
		60	60.1	0.2	4.2
		Total volume of water injected			**5.6**

Notes:

[1] Injection test start time
[2] Initial entry for each well represents the amount of water initially required to fill the monitoring well casing above the water table.
psi – pounds per square inch
gpm – gallons per minute
gal – gallons

In-line with the data presented in ***Table 2***, there was no measurable groundwater response observed in surrounding monitoring wells during the injection tests. Following completion of the step-rate injection tests, water levels declined slowly in the injection wells and had not returned to pre-injection levels in any of the wells by the end of the testing week. For example, the step-rate injection tests were performed in monitoring wells GRTS-MW03B and GRTS-MW04B on the first day of testing and approximately 40 hours after the tests were complete, water levels had not returned to pre-injection levels. These slow rates of water level decline are consistent with the results of slug testing within this area, in which water levels were very slow to return to their previous levels in the wells screened from 90 – 110 feet bgs.

In general, these results were anticipated due to the UMCf within the 90 – 110 feet bgs interval being semi-consolidated/more cemented and due to aquifer test results indicating that this interval has an extremely low hydraulic conductivity (estimated at 0.002 ft/day). The low injection rates at high pressures observed during the step test indicate that injections of carbon-substrate laden water and follow-up distribution water into this lithological zone would be at prohibitively low injection rates, even at high injection pressures, which may result in ISB being impractical in the lower UMCf from 90 – 110 feet bgs within this area or other areas with similar characteristics.

2.6 LABORATORY STUDIES

Bench-scale laboratory studies performed in connection with previous and on-going treatability studies have provided significant data on the biodegradation potential of perchlorate and other electron acceptors using emulsified vegetable oil (EVO) as the carbon substrate, as well as further information on the potential longevity of the carbon substrate. The original proposal presented in the Work Plan to perform a single study for the Las Vegas Wash Bioremediation Pilot Study and Galleria Drive Bioremediation Treatability Study presumed that soil lithological and geochemical characteristics were similar. Preliminary chemical and lithological analyses have indicated that the soil from the two areas is geochemically and mineralogically quite different. Therefore, these two areas were not combined for purposes of bench-scale testing.

As explained in Section 2.3.1.2 and 2.4, soil and groundwater collected from both the 60 – 85 feet bgs and 90 – 110 feet bgs intervals were transported to UNLV to perform bench-scale studies using area-specific soil and groundwater. Soil was collected during drilling operations and placed in sterile plastic buckets with sterile hand shovels. Four 3-gallon buckets of soil cuttings were collected during drilling operations associated with GRTS-MW03A/B to be used in the batch microcosm testing.

Initial bench-scale tests only targeted the 60 – 85 feet bgs interval. Based on data collected during the Phase 1 pre-design activities, Modification No. 3 recommended additional bench-scale testing on the soil and groundwater collected from the 90 – 110 feet bgs interval. The following sections provide a preliminary overview of the studies and associated results that are currently available. A final bench-scale treatability study results report will be provided as an appendix in the forthcoming *Galleria Drive Bioremediation Treatability Study Results Report*.

2.6.1 Laboratory Studies: 60 – 85 Feet BGS Interval

Short-term batch microcosm perchlorate biodegradation tests were performed using soil and groundwater from the UMCf collected from the 60 – 85 feet bgs to confirm the ability of EVO and soluble substrates (for example, glycerin) to biodegrade perchlorate and provide an estimate of the acclimation time and perchlorate biodegradation timeframes. Results from the studies performed using the soil and groundwater from the 60 – 85 feet bgs interval indicated that perchlorate concentrations reduced from 6.8 mg/L to below detection limits (<0.05 mg/L) in the microcosm test within 18 days and 23 days using EVO and glycerin, respectively. The relatively high TDS concentrations in groundwater within the 60 – 85 feet bgs interval (approximately 15,000 mg/L in samples transported to UNLV) did not hinder microbial activity and biodegradation of perchlorate. Based on the results of the batch microcosm testing, bioaugmentation (the addition of acclimated perchlorate microorganisms) and/or the addition of nitrogen micronutrients are unlikely to be required at this site.

2.6.2 Laboratory Studies: 90 – 110 Feet BGS Interval

Based on recommendations in Modification No. 3, additional bench-scale testing on the soil and groundwater collected from the 90 – 110 feet bgs interval began in September 2018. Specifically, batch microcosm testing was included to evaluate ISB in the 90 – 110 feet bgs interval to understand if native microorganisms can successfully overcome the high sulfate and TDS concentrations and proceed to biodegrade perchlorate and chlorate. As explained in Section 2.4.2, high levels of sulfate and TDS in groundwater (concentrations as high as 34,000 and 64,000 mg/L, respectively) could pose a challenge to the microbial community. Additionally, sulfate can also be an electron acceptor and potential carbon substrate consumer during bioremediation processes. Uncontrolled sulfate biodegradation could result in (1) a gradual predominance of sulfate-reducing microorganisms that could out-compete perchlorate reducing microorganisms, (2) the production of large quantities of hydrogen sulfide, and (3) the precipitation of metal sulfides that further reduce the already low hydraulic conductivity and permeability in the subsurface.

As part of this testing, batch microcosms were set up to separately evaluate EVO and glycerin as carbon substrates as well as the need for bioaugmentation. Initial results of the batch microcosms five days after start-up indicate that perchlorate is biodegrading in microcosms that are treated with either EVO or glycerin as the carbon substrate. Perchlorate concentrations decreased by approximately 57 percent (from 3.5 mg/L to 1.5 mg/L) within the first 5 days in the microcosms amended with EVO, while microcosms that have been amended with glycerin have observed perchlorate reductions of approximately 29 percent (from 3.5 mg/L to 2.5 mg/L). Within 11 days after start-up, perchlorate was reduced in both sets of amended microcosms (EOS and glycerin) to less than 0.05 mg/L. Perchlorate concentrations have remained less than 0.05 mg/L in subsequent samples collected on Day 15 and 18. Batch microcosms were also set-up to evaluate both EVO and glycerin separately with bioaugmentation using the sludge from the onsite fluidized-bed reactor. Bioaugmentation of the microcosms appears to slightly hasten the onset and timeframe of perchlorate biodegradation in the laboratory setting. Based on the results to-date, the high sulfate and TDS concentrations present in the study area do not appear to be immediately toxic to native microorganisms, which appear to adapt well upon the addition of a carbon substrate.

In addition to periodic sampling for perchlorate and chlorate, sulfate concentrations have also been monitored since start-up of the batch microcosm tests. Initial results of sulfate concentrations indicate the quick onset of sulfate reduction in the microcosms with approximately 15 to 20 percent removal of sulfate within the first 19 days, which equates to a decrease of approximately 5,000 mg/L of sulfate. This indicates that significant sulfate reduction may be expected in field applications of ISB in the lower UMCf from 90 – 110 feet bgs. As previously explained, rapid and excessive sulfate reduction is generally not desirable because of potential problems it could cause with precipitation of metal sulfides, over consumption of carbon substrate, and production of hydrogen sulfide.

In conclusion, these batch microcosm results indicate that perchlorate reducing microorganisms can biodegrade perchlorate in groundwater in the treatability study vicinity, regardless of the elevated TDS and sulfate concentrations present within the 90 – 110 feet bgs interval. Batch microcosm tests for the 90 – 110 feet bgs interval are now complete and UNLV is in the process of finalizing the data and associated reporting, which is expected to be completed in the first quarter of 2019.

2.6.3 Sorption/Desorption Tests

Following completion of the batch microcosm testing, EVO batch sorption/desorption tests on soil and groundwater from the 60 – 85 feet bgs zone of the UMCf were performed to understand the interactions of site-specific soil with EVO. As part of this testing, different quantities of wet soil from the 60 – 85 feet bgs zone were placed in centrifuge tubes with known quantities of EVO. Standard adsorption test procedures of centrifuging, supernatant extraction, and soil incineration were used to determine the adsorption capacity of soil. Results indicated that the adsorption capacity of the soil was between 0.08 to 0.18 grams of oil/gram of soil, which is approximately three times greater than estimates obtained during previous bench-scale studies on alluvial material.

3.0 PHASE 2 TREATABILITY STUDY DESIGN

This section describes the Phase 2 treatability study design, which includes specific objectives, injection and monitoring well layout, and injection design. The treatability study design has been modified from the conceptual design that was presented in the Work Plan based on the Phase 1 pre-design results described in Section 2.0 of this Addendum. As explained in Section 1.1, the overall objective of the treatability study is to demonstrate and evaluate the effectiveness of implementing ISB to reduce the contaminants present in the UMCf that are migrating through the vicinity of Galleria Drive within the Eastside Study Area.

As described in Section 2.4.2, perchlorate was detected in groundwater from monitoring wells screened in both the 60 – 85 feet bgs and 90 – 110 feet bgs intervals. Results from the step-rate injection testing (Section 2.6) indicate that ISB will be difficult to implement in the 90 – 110 feet bgs interval due to the extremely low injection rates (even at high injection pressures). Although the batch microcosm results do not point to any obvious toxicity due to high TDS and sulfate concentrations, physical hurdles make the technology impractical. The more cemented/semi-consolidated nature of the deposits and low hydraulic conductivity are very difficult to overcome, which as described in Section 2.6, results in limited injectability. Follow-up injections and subsequent events may prove to be even more prohibitive, once bioactivity occurs. This could particularly be true once sulfate biodegradation and sulfide precipitation occurs and hydraulic conductivity further reduces to a very minimal level. As a result, the Galleria Drive Bioremediation Treatability Study will focus on the implementation of ISB for the 60 – 85 feet bgs interval within the UMCf. Completion of this treatability study will provide important information to assess the effectiveness of ISB within the UMCf, which has not been evaluated to date, and examine how effective ISB would be at achieving the RAO of mid-plume containment and mass reduction, which will provide key data for the FS.

3.1 TREATABILITY STUDY OBJECTIVES

The objectives of the treatability study performed in the upper UMCf, which will focus on the 60 – 85 feet bgs interval, are to accomplish the following:

- Evaluate the feasibility and effectiveness of implementing ISB in the UMCf to reduce the contaminant mass flux that is migrating through the vicinity of Galleria Drive within the Eastside Study Area (the location of the mid-plume RAO boundary).
- Estimate the zone of influence for substrate and biodegradation achievable in the UMCf during the treatability study.
- Assess the impact of elevated sulfate and TDS concentrations on the bioremediation process.
- Estimate or extrapolate the longevity of the carbon substrate and frequency of carbon substrate replenishment required to reduce contaminants immediately downgradient of the treatability study injection transect.
- Provide critical information applicable to the remedial alternatives evaluation in the forthcoming FS.

3.2 TREATABILITY STUDY LAYOUT AND WELL DESIGN

Both injection wells and a supplemental monitoring well network will be installed to evaluate the effectiveness of the ISB treatability study. The layout of proposed injection and monitoring wells is provided in Figure 5. The same pre-installation procedures, including utility surveys and filing of well permit applications, will be followed as described in Section 2.3.1.1. Drilling, well installation, and well development procedures are provided in the *Field Sampling Plan, Revision 1* (ENVIRON, 2014).

All fieldwork associated with the treatability study will be conducted in accordance with an Activity Hazard Analysis and other elements of the Site-Wide Health and Safety Plan (Tetra Tech, 2015), which addresses

potential chemical and physical hazards associated with the treatability study. It is anticipated that modified Level D personal protective equipment will be required for all field activities.

3.2.1 Injection Well Layout and Design

The final injection well construction and layout design are based on the Phase 1 pre-design results described in Section 2.0 and lessons learned from previous and on-going treatability studies, which are still being evaluated. Among the lessons learned are that a double-transect with staggered wells is not advantageous in a highly heterogeneous subsurface with considerable percentages of fine lenses among more conductive lenses. In general, the treatability study design in this Addendum is similar to the conceptual design presented in the Work Plan. Details and variances from the conceptual design are presented below:

- **Location** – The injection wells will be installed in a single injection well transect row that is approximately 200 feet long, as presented in Figure 5. The orientation of the injection well transect was slightly modified from the conceptual design to account for the northeasterly groundwater flow direction. The orientation of this injection well transect is perpendicular to groundwater flow to intersect contaminated groundwater flowing through the treatability study area.
- **Targeted treatment interval** – The lithology and potential preferential flow zones within the UMCf in the treatability study area were evaluated to determine the appropriate injection well screen length and depth. Based on a review of these data, injection wells will generally be screened from 60 – 85 feet bgs to target contaminants within the upper portion of the UMCf. Exact top of screen and associated screen length will be determined based on the lithology observed during drilling and indication of first water in the borehole, which may range from 47 to 60 feet bgs based on pre-design water levels.
- **Injection wells** – Nine injection well locations will be installed along the 200-foot transect, resulting in an injection well spacing of approximately 25 feet. This injection well spacing should be sufficient to optimize subsurface distribution and account for variability and non-uniform groundwater flow and lithology by improving the contact of carbon substrate with contaminants in the saturated matrix. However, up to three additional injection well locations may be installed at a later date, if warranted, based on monitoring results following the first injection event. This approach will also assist in the evaluation of optimal injection spacing within the UMCf. Injection wells will be constructed of 2-inch schedule 80 PVC casing and screened with slotted PVC well screen (similar to the pre-design monitoring wells discussed in Section 2.3.1.3). If required, nested injection wells may be installed if targeted treatment thickness is greater than 20 feet (determined based on field observation of first water in borehole to a targeted depth of 85 feet bgs) in order to provide optimal distribution of carbon substrate. All injection wells will be completed with neat cement grout to surface and flush-mounted, traffic-rated well boxes, at an elevation approximately 0.5-inch above grade. Following well construction, but no sooner than 48 hours after well construction is complete, each of the newly installed wells will be developed.

Prior to the carbon substrate injections, slug tests will be performed on a subset of injection wells to determine pre-injection hydraulic conditions, using the same methods described in Section 2.5.1. NMR logging may also be performed in the injection wells, if it is determined in consultation with the Trust that additional data are needed based on field observations during drilling. Although no dye tracer study is contemplated at this time, if observations during the bioremediation treatability study data collection indicate that a dye tracer study would be valuable, a dye could be added to the injectate solution during a subsequent injection event and monitored at downgradient monitoring well locations accordingly. A treatability/pilot study modification would be submitted to provide details of the dye tracer study if incorporated into the bioremediation treatability study program.

3.2.2 Effectiveness Monitoring Well Layout and Design

Based on lessons learned from the other bioremediation treatability studies performed to date, a monitoring well network consisting of upgradient, cross-gradient, and downgradient monitoring wells will be installed at strategic

locations within the treatability study area to determine remediation effectiveness. Monitoring wells will be installed upgradient of the injection well network to determine the general contaminant concentrations in groundwater that is migrating into the injection well transect. Cross-gradient and downgradient monitoring wells will be installed at strategic locations to monitor treatment effectiveness and to help estimate the zone of influence of the carbon substrate following injections. The final treatability study layout includes installing an additional 12 monitoring wells at various locations directly in-line and offset from the injection wells at varying distances upgradient and downgradient of the injection well transects, as shown in Figure 5. Existing monitoring wells installed as part of the pre-design phase (GRTS-MW01A, GRTS-MW02A, GRTS-MW03A, GRTS-MW04A, and GRTS-MW05A/B) and previously installed wells MCF-06B and MCF-06C will also be incorporated into the effectiveness monitoring program.

Monitoring wells will be constructed of 2-inch schedule 40 PVC casing and screened with 2-inch diameter, 0.010-inch slotted PVC well screen from approximately 60 – 85 feet bgs. Wells will be installed by the same methods and procedures as the pre-design monitoring wells as discussed in Section 2.3.1.3. Wells will be completed with flush-mounted, traffic-rated well boxes at an elevation approximately one-half inch above grade. Following well construction, but no sooner than 48 hours after well construction is compete, each of the newly installed wells will be developed.

Prior to the carbon substrate injections, slug tests will be performed on a subset of monitoring wells to determine pre-injection hydraulic conditions using the same methods described in Section 2.5.1. Slug tests will be performed periodically throughout the treatability study, as they provide valuable information on subsurface conductivity changes following carbon substrate injections. NMR logging will also be performed in up to five additional monitoring wells selected based on field observations during drilling.

3.3 INJECTION DESIGN

This section presents the design for injections of carbon substrate and subsequent distribution water for the treatability study. In general, the injection design is consistent with the conceptual design presented in the Work Plan. Results from the previous bioremediation treatability study on COH property and the on-going SWF Treatability Study have provided preliminary findings on the longevity of each carbon substrate injection event, lateral and downgradient coverage or influence of the injections, and impact of the distribution water. Because Phase 2 of the Galleria Drive Bioremediation Treatability Study will be performed in the UMCf, the results of the previous and on-going studies performed in the alluvium have only been used as general guidance for the design needs of this study with respect to carbon substrate injections and follow-up distribution water.

3.3.1 Carbon Substrate Injections

The carbon substrate will be pressure-injected into injection wells using a mobile injection system, consisting of a tanker or trailer unit with a manifold piping system and hoses supplied with valves and regulators for controlling and monitoring the rates of injection. Prior to each injection, the injection solution will be prepared in a truck-mounted batch tank using water for dilution of the carbon substrate. The injection solution will be prepared by thoroughly mixing the carbon substrate, additional amendments, and water in the mixing tank. The injection solution will then be pressure-injected into the injection wells through a manifold with hoses equipped with quick disconnect fittings. Pressure gauges and a flow totalizer will be used to monitor the pressure and flow rates during injection at each injection well.

Based on the previous treatability studies, bench-scale study results, and pre-design results, EVO was selected as the primary carbon substrate. In addition to EVO, a soluble substrate and select additional nutrients and amendments will be blended into the carbon substrate solution. The soluble substrate, namely glycerin, will be added to the injectate solution to serve as an immediate source of carbon to drive the groundwater anaerobic rapidly and reduce acclimation time at the start of the study. Phosphate will also be added to serve as a nutrient for the microorganisms to reduce acclimation times during the first injection event. The use of phosphorus in

subsequent injection events will be evaluated and may be reduced or eliminated if monitoring results indicate it is no longer required. Finally, the results from the bench-scale studies and biotrap results indicate that bioaugmentation is not required for perchlorate biodegradation. As a result, bioaugmentation will not be included in the field treatability study.

Final quantities of the carbon substrate and associated amendments will be based on:

- Results and findings of the pre-design activities outlined in Section 2.0 (including both field activities and UNLV laboratory studies);
- Lithological and soil characteristics of the UMCf;
- Chemistry and geochemistry of the groundwater collected during the baseline groundwater sampling event occurring immediately prior to injections from the newly installed treatability study injection and monitoring wells (described in Section 3.2);
- Stoichiometric requirements for the carbon substrate based on the mass of perchlorate and other electron acceptors that will migrate through the treatability study area; and
- Results and findings of the previous and on-going treatability studies and literature case studies.

Prior to performing the injections, the carbon substrate solution (EVO, glycerin, and phosphate) will be diluted with water. This dilution is generally performed at a ratio of 1:4 parts of carbon substrate to water. However, this dilution may be increased up to 1:20 due to the lower hydraulic conductivity within the UMCf. Water used for dilution activities will be obtained from a nearby hydrant. An evaluation of water sources is provided in Section 3.3.2.

As presented in the previous conceptual design in the Work Plan, up to three separate injection events may be required during the treatability study timeframe, which will be sufficient to evaluate the objectives described in Section 3.1. It is anticipated that injection events will be spaced approximately 6 to 8 months apart; however, the final injection event schedule will be based on the effectiveness monitoring results following the first injection event.

3.3.2 Distribution Water

A designated quantity of water will be injected into each injection well either with or following each injection. This distribution water will improve the subsurface distribution of the carbon substrate within the injection well transect to create a more complete treatment zone. As presented in the conceptual design in the Work Plan, there are two choices for available water sources used as distribution water during the injections. These include COH water obtained from a nearby hydrant or extracted groundwater from nearby injection and/or monitoring wells. It should be noted that for the previous treatability study near the COH water treatment facility, hydrant water was used as the source for distribution water, while the SWF Area Treatability Study used extracted water from upgradient monitoring wells in the immediate vicinity of the treatability study. Although the use of extracted groundwater has advantages, the hydrogeologic characteristics of the UMCf within the bioremediation treatability study area make extracted groundwater a less than optimal water source due to the potential low yield. As a result, COH hydrant water will be used as the water source for both carbon substrate dilution and subsequent injections of distribution water.

4.0 PHASE 2 EFFECTIVENESS MONITORING PLAN

This section describes the monitoring program that will be used to assess treatment effectiveness during the treatability study.

4.1 GROUNDWATER SAMPLING PROCEDURES

General groundwater sampling activities will follow the guidance of the *Field Sampling Plan, Revision 1* (ENVIRON, 2014). Prior to groundwater sample collection, groundwater levels will be gauged in all wells for use in potentiometric contouring. Groundwater samples will be collected using low-flow purging and sampling techniques. During this purging, a pump capable of purging between approximately 0.1 to 0.13 gpm will be used to minimize drawdown and induce inflow of fresh groundwater. The pump discharge water will pass through a flow-through cell analyzer for continuous monitoring of field parameters (temperature, pH, turbidity, electrical conductivity, dissolved oxygen [DO], and oxidation-reduction potential [ORP]). Field parameters will be monitored and recorded on field sampling forms during purging. After the field parameter readings and water levels have stabilized, the wells will be sampled. Per the NDEP letter dated June 27, 2016, field-filtering of water samples for perchlorate analysis will not be required. Filtering for dissolved metals and hexavalent chromium analyses will be conducted in the field using a 0.45-micron filter.

4.2 EFFECTIVENESS MONITORING

Groundwater samples will be collected from all injection and monitoring wells in the vicinity of the treatability study to establish baseline conditions prior to the injections. After injections have occurred, groundwater samples will be periodically collected from the upgradient, cross gradient, and downgradient monitoring wells. The effectiveness monitoring well network will include 20 monitoring wells, namely GRTS-MW01A, GRTS-MW02A, GRTS-MW03A, GRTS-MW04A, GRTS-MW05A/B, the 12 newly installed monitoring wells proposed as part of the treatability study (illustrated in Figure 5), and existing monitoring wells MCF-06B and MCF-06C. A variety of field, laboratory, and microbial parameters that will be evaluated during the study are listed in ***Table 3***, which presents the parameters, associated analytical methods, and purpose. It is anticipated that groundwater sampling events will be performed on a monthly basis during the treatability study timeframe. The actual frequency of sampling, selected wells, and specific parameters to be sampled during each individual event may be adjusted based on the results from treatability study effectiveness monitoring events. Monitoring wells screened deeper than 90 feet bgs (ES-13, GRTS-MW01B, GRTS-MW02B, GRTS-MW03B, and GRTS-MW04B) will be periodically included in the groundwater sampling program to evaluate any impacts from injections in the deeper zone. Specialized microbial analyses, namely, PLFA analyses and the presence of the perchlorate reductase gene, will be determined via the employment of Bio-Traps® in select wells during the study. In addition, slug tests will be repeated periodically during the treatability study to examine any changes in hydraulic conductivity as a result of carbon injections and geochemical processes.

Table 3 Example Groundwater Effectiveness Monitoring Sampling Protocol

Parameter	Analytical Method	Purpose
Field Parameters		
EC	Field Meter	Assess geochemical conditions
pH	Field Meter	
DO	Field Meter	
ORP	Field Meter	
Temperature	Field Meter	
Turbidity	Field Meter	

Parameter	Analytical Method	Purpose
Field Parameters		
Sulfide	HACH Field Kit	Examine secondary geochemical impacts
Ferrous Iron	HACH Field Kit	Assess effect of reducing conditions on iron
Laboratory Parameters		
Perchlorate	E314.0	Assess treatment effectiveness
Chlorate	E300.1	Assess treatment effectiveness and examination as intermediate by-product of perchlorate biodegradation
Hexavalent Chromium	E218.6	Examine impact of reductive biological treatment on hexavalent chromium in groundwater
TOC	SM5310B	Assess carbon substrate distribution in the aquifer
TDS	SM2540C	Assess any impact of salts on delayed or slower perchlorate biodegradation in the flow-through mode
Alkalinity	SM2320B	Assess geochemical conditions
Nitrate	E300.0	Assessment of nitrate as the most likely competing electron acceptor and carbon substrate consumer
Chloride	E300.0	Examine the contribution of chloride to TDS
Sulfate	E300.0	Assessment of sulfate as an electron acceptor and potential carbon substrate consumer
Total Nitrogen	E351.2/E300.0	Examine the need for micronutrients
Total Phosphorus	E365.3	Examine the need for micronutrients
Manganese	SW846 6010B	Assess potential for biologically driven dissolution of manganese
Methane	RSK175	Examine secondary geochemical impacts
Dissolved Metals	SW6010B/6020	Assess secondary impacts of treatment (includes arsenic, chromium, iron, and manganese)
VFAs	VFA-IC	Surrogate carbon substrate assessment
PLFA	Microbial Insights Method	Examine microbial response to carbon substrate addition
Perchlorate Reductase Gene	Microbial Insights Method	Examine microbial response to carbon substrate addition

Notes:

BL: Baseline
EC: Electrical conductivity
DO: Dissolved Oxygen
ORP: Oxidation-reduction potential
PLFA: Phospholipid Fatty Acids
TOC: Total organic carbon
TDS: Total dissolved solids
VFAs: Volatile Fatty Acids

4.3 MASS FLUX EVALUATION

In conjunction with the groundwater monitoring, and as requested by NDEP, a groundwater model will be developed to assess the remedial effectiveness of the treatability study. The objective of the groundwater modeling is to calculate the groundwater flux through the injection well transects before and after injection. The groundwater model results will be used to estimate the amount of perchlorate mass destroyed and amount of perchlorate mass that remains in the subsurface after the treatability study is completed. Specifically, the groundwater model for this treatability study will be based on the most recent site-wide groundwater model available at the time of data collection. This groundwater model will be modified to focus on the treatability study area by using grid refinement and site-specific material properties measured by field techniques and laboratory analyses, such as geophysics, NMR, slug tests, and physical properties. Once constructed, the modified groundwater model will be calibrated to the groundwater response to injections conducted during this study. Following site-specific calibration, this model will be used to calculate groundwater flux through injection well transects and estimate the perchlorate mass destroyed or left in place by the treatability study.

4.4 DATA VALIDATION

All treatability study field samples and field quality assurance/quality control (QA/QC) samples will be evaluated for quality and usability. Field QA/QC samples will include equipment blanks, field blanks, field duplicates, and matrix spike/matrix spike duplicates. The QA/QC samples will provide information on the effects of sampling procedures and assess sampling contamination, laboratory performance, and matrix effects.

The laboratory analytical data will be verified and validated in accordance with procedures described in the *Quality Assurance Project Plan, Revision 2* (Ramboll Environ, 2017), *NDEP Data Verification and Validation Requirements* (NDEP, 2018), and email communication on NDEP data validation guidance (Clough, 2018).

5.0 PHASE 2 PERMITTING REQUIREMENTS

Multiple permits will be required prior to performing injection well installation and injection activities associated with this treatability study. This section presents a summary of the permit requirements that will likely be required for the implementation of the activities described in this Work Plan Addendum.

5.1 PERMITTING

A series of permits will be required for the various activities that are being proposed as part of the treatability study. In addition to the permits described here, a review of other potential permitting requirements was conducted. Based on the project design, several regulatory requirements likely will not apply. No dust control permit is needed, because the soil disturbance is expected to be less than 0.25 acres. Authorization under the construction stormwater general permit administered by NDEP is not anticipated, because cumulative disturbances are not expected to exceed 1 acre. Lastly, there will be no sustained wastewater discharges from well operations, so a discharge permit will not be required. Water from short-term well development and sampling will be collected and treated in the GWETS treatment system onsite.

5.1.1 Well Installation Permitting

Treatability study activities will require a NAC 534.441 Monitor Well Drilling Waiver and a NAC 534.320 Notice of Intent Card prior to installation of injection and/or monitoring wells associated with the treatability study. The Monitoring Well Drilling Waiver also requires a completed, signed, and notarized Affidavit of Intent to Abandon a Well as an attachment. As required, all injection and monitoring wells will be drilled by a licensed well driller pursuant to Nevada Revised Statutes 534.160 and will be constructed pursuant to NAC Chapter 534 – Underground Water and Wells. Upon the conclusion of this study, all injection and monitoring well abandonment will be done in accordance with the provisions contained in NAC 534.4365 and all other applicable rules and regulations for plugging wells in the State of Nevada.

5.1.2 NDEP – Underground Injection Control Program

This treatability study will require UIC permit authorization, which is anticipated to be issued under the NDEP UIC General Permit for Long-Term Remediation for injection of carbon substrate, amendments, and water into the saturated subsurface. Permit authorization is expected to be a modification to the existing general permit authorization, GU07RL-51057, issued for the bioremediation treatability studies to date. Alternatively, NDEP may require application for issuance of an individual UIC permit. The UIC permit will require injection reports to be submitted on a semi-annual basis.

6.0 PHASE 2 REPORTING

Monthly status updates will be provided to the Trust and NDEP summarizing the progress and results of the treatability study. Following completion of the treatability study, a final Galleria Drive Bioremediation Treatability Study Report will be prepared and submitted for NDEP and USEPA review. This report will summarize the treatability study activities and present the results of reducing contaminant concentrations in groundwater in the vicinity of the treatability study location. This report will include:

- Summary and application of bench-scale testing results, including final UNLV bench-scale summary report;
- Field treatability study implementation details based on the design presented herein, including presentation of the final injection and monitoring well layout, treatment depths and intervals in the UMCf, and a summary of injection activities;
- Summary of groundwater analytical data collected as part of the effectiveness monitoring program and evaluation of ISB effectiveness in reducing contaminants in groundwater within the treatability study area, including estimates of the perchlorate, chlorate and hexavalent chromium mass reduction during the treatability study timeframe;
- Estimation of the approximate degradation rates that were attainable in the field from trend graphs of individual monitoring wells;
- Determination of the technology's feasibility and effectiveness for full-scale application and other relevant components required for proper evaluation in the FS; and
- Preliminary cost considerations for future implementation of the technology including a summary of costs incurred during field implementation of this study and preliminary evaluation of cost for in-situ bioremediation.

7.0 PHASE 2 SCHEDULE

Phase 2 of this treatability study will begin upon NDEP and USEPA approval of this Work Plan Addendum, Trust approval of funding and providing notice to proceed, and timely agency approval of all necessary permits. Tetra Tech will coordinate its activities with Ramboll, which is leading the nearby ZVI Enhanced Bioremediation Treatability Study, to gain efficiencies where appropriate. It is expected that this treatability study (including submittal of the final report) will be completed by December 2020.

8.0 REFERENCES

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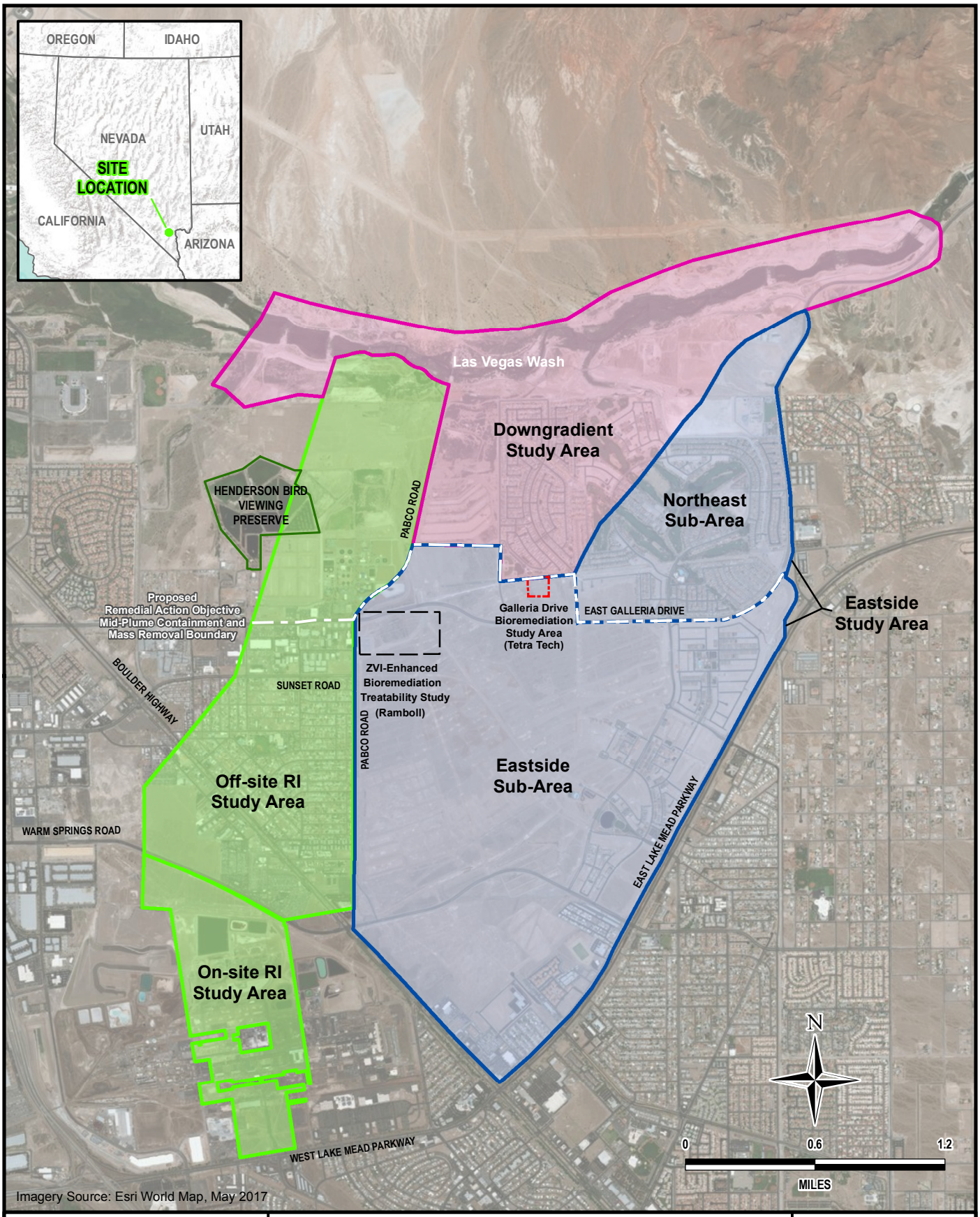
Figures



\\TTS100FS1\PROJECTS\NERT\GIS FIGURE DATABASE\MXD\M17\WP_ADDENDUM\FIGURE1.MXD

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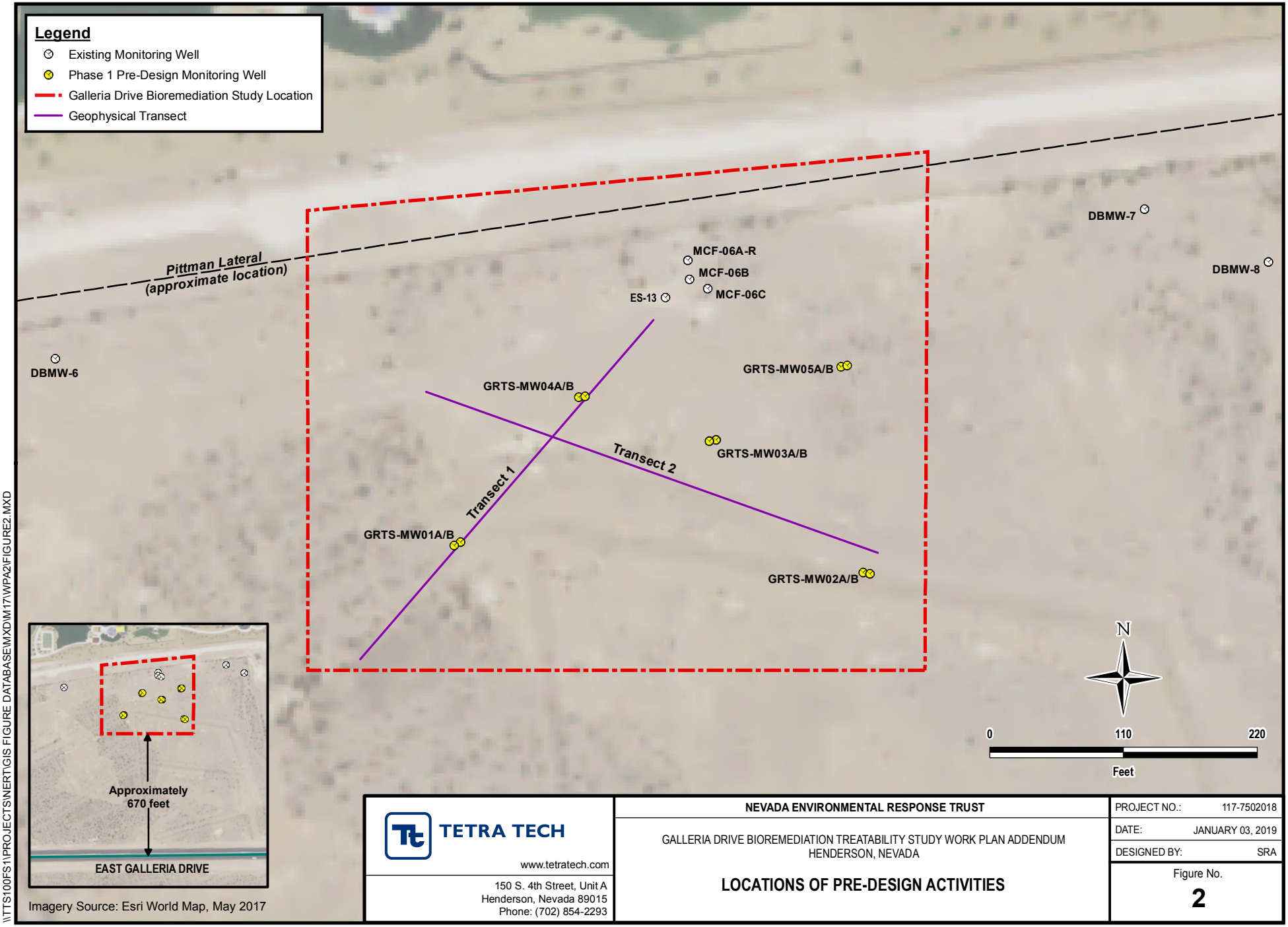
NEVADA ENVIRONMENTAL RESPONSE TRUST

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

TREATABILITY STUDY LOCATION

Project No.:	117-7502018
Date:	JUNE 28, 2018
Designed By:	SRA

Figure No.
1



Imagery Source: Esri World Map, May 2017

\\TTS100FS1\PROJECTS\NERT\GIS FIGURE DATABASE\MXD\M17\WPA2\FIGURE2.MXD

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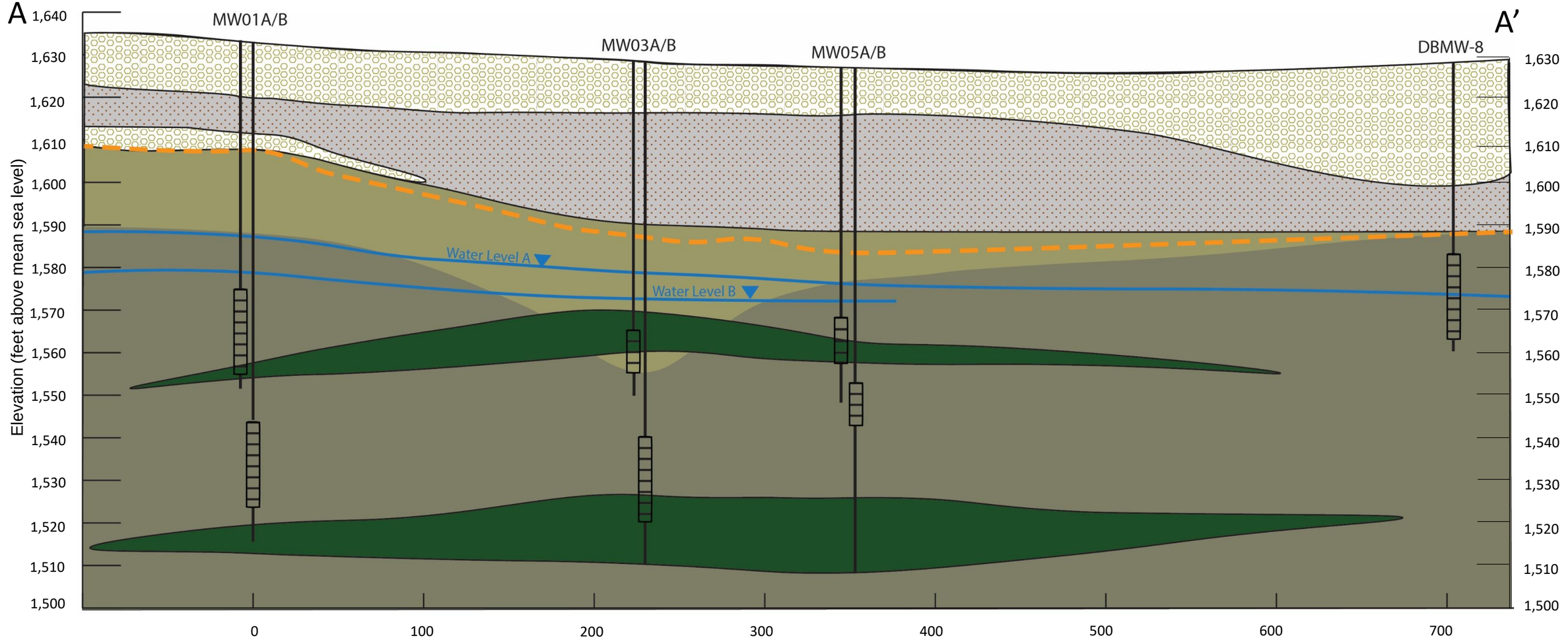
NEVADA ENVIRONMENTAL RESPONSE TRUST

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

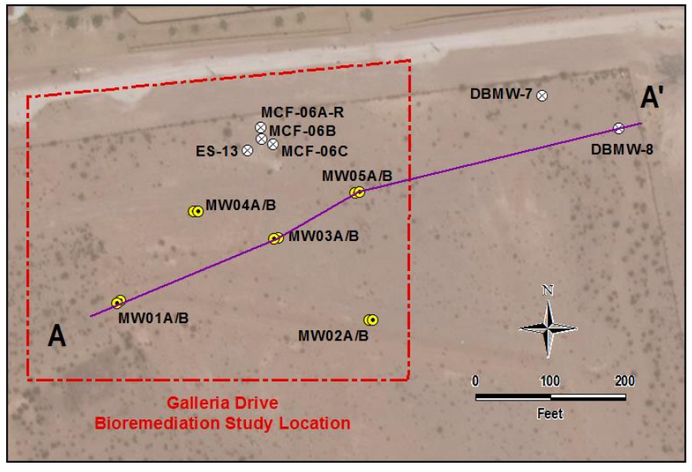
LOCATIONS OF PRE-DESIGN ACTIVITIES

PROJECT NO.:	117-7502018
DATE:	JANUARY 03, 2019
DESIGNED BY:	SRA

Figure No.
2



Cross-Section A-A'



- Alluvium - Sand
- Alluvium – Gravel and Sand with Gravel Channel Fill (>30% Gravel)
- Alluvium – Sandy Silt and Silty Sand (>30% Silt)
- Upper Muddy Creek Formation - Silt and Clay
- Semi-Consolidated Upper Muddy Creek Formation - Silt and Clay[1]
- Upper Muddy Creek Formation - Organic-rich Silt and Clay
- Well Casing
- Well Screen
- Total Boring Depth
- Depth to First Gypsum Encounter

Note:

1. Semi-consolidated Upper Muddy Creek formation contact represents the depth of the first occurrence of more cemented and consolidated material. Degree of cementation and consolidation varies with depth.

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NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

GEOLOGIC CROSS-SECTION A-A'

Project No.:	117-7502018
Date:	MARCH 4, 2019
Designed By:	MRB

Figure No.
3a

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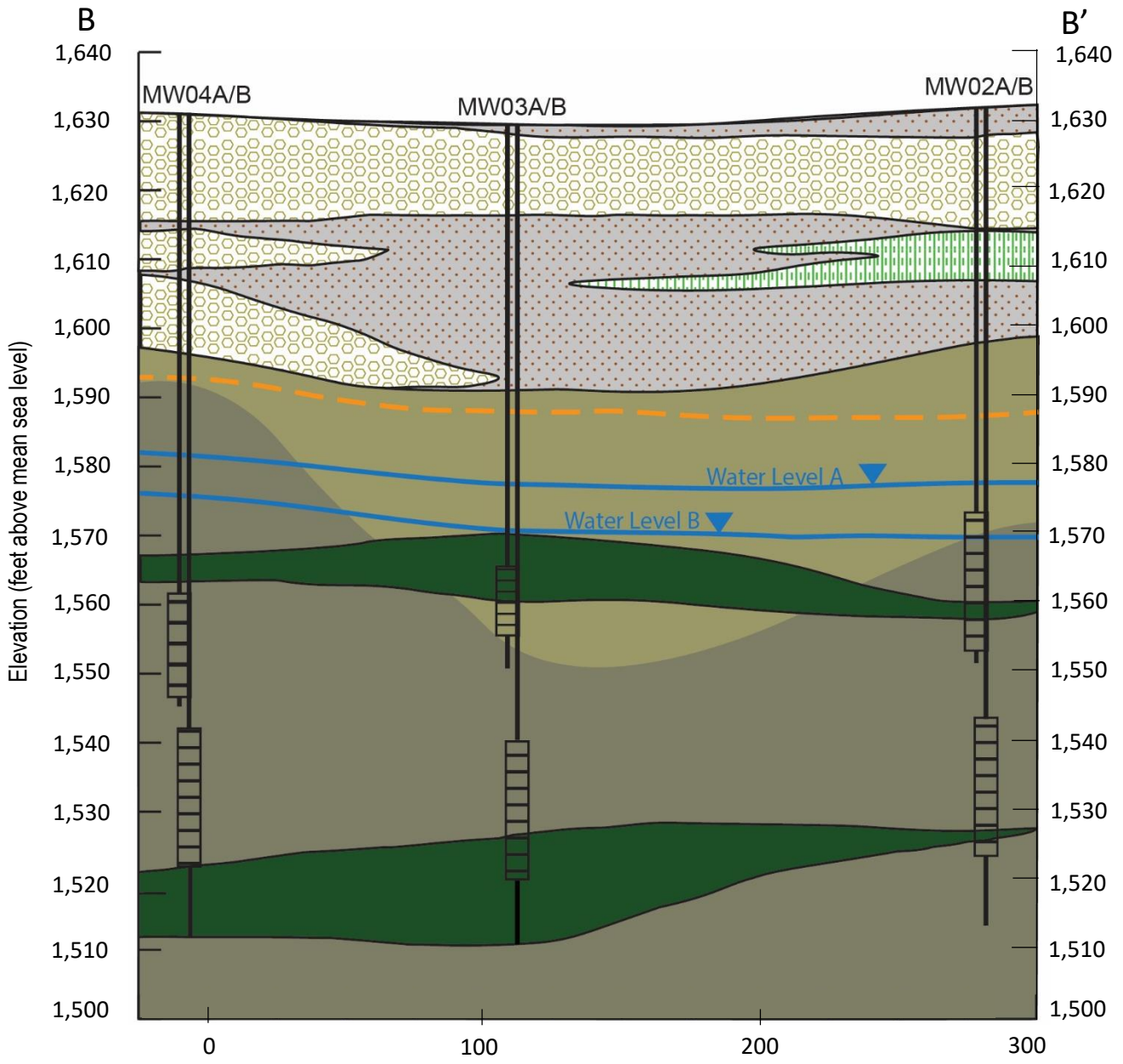
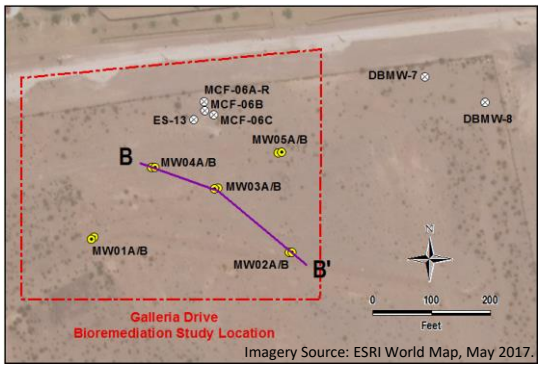


Cross-Section B-B'



- Alluvium - Sand
- Alluvium – Gravel and Sand with Gravel Channel Fill (>30% Gravel)
- Alluvium – Sandy Silt and Silty Sand (>30% Silt)
- Upper Muddy Creek Formation-Silt and Clay
- Semi-Consolidated Upper Muddy Creek Formation – Silt and Clay[1]
- Upper Muddy Creek Formation-Organic-rich Silt and Clay
- Well Casing
- Well Screen
- Total Boring Depth
- Depth to First Gypsum Encounter

Note:
1. Semi-consolidated Upper Muddy Creek formation contact represents the depth of the first occurrence of more cemented and consolidated material. Degree of cementation and consolidation varies with depth.

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NEVADA ENVIRONMENTAL RESPONSE TRUST

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORKPLAN ADDENDUM
CLARK COUNTY, NEVADA

GEOLOGIC CROSS-SECTION B-B'

Project No.:	117-7502018
Date:	MARCH 4, 2019
Designed By:	MRB

Figure No.
3b

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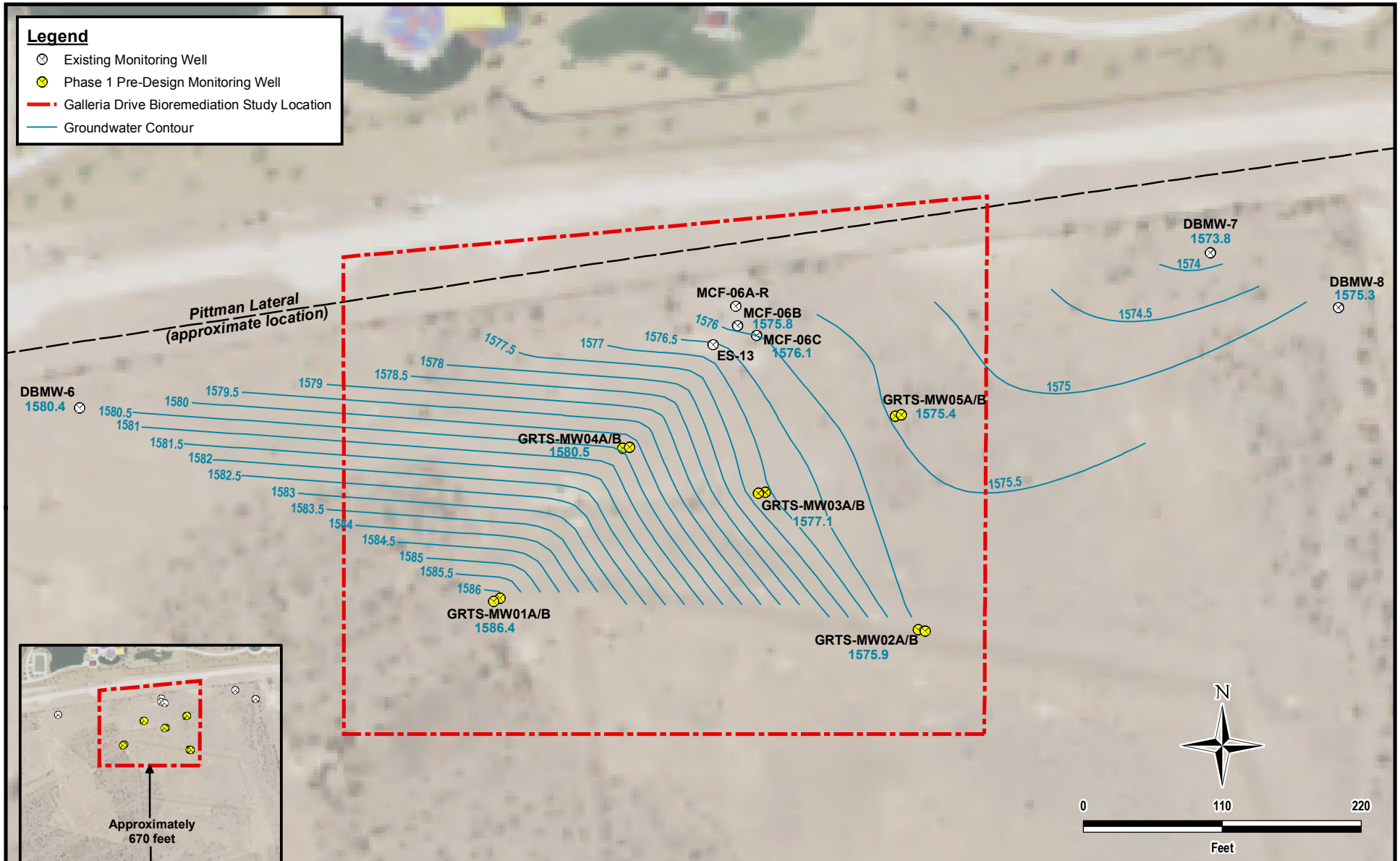

Notes:
1. Groundwater elevations were measured in May 2018.
2. Imagery Source: Esri World Map, May 2017.

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NEVADA ENVIRONMENTAL RESPONSE TRUST

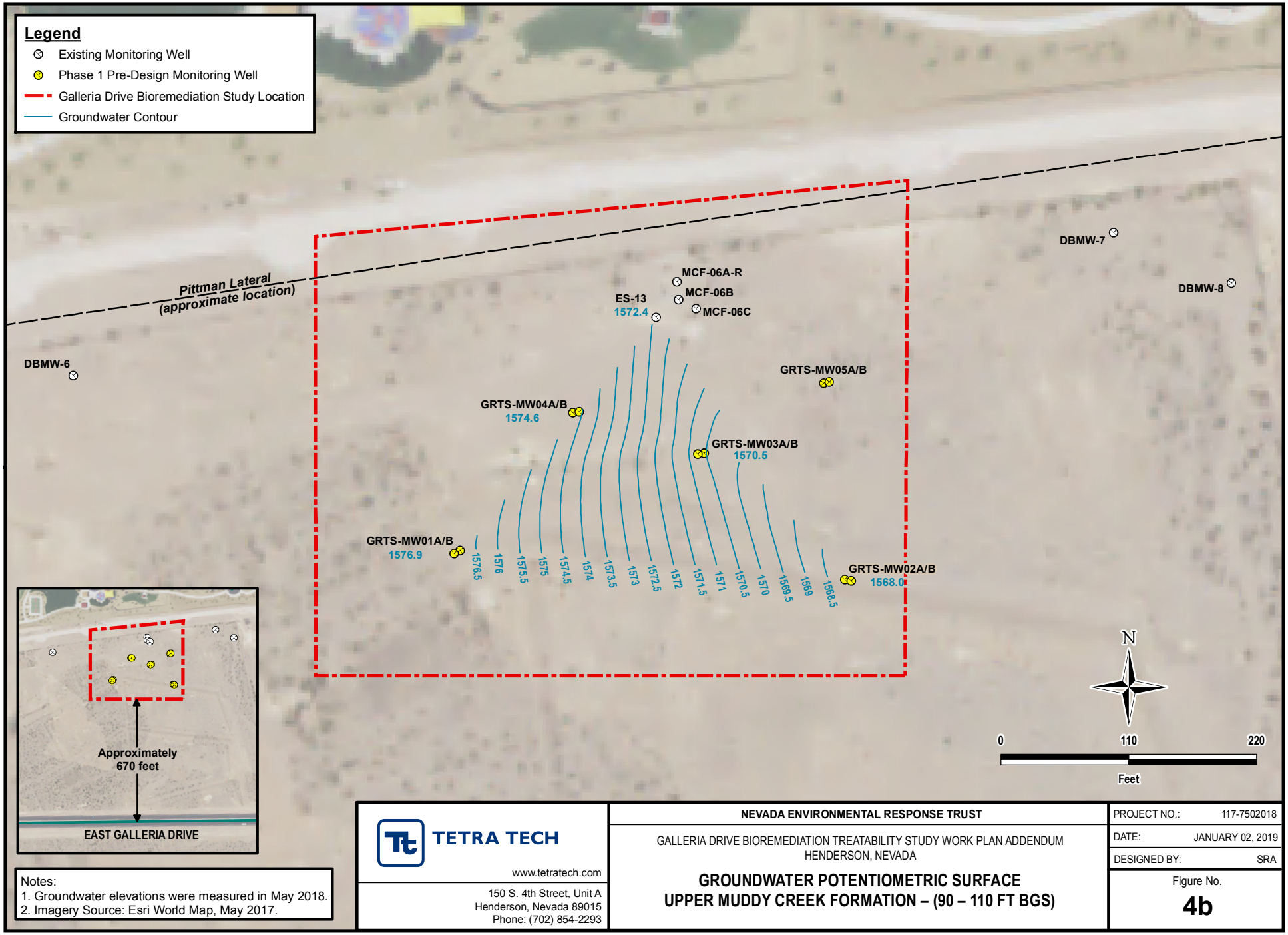
GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

GROUNDWATER POTENTIOMETRIC SURFACE
UPPER MUDDY CREEK FORMATION – (60 – 85 FT BGS)

PROJECT NO.:	117-7502018
DATE:	JANUARY 02, 2019
DESIGNED BY:	SRA

Figure No.
4a

\\TTS100FS1\PROJECTS\NERT\GIS FIGURE DATABASE\MXD\M17\WPA2\FIGURE4A.MXD



Notes:
1. Groundwater elevations were measured in May 2018.
2. Imagery Source: Esri World Map, May 2017.

TETRA TECH
www.tetratech.com
150 S. 4th Street, Unit A
Henderson, Nevada 89015
Phone: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST

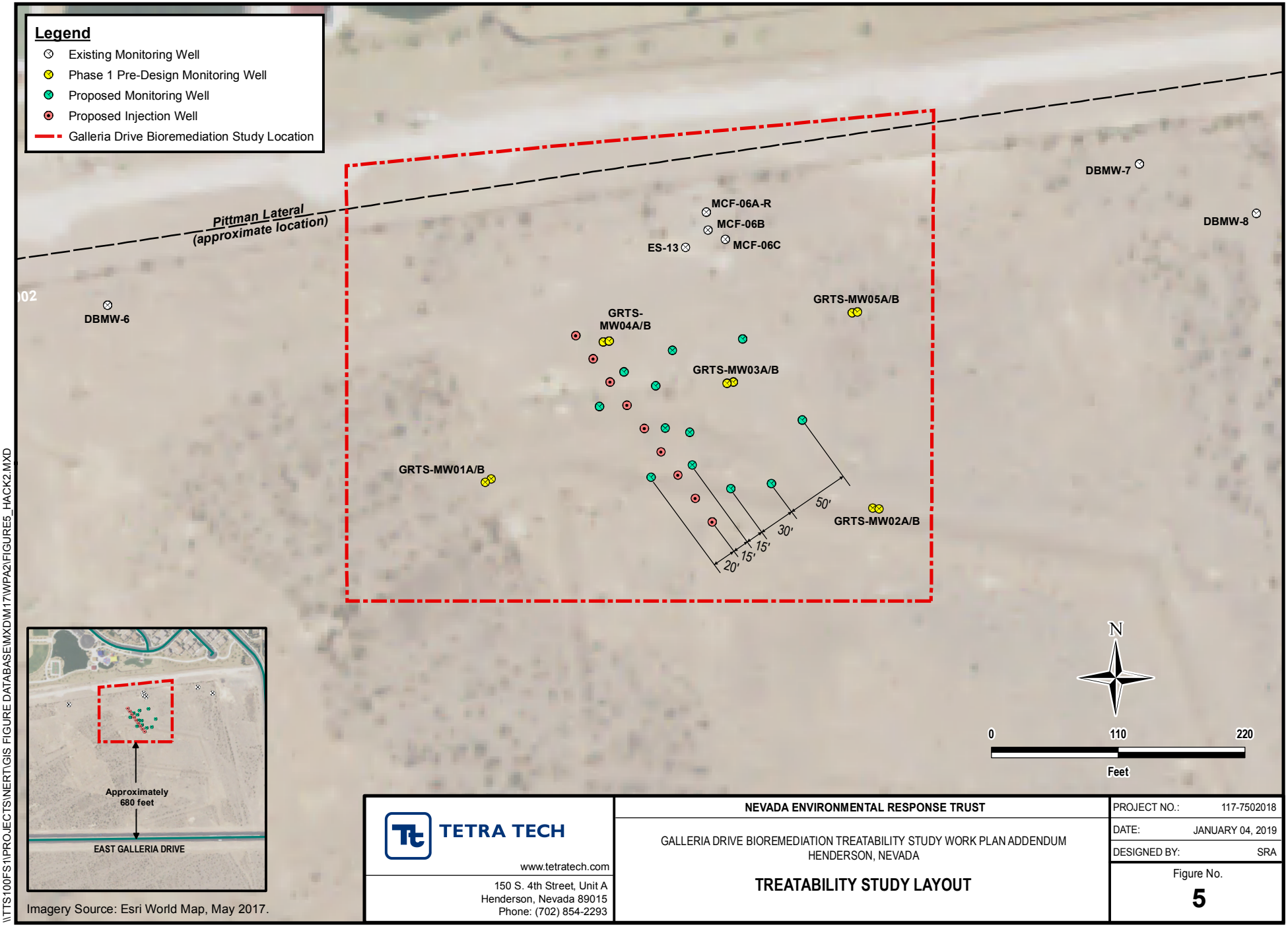
GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

GROUNDWATER POTENTIOMETRIC SURFACE
UPPER MUDDY CREEK FORMATION – (90 – 110 FT BGS)

PROJECT NO.:	117-7502018
DATE:	JANUARY 02, 2019
DESIGNED BY:	SRA

Figure No.
4b

\\TTS100FS1\PROJECTS\NERT\GIS FIGURE DATABASE\MXD\M17\WPA2\FIGURE4B.MXD



\\TTS100FS1\PROJECTS\NERT\GIS FIGURE DATABASE\MXD\M117\WPA2\FIGURE5_HACK2.MXD

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NEVADA ENVIRONMENTAL RESPONSE TRUST

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

TREATABILITY STUDY LAYOUT

PROJECT NO.:	117-7502018
DATE:	JANUARY 04, 2019
DESIGNED BY:	SRA

Figure No.
5

Appendix A
Geophysical Survey Report

REPORT

GEOPHYSICAL INVESTIGATION
NERT SITE
HENDERSON, NEVADA

GEO*Vision* Project No. 18136

Prepared for

Tetra Tech
1092 Commerce Park Dr., Suite 100
Oak Ridge, Tennessee 37830

Prepared by

GEOVision Geophysical Services
1124 Olympic Drive
Corona, CA 92881

Report 18136-01 rev 1

May 18, 2018

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1 INTRODUCTION

A time domain electromagnetic (TDEM) geophysical study was conducted in an area within the NERT site in Henderson, Nevada on March 28 and April 9, 2018. The purpose of the geophysical study was to map the interface between the Upper Muddy Creek formation (Tertiary Clay Unit) and the overlying alluvium, and to identify paleochannels cut into the clay unit, if possible. The principal geophysical technique employed was time domain electromagnetic (TDEM) soundings.

TDEM sounding data were collected along 2 traverses, each consisting of 4 individual soundings. The traverses, labeled Line 1 and Line 2 in Figure 1, were generally placed by Tetra Tech and modified by **GEO***Vision* to maximize the available space within site constraints. TDEM soundings were collected at 40 meter intervals using 40 m x 40 m transmitter loops. The position of each sounding was recorded by **GEO***Vision* using a submeter GPS (Table 1).

2 INSTRUMENTATION AND PROCEDURES

2.1 Survey Control

Two geophysical traverses (Line 1 and Line 2) were established by **GEO***Vision* and Tetra Tech prior to field activities. Sounding locations were staked at 40 m intervals along each traverse and surveyed using a Trimble® ProXRS submeter GPS system. Line 1 and Line 2 sounding locations are presented on a site map in Figure 1 and summarized in Table 1.

2.2 Time Domain Electromagnetic Survey

A Geonics EM47 transmitter (Tx), high-frequency receiver coil, and a Protem digital receiver (Rx) were used to conduct TDEM soundings. Soundings were acquired using a central-loop configuration in which the receiver coil is placed in the center of the transmitter loop.

At each sounding location a transmitter loop consisting of insulated 12-gauge copper wire was deployed on the ground as a square loop, centered on the sounding location, with roughly 40 m (131 ft) sides. The receiver coil was placed in the center of the transmitter loop and connected to the Rx via com cable. A reference cable between the Tx and Rx synchronized the system.

The EM-47 Tx, placed at one corner of the wire-loop, was used to drive current through the wire loop as a periodic modified square wave pattern. The Tx was operated at repetition frequencies of 285, 75 and 30 Hz. Generally, a Tx current of 2 amps was used for all repetition rates. The current driven through the Tx loop induces eddy currents in the subsurface, which generate secondary magnetic fields. The Rx coil records the decay of the secondary magnetic field during current off cycles at 20 logarithmically-spaced time gates. Hundreds of measurements were stacked at each location to improve signal to noise ratio. Data from each sounding were stored on Rx memory and transferred to a PC for processing.

3 DATA ANALYSIS

3.1 Time Domain Electromagnetic Survey

TDEM data collected for the eight soundings were transferred from the Protem Rx to a PC for editing and processing. All processing and modeling was performed with the software package Aarhus SPIA (HydroGeophysics Group, HGG). The initial step was to input all of the soundings into the program. For each sounding, data from the three frequencies were combined to produce one stacked voltage decay curve (transient). Measurements exhibiting excessive noise were either deleted or masked. Next data were transformed into apparent resistivity versus time gate. Each apparent resistivity curve was modeled by inversion to obtain a one-dimensional (1-D) geoelectric model. The inversion program then adjusts parameters so that the calculated curve converges to best fit the raw data. Two types of inversion routines were utilized: a simple 1-D layered model inversion and an advanced 1-D model inversion. The simple SPIA model inversion routine returns a smooth inverted model of 20 layers and a layered inverted model of 5 layers. Initial inversion model results were then evaluated; ensuring layers, boundaries, and error were within acceptable levels. To determine the influence and best fit of the number of layers on the solution, separate inversions with different numbers of layers were inverted with the Advanced Inversion subroutine, utilizing the results of the previous simple inversion and context of the site geology. The subsequent starting model parameters were used to generate a model with a final inversion, which is then output as a table and a graphic. Final model results were evaluated for geologic validity and submitted for internal QC.

The interpreted geoelectric model derived from each TDEM sounding is not unique. The magnitude of each individual layer resistivity and thickness can normally vary within a limited range with no significant change to the data fit. This variation is termed equivalence and is a problem faced by most surface geophysical techniques. Another form of analyzing equivalence is in the total number of layers used in the inversion model. In the SPIA program, the interpreter sets a fixed number of layers. During the inversion process, the program adjusts the layer resistivity and thickness so the model best fits the data. Generally, a minimum number of layers are used in the modeling program. This is determined by increasing the number of layers in the model until additional layers do not significantly improve the data fit. Models with three to five layers were used for the TDEM data collected during this investigation.

4 RESULTS

The purpose of the TDEM soundings was to image the subsurface in an attempt to determine the depth to the interface between the alluvium and the underlying Upper Muddy Creek formation and, if possible, determine if any paleochannels were present beneath the traverses. TDEM data inverted consistently and modeled easily. Error in the TDEM data may have been due to noise, likely the consequence of fence lines or monitor wells near the transmitter loops, and power lines in the vicinity. Although there were noise sources, repeat readings and longer acquisition times improved the signal to noise ratio, increasing confidence in the data and interpretations. A representative 1-D layered resistivity model, typical for the 8 TDEM soundings acquired for this project, is presented in Figure 2. The stacked resistivity curve and 1-D Layered model exhibit good agreement and low error. Residual errors for all models were less than 1, well within acceptable range.

Model resistivity results for Line 1 and Line 2 are presented as derived earth models in Figure 3 and Figure 4. Individual model results are provided in Table 2 through Table 9. Derived earth models are presented schematically, plotting model resistivities vertically beneath each station, i.e. 0 m, 40 m, 80 m, 120 m, along profile. Common resistivity values were connected along profile. This resulted in 3 layer earth models. The uppermost is likely associated with unsaturated coarse-grained sediment, exhibiting a resistivity ranging from 25 to 100 ohm-m and thickness of 28 to 43 ft. The second layer is likely associated with unsaturated Upper Muddy Creek formation (UMCf) and exhibits a resistivity of 4 to 10 ohm-m and a thickness ranging from 21 to 32 ft. The half space (lowest layer), below the unsaturated UMCf exhibits resistivity ranging from 0.5 to 2 ohm-m and is interpreted as saturated UMCf. Lithologic information from borehole logs and depth to water measurements obtained from monitor wells in the vicinity agree with the TDEM model results.

Interpreted depth to top of the interface between the alluvium and unsaturated UMCf ranges from approximately 28 to 43 ft, exhibiting minor lateral variability between soundings. However, there is no clear evidence of paleochannels at the resolution obtained using the TDEM method.

5 CONCLUSIONS & RECOMMENDATIONS

A geophysical study was conducted in an area within the NERT site in Henderson, Nevada on March 28 and April 9, 2018. The purpose of the geophysical study was to map the interface between the Upper Muddy Creek formation (Tertiary Clay Unit) and the overlying alluvium, and to identify paleochannels cut into the clay unit, if possible. The geophysical technique employed was time domain electromagnetic (TDEM) soundings. TDEM data inverted consistently and modeled easily with very good results and low model error. Repeat readings and longer acquisition times improved the signal to noise ratio, increasing confidence in the data and interpretations. Model resistivity results for Line 1 and Line 2 are presented as Figure 3 and Figure 4, and Table 2 through Table 9. Depth to the interface between the alluvium and the unsaturated Upper Muddy Creek formation is interpreted to range from approximately 28 to 43 ft. Results exhibit minor lateral variability between soundings. However, there is no clear evidence of paleochannels at the resolution obtained using the TDEM method.

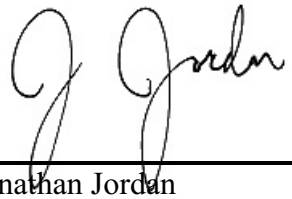
The 40 m Tx loop size, although successful at imaging the top of the interpreted interface, provided a very coarse sampling interval, likely too coarse to image potential paleochannels that may be smaller than 40 m wide. **GEO***Vision* recommends two-dimensional (2-D) electrical resistivity transects deployed coincidently along Line 1 and Line 2. Electrical resistivity profiles will provide true 2-D data and much higher near surface resolution which may allow better delineation of potential paleochannels cut into the UMCf.

Previous studies in the vicinity have also had positive results using the Geonics EM-34 system. **GEO***Vision* recommends acquiring EM-34 data at this site. It may be advantageous to grid the area of interest at approximately 10 m station intervals. Although the EM-34 provides 1-D sounding data, if deployed in a grid pattern, data may be contoured as a 2-D map or potentially a 3-D volume, which may help identify potential paleochannels cut into the UMCf.

6 CERTIFICATION

All geophysical data, analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a **GEO***Vision* California Professional Geophysicist.

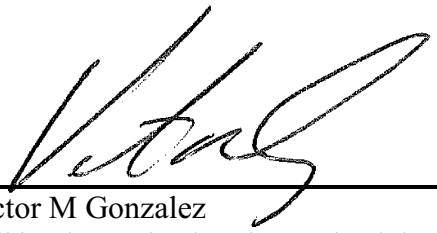
Prepared by



05/18/2018

Jonathan Jordan — Date
Senior Staff Geophysicist
GEO*Vision* Geophysical Services

Reviewed and approved by



05/18/2018

Victor M Gonzalez — Date
California Professional Geophysicist, P.Gp. 1074
GEO*Vision* Geophysical Services

* This geophysical investigation was conducted under the supervision of a California Professional Geophysicist using industry standard methods and equipment. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing, interpretation, and reporting. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review for a period of at least one year.

  A professional geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations, or ordinances.

Table 1 TDEM SOUNDING LOCATIONS

Line	Sounding	Northing (US Feet)	Easting (US Feet)	Elevation (US Feet)
1	1	26,728,682	834,646	1,634
1	2	26,728,782	834,729	1,633
1	3	26,728,880	834,815	1,630
1	4	26,728,979	834,901	1,630
2	1	26,728,920	834,715	1,628
2	2	26,728,876	834,839	1,627
2	3	26,728,831	834,961	1,627
2	4	26,728,788	835,085	1,627

1. Coordinates in NV State Plane, Nevada East (2701), NAD83 (Conus), US Survey Feet.
2. Coordinates taken with a Trimble ProXRS GPS System with OmniSTAR submeter corrections.

Table 2. Line 1 Station 1 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	25.7	41.7	**41.7**
2	4.2	23.2	65
3	1.5	46.3	110.9
4	0.9	86	196.9
5	1.0	∞	∞

Table 3. Line 1 Station 2 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	38.5	43.3	**43.3**
2	4.7	21.8	65
3	1.5	53.2	118.4
4	0.8	∞	∞

Table 4. Line 1 Station 3 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	96.7	34.1	**34.1**
2	8.0	30.2	64.3
3	1.8	53.5	117.8
4	0.9	81.7	199.5
5	1.0	∞	∞

Table 5. Line 1 Station 4 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	42.4	42.7	**42.7**
2	6.1	26.3	68.9
3	1.9	97.4	166.3
4	0.6	∞	∞

**** Bold indicates depth to top of Upper Muddy Creek Formation in derived 3 layer earth model**

Table 6. Line 2 Station 1 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	70.2	39.0	**39**
2	5.2	24.6	63.7
3	1.6	62.0	125.7
4	0.8	∞	∞

Table 7. Line 2 Station 2 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	61.3	28.2	**28.2**
2	10.0	31.8	60
3	1.7	52.2	112.2
4	1.1	∞	∞

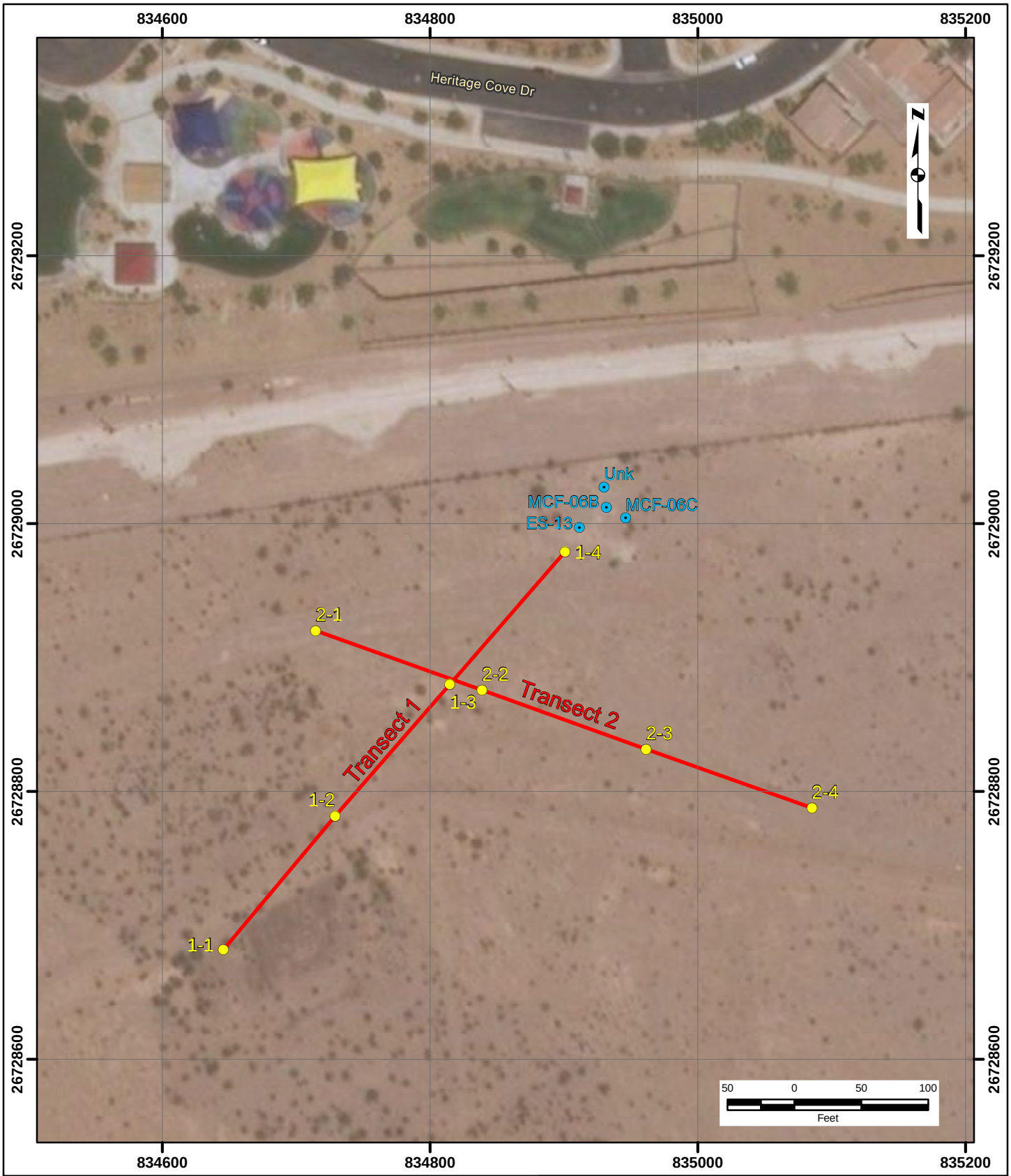
Table 8. Line 2 Station 3 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	40.3	34.5	**34.5**
2	7.7	32.4	66.9
3	1.9	∞	∞

Table 9. Line 2 Station 4 Model Results

Layer	Resistivity (Ω-m)	Thickness (ft)	Depth to Interface (ft)
1	37.8	38.1	**38.1**
2	6.1	32.4	70.5
3	1.6	38.4	108.9
4	1.1	∞	∞

**** Bold indicates depth to top of Upper Muddy Creek formation in derived 3 layer earth model**



Legend

- Geophysical Transect
- Existing Monitoring Well
- TDEM Sounding Location (1-1 = Transect 1 - Sounding 1)

NOTES:
1. Nevada State Plane Coordinate System, NAD 83, East (2701), US Survey Feet
2. Base map source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

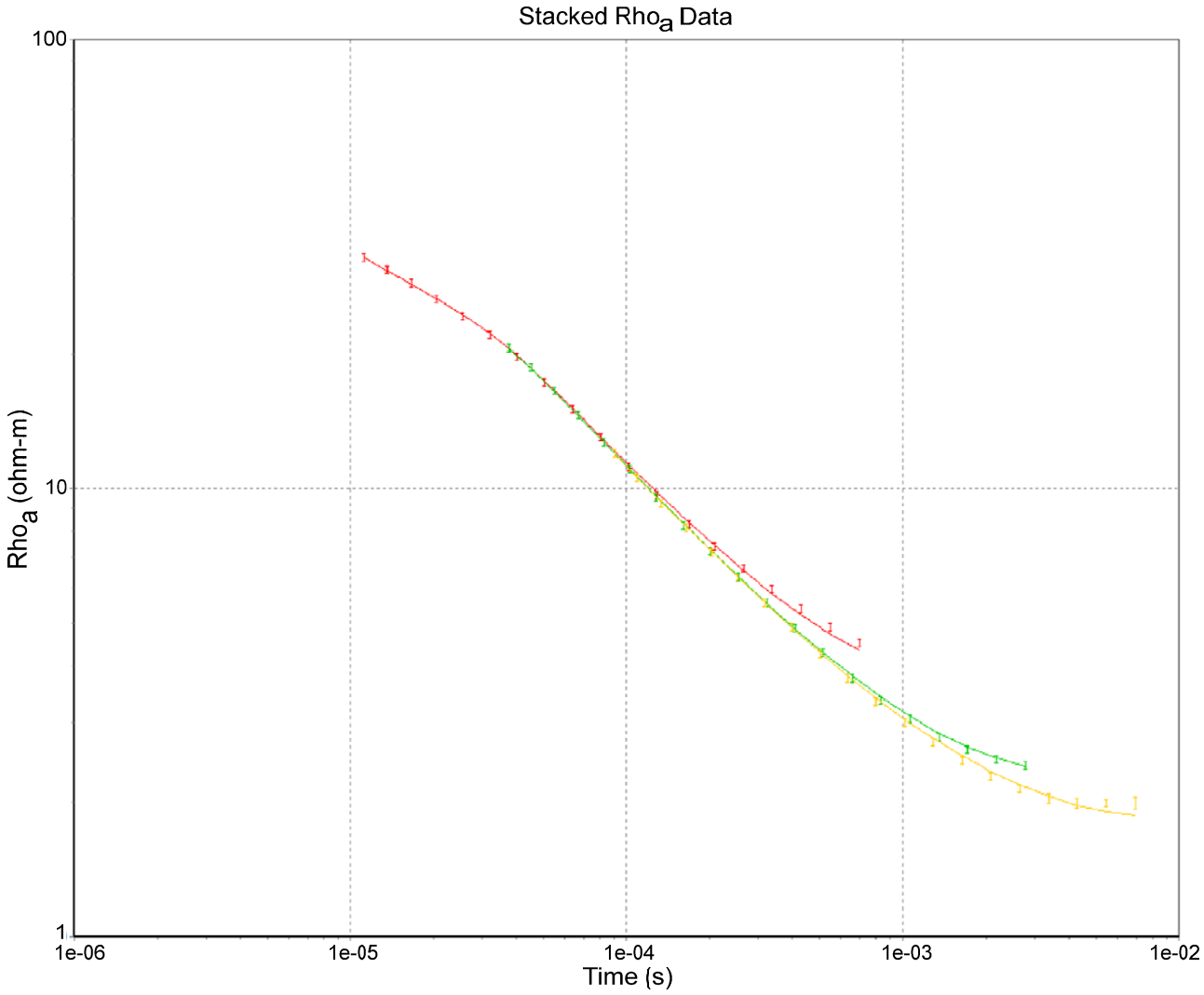
GEOVision geophysical services

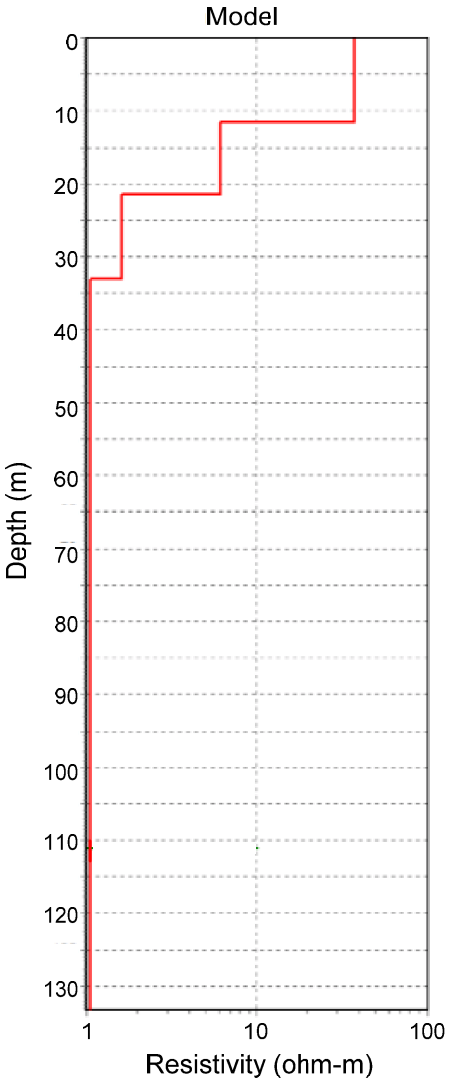
Date:	4/5/2018
GV Project:	18136
Developed by:	E Feldman
Drawn by:	T Rodriguez
Approved by:	W Dalrymple
File Name:	18136_1.MXD

FIGURE 1
SITE MAP

SITE LOCATED AT
NERT SITE
HENDERSON, NEVADA

PREPARED FOR
TETRA TECH, INC.





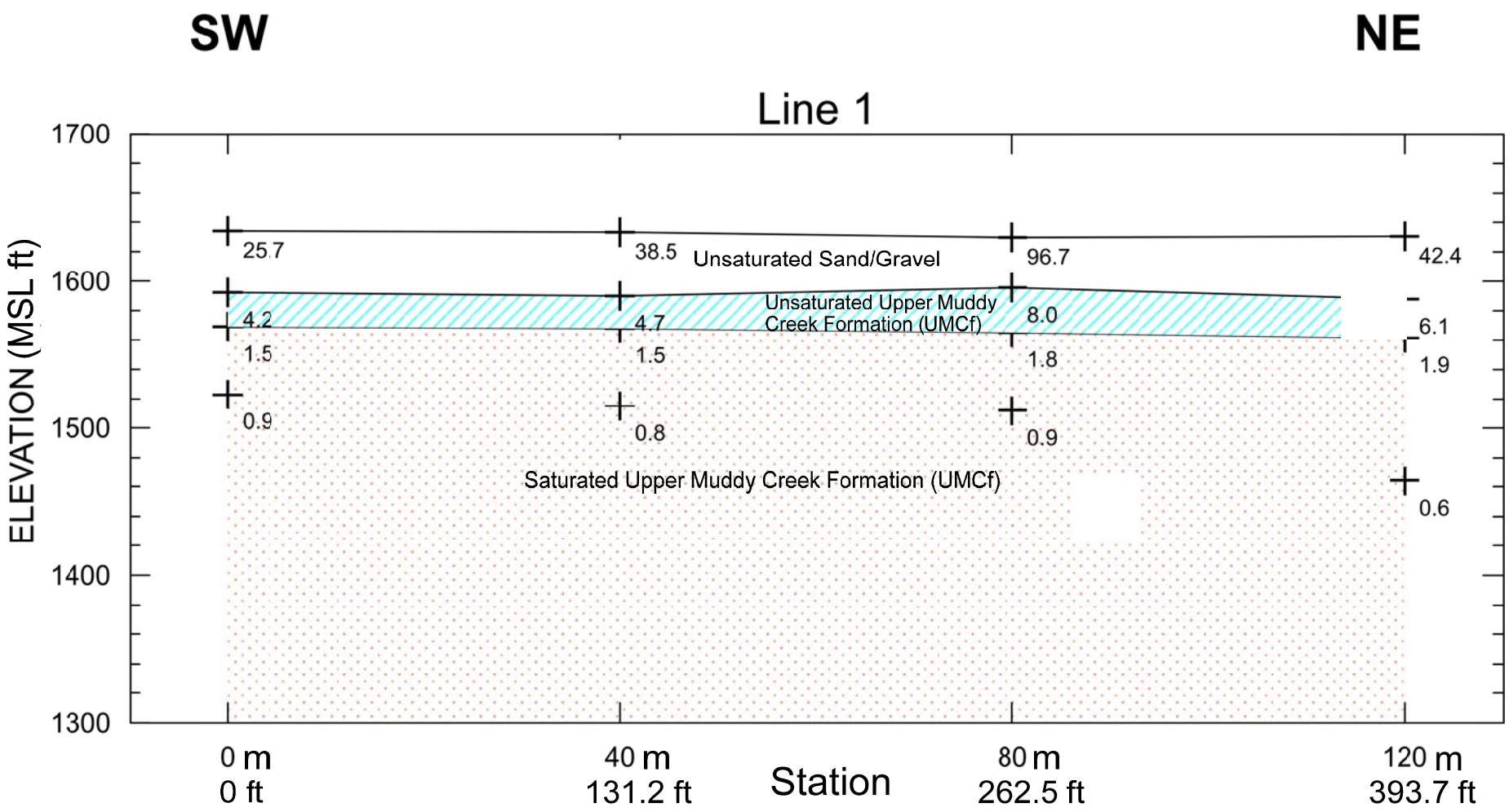
GEOVision geophysical services

Figure 2

Example 1D Layered TDEM Model
Line 1 Station 1
GV Project No. 18136

NERT Site
Henderson, Nevada

Prepared for Tetra Tech



Legend

\+ Model Resistivity (Ω-m)

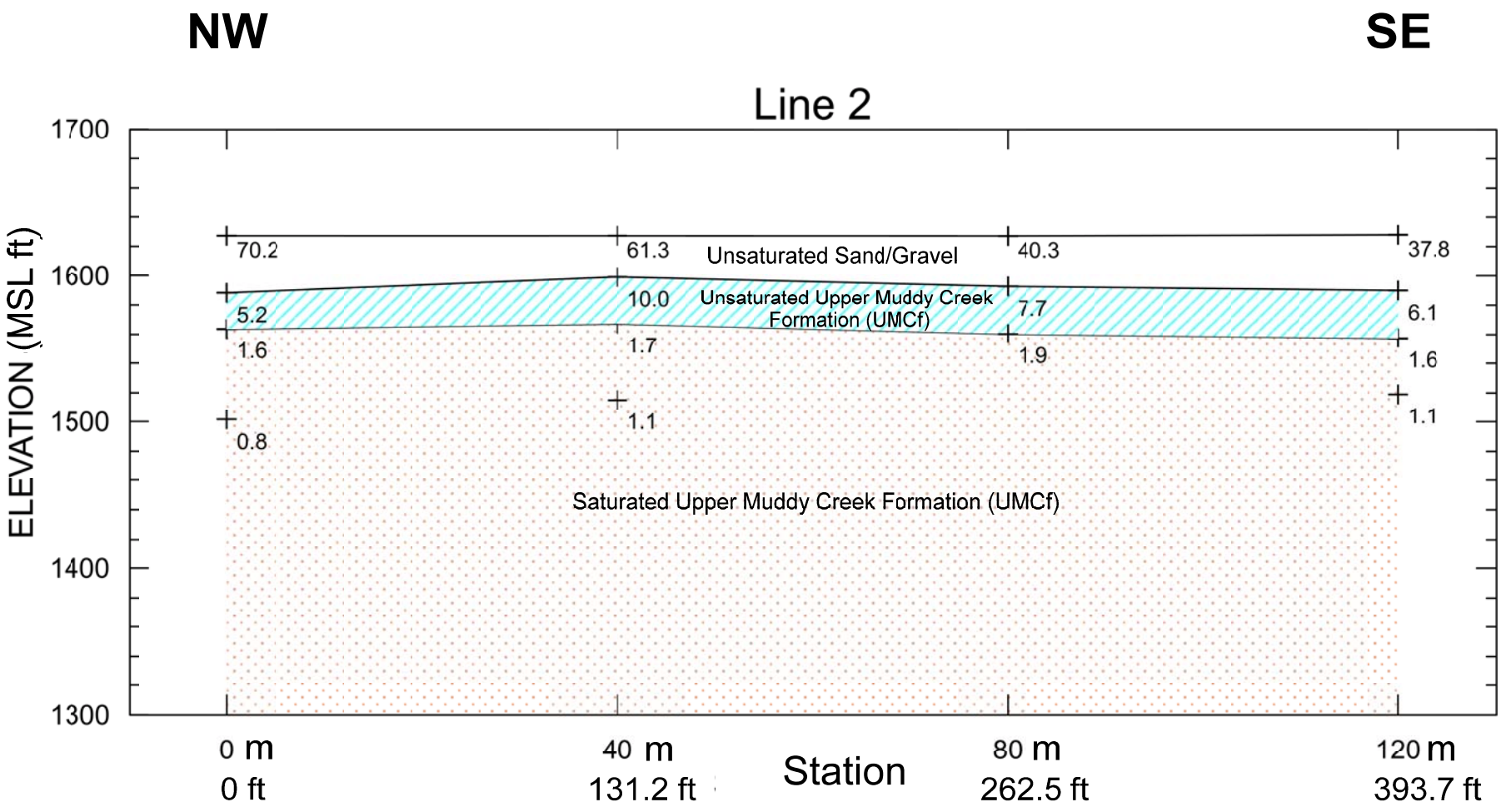
GEOVision geophysical services

Figure 3

Line 1 TDEM Derived Earth Model
GV Project No. 18136

NERT Site
Henderson, Nevada

Prepared for Tetra Tech



Legend

\+ Model Resistivity (Ω-m)

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Figure 4

Line 2 TDEM Derived Earth Model
GV Project No. 18136

NERT Site
Henderson, Nevada

Prepared for Tetra Tech

Appendix B
Boring Logs and Well Construction Details

Table B.1 - Monitoring Well Construction Summary

Monitoring Well/ Borehole ID	Northing	Easting	Ground Surface Elevation	Top of Casing Elevation	Well Diameter	Borehole Diameter	Borehole Total Depth	Well Total Depth	Top of Screen	Bottom of Screen	Screen Length	Slot Size
			feet amsl	feet amsl	inches	inches	feet bgs	feet bgs	feet bgs	feet bgs	feet	inches
GRTS-MW01A	26728794.03	834737.35	1633.88	1633.49	2	6	82	80.5	60	80	20	0.010
GRTS-MW01B	26728796.86	834742.46	1633.88	1633.32	2	6	120	110.5	90	110	20	0.010
GRTS-MW02A	26728771.59	835074.09	1632.59	1632.04	2	6	82	80.5	60	80	20	0.010
GRTS-MW02B	26728770.64	835079.15	1632.43	1631.89	2	6	120	110.5	90	110	20	0.010
GRTS-MW03A	26728879.93	834947.17	1630.72	1630.18	4	8	80	75.5	65	75	10	0.010
GRTS-MW03B	26728880.95	834952.89	1630.55	1630.27	4	8	120	110.5	90	110	20	0.010
GRTS-MW04A	26728915.61	834839.84	1631.09	1630.70	2	6	86.5	85.5	70	85	15	0.010
GRTS-MW04B	26728916.48	834845.04	1631.19	1630.86	2	6	120	110	89.5	109.5	20	0.010
GRTS-MW05A	26728941.02	835055.82	1628.63	1628.19	2	6	80	70.5	60	70	10	0.010
GRTS-MW05B	26728941.82	835060.59	1628.61	1628.23	2	6	120	85.5	75	85	10	0.010

Notes

amsl above mean sea level
bgs below ground surface

WELL NUMBER GRTS-MW01A

TETRA TECH

CLIENT Nevada Environmental Response Trust
PROJECT NAME Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER 117-7502018-M17
PROJECT LOCATION Henderson, NV
DATE STARTED 4/20/18 **COMPLETED** 4/21/18
GROUND ELEVATION 1633.88 ft MSL
DRILLING METHOD Sonic
NORTHING 26728794.03 **EASTING** 834737.35
DRILLING CONTRACTOR Cascade Drilling
BOREHOLE DIAMETER 6" **TOTAL DEPTH** 82 ft
LOGGED BY J. Bunkers **CHECKED BY** M. Baron
NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0			0 -82' - SEE LOG FOR GRTS-MW01B FOR LITHOLOGY.	Casing Top Elev: 1633.49 (ft) Casing Type: 2" Sched. 40 PVC Bottom of Flush Mount Vault 5% Bentonite-Cement (0.7'-52.5')
10				
20				
30				
40				
50				

(Continued Next Page)

WELL NUMBER GRTS-MW01A

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
50			0 -82' - SEE LOG FOR GRTS-MW01B FOR LITHOLOGY.*(continued from previous)*	Hydrated Bentonite 3/8" Chips (52.5'-57.5')
60				Filter Pack Pioneer Sand #2/12 (57.5'-82')
70				0.010" slot, 2" Sch. 40 PVC (60'-80')
80			82.0	1551.9

Bottom of borehole at 82.0 feet.

WELL NUMBER GRTS-MW01B

TETRA TECH

CLIENT	Nevada Environmental Response Trust	**PROJECT NAME**	Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER	117-7502018-M17	**PROJECT LOCATION**	Henderson, NV
DATE STARTED	4/18/18 **COMPLETED** 4/20/18	**GROUND ELEVATION**	1633.88 ft MSL
DRILLING METHOD	Sonic	**NORTHING** 26728796.86	**EASTING** 834742.46
DRILLING CONTRACTOR	Cascade Drilling	**BOREHOLE DIAMETER**	6" **TOTAL DEPTH** 120 ft
LOGGED BY	J. Bunkers **CHECKED BY** M. Baron		

NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0					Casing Top Elev: 1633.32 (ft) Casing Type: 2" Sched. 40 PVC
		GM		0'-4'- (GM) Light brown (7.5YR 6/4); **Well graded SILTY GRAVEL with SAND**; Dry; Loose; 40% gravel, 30% sand, 30% silt; 10% coarse, 40% medium, 50% fine grained sand; Angular grains.	Bottom of Flush Mount Vault
				4.0 — 1629.9	
5		GM		4'-10'- (GM) Brown (7.5YR 5/4); **Well graded SILTY GRAVEL with SAND**; Dry; Loose; 50% gravel, 30% sand, 20% silt; 20% coarse, 40% medium, 40% fine grained sand; Angular grains.	
10				10.0 — 1623.9	
		SW-SM		10'-16'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 30% gravel, 60% sand, 10% silt; 30% coarse, 30% medium, 40% fine grained sand; Angular grains; Few caliche nodules.	
15				16.0 — 1617.9	
		SW-SM		16'-24'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 20% gravel, 70% sand, 10% silt; 45% coarse, 25% medium, 30% fine grained sand; Angular to subrounded grains; Volcanic sand.	
20				24.0 — 1609.9	
		GW-GM		24'-27'- (GW-GM) Brown (7.5YR 4/3); **Well graded GRAVEL with SILT and SAND**; Dry; Loose; 50% gravel, 40% sand, 10% silt; 20% coarse, 50% medium, 30% fine grained sand; Subangular to subrounded grains; Volcanic sand; Some cobbles up to 3.5 inch.	
25				27.0 — 1606.9	
		ML		27.2 — 1606.7 27'-27.2'- (ML) Brown (7.5YR 5/4); **SILT**; Dry; Stiff; 10% sand, 80% silt, 10% clay; 100% fine grained sand; Low to medium plasticity. 27.8 — 1606.1	
				27.2'-27.8'- White (N9); Gypsum bed.	
		ML		27.8'-29.8'- (ML) Brown (7.5YR 5/4); **SILT**; Dry; Stiff; 10% sand, 80% silt, 10% clay; 100% fine grained sand; Low to medium plasticity.	
30				29.8 — 1604.1	

(Continued Next Page)

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
30				30.5 29.8'-30.5'- White (N9); Gypsum bed.*(continued from previous)*	1603.4	
		CH		30.5'-34'- (CH) Light gray (5Y 7/2); **FAT CLAY**; Dry; Stiff; 20% silt, 80% clay; High plasticity.		
				34.0	1599.9	
35				34'-35'- White (N9); Gypsum bed. 35.0	1598.9	
		CH		35'-37.5'- (CH) Brown (7.5YR 5/3); **FAT CLAY**; Dry; Stiff; 20% silt, 80% clay; High plasticity; Abundant gypsum crystals.		
				37.5	1596.4	
		CH		37.5'-39.5'- (CH) Olive gray (5Y 5/2); **FAT CLAY**; Dry; Stiff; 100% clay; High plasticity.		
				39.5	1594.4	
40		CH		39.5'-40.5'- (CH) Light yellowish brown (10YR 6/4); **FAT CLAY**; Dry; Stiff; 100% clay; High plasticity; Few fine grained gypsum crystals. 40.5	1593.4	
				40.5'-41.5'- White (N9); Gypsum bed. 41.5	1592.4	
		MH		41.5'-44.5'- (MH) Light yellowish brown (10YR 6/4); **ELASTIC SILT**; Dry; Stiff; 5% sand, 70% silt, 25% clay; 100% fine grained sand; Medium to high plasticity.		5% Bentonite-Cement (0.5'-84')
				44.5	1589.4	
45		CH		44.5'-48'- (CH) Brown (7.5YR 4/3); **FAT CLAY**; Moist; Stiff; 5% silt, 95% clay; High plasticity; Abundant gypsum crystals.		
				48.0	1585.9	
		ML		48'-49'- (ML) Brown (7.5YR 4/3); **SILT**; Moist; Stiff; 5% sand, 70% silt, 25% clay; 100% fine grained sand; Non plastic to low plasticity; No gypsum crystals. 49.0	1584.9	
50		CH		49'-54'- (CH) Reddish brown (5YR 5/4); **FAT CLAY**; Moist; Stiff; 100% clay; High plasticity; Abundant disseminated gypsum crystals.		
				54.0	1579.9	
55		CL		54'-61'- (CL) Light gray (2.5Y 7/2); **LEAN CLAY**; Moist; Soft; 10% silt, 90% clay; Low to medium plasticity; Abundant very fine to fine gypsum crystals. Below 58' - No gypsum crystals.		
60				61.0	1572.9	
		CL		61.5 61'-61.5'- (CL) Brown (7.5YR 4/3); **LEAN CLAY**; Moist; Stiff; 10% silt, 90% clay; Low to medium plasticity; Abundant gypsum crystals. 62.0	1572.4 1571.9	
		CL		61.5'-62'- White (N9); Gypsum bed. 62'-65'- (CL) Brown (7.5YR 4/3); **LEAN CLAY**; Moist; Stiff; 10% silt, 90% clay; Low to medium plasticity; Abundant gypsum crystals.		

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CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
65				65.0 1568.9	
		CL		65'-70'- (CL) Light gray (2.5Y 7/2); **LEAN CLAY**; Moist; Stiff; 10% silt, 90% clay; Low to medium plasticity; Abundant corase grained gypsum crystals.	
				Below 69' - No gypsum crystals.	
70				70.0 1563.9	
		CL		70'-72.5'- (CL) Olive gray (5Y 5/2); **LEAN CLAY**; Moist; Stiff; 10% silt, 90% clay; Low to medium plasticity.	
				72.5 1561.4	
		CL		72.5'-73.5'- (CL) Brown (7.5YR 4/4); **LEAN CLAY**; Moist; Stiff; 10% silt, 90% clay; Low to medium plasticity. 73.5 1560.4	
				73.5'-74.5'- White (N9); Gypsum bed. 74.5 1559.4	
75		CH		75.0 74.5'-75'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Wet; Soft; 100% clay; High plasticity; Abundant gypsum crystals. 1558.9	
		CH		75'-77.5'- (CH) Brown (7.5YR 4/3); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; No gypsum crystals.	
				77.5 1556.4	
		CH		78.0 77.5'-78'- (CH) Brown (7.5YR 4/3); **FAT CLAY**; Wet; Soft; 100% clay; High plasticity; Abundant gypsum crystals. 1555.9	
80		CH		78'-81'- (CH) Brown (7.5YR 5/4); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Organic odor; Few organic lenses; No gypsum crystals.	
				81.0 1552.9	
		CH		81.5 81'-81.5'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Stiff; 100% clay; High 1552.4	
				82.0 plasticity; Abundant gypsum crystals. 1551.9	
				81.5'-82'- White (N9); Gypsum bed.	
85		CH		82'-87'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Abundant gypsum crystals.	◄Hydrated Bentonite 3/8" Chips (84'-88')
				87.0 1546.9	
		CH		88.0 87'-88'- (CH) Light gray (5Y 7/2); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Abundant gypsum crystals. 1545.9	
90		CH		88'-95'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity.	◄Filter Pack Pioneer Sand #2/12 (88'-111')
				95.0 1538.9	
95		ML		95'-102'- (ML) Dark brown (7.5YR 3/4); **SILT**; Wet; Soft; 3% sand, 57% silt, 40% clay; 100% fine grained sand; Low to medium plasticity; No gypsum crystals.	

(Continued Next Page)

WELL NUMBER GRTS-MW01B

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
100		ML		95'-102'- (ML) Dark brown (7.5YR 3/4); **SILT**; Wet; Soft; 3% sand, 57% silt, 40% clay; 100% fine grained sand; Low to medium plasticity; No gypsum crystals.*(continued from previous)*		0.010" slot, 2" Sch. 40 PVC (90'-110')
					102.0 1531.9	
		CH		102'-106'- (CH) Dark brown (7.5YR 3/3); **FAT CLAY**; Moist; Stiff; 20% silt, 80% clay; High plasticity.		
105					106.0 1527.9	
		CH		106'-114.5'- (CH) Dark brown (7.5YR 3/3); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Abundant disseminated gypsum crystals.		
110						
					114.5 1519.4	
115		CH		114.5'-116'- (CH) Mottled Dark gray (N2) with black (2.5Y 4/1); **FAT CLAY**; Wet; Stiff; 100% clay; Mottled; High plasticity; Organic odor.	116.0 1517.9	Hydrated Bentonite 3/8" Chips (111'-120')
		CH		116'-120'- (CH) Light olive gray (5Y 6/2); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Organic odor.		
120					120.0 1513.9	

Bottom of borehole at 120.0 feet.

WELL NUMBER GRTS-MW02A

TETRA TECH

CLIENT Nevada Environmental Response Trust
PROJECT NAME Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER 117-7502018-M17
PROJECT LOCATION Henderson, NV
DATE STARTED 4/15/18 **COMPLETED** 4/15/18
GROUND ELEVATION 1632.59 ft MSL
DRILLING METHOD Sonic
NORTHING 26728771.59 **EASTING** 835074.09
DRILLING CONTRACTOR Cascade Drilling
BOREHOLE DIAMETER 6" **TOTAL DEPTH** 82 ft
LOGGED BY J. Bunkers **CHECKED BY** M. Baron
NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0			0 -82' - SEE LOG FOR GRTS-MW02B FOR LITHOLOGY.	Casing Top Elev: 1632.04 (ft) Casing Type: 2" Sched. 40 PVC Bottom of Flush Mount Vault 5% Bentonite-Cement (0.7'-53')
10				
20				
30				
40				
50				

(Continued Next Page)

WELL NUMBER GRTS-MW02A

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
50			0 -82' - SEE LOG FOR GRTS-MW02B FOR LITHOLOGY.*(continued from previous)*	Hydrated Bentonite 3/8" Chips (53'-57.5')
60				Filter Pack Pioneer Sand #2/12 (57.5'-82')
70				0.010" slot, 2" Sch. 40 PVC (60'-80')
80			82.0	1550.6

Bottom of borehole at 82.0 feet.

WELL NUMBER GRTS-MW02B

TETRA TECH

CLIENT	Nevada Environmental Response Trust	**PROJECT NAME**	Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER	117-7502018-M17	**PROJECT LOCATION**	Henderson, NV
DATE STARTED	4/13/18 **COMPLETED** 4/14/18	**GROUND ELEVATION**	1632.43 ft MSL
DRILLING METHOD	Sonic	**NORTHING** 26728770.64	**EASTING** 835079.15
DRILLING CONTRACTOR	Cascade Drilling	**BOREHOLE DIAMETER**	6" **TOTAL DEPTH** 120 ft
LOGGED BY	J. Bunkers **CHECKED BY** M. Baron		

NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0					Casing Top Elev: 1631.89 (ft) Casing Type: 2" Sched. 40 PVC
		SM		0'-2'- (SM) Light brown (7.5YR 6/4); **SILTY SAND**; Dry; Loose; 10% gravel, 60% sand, 30% silt; 40% medium, 60% fine grained sand; Subangular grains.	← Bottom of Flush Mount Vault
				2.0 — 1630.4	
		SW-SM		2'-4'- (SW-SM) Brown (7.5YR 5/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 40% gravel, 50% sand, 10% silt; 30% coarse, 50% medium, 20% fine grained sand; Subangular grains.	
				4.0 — 1628.4	
5		GW		4'-5'- (GW) Brown (7.5YR 4/4); **Well graded GRAVEL with SAND**; Dry; Loose; 60% gravel, 40% sand; 50% coarse, 40% medium, 10% fine grained sand; Subangular grains.	
				5.0 — 1627.4	
		GW-GM		5'-10'- (GW-GM) Brown (7.5YR 4/4); **Well graded GRAVEL with SILT and SAND**; Dry; Loose; 50% gravel, 40% sand, 10% silt; 50% coarse, 50% medium grained sand; Subangular grains.	
10				10.0 — 1622.4	
				10 -12' - No recovery.	
				12.0 — 1620.4	
		SW-SM		12'-19'- (SW-SM) Brown (7.5YR 4/3); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 40% gravel, 50% sand, 10% silt; 30% coarse, 40% medium, 40% fine grained sand; Subangular to subrounded grains; Fine to very coarse gravel up to 3 inch.	
15					
				19.0 — 1613.4	
20		SM		19'-27'- (SM) Brown (7.5YR 4/4); **SILTY SAND**; Dry; Loose; 10% gravel, 50% sand, 40% silt; 40% coarse, 40% medium, 20% fine grained sand; Subangular to subrounded grains; Volcanic sand.	
25					
				27.0 — 1605.4	
				27 -28.5' - No recovery.	
				28.5 — 1603.9	
30		SW		28.5'-36'- (SW) Brown (7.5YR 4/4); **Well graded SAND with GRAVEL**; Dry; Loose; 20% gravel, 75% sand, 5% silt; 35% coarse, 35% medium, 30% fine grained sand; Angular to subrounded grains; Few caliche nodules.	

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CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
30						
		SW		28.5'-36'- (SW) Brown (7.5YR 4/4); **Well graded SAND with GRAVEL**; Dry; Loose; 20% gravel, 75% sand, 5% silt; 35% coarse, 35% medium, 30% fine grained sand; Angular to subrounded grains; Few caliche nodules.*(continued from previous)*		
				Below 33' - Few cobbles up to 3.5 inch.		
35				36.0	1596.4	
		MH		36'-38'- (MH) Light gray (5Y 7/2); **ELASTIC SILT**; Dry; Stiff; 70% silt, 30% clay; Medium plasticity.		
				38.0	1594.4	
		ML		38'-40'- (ML) Pale brown (10YR 6/3); **SANDY SILT**; Dry; Stiff; 30% sand, 60% silt, 10% clay; 100% fine grained sand; Non plastic plasticity.		
40				40.0	1592.4	
		ML		40'-44'- (ML) Brown (7.5YR 4/3); **SANDY SILT**; Dry; Stiff; 30% sand, 70% silt; 100% fine grained sand; Non plastic plasticity.		5% Bentonite-Cement (0.5'-82.5')
				44.0	1588.4	
		CH		44'-46'- (CH) Pale brown (10YR 6/3); **FAT CLAY**; Dry; Stiff; 5% sand, 30% silt, 65% clay; 100% fine grained sand; High plasticity.		
45				46.0	1586.4	
		CH		46'-50.5'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Moist; Stiff; 5% silt, 95% clay; High plasticity; Abundant disseminated gypsum crystals up to 3 inch.		
50				50.5	1581.9	
		CH		51.3	1581.1	50.5'-51.3'- (CH) Gray (5Y 7/2); **FAT CLAY**; Moist; Stiff; 100% clay; High plasticity; Abundant fine grained gypsum crystals.
		CH		51.3'-56'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Moist; Stiff; 100% clay; High plasticity.		
55				56.0	1576.4	
		MH		56'-63.5'- (MH) Light gray (5Y 7/2); **ELASTIC SILT**; Moist; Stiff; 5% sand, 50% silt, 45% clay; 100% fine grained sand; Medium to high plasticity; Abundant gypsum crystals.		
60				63.5	1568.9	
				63.5'-64.5'- White (N9); Gypsum bed.		

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CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
65		CH		64.5 (1567.9) 64.5'-67'- (CH) Brown (7.5YR 4/3); **FAT CLAY**; Wet; Very stiff; 5% silt, 95% clay; High plasticity; Abundant gypsum crystals. 67.0 (1565.4)	
70		CH		67'-70'- (CH) Pale yellow (5Y 8/2); **FAT CLAY**; Moist; Stiff; 100% clay; High plasticity; Grades to 30% fine grained gypsum crystals at base. 70.0 (1562.4)	
		CH		70'-73'- (CH) Olive gray (5Y 5/2); **FAT CLAY**; Moist; Stiff; 10% silt, 90% clay; High plasticity. 73.0 (1559.4)	
75		CH		73'-75'- (CH) Mottled Grayish brown (N2) black (10YR 5/2); **FAT CLAY**; Moist; Stiff; 10% silt, 90% clay; Mottled; High plasticity. 75.0 (1557.4)	
		CH		75'-76.5'- (CH) Grayish brown (10YR 5/2); **FAT CLAY**; Dry; Stiff; 10% silt, 90% clay; High plasticity; Gypsum crystals to 2 inch. 76.5 (1555.9)	
80		CH		76.5'-81'- (CH) Dark brown (7.5YR 3/3); **FAT CLAY**; Moist; Very stiff; 100% clay; High plasticity. 81.0 (1551.4)	
		CH		81'-84'- (CH) Light gray (5Y 7/2); **FAT CLAY**; Moist; Stiff; 10% silt, 90% clay; Medium to high plasticity; Abundant disseminated gypsum crystals up to 2 inch. 84.0 (1548.4)	
85		CH		84'-91'- (CH) Dark brown (7.5YR 3/3); **FAT CLAY**; Moist; Stiff; 10% silt, 90% clay; Medium to high plasticity; Abundant disseminated gypsum crystals up to 2 inch. Below 87' - Abundant fine grained gypsum crystals. 91.0 (1541.4)	Hydrated Bentonite 3/8" Chips (82.5'-87.2')
90		CH		91'-92'- (CH) Light gray (5Y 7/2); **FAT CLAY**; Wet; Stiff; 10% silt, 90% clay; High plasticity; Gypsum bed with crystals to 2 inch. 92.0 (1540.4)	Filter Pack Pioneer Sand #2/12 (87.2'-111')
		CH		92'-96'- (CH) Dark brown (7.5YR 3/3); **CLAY**; Wet; Stiff; 30% silt, 70% clay; Low to medium plasticity; Abundant gypsum crystals to 2 inch. 96.0 (1536.4)	
95		ML		96'-107'- (ML) Brown (7.5YR 4/3); **SILT with SAND**; Wet; Soft to stiff; 15% sand, 80% silt, 5% clay; Non plastic plasticity; No gypsum crystals.	

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WELL NUMBER GRTS-MW02B

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
100		ML		96'-107'- (ML) Brown (7.5YR 4/3); **SILT with SAND**; Wet; Soft to stiff; 15% sand, 80% silt, 5% clay; Non plastic plasticity; No gypsum crystals.*(continued from previous)*		0.010" slot, 2" Sch. 40 PVC (90'-110')
105						
				107.0	1525.4	
		MH		108.0 107'-108'- (MH) Light gray (5Y 7/2); **ELASTIC SILT**; Wet; Stiff; 10% sand, 80% silt, 10% clay; Medium plasticity; 1 inch black organic lens.	1524.4	
		SM		109.0 108'-109'- (SM) Olive gray (5Y 5/2); **SILTY SAND**; Wet; Dense; 75% sand, 22% silt, 3% clay; 100% fine grained sand.	1523.4	
110		ML		110.0 109'-110'- (ML) Grayish brown (10YR 5/2); **SILT with SAND**; Wet; Stiff; 25% sand, 65% silt, 10% clay; 100% fine grained sand; Low plasticity; Abundant gypsum crystals.	1522.4	
				110'-118.5'- (CH) Brown (7.5YR 4/3); **FAT CLAY**; Wet; Stiff; 20% silt, 80% clay; High plasticity; Abundant gypsum crystals.		
115		CH				Hydrated Bentonite 3/8" Chips (111'-120')
				118.5	1513.9	
		CH		120.0 118.5'-120'- (CH) Gray (10YR 5/1); **FAT CLAY**; Wet; Stiff; 5% silt, 95% clay; High plasticity.	1512.4	
120						

Bottom of borehole at 120.0 feet.

WELL NUMBER GRTS-MW03A

TETRA TECH

CLIENT Nevada Environmental Response Trust
PROJECT NAME Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER 117-7502018-M17
PROJECT LOCATION Henderson, NV
DATE STARTED 4/26/18 **COMPLETED** 4/26/18
GROUND ELEVATION 1630.72 ft MSL
DRILLING METHOD Sonic
NORTHING 26728879.93 **EASTING** 834947.17
DRILLING CONTRACTOR Cascade Drilling
BOREHOLE DIAMETER 8" **TOTAL DEPTH** 80 ft
LOGGED BY J. Bunkers **CHECKED BY** M. Baron
NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0			0 -80' - SEE LOG FOR GRTS-MW03B FOR LITHOLOGY.	Casing Top Elev: 1630.18 (ft) Casing Type: 4" Sched. 40 PVC Bottom of Flush Mount Vault 5% Bentonite-Cement (0.7'-59')
10				
20				
30				
40				
50				

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TETRA TECH

WELL NUMBER GRTS-MW03A

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
50			0 -80' - SEE LOG FOR GRTS-MW03B FOR LITHOLOGY.*(continued from previous)*	
60				Hydrated Bentonite 3/8" Chips (59'-63')
				Filter Pack Pioneer Sand #2/12 (63'-76')
70				0.010" slot, 4" Sch. 40 PVC (65'-75')
80			80.0 1550.7	Hydrated Bentonite 3/8" Chips (76'-80')

Bottom of borehole at 80.0 feet.

WELL NUMBER GRTS-MW03B

TETRA TECH

CLIENT	Nevada Environmental Response Trust	**PROJECT NAME**	Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER	117-7502018-M17	**PROJECT LOCATION**	Henderson, NV
DATE STARTED	4/25/18 **COMPLETED** 4/26/18	**GROUND ELEVATION**	1630.55 ft MSL
DRILLING METHOD	Sonic	**NORTHING** 26728880.95	**EASTING** 834952.89
DRILLING CONTRACTOR	Cascade Drilling	**BOREHOLE DIAMETER**	8" **TOTAL DEPTH** 120 ft
LOGGED BY	J. Bunkers **CHECKED BY** M. Baron		

NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0					Casing Top Elev: 1630.2 (ft) Casing Type: 4" Sched. 40 PVC
		SW		0'-0.3'- (SW) Light brown (7.5YR 6/4); **Well graded SAND with GRAVEL**; Dry; Loose; 40% gravel, 60% sand; 50% coarse, 30% medium, 20% fine grained sand; Angular grains. 1630.3	Bottom of Flush Mount Vault
		GW		0.3'-4'- (GW) Brown (7.5YR 5/4); **Well graded GRAVEL with SAND**; Dry; Loose; 60% gravel, 40% sand; 60% coarse, 30% medium, 10% fine grained sand; Angular grains. 4.0 1626.6	
5		GP		4'-6'- (GP) Brown (7.5YR 5/4); **Well graded GRAVEL with SAND**; Dry; Loose; 50% gravel, 50% sand; 70% coarse, 20% medium, 10% fine grained sand; Angular grains. 6.0 1624.6	
		SW		6'-10'- (SW) Brown (7.5YR 5/4); **Well graded SAND with GRAVEL**; Dry; Loose; 40% gravel, 60% sand; 50% coarse, 40% medium, 10% fine grained sand; Angular grains. 10.0 1620.6	
10		SW		10'-14'- (SW) Brown (7.5YR 4/3); **Well graded SAND with GRAVEL**; Dry; Loose; 40% gravel, 55% sand, 5% silt; 50% coarse, 40% medium, 10% fine grained sand; Subangular to subrounded grains. 14.0 1616.6	
15		SW		14'-18'- (SW) Brown (7.5YR 4/3); **Well graded SAND**; Dry; Loose; 10% gravel, 85% sand, 5% silt; 40% coarse, 40% medium, 20% fine grained sand; Angular to subangular grains; Volcanic sand. 18.0 1612.6	
20		SW		18'-26'- (SW) Brown (7.5YR 4/4); **Well graded SAND with GRAVEL**; Dry; Loose; 20% gravel, 75% sand, 5% silt; 30% coarse, 40% medium, 30% fine grained sand; Subangular grains; Few caliche nodules. 26.0 1604.6	
25		SW-SM		26'-36'- (SW-SM) Brown (7.5YR 4/3); **Well graded SAND with SILT**; Dry; Loose; 10% gravel, 80% sand, 10% silt; 50% coarse, 40% medium, 10% fine grained sand; Subangular grains; Gravel up to 2 inch; Few caliche nodules.	
30					

(Continued Next Page)

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
30						
		SW-SM		26'-36'- (SW-SM) Brown (7.5YR 4/3); **Well graded SAND with SILT**; Dry; Loose; 10% gravel, 80% sand, 10% silt; 50% coarse, 40% medium, 10% fine grained sand; Subangular grains; Gravel up to 2 inch; Few caliche nodules.*(continued from previous)*		
35					1594.6	
		SW		36'-43.5'- (SW) Brown (7.5YR 4/3); **Well graded SAND with GRAVEL**; Dry; Loose; 25% gravel, 75% sand; 70% coarse, 20% medium, 10% fine grained sand; Subangular grains; Iron oxide staining; Few caliche nodules.		
40					1587.1	5% Bentonite-Cement (0.8'-83')
		ML		43.5'-46'- (ML) Brown (7.5YR 4/3); **SILT**; Moist; Soft; 60% silt, 40% clay; Medium plasticity; Abundant disseminated gypsum crystals.		
45					1584.6	
		ML		46'-48'- (ML) Brown (7.5YR 4/3); **SILT**; Moist; Soft; 3% sand, 57% silt, 40% clay; 100% fine grained sand; Medium to low plasticity.		
					1582.6	
		ML		48'-49'- (ML) Light gray (10YR 7/2); **SILT**; Moist; Soft; 3% sand, 57% silt, 40% clay; 100% fine grained sand; Medium to low plasticity.	1581.6	
50		ML		49'-51'- (ML) Yellowish red (5YR 4/6); **SILT**; Moist; Stiff; 3% sand, 57% silt, 40% clay; 100% fine grained sand; Low plasticity.		
					1579.6	
		SM		51'-54'- (SM) Brown (7.5YR 5/4); **SILTY SAND**; Moist; Loose; 10% gravel, 50% sand, 40% silt; 30% coarse, 30% medium, 40% fine grained sand; Subangular to subrounded grains; Iron oxide staining.		
					1576.6	
55		ML		54'-57.5'- (ML) Light brownish gray (10YR 6/2); **SILT**; Moist; Stiff; 5% sand, 75% silt, 20% clay; 100% fine grained sand; Low plasticity; Some medium grained gypsum crystals.		
					1573.1	
		CL		57.5'-59'- (CL) White (10YR 8/1); **LEAN CLAY**; Wet; Stiff; 5% silt, 95% clay; Non plastic plasticity; Mostly gypsum crystals.		
					1571.6	
60		CH		59'-61'- (CH) Strong brown (7.5YR 4/6); **FAT CLAY**; Moist; Stiff; 3% sand, 37% silt, 60% clay; 100% fine grained sand; High plasticity; No gypsum crystals.		
					1569.6	
		CH		61'-70'- (CH) Mottled Gray (N2) with black (5Y 6/1); **FAT CLAY**; Wet; Stiff; 30% silt, 70% clay; Mottled; High plasticity; Organic odor.		

(Continued Next Page)

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
65		CH		61'-70'- (CH) Mottled Gray (N2) with black (5Y 6/1); **FAT CLAY**; Wet; Stiff; 30% silt, 70% clay; Mottled; High plasticity; Organic odor.*(continued from previous)*	
70		ML		70.0 (1560.6) 70'-71'- (ML) Pale yellow (5Y 7/3); **SILT**; Dry; Stiff; 70% silt, 30% clay; Low plasticity; Some medium grained gypsum crystals. 71.0 (1559.6)	
		CH		71'-76'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Moist; Stiff; 5% silt, 95% clay; High plasticity; Abundant coarse grained gypsum crystals.	
75				76.0 (1554.6)	
		CL		76'-78'- (CL) Brown (7.5YR 5/3); **LEAN CLAY**; Moist; Very stiff; 15% silt, 85% clay; Low to medium plasticity; Few fine grained gypsum crystals.	
				78.0 (1552.6)	
80		CH		78'-81'- (CH) Brown (7.5YR 5/3); **FAT CLAY**; Moist; Stiff; 100% clay; High plasticity; Abundant coarse grained gypsum crystals.	
				81.0 (1549.6)	
		CH		81'-85.5'- (CH) Dark brown (7.5YR 3/3); **FAT CLAY**; Wet; Stiff; 25% silt, 75% clay; Medium to high plasticity; Abundant smedium grained gypsum crystals.	
85				Below 84.5' - Gypsum bed.	
				85.5 (1545.1)	◄Hydrated Bentonite 3/8" Chips (83'-87.8')
		CH		85.5'-92.5'- (CH) Dark brown (7.5YR 3/3); **FAT CLAY**; Wet; Stiff; 5% silt, 95% clay; High plasticity; Abundant gypsum crystals.	◄Filter Pack Pioneer Sand #2/12 (87.8'-111')
90					
				92.5 (1538.1)	
		ML		92.5'-103'- (ML) Dark brown (7.5YR 3/4); **SILT**; Wet; Soft; 5% sand, 85% silt, 10% clay; 100% fine grained sand; Low plasticity.	
95					

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WELL NUMBER GRTS-MW03B

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
100		ML		92.5'-103'- (ML) Dark brown (7.5YR 3/4); **SILT**; Wet; Soft; 5% sand, 85% silt, 10% clay; 100% fine grained sand; Low plasticity.*(continued from previous)*		0.010" slot, 4" Sch. 40 PVC (90'-110')
				103.0	1527.6	
		CH		103'-105'- (CH) Light gray (5Y 7/1); **FAT CLAY**; Wet; Stiff; 20% silt, 80% clay; Medium plasticity; Abundant gypsum crystals. Below 104' - Black (N2) Organic odor; Organic clay.		
105				105.0	1525.6	
		CH		105'-106'- (CH) Light olive gray (5Y 6/2); **FAT CLAY**; Moist; Stiff; 5% silt, 95% clay; Medium to high plasticity; Organic odor; No gypsum crystals.		
				106.0	1524.6	
		CH		106'-110.5'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Abundant disseminated gypsum crystals.		
110				110.5	1520.1	
		CH		110.5'-120'- (CH) Olive gray (5Y 5/2); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Organic odor; Abundant disseminated gypsum crystals.		Hydrated Bentonite 3/8" Chips (111'-120')
115						
120				120.0	1510.6	

Bottom of borehole at 120.0 feet.

WELL NUMBER GRTS-MW04A

TETRA TECH

CLIENT Nevada Environmental Response Trust
PROJECT NAME Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER 117-7502018-M17
PROJECT LOCATION Henderson, NV
DATE STARTED 4/14/18 **COMPLETED** 4/15/18
GROUND ELEVATION 1631.09 ft MSL
DRILLING METHOD Sonic
NORTHING 26728915.61 **EASTING** 834839.84
DRILLING CONTRACTOR Cascade Drilling
BOREHOLE DIAMETER 6" **TOTAL DEPTH** 86.5 ft
LOGGED BY J. Bunkers **CHECKED BY** M. Baron
NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0				Casing Top Elev: 1630.7 (ft) Casing Type: 2" Sched. 40 PVC
			0 -86.5' - SEE LOG FOR GRTS-MW04B FOR LITHOLOGY.	Bottom of Flush Mount Vault
10				
20				
30				5% Bentonite-Cement (0.7'-64')
40				
50				

(Continued Next Page)

WELL NUMBER GRTS-MW04A

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
50			0 -86.5' - SEE LOG FOR GRTS-MW04B FOR LITHOLOGY.*(continued from previous)*	Hydrated Bentonite 3/8" Chips (64'-68')
60				Filter Pack Pioneer Sand #2/12 (68'-86.5')
70				0.010" slot, 2" Sch. 40 PVC (70'-85')
80			86.5	1544.6

Bottom of borehole at 86.5 feet.

WELL NUMBER GRTS-MW04B

TETRA TECH

CLIENT Nevada Environmental Response Trust
PROJECT NAME Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER 117-7502018-M17
PROJECT LOCATION Henderson, NV
DATE STARTED 4/11/18 **COMPLETED** 4/13/18
GROUND ELEVATION 1631.19 ft MSL
DRILLING METHOD Sonic
NORTHING 26728916.48 **EASTING** 834845.04
DRILLING CONTRACTOR Cascade Drilling
BOREHOLE DIAMETER 6" **TOTAL DEPTH** 120 ft
LOGGED BY J. Bunkers **CHECKED BY** M. Baron
NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0					Casing Top Elev: 1630.86 (ft) Casing Type: 2" Sched. 40 PVC
		GP		0'-10'- (GP) Brown (7.5YR 5/4); **Poorly graded GRAVEL with SAND**; Dry; Loose; 60% gravel, 40% sand; 50% coarse, 40% medium, 10% fine grained sand; Angular grains.	Bottom of Flush Mount Vault
10				10.0 — 1621.2	
		SM		10'-16.5'- (SM) Light brown (7.5YR 6/3); **SILTY SAND with GRAVEL**; Dry; Loose; 30% gravel, 50% sand, 20% silt; 30% coarse, 30% medium, 40% fine grained sand; Angular to subrounded grains.	
15				16.5 — 1614.7	
		SM		16.5'-17.5'- (SM) Strong brown (7.5YR 5/6); **SILTY SAND**; Dry; Loose; 5% gravel, 75% sand, 20% silt; 50% coarse, 30% medium, 20% fine grained sand; Subangular to subrounded grains; Volcanic sand.	
				17.5 — 1613.7	
20		GW-GM		17.5'-22'- (GW-GM) Brown (7.5YR 5/4); **Well graded GRAVEL with SILT and SAND**; Dry; Loose; 60% gravel, 30% sand, 10% silt; 30% coarse, 20% medium, 50% fine grained sand; Subangular to subrounded grains; Gravel up to 3 inch.	
				22.0 — 1609.2	
25		SW-SM		22'-36'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 30% gravel, 60% sand, 10% silt; 30% coarse, 20% medium, 50% fine grained sand; Angular to subrounded grains.	
30					

(Continued Next Page)

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
30						
		SW-SM		22'-36'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 30% gravel, 60% sand, 10% silt; 30% coarse, 20% medium, 50% fine grained sand; Angular to subrounded grains.*(continued from previous)*		
35						
				36.0	1595.2	
		ML		36'-39'- (ML) Brown (7.5YR 5/4); **SILT with SAND**; Moist; Soft; 20% sand, 70% silt, 10% clay; 100% fine grained sand; Low plasticity.		
				39.0	1592.2	
40		MH		39'-44'- (MH) Dark brown (7.5YR 3/4); **ELASTIC SILT**; Moist; Hard; 50% silt, 50% clay; High plasticity; Abundant gypsum crystals up to 2 inch.		5% Bentonite-Cement (1'-80')
				44.0	1587.2	
		ML		44'-49'- (ML) Brown (7.5YR 5/4); **SANDY SILT**; Moist; Stiff; 30% sand, 60% silt, 10% clay; 100% fine grained sand; Low plasticity; Abundant gypsum crystals.		
45				49.0	1582.2	
		ML		49'-58'- (ML) Yellowish brown (2.5YR 6/4); **SANDY SILT**; Moist; Stiff; 35% sand, 50% silt, 15% clay; 100% fine grained sand; Low plasticity; Abundant coarse grained gypsum crystals.		
50						
55						
				58.0	1573.2	
		ML		58'-61'- (ML) Brown (7.5YR 5/4); **SANDY SILT**; Moist; Stiff; 35% sand, 50% silt, 15% clay; 100% fine grained sand; Low plasticity; Abundant coarse grained gypsum crystals.		
60				61.0	1570.2	
		CH		61'-65.5'- (CH) Light gray (2.5YR 7/2); **FAT CLAY**; Moist; Soft; 10% silt, 90% clay; High plasticity.		

(Continued Next Page)

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
65		CH		61'-65.5'- (CH) Light gray (2.5YR 7/2); **FAT CLAY**; Moist; Soft; 10% silt, 90% clay; High plasticity.*(continued from previous)*	
				65.5 1565.7	
		CH		65.5'-69'- (CH) Gray (5YR 5/1); **FAT CLAY**; Wet; Soft; 10% silt, 90% clay; High plasticity; Organic odor.	
				69.0 1562.2	
70		CH		69'-74'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Moist; Soft; 10% silt, 90% clay; High plasticity; Gypsum crystals up to 1 inch.	
				Below 72'.	
				74.0 1557.2	
75		CH		74'-78.5'- (CH) Brown (7.5YR 4/3); **FAT CLAY**; Moist; Soft; 10% silt, 90% clay; High plasticity.	
				78.5 1552.7	
		CH		78.5'-81'- (CH) Light gray (2.5YR 7/2); **FAT CLAY**; Moist; Soft; 10% silt, 90% clay; High plasticity.	
80				Below 79' - 2-inch sand lens.	
				81.0 1550.2	
		ML		81'-88'- (ML) Brown (7.5YR 4/3); **SILT with SAND**; Moist; Stiff; 15% sand, 60% silt, 25% clay; 10% medium, 90% fine grained sand; Low to medium plasticity; Medium grained gypsum crystals.	Hydrated Bentonite 3/8" Chips (80-87')
85				Below 85.5' - Dark brown (7.5YR 3/3). Below 86' - White (N9) Dry; Gypsum bed. Below 86.2' - Light gray (5Y 7/2). Below 87' - Brown (7.5YR 4/3) Abundant coarse grained gypsum crystals.	
				88.0 1543.2	
		ML		88'-100'- (ML) Strong brown (7.5YR 4/3); **SILT**; Moist; Very stiff; 10% sand, 75% silt, 15% clay; 100% fine grained sand; Low plasticity.	Filter Pack Pioneer Sand #2/12 (87'-110.5')
90					
		ML		Below 94' - Wet.	
95					

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WELL NUMBER GRTS-MW04B

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
100		ML		88'-100'- (ML) Strong brown (7.5YR 4/3); **SILT**; Moist; Very stiff; 10% sand, 75% silt, 15% clay; 100% fine grained sand; Low plasticity.*(continued from previous)*	1531.2	0.010" slot, 2" Sch. 40 PVC (89.5'-109.5')
			100.0			
		ML		100'-102'- (ML) Brown (7.5YR 4/2); **SANDY SILT**; Moist; Stiff; 35% sand, 60% silt, 5% clay; 100% fine grained sand; Non plastic plasticity.		
			102.0		1529.2	
105		CH		102'-106'- (CH) Light gray (2.5Y 7/2); **FAT CLAY**; Moist; Stiff; 30% silt, 70% clay; Medium to high plasticity; Gypsum crystals up to 1 inch.		
				Below 104' - Dry; Organic odor.		
			106.0		1525.2	
		CH		106'-110'- (CH) Light brown (7.5YR 6/4); **FAT CLAY**; Moist; Stiff; High plasticity; Gypsum bed.		
110			110.0		1521.2	
		CH		110'-120'- (CH) Mottled Light gray (N2) with black (5Y 7/2); **FAT CLAY**; Moist; Very stiff; 100% clay; Mottled; High plasticity; Organic odor; Abundant disseminated gypsum crystals.		Hydrated Bentonite 3/8" Chips (110.5'-120')
115				Below 116' - Greenish gray (5GY 5/2) Moist.		
120			120.0		1511.2	

Bottom of borehole at 120.0 feet.

WELL NUMBER GRTS-MW05A

TETRA TECH

CLIENT Nevada Environmental Response Trust
PROJECT NAME Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER 117-7502018-M17
PROJECT LOCATION Henderson, NV
DATE STARTED 4/18/18 **COMPLETED** 4/18/18
GROUND ELEVATION 1628.63 ft MSL
DRILLING METHOD Sonic
NORTHING 26728941.02 **EASTING** 835055.82
DRILLING CONTRACTOR Cascade Drilling
BOREHOLE DIAMETER 6" **TOTAL DEPTH** 80 ft
LOGGED BY J. Bunkers **CHECKED BY** M. Baron
NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0			0 -80' - SEE LOG FOR GRTS-MW05B FOR LITHOLOGY.	Casing Top Elev: 1628.19 (ft) Casing Type: 2" Sched. 40 PVC Bottom of Flush Mount Vault 5% Bentonite-Cement (0.7'-54')
10				
20				
30				
40				
50				

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TETRA TECH

WELL NUMBER GRTS-MW05A

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
50			0 -80' - SEE LOG FOR GRTS-MW05B FOR LITHOLOGY.*(continued from previous)*	Hydrated Bentonite 3/8" Chips (54'-58')
60				Filter Pack Pioneer Sand #2/12 (58'-71')
				0.010" slot, 2" Sch. 40 PVC (60'-70')
70				
				Hydrated Bentonite 3/8" Chips (71'-80')
80			80.0 1548.6	

Bottom of borehole at 80.0 feet.

WELL NUMBER GRTS-MW05B

TETRA TECH

CLIENT	Nevada Environmental Response Trust	**PROJECT NAME**	Galleria Drive Bioremediation Treatability Study
PROJECT NUMBER	117-7502018-M17	**PROJECT LOCATION**	Henderson, NV
DATE STARTED	4/17/18 **COMPLETED** 4/17/18	**GROUND ELEVATION**	1628.61 ft MSL
DRILLING METHOD	Sonic	**NORTHING** 26728941.82	**EASTING** 835060.59
DRILLING CONTRACTOR	Cascade Drilling	**BOREHOLE DIAMETER**	6" **TOTAL DEPTH** 120 ft
LOGGED BY	J. Bunkers **CHECKED BY** M. Baron		

NOTES Air knife to 10 feet below ground surface.

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0					Casing Top Elev: 1628.23 (ft) Casing Type: 2" Sched. 40 PVC
		SM		0'-0.3'- (SM) Brown (7.5YR 6/4); **SILTY SAND with GRAVEL**; Dry; Loose; 30% gravel, 50% sand, 20% silt; 40% coarse, 30% medium, 30% fine grained sand; Angular grains; Fine grained gravel. 1628.3	
		GW-GM		0.3'-6'- (GW-GM) Brown (7.5YR 5/4); **Well graded GRAVEL with SILT and SAND**; Dry; Loose; 50% gravel, 40% sand, 10% silt; 50% coarse, 30% medium, 20% fine grained sand; Angular grains; Gravel and cobbles up to 6 inch.	
5				6.0 1622.6	
		SW-SM		6'-8.5'- (SW-SM) Brown (7.5YR 5/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 40% gravel, 50% sand, 10% silt; 50% coarse, 40% medium, 10% fine grained sand; Angular grains; Strong cementation.	
				8.5 1620.1	
		SW-SM		8.5'-10'- (SW-SM) Brown (7.5YR 5/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 30% gravel, 60% sand, 10% silt; 40% coarse, 50% medium, 10% fine grained sand; Angular grains.	
10				10.0 1618.6	
		GW-GM		10'-13.5'- (GW-GM) Brown (7.5YR 5/4); **Well graded GRAVEL with SILT and SAND**; Dry; Loose; 50% gravel, 40% sand, 10% silt; 40% coarse, 30% medium, 30% fine grained sand; Subangular to subrounded grains.	
				13.5 1615.1	
		SW-SM		13.5'-16'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 15% gravel, 75% sand, 10% silt; 40% coarse, 40% medium, 20% fine grained sand; Angular to subrounded grains; Volcanic sand.	
15				16.0 1612.6	
				16 -18.5' - No recovery.	
				18.5 1610.1	
		SW-SM		18.5'-33'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 15% gravel, 75% sand, 10% silt; 40% coarse, 40% medium, 20% fine grained sand; Angular to subrounded grains; Volcanic sand.	
20					
25					
30					

Bottom of Flush Mount Vault

(Continued Next Page)

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
30						
		SW-SM		18.5'-33'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND with SILT and GRAVEL**; Dry; Loose; 15% gravel, 75% sand, 10% silt; 40% coarse, 40% medium, 20% fine grained sand; Angular to subrounded grains; Volcanic sand. *(continued from previous)*		
					33.0 / 1595.6	
		SW		33'-33.5'- (SW) Brown (7.5YR 4/4); **Well graded SAND with GRAVEL**; Dry; Loose; 25% gravel, 75% sand; 40% coarse, 40% medium, 20% fine grained sand; Angular to subrounded grains; Few cobbles up to 3.5 inch.	33.5 / 1595.1	
35		SM		33.5'-39'- (SM) Brown (7.5YR 4/4); **SILTY SAND**; Dry; Loose; 2% gravel, 80% sand, 15% silt; 40% coarse, 10% medium, 60% fine grained sand; Subangular to rounded grains.		5% Bentonite-Cement (0.9'-68')
					39.0 / 1589.6	
40		ML		39'-40.5'- (ML) Brown (7.5YR 4/3); **SILT**; Moist; Soft; 5% sand, 70% silt, 25% clay; 100% fine grained sand; Low to medium plasticity.	40.5 / 1588.1	
		ML		40.5'-42'- (ML) Light gray (10YR 7/2); **SILT**; Moist; Soft; 5% sand, 70% silt, 25% clay; 100% fine grained sand; Low to medium plasticity.	42.0 / 1586.6	
		CH		42'-46'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Moist; Stiff; 10% silt, 90% clay; High plasticity; Gypsum occurs in beds and as disseminated gypsum crystals up to 3 inch.		
45				Below 45' - 5% fine grained gypsum crystals.	46.0 / 1582.6	
		CL		46'-47.5'- (CL) Brown (7.5YR 5/4); **LEAN CLAY**; Moist; Soft; 3% sand, 30% silt, 67% clay; 100% fine grained sand; Non plastic to low plasticity; No gypsum crystals.	47.5 / 1581.1	
		CH		47.5'-50'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Moist; Stiff; 3% silt, 97% clay; High plasticity; Abundant coarse grained gypsum crystals.		
50					50.0 / 1578.6	
		CH		50'-51'- (CH) Brown (7.5YR 5/4); **FAT CLAY**; Moist; Stiff; 3% silt, 97% clay; High plasticity; Abundant coarse grained gypsum crystals.	51.0 / 1577.6	
		SW-SM		51'-52.5'- (SW-SM) Brown (7.5YR 4/4); **Well graded SAND**; Dry; Loose; 15% gravel, 75% sand, 10% silt; 40% coarse, 40% medium, 20% fine grained sand; Angular to subrounded grains; Reacts with acid.	52.5 / 1576.1	
		CL		52.5'-53.5'- (CL) Brown (7.5YR 4/4); **LEAN CLAY**; Moist; Stiff; 50% silt, 50% clay; Low plasticity; Abundant gypsum crystals.	53.5 / 1575.1	
		CL		53.5'-55'- (CL) Olive gray (5Y 5/2); **LEAN CLAY**; Moist; Stiff; 50% silt, 50% clay; Low plasticity; Grades to few disseminated gypsum crystals.	55.0 / 1573.6	
55		CL		55'-59.3'- (CL) Light gray (10YR 7/2); **LEAN CLAY**; Moist; Stiff; 50% silt, 50% clay; Low plasticity; Few fine grained gypsum crystals.		
					59.3 / 1569.3	
60				59.3'-60.5'- White (N9); Gypsum bed.	60.5 / 1568.1	
		CH		60.5'-62'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Wet; Stiff; 5% silt, 95% clay; High plasticity.	62.0 / 1566.6	
		CH		62'-66'- (CH) Light gray (2.5Y 7/2); **FAT CLAY**; Wet; Stiff; 5% silt, 95% clay; Medium to high plasticity; Few fine grained gypsum crystals.		

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CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
65		CH		62'-66'- (CH) Light gray (2.5Y 7/2); **FAT CLAY**; Wet; Stiff; 5% silt, 95% clay; Medium to high plasticity; Few fine grained gypsum crystals.*(continued from previous)*		
				66.0	1562.6	
		CH		66'-71'- (CH) Mottled Olive gray (N2) with black (5Y 5/2); **FAT CLAY**; Wet; Stiff; 5% silt, 95% clay; Mottled; Medium to high plasticity; Organic odor.		
70				71.0	1557.6	Hydrated Bentonite 3/8" Chips (68'-73')
		CH		71'-74'- (CH) Brown (7.5YR 5/4); **FAT CLAY**; Dry; Stiff; 3% silt, 97% clay; Medium to high plasticity; Abundant coarse grained gypsum crystals.		
				74.0	1554.6	Filter Pack Pioneer Sand #2/12 (73'-86')
75		CH		74'-76'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Few disseminated gypsum crystals.		
				76.0	1552.6	
		CH		76'-79'- (CH) Brown (7.5YR 4/4); **FAT CLAY**; Wet; Stiff; 5% sand, 30% silt, 65% clay; 100% fine grained sand; High plasticity.		
				79.0	1549.6	
80		CH		79'-84'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Very stiff; 100% clay; High plasticity; Abundant disseminated gypsum crystals up to 3 inch.		0.010" slot, 2" Sch. 40 PVC (75'-85')
				84.0	1544.6	
85		CL		84'-86'- (CL) Brown (7.5YR 4/4); **LEAN CLAY**; Wet; Very stiff; 5% sand, 35% silt, 60% clay; 100% fine grained sand; Medium plasticity.		
				86.0	1542.6	
		CH		86'-87.5'- (CH) Light gray (5Y 7/2); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Abundant disseminated gypsum crystals up to 3 inch.		
				87.5	1541.1	
90		CH		87.5'-91'- (CH) Brown (7.5YR 4/3); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity.		
				91.0	1537.6	
95		ML		91'-102.5'- (ML) Brown (7.5YR 4/4); **SILT**; Wet; Soft; 3% sand, 70% silt, 27% clay; 100% fine grained sand; Low to medium plasticity; No gypsum crystals.		

(Continued Next Page)

WELL NUMBER GRTS-MW05B

TETRA TECH

CLIENT Nevada Environmental Response Trust **PROJECT NAME** Galleria Drive Bioremediation Treatability Study

PROJECT NUMBER 117-7502018-M17 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
100		ML		91'-102.5'- (ML) Brown (7.5YR 4/4); **SILT**; Wet; Soft; 3% sand, 70% silt, 27% clay; 100% fine grained sand; Low to medium plasticity; No gypsum crystals.*(continued from previous)*		
					1526.1	
				102.5		
		CH		102.5'-104'- (CH) Light gray (5Y 7/1); **FAT CLAY**; Moist; Stiff to very stiff; 5% silt, 95% clay; Medium to high plasticity; Organic odor; Black organic layers; No gypsum crystals.		Hydrated Bentonite 3/8" Chips (86'-120')
				104.0	1524.6	
105		CH		104'-106'- (CH) Olive gray (5Y 5/2); **FAT CLAY**; Moist; Stiff; 5% silt, 95% clay; High plasticity.		
				106.0	1522.6	
		CH		106'-107'- (CH) Pale olive (5Y 6/3); **FAT CLAY**; Moist; Stiff; 5% silt, 95% clay; High plasticity; Abundant gypsum crystals.		
				107.0	1521.6	
		CH		107'-109'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Stiff; 100% clay; High plasticity; Abundant gypsum crystals.		
				109.0 Below 108.5' - Black (N2) **CLAY** Organic odor; Organic layer.	1519.6	
110		CH		109'-110'- (CH) Dark brown (7.5YR 3/4); **FAT CLAY**; Wet; Very stiff; 100% clay; High plasticity; Abundant gypsum crystals.		
				110.0	1518.6	
				110'-120'- (CH) Olive gray (5Y 5/2); **FAT CLAY**; Wet; Very stiff; 100% clay; High plasticity; Abundant gypsum crystals; Organic lenses.		
115		CH				
120				120.0	1508.6	

Bottom of borehole at 120.0 feet.

Core Photos

Core Photos
GRTS-MW01B


GRTS-MW01B
4/18/18
←10'-12'→


GRTS-MW01B
4/18/18
←12'-14'→


GRTS-MW01B
4/18/18
←14'-16'→


GRTS-MW01B
4/18/18
←16'-18.5'→


GRTS-MW01B
4/18/18
←18.5'-21'→


GRTS-MW01B
4/18/18
←21'-23.5'→


GRTS-MW01B
4/18/18
← 23.5'-26' →


GRTS-MW01B
4/18/18
← 26'-28.5' →


GRTS-MW01B
4/18/18
← 28.5'-31' →


33
GRTS-MW01B
4/18/18
← 31'-33' →


GRTS-MW01B
4/18/18
← 33'-35' →


GRTS-MW01B
4/18/18
← 35'-37.5' →


GRTS-MW01B
4/18/18
← 37.5'-40' →


GRTS-MW01B
4/18/18
← 40'-42' →


GRTS-MW01B
4/18/18
← 42'-44' →


GRTS-MW01B
4/18/18
← 44'-46' →


GRTS-MW01B
4/18/18
←46'-48.5'→


GRTS-MW01B
4/18/18
←48.5'-51'→


GRTS-MW01B
4/18/18
←51'-53.5'→


GRTS-MW01B
4/18/18
←53.5'-56'→


GRTS-MW01B
4/18/18
←56'-58'→


GRTS-MW01B
4/18/18
←58'-60'→


GRTS-MW01B
4/19/18
←60'-62.5'→


GRTS-MW01B
4/19/18
←62.5'-65'→


GRTS-MW01B
4/19/18
←65'-67.5'→


GRTS-MW01B
4/19/18
←67.5'-70'→


GRTS-MW01B
4/19/18
← 70'-72' →


GRTS-MW01B
4/19/18
← 72'-74' →


GRTS-MW01B
4/19/18
← 74'-76' →


GRTS-MW01B
4/19/18
← 76'-78.5' →


GRTS-MW01B
4/19/18
78.5'-81'


GRTS-MW01B
4/19/18
81'-83.5'


GRTS-MW01B
4/19/18
←83.5'-86'→


GRTS-MW01B
4/19/18
←86'-88.5'→


GRTS-MW01B
4/19/18
← 88.5'-91' →


GRTS-MW01B
4/19/18
← 91'-93.5' →


GRTS-MW01B
4/19/18
←93.5'-96'→


GRTS-MW01B
4/19/18
←96'-98.5'→


GRTS-MW01B
4/19/18
← 98.5-101 →


GRTS-MW01B
4/19/18
← 101'-103.5' →


GRTS-MW01B
4/19/18
←103.5'-106'→


GRTS-MW01B
4/19/18
←106'-108'→


GRTS-MW01B
4/19/18
←108'-110'→


GRTS-MW01B
4/19/18
←110'-112.5'→


GRTS-MW01B
4/19/18
←112.5'-115'→


GRTS-MW01B
4/19/18
←115'-117.5'→


GRTS-MW01B
4/19/18
←117.5'-120'→

Core Photos
GRTS-MW02B


GRTS-MW02B
4/13/18
← 12'-14' →


GRTS-MW02B
4/13/18
← 14'-16' →

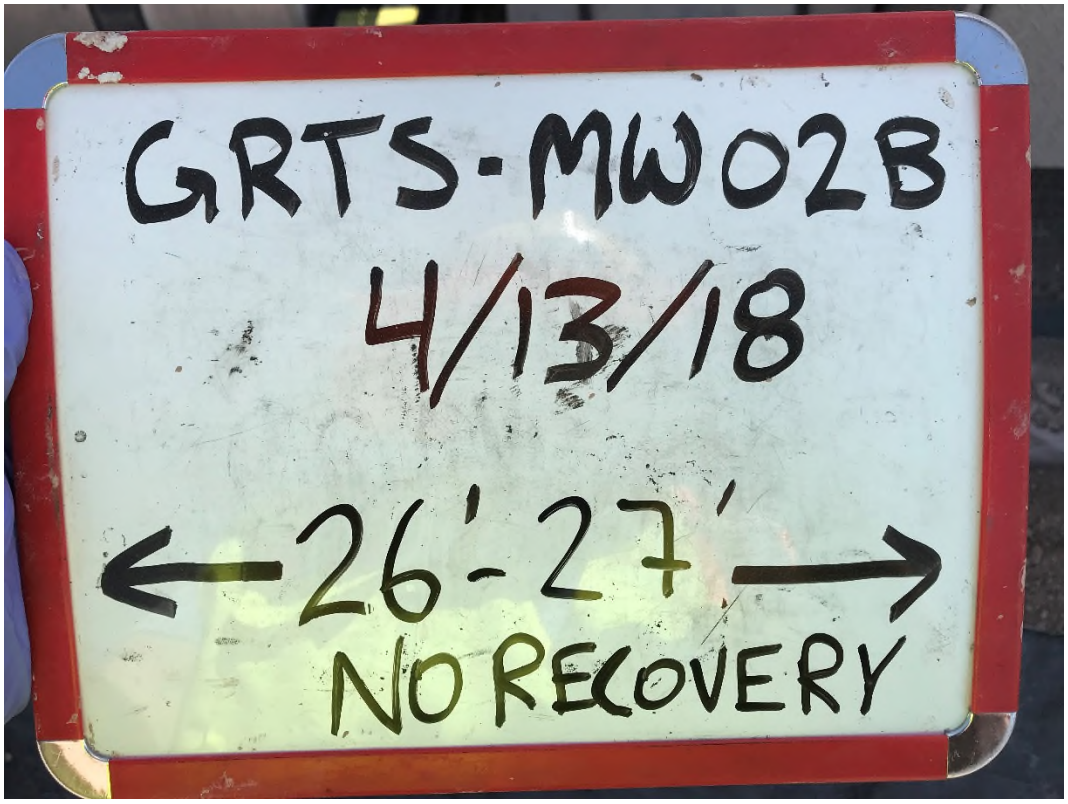

GRTS-MW02B
4/13/18
← 16'-18' →


GRTS-MW02B
4/13/18
← 18'-20' →


GRTS-MW02B
4/13/18
←20'-22'→


GRTS-MW02B
4/13/18
←22'-24'→


GRTS-MW02B
4/13/18
←24'-26'→


GRTS-MW02B
4/13/18
←26'-27'→
NO RECOVERY


GRTS-MW02B
4/13/18
←27'-28.5'→


GRTS-MW02B
4/13/18
←28.5'-31'→


GRTS-MW02B
4/13/18
←31'-33.5'→


GRTS-MW02B
4/13/18
←33.5'-36'→


GRTS-MW02B
4/13/18
←58.5'-61'→


GRTS-MW02B
4/13/18
←61'-63.5'→


GRTS-MW02B
4/13/18
←63.5'-66'→


GRTS-MW02B
4/14/18
←66'-68.5'→


GRTS-MW02B
4/14/18
←68.5'-71'→


GRTS-MW02B
4/14/18
←71'-73.5'→


GRTS-MW02B
4/14/18
←73.5'-76'→


GRTS-MW02B
4/14/18
←76'-78.5'→


GRTS-MW02B
4/14/18
←78.5'-81'→


GRTS-MW02B
4/14/18
←81'-83.5'→


GRTS-MW02B
4/14/18
←83.5'-86'→


GRTS-MW02B
4/14/18
←86'-88.5'→


GRTS-MW02B
4/14/18
←88.5'-91'→


GRTS-MW02B
4/14/18
←91'-93.5'→


GRTS-MW02B
4/14/18
← 93.5-96' →


GRTS-MW02B
4/14/18
← 96'-98.5' →


GRTS-MW02B
4/14/18
←98.5'-101'→


GRTS-MW02B
4/14/18
←101'-103.5'→


GRTS-MW02B
4/14/18
←103.5'-106'→


GRTS-MW02B
4/14/18
←106'-108.5'→


GRTS-MW02B
4/14/18
←108.5-111'→


GRTS-MW02B
4/14/18
←111'-113.5'→

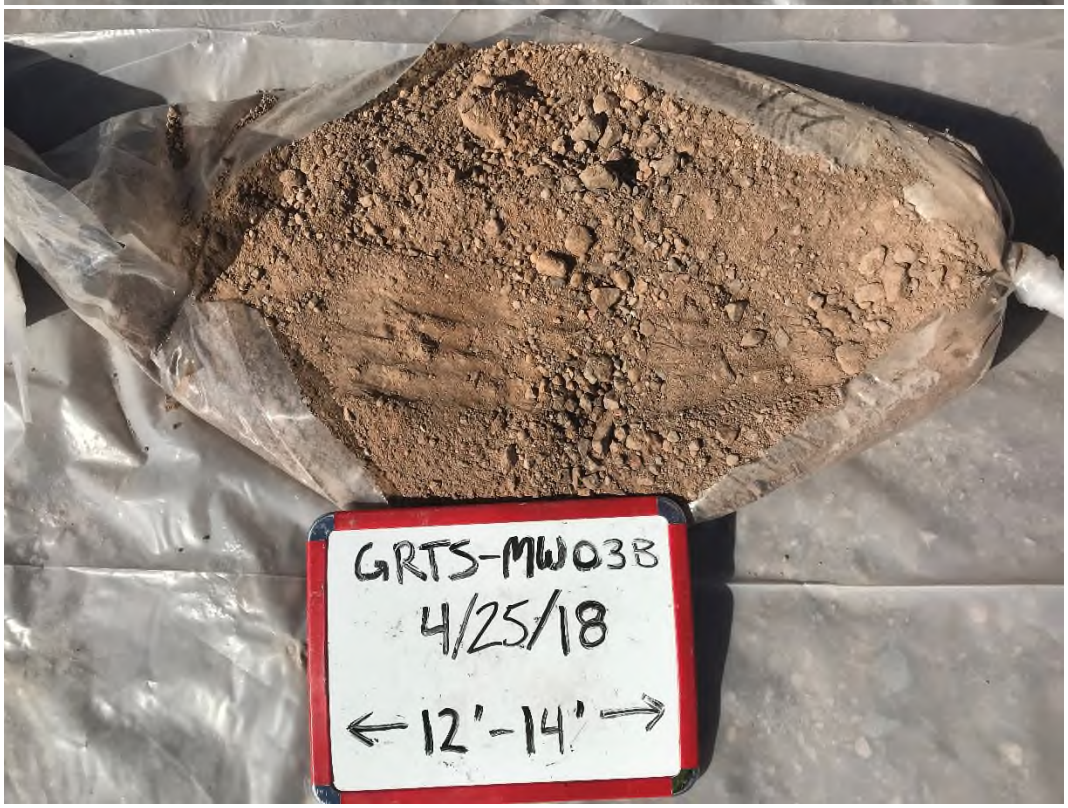

GRTS-MW02B
4/14/18
←113.5-116'→


GRTS-MW02B
4/14/18
←116'-118.5'→


GRTS-MW02B
4/14/18
← 118.5-120' →

Core Photos
GRTS-MW03B


GRTS-MW03B
4/25/18
← 10'-12' →


GRTS-MW03B
4/25/18
← 12'-14' →


GRTS-MW03B
4/25/18
← 14'-16' →


GRTS-MW03B
4/25/18
← 16'-18.5' →


GRTS-MW03B
4/25/18
← 18.5'-21' →


GRTS-MW03B
4/25/18
← 21'-23.5' →


GRTS-MW03B
4/25/18
←23.5'-26'→


GRTS-MW03B
4/25/18
←26'-28.5'→


GRTS-MW03B
4/25/18
← 28.5'-31' →


GRTS-MW03B
4/25/18
← 31'-33.5' →


36
GRTS-MW03B
4/25/18
← 33.5'-36' →


GRTS-MW03B
4/25/18
← 36'-38.5' →


GRTS-MW03B
4/25/18
← 38.5'-41' →


GRTS-MW03B
4/25/18
← 41'-43' →


GRTS-MW03B
4/25/18
← 43'-45' →


GRTS-MW03B
4/25/18
← 45'-47' →


GRTS-MW03B
4/25/18
← 47'-49' →


GRTS-MW03B
4/25/18
← 49'-51' →


GRTS-MW03B
4/25/18
←51'-53.5'→


GRTS-MW03B
4/25/18
←53.5-56'→


GRTS-MW03B
4/25/18
←56'-58.5'→


GRTS-MW03B
4/25/18
←58.5'-61'→


GRTS-MW03B
4/25/18
←61'-63.5'→


GRTS-MW03B
4/25/18
←63.5'-66'→


GRTS-MW03B
4/25/18
← 66'-68.5' →


GRTS-MW03B
4/25/18
← 68.5'-71' →


GRTS-MW03B
4/25/18
← 71'-73.5' →


GRTS-MW03B
4/25/18
← 73.5'-76' →


GRTS-MW03B
4/25/18
←76'-78.5'→


GRTS-MW03B
4/25/18
←78.5'-81'→


GRTS-MW03B
4/25/18
←81'-83.5'→


GRTS-MW03B
4/25/18
←83.5-86'→


GRTS-MW03B
4/25/18
← 86'-88.5' →


GRTS-MW03B
4/25/18
← 88.5'-91' →


GRTS-MW03B
4/25/18
←91'-93.5'→


GRTS-MW03B
4/25/18
←93.5'-96'→


GRTS-MW03B
4/25/18
←96'-98.5'→


GRTS-MW03B
4/25/18
←98.5'-101'→


GRTS-MW03B
4/25/18
← 101'-103' →


GRTS-MW03B
4/25/18
← 103'-106' →


GRTS-MW03B
4/25/18
← 106'-109' →


GRTS-MW03B
4/25/18
← 109'-110' →


GRTS-MW03B
4/25/18
← 110'-112.5' →


GRTS-MW03B
4/25/18
← 112.5'-115' →


GRTS-MW03B
4/25/18
← 115'-117.5' →


GRTS-MW03B
4/25/18
← 117.5'-120' →

Core Photos
GRTS-MW04B


GRTS-MW04B
4/11/18
← 10-12.5 →


GRTS-MW04B
4/11/18
← 12.5'-14 →


GRTS-MW04B
4/11/18
←14"-16'→


GRTS-MW04B
4/11/18
←16"-18.5'→

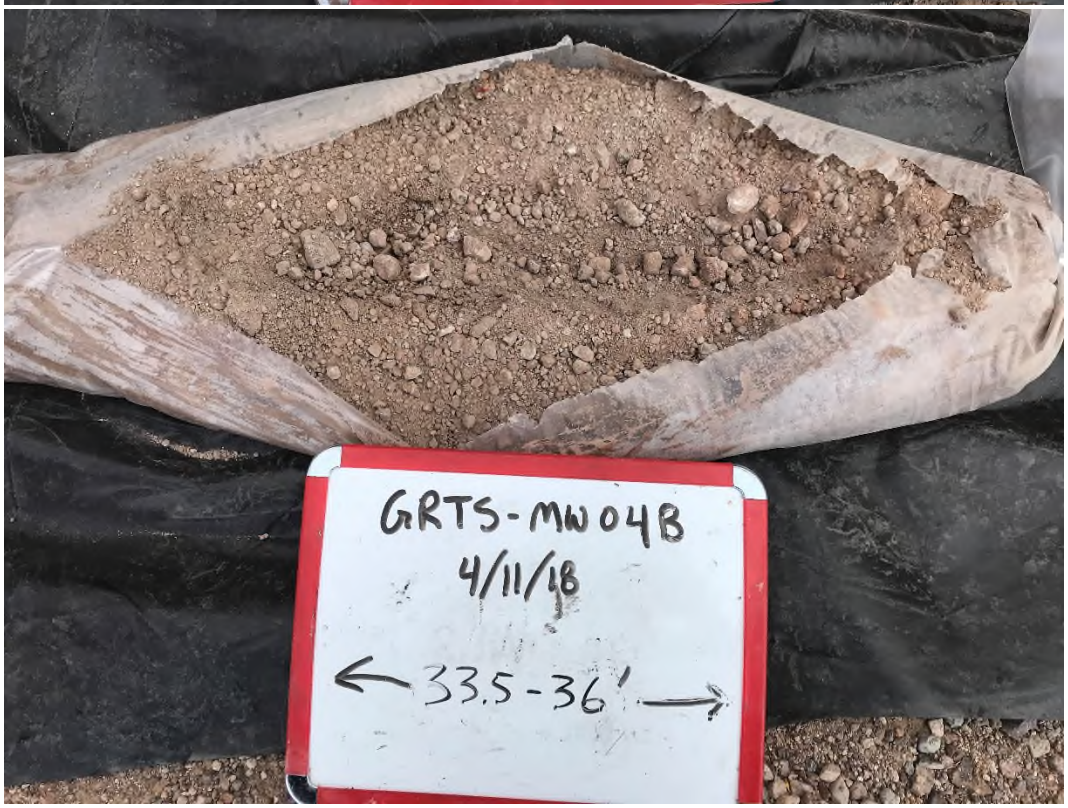

21
GRTS-MW04B
4/11/18
←18.5'-21'→


GRTS-MW04B
4/11/18
← 21'-23.5' →


26
GRTS-MW04B
4/11/18
← 23.5-26' →


23.5
GRTS-MW04B
4/11/18
← 26'-31' →


GRTS-MW04B
4/11/18
31 - 33.5'


GRTS-MW04B
4/11/18
33.5 - 36'


GRTS-MW04B
4/11/18
← 36'-38' →


40'
GRTS-MW04B
4/11/18
← 38'-40' →


42
GRTS-MW04B
4/11/18
← 40'-42' →


GRTS-MW04B
4/11/18
← 42'-44' →

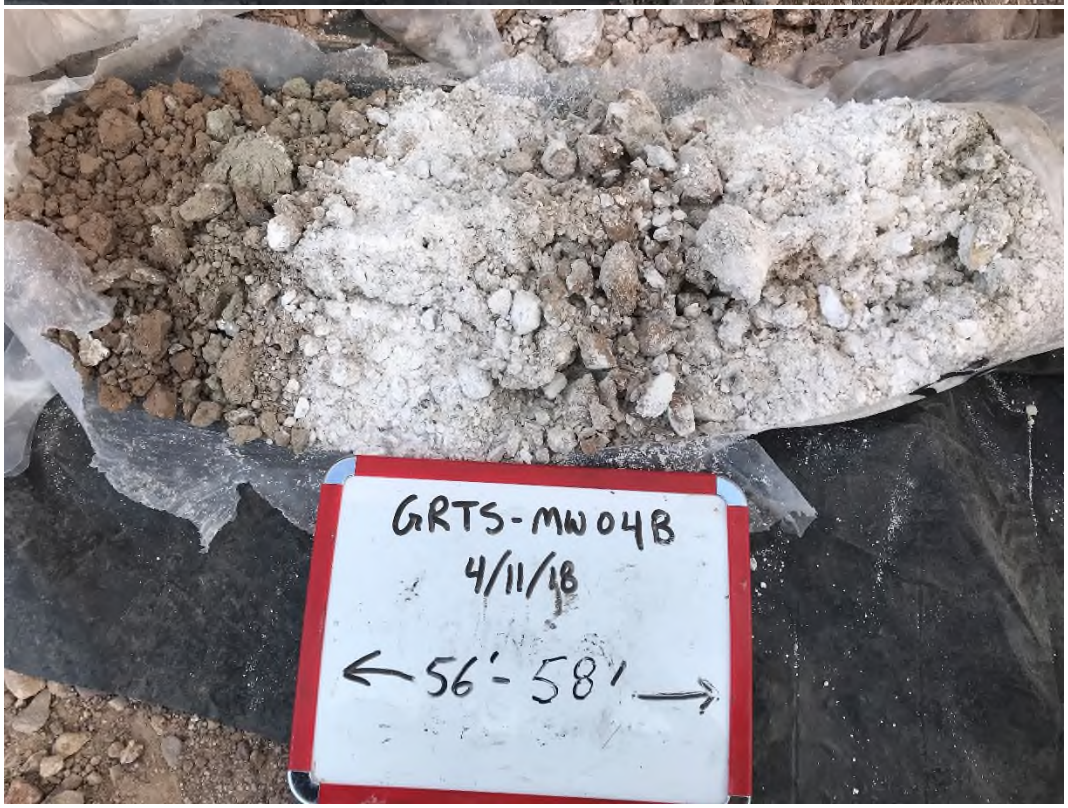

GRTS-MW04B
4/11/18
← 44' - 46.5' →


GRTS-MW04B
4/11/18
← 46.5'-49' →


GRTS-MW04B
4/11/18
← 49'-51' →


GRTS-MW04B
4/11/18
← 51'-53.5' →


GRTS-MW04B
4/11/18
←53.5-56'→


GRTS-MW04B
4/11/18
←56'-58'→


GRTS-MW04B
4/11/18
←58-60'→


GRTS-MW04B
4/12/18
←60'-62.5'→


GRTS-MW04B
4/12/18
← 62.5' - 65' →


GRTS-MW04B
4/12/18
← 65' - 67.5' →


GRTS-MW04B
4/12/18
←67.5-70'→


GRTS-MW04B
4/12/18
←70'-73'→


GRTS-MW04B
4/12/18
73'-75'


GRTS-MW04B
4/12/18
75'-77.5'

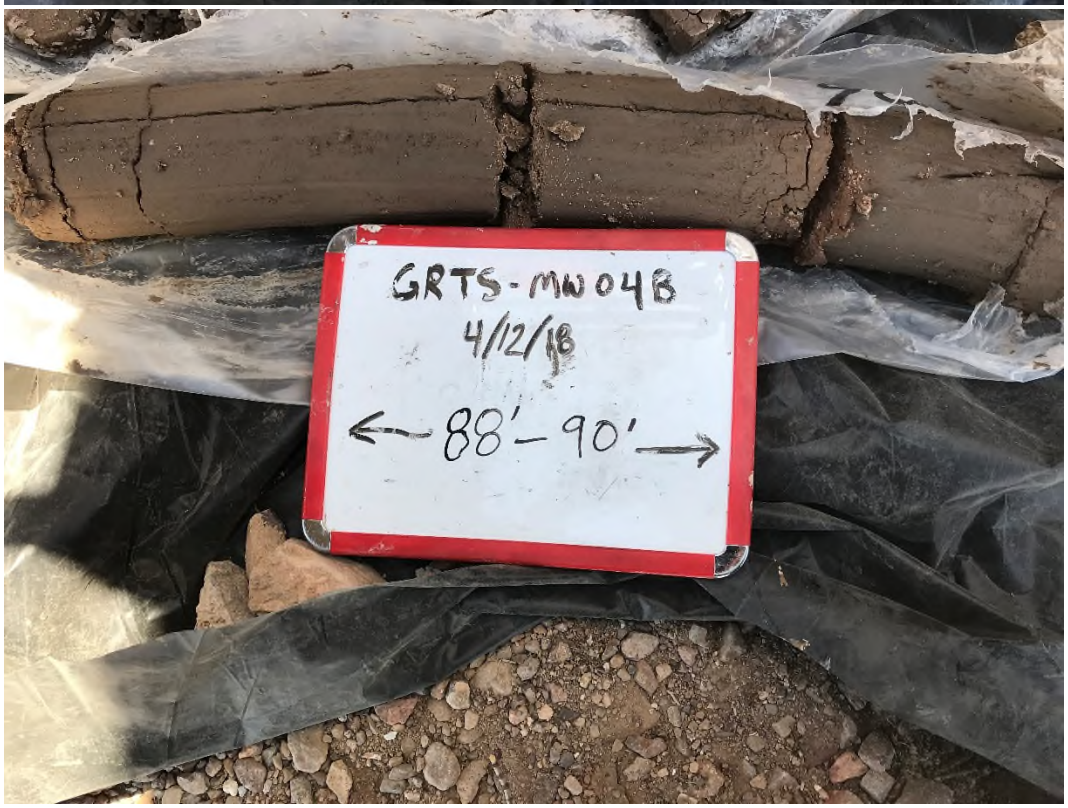

GRTS-MW04B
4/12/18
77.5-80'


GRTS-MW04B
4/12/18
80'-82'


GRTS-MW04B
4/12/18
82'-84'


GRTS-MW04B
4/12/18
84'-86'


GRTS-MW04B
4/12/18
86'-88'


GRTS-MW04B
4/12/18
88'-90'


GRTS-MW04B
4/12/18
←90'-92.5'→
92.5


GRTS-MW04B
4/12/18
←92.5'-95'→


GRTS-MW04B
4/12/18
←95-97.5'→


GRTS-MW04B
4/12/18
←97.5'-100'→


GRTS-MW04B
4/12/18
← 100'-102' →


GRTS-MW04B
4/12/18
← 102'-104' →


GRTS-MW04B
4/12/18
← 104'-106' →


GRTS-MW04B
4/12/18
← 106-108.5' →


GRTS-MW04B
4/12/18
← 108.5' - 111' →


GRTS-MW04B
4/12/18
← 111' - 114' →


GRTS-MW04B
4/12/18
← 114-116' →


GRTS-MW04B
4/12/18
← 116'-118' →

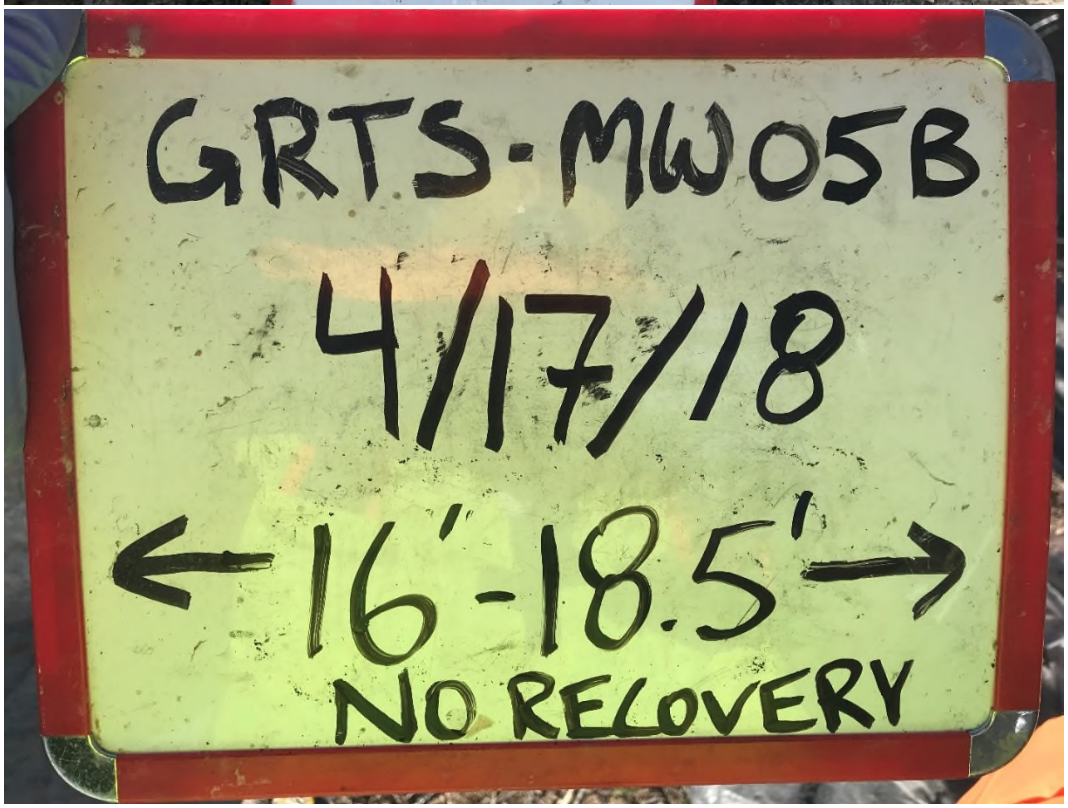

GRTS-MW04B
4/12/18
← 118'-120' →

Core Photos
GRTS-MW05B


12'
GRTS-MW05B
4/17/18
← 10'-12' →


GRTS-MW05B
4/17/18
← 12'-14' →


GRTS-MW05B
4/17/18
← 14' - 16' →


GRTS-MW05B
4/17/18
← 16' - 18.5' →
NO RECOVERY


GRTS-MW05B
4/17/18
←18.5'-21'→


GRTS-MW05B
4/17/18
←21'-23.5'→


26'
GRTS-MW05B
4/17/18
← 23.5'-26' →


GRTS-MW05B
4/17/18
← 26'-28.5' →


GRTS-MW05B
4/17/18
← 28.5'-31' →


GRTS-MW05B
4/17/18
← 31'-33.5' →


GRTS-MW05B
4/17/18
← 33.5'-36' →


GRTS-MW05B
4/17/18
← 36'-38' →


GRTS-MW05B
4/17/18
←38'-41'→


GRTS-MW05B
4/17/18
←41'-43.5'→


GRTS-MW05B
4/17/18
← 43.5'-46' →


GRTS-MW05B
4/17/18
← 46'-48.5' →


GRTS-MW05B
4/17/18
← 48.5'-51' →


GRTS-MW05B
4/17/18
← 51'-54' →


GRTS-MW05B
4/17/18
← 54'-56' →


GRTS-MW05B
4/17/18
← 56'-58.5' →


GRTS-MW05B
4/17/18
←58.5'-61'→


GRTS-MW05B
4/17/18
←61'-63.5'→


GRTS-MW05B
4/17/18
← 63.5'-66' →


GRTS-MW05B
4/17/18
← 66'-68.5' →


GRTS-MW05B
4/17/18
← 68.5'-71' →


GRTS-MW05B
4/17/18
← 71'-73.5' →


GRTS-MW05B
4/17/18
← 73.5-76' →


GRTS-MW05B
4/17/18
← 76'-78.5' →


GRTS-MW05B
4/17/18
←78.5'-81'→


GRTS-MW05B
4/17/18
←81'-83.5'→


GRTS-MW05B
4/17/18
←83.5'-86'→


GRTS-MW05B
4/17/18
←86'-88.5'→


GRTS-MW05B
4/17/18
←88.5'-91'→


GRTS-MW05B
4/17/18
←91'-93.5'→


GRTS-MW05B
4/17/18
←93.5'-96'→
96


GRTS-MW05B
4/17/18
←96'-98.5'→


GRTS-MW05B
4/17/18
←98.5'-101'→


GRTS-MW05B
4/17/18
←101'-102.5'→


GRTS-MW05B
4/17/18
←102.5'-105'→


GRTS-MW05B
4/17/18
←105'-107.5'→


GRTS-MW05B
4/17/18
←107.5-110'→


112.5
GRTS-MW05B
4/17/18
←110'-112.5'→


GRTS-MW05B
4/17/18
←112.5-115'→


GRTS-MW05B
4/17/18
←115'-117.5'→


GRTS-MW05B
4/17/18
←117.5'-120'→

Appendix C
Analytical Data Summary Tables

Galleria Drive Bioremediation Treatability Study Work Plan Addendum

Table C.1 Soil Analytical Results

Location	Sample Date	QCType	Depth (ft bgs)	Lab SampleID	EPA 314.0	Anions by EPA 300.0 (soluble)			EPA 300.1B	EPA 351.2	SW6010B	SW9060A	SM 2320B (soluble)		SM 2320B (soluble)	SM 2540C (soluble)
					Perchlorate	Chloride (as Cl)	Nitrate (as NO3)	Sulfate	Chlorate	Total Kjeldahl Nitrogen (TKN)	Phosphorus	Total Organic Carbon	Alkalinity as CaCO3	Bicarbonate ion as HCO3	Carbonate (as CO3)	Total Dissolved Solids
					mg/kg	mg/L	mg/L	mg/L	ug/kg	mg/kg	mg/kg	mg/kg	mg/L	mg/L	mg/L	mg/L
GRTS-MW01B	4/19/2018	FD	110 - 110.5	440-209324-6	<0.067	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	70 - 70.5	440-209324-1	2.4	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	80 - 80.5	440-209324-2	<0.065	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	90 - 90.5	440-209324-3	<0.064	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	100 - 100.5	440-209324-4	<0.063 UJ	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	110 - 110.5	440-209324-5	<0.068	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	120 - 120.5	440-209324-7	<0.068	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/13/2018	N	65 - 65.5	440-209035-1	0.52	19	1.3	1,700	2,700 J	11 J	81	<600 UJ	<4.0	<4.8	<2.4	2,400
GRTS-MW02B	4/14/2018	FD	109 - 109.5	440-209035-5	<0.072	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	70 - 70.5	440-209035-2	0.069	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	81 - 81.5	440-209035-3	0.20	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	91 - 91.5	440-209035-6	<0.070	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	92 - 92.5	440-209035-7	<0.070	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	100 - 100.5	440-209035-8	<0.066	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	109 - 109.5	440-209035-4	<0.069	61	<0.25	1,800	<370 UJ	57 J	210	7,900 J	<4.0	<4.8	<2.4	3,400
GRTS-MW02B	4/14/2018	N	120 - 120.5	440-209035-9	<0.066	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	FD	110 - 110.5	440-209880-9	0.076 J	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	63 - 63.5	440-209880-1	0.22	140	<1.3	1,900	<350 UJ	63 J	210	26,000 J	<4.0	<4.8	<2.4	2,600
GRTS-MW03B	4/25/2018	N	73 - 73.5	440-209880-2	0.77	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	83 - 83.5	440-209880-3	<0.061	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	93 - 93.5	440-209880-4	0.75	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	95 - 95.5	440-209880-6	0.29	160	<1.3	1,600	<330 UJ	67 J	700	<600 UJ	<4.0	<4.8	<2.4	2,600
GRTS-MW03B	4/25/2018	N	102 - 102.5	440-209880-5	0.20 J	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	110 - 110.5	440-209880-7	0.072 J	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	120 - 120.5	440-209880-8	<0.080	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	70 - 70.5	440-208822-1	0.57	130	<0.25	610	<330 UJ	88 J	490	1,900 J	<4.0	<4.8	<2.4	1,300
GRTS-MW04B	4/12/2018	N	79 - 79.5	440-208822-2	<0.015	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	90 - 90.5	440-208822-3	<0.066	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	94 - 94.5	440-208822-7	<0.065	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	100 - 100.5	440-208822-4	<0.067	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	110 - 110.5	440-208822-5	<0.077	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	120 - 120.5	440-208822-6	<0.061	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	FD	72 - 72.5	440-209097-6	1.3 J	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	45.5 - 46	440-209097-1	0.56	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	47 - 47.5	440-209097-2	0.68	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	52 - 52.5	440-209097-3	0.60	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	61 - 61.5	440-209097-4	1.2	99	0.36 J	1,900	1,100 J	62 J	180	33,000 J	<4.0	<4.8	<2.4	2,400
GRTS-MW05B	4/17/2018	N	72 - 72.5	440-209097-5	1.7 J	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	82 - 82.5	440-209097-7	<0.065	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	92 - 92.5	440-209097-8	<0.066	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	102 - 102.5	440-209097-9	<0.058	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	111 - 111.5	440-209097-10	<0.064	---	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	120 - 120.5	440-209097-11	<0.013	---	---	---	---	---	---	---	---	---	---	---

Notes

mg/kg	milligrams per kilogram
mg/L	milligrams per liter
ug/L	micrograms per liter
ug/kg	micrograms per kilogram
SU	Standard Units
FD	Field duplicate
N	Normal field sample
<	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J-	The result is an estimated quantity, but the result may be biased low.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
--	Not Analyzed

Table C.1 Soil Analytical Results

Location	Sample Date	QCType	Depth (ft bgs)	Lab SampleID	SW6010B (soluble)				SW6020 (soluble)				SW7199	SW9045
					Calcium	Magnesium	Potassium	Sodium	Arsenic	Chromium	Iron	Manganese	Chromium, Hexavalent	pH
					mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	mg/kg	SU
GRTS-MW01B	4/19/2018	FD	110 - 110.5	440-209324-6	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	70 - 70.5	440-209324-1	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	80 - 80.5	440-209324-2	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	90 - 90.5	440-209324-3	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	100 - 100.5	440-209324-4	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	110 - 110.5	440-209324-5	---	---	---	---	---	---	---	---	---	---
GRTS-MW01B	4/19/2018	N	120 - 120.5	440-209324-7	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/13/2018	N	65 - 65.5	440-209035-1	640	24	22	18	7.9	3.1 J	<40	<2.5	<0.24	7.2 J
GRTS-MW02B	4/14/2018	FD	109 - 109.5	440-209035-5	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	70 - 70.5	440-209035-2	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	81 - 81.5	440-209035-3	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	91 - 91.5	440-209035-6	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	92 - 92.5	440-209035-7	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	100 - 100.5	440-209035-8	---	---	---	---	---	---	---	---	---	---
GRTS-MW02B	4/14/2018	N	109 - 109.5	440-209035-4	610	55	230 J	58	7.1	<2.5	<40	6.2	<0.22	7.4 J
GRTS-MW02B	4/14/2018	N	120 - 120.5	440-209035-9	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	FD	110 - 110.5	440-209880-9	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	63 - 63.5	440-209880-1	510	86	98	81	3.8 J	<2.5	<40	<2.5	<0.21	7.6 J
GRTS-MW03B	4/25/2018	N	73 - 73.5	440-209880-2	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	83 - 83.5	440-209880-3	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	93 - 93.5	440-209880-4	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	95 - 95.5	440-209880-6	360	94 J	150 J	110 J	<2.5	2.6 J	<40	13	<0.20	7.8 J
GRTS-MW03B	4/25/2018	N	102 - 102.5	440-209880-5	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	110 - 110.5	440-209880-7	---	---	---	---	---	---	---	---	---	---
GRTS-MW03B	4/25/2018	N	120 - 120.5	440-209880-8	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	70 - 70.5	440-208822-1	33	61	120	88	5.0	<2.5	<40	<2.5	<0.20	7.6 J
GRTS-MW04B	4/12/2018	N	79 - 79.5	440-208822-2	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	90 - 90.5	440-208822-3	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	94 - 94.5	440-208822-7	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	100 - 100.5	440-208822-4	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	110 - 110.5	440-208822-5	---	---	---	---	---	---	---	---	---	---
GRTS-MW04B	4/12/2018	N	120 - 120.5	440-208822-6	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	FD	72 - 72.5	440-209097-6	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	45.5 - 46	440-209097-1	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	47 - 47.5	440-209097-2	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	52 - 52.5	440-209097-3	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	61 - 61.5	440-209097-4	500	70	97	65	<2.5	6.0 J	<40	<2.5	<0.20	7.4 J
GRTS-MW05B	4/17/2018	N	72 - 72.5	440-209097-5	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	82 - 82.5	440-209097-7	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	92 - 92.5	440-209097-8	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	102 - 102.5	440-209097-9	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	111 - 111.5	440-209097-10	---	---	---	---	---	---	---	---	---	---
GRTS-MW05B	4/17/2018	N	120 - 120.5	440-209097-11	---	---	---	---	---	---	---	---	---	---

Notes

mg/kg	milligrams per kilogram
mg/L	milligrams per liter
ug/L	micrograms per liter
ug/kg	micrograms per kilogram
SU	Standard Units
FD	Field duplicate
N	Normal field sample
<	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J-	The result is an estimated quantity, but the result may be biased low.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
--	Not Analyzed

Galleria Drive Bioremediation Treatability Study Work Plan Addendum

Table C.2 Soil Microbial Results

Location	Sample Date	Depth (ft bgs)	Sample Matrix	Microbial Census	Microbial Phospholipid Fatty Acid Analysis (PLFA)								
				Perchlorate reductase gene (pcrA)	Total Biomass	Proteobacteria (Monos)	Firmicutes (TerBrSats)	Anaerobic metal reducers (BrMonos)	SRB/Actinomycetes (MidBrSats)	General (Nsats)	Eukaryotes (polyenoics)	Slowed Growth	Decreased Permeability
				cells/gram	cells/gram	%	%	%	%	%	%	ratio cy/cis	ratio trans/cis
GRTS-MW01B	4/19/2018	75-75.5	Soil	<1.67E+04 (I)	3.22E+05	19.71	5.25	0	0	68.17	6.88	1.95	0
GRTS-MW03B	4/26/2018	63-63.5	Soil	<1.67E+04 (I)	4.74E+05	10.80	14.03	0	2.37	69.80	3.01	0	0

Notes

Monos	Monoenoic
TerBrSats	Terminally Branched Saturated
BrMonos	Branched Monoenoic
MidBrSats	Mid-Chain Branched Saturated
Nsats	Normal Saturated
<	Not detected
(I)	Inhibited

Galleria Drive Bioremediation Treatability Study Work Plan Addendum

Table C.3 Discrete-Depth Groundwater Analytical Results

Location	Sample Depth	Sample Date	QCType	Lab SampleID	EPA 314.0		EPA 300.1
					Perchlorate	Nitrate (as N)	Chlorate
	feet bgs				ug/L	mg/L	ug/L
GRTS-MW01B	74.5	4/19/2018	N	440-209325-1	1,800	4.5 J	1,800
GRTS-MW04B	79	4/12/2018	N	440-208821-1	6,000	<5.5	7,700

Notes

bgs	below ground surface
ug/L	micrograms per liter
mg/L	milligrams per liter
N	Normal field sample
<	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Table C.4 Groundwater Analytical Results

Location	Sample Date	QCType	Lab SampleID	Monitoring Well Screened Interval	EPA 314.0	Anions by EPA 300.0				EPA 300.1	EPA 351.2	EPA 365.3	Field Tests			Field Tests					NTOTAL	RSK175
					Perchlorate	Chloride (as Cl)	Nitrate (as N)	Nitrite (as N)	Sulfate	Chlorate	Total Kjeldahl Nitrogen (TKN)	Phosphorus	Dissolved Oxygen	Ferrous Iron	Oxidation-Reduction Potential	pH	Specific Conductivity	Sulfide	Temperature	Turbidity	Nitrogen, Total	Methane
				feet bgs	ug/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L	mV	SU	mS/cm	mg/L	C	NTU	mg/L	mg/L
ES-13	5/9/2018	N	440-210948-5	90'-105'	2,800	8,100	<5.5	<7.0	26,000	1,600	<0.10	0.080	2.01	0.0	-58	7.71	47.5	0.0	28.6	2.8	<0.11	<0.00025
GRTS-MW01A	5/10/2018	N	440-211094-3	60'-80'	14,000	5,300	22	<7.0	11,000	19,000	<0.10	0.087	0.42	0.0	47.9	7.75	26.05	0.0	29.41	25.5	22	<0.00025
GRTS-MW01B	5/10/2018	N	440-211094-4	90'-110'	3,200	12,000	<5.5	<7.0	34,000	<250	4.3	0.68	0.30	0.0	113	8.10	50.9	0.0	35.47	102	4.3	0.0015
GRTS-MW02A	5/10/2018	N	440-211094-1	60'-80'	5,600	3,200	24	<3.5	7,000	8,200	0.42	0.16	4.92	0.0	48.8	7.86	18.13	0.0	30.82	119	24	<0.00025
GRTS-MW02B	5/10/2018	N	440-211094-2	90'-110'	<50	8,100	<5.5	<7.0	30,000	<250	3.6	0.90	7.45	0.0	150	8.19	43.5	0.0	28.22	550	3.6	<0.00025
GRTS-MW03A	5/7/2018	FD	440-210696-3	65'-75'	5,700	1,700	37	<1.4	3,400	12,000	<0.10	<0.025	---	---	---	---	---	---	---	---	37	<0.00025
GRTS-MW03A	5/7/2018	N	440-210696-2	65'-75'	5,600	1,700	38	<1.4	3,500	12,000	<0.10	<0.025	2.31	0.0	-10.2	7.82	12.36	0.0	30.44	5.75	38	<0.00025
GRTS-MW03B	5/7/2018	N	440-210696-1	90'-110'	1,700	8,500	<5.5	<7.0	27,000	150 J	0.38	<0.025	3.29	0.0	162	8.10	45.7	0.0	34.88	8.3	0.38	<0.00025
GRTS-MW04A	5/8/2018	N	440-210833-1	70'-85'	8,800	7,300	5.8 J	<7.0	18,000	10,000	<0.10	0.089	0.79	0.0	90.3	7.66	43.80	0.0	28.70	27.3	5.8	<0.00025 UJ
GRTS-MW04B	5/8/2018	N	440-210833-2	89.5'-109.5'	<50	10,000	<5.5	<7.0	31,000	<100	2.1	0.28	0.50	0.0	131	7.87	78.2	0.0	35.19	10.3	2.1	0.0016
GRTS-MW05A	5/9/2018	N	440-210948-1	60'-70'	8,000	2,000	36	<3.5	4,000	13,000	R	0.059	5.26	0.0	141	8.22	12.5	0.0	30.61	19.3	36	<0.00025
GRTS-MW05B	5/9/2018	N	440-210948-2	75'-85'	6,800	6,000	5.8 J	<7.0	18,000	9,600	0.27	0.14	2.61	0.0	60.2	7.92	38.1	0.0	27.34	26.4	6.1	0.0014
MCF-06B	5/9/2018	N	440-210948-4	82'-67'	3,300	6,500	<5.5	<7.0	19,000	3,700	<0.10	0.11	1.34	0.0	55.6	6.79	47.43	0.0	30.46	0.66	<0.11	<0.00025
MCF-06C	5/8/2018	N	440-210833-3	59'-44'	7,100	1,600	43	<1.4	2,800	11,000	<0.10	0.047 J	2.75	0.0	153	7.59	13.9	0.0	29.67	46.7	43	<0.00025

Notes

bgs	below ground surface	SU	standard units
ug/L	micrograms per liter	mS/cm	milliSiemens per centimeter
mg/L	milligrams per liter	C	degrees Celsius
mV	milliVolts	NTU	nephelometric turbidity unit
N	normal field sample	FD	field duplicate

<	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J-	The result is an estimated quantity, but the result may be biased low.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

Table C.4 Groundwater Analytical Results

Location	Sample Date	QCType	Lab SampleID	Monitoring Well Screened Interval	SM 2320B	SM 2320B	SM 2320B	SM 2320B	SM 2540C	SM 5310B	Dissolved Metals by SW6010B												Total Manganese by SW6010B	Dissolved Manganese by SW6010B
					Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Dissolved Solids	Total Organic Carbon	Aluminum	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium		
				feet bgs	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ES-13	5/9/2018	N	440-210948-5	90'-105'	87	87	<4.0	<4.0	54,000	1.8	<0.50	<0.050	<0.010	10	<0.025	570	<0.025	<0.050	<0.050	<0.50	<0.038	5,100	<0.15	<0.15
GRTS-MW01A	5/10/2018	N	440-211094-3	60'-80'	78	78	<4.0	<4.0	27,000	1.9	<0.50	<0.050	<0.010	5.2	<0.025	520	0.085	<0.050	<0.050	<0.50	<0.038	1,900	<0.15	<0.15
GRTS-MW01B	5/10/2018	N	440-211094-4	90'-110'	100	100	<4.0	<4.0	64,000	3.4	0.53 J	<0.050	<0.010	9.6	<0.025	550	<0.025	<0.050	<0.050	0.52 J	<0.076	6,100	0.36	0.24
GRTS-MW02A	5/10/2018	N	440-211094-1	60'-80'	75	75	<4.0	<4.0	17,000	2.4	0.50 J	0.056 J	<0.010	4.2	<0.025	590	0.036 J	<0.050	<0.050	0.55 J	<0.038	1,200	0.12	<0.15
GRTS-MW02B	5/10/2018	N	440-211094-2	90'-110'	99	99	<4.0	<4.0	50,000	4.6	3.5	0.073 J	<0.010	9.0	<0.025	520	<0.025	<0.050	<0.050	3.7	<0.038	5,400	0.64	0.46
GRTS-MW03A	5/7/2018	FD	440-210696-3	65'-75'	78	78	<4.0	<4.0	8,600	2.2	<0.50	<0.050	<0.010	3.0	<0.025	670	0.11	<0.050	<0.050	<0.50	<0.038	570	<0.075	<0.15
GRTS-MW03A	5/7/2018	N	440-210696-2	65'-75'	78	78	<4.0	<4.0	8,600	1.9	<0.50	<0.050	<0.010	2.8	<0.025	640	0.11	<0.050	<0.050	<0.50	<0.038	540	<0.075	<0.15
GRTS-MW03B	5/7/2018	N	440-210696-1	90'-110'	95	95	<4.0	<4.0	50,000	4.1	<1.3	<0.13	<0.025	9.7	<0.063	570	<0.063	<0.13	<0.13	<1.3	<0.095	5,600	0.46 J	0.40 J
GRTS-MW04A	5/8/2018	N	440-210833-1	70'-85'	89	89	<4.0	<4.0	39,000	1.2	<0.50	<0.050	<0.010	8.6	<0.025	590	0.050	<0.050	<0.050	<0.50	<0.038	3,700	<0.15	<0.15
GRTS-MW04B	5/8/2018	N	440-210833-2	89.5'-109.5'	100	100	<4.0	<4.0	60,000	3.8	<0.50	<0.050	<0.010	11	<0.025	610	<0.025	<0.050	<0.050	<0.50	<0.038	6,300	0.36	0.34
GRTS-MW05A	5/9/2018	N	440-210948-1	60'-70'	66	66	<4.0	<4.0	11,000	1.9	<0.10	0.030	<0.0020	3.3	<0.0050	660	0.085	<0.010	0.020	<0.10	<0.0076	700	<0.030	<0.030
GRTS-MW05B	5/9/2018	N	440-210948-2	75'-85'	99	99	<4.0	<4.0	38,000	2.8	<0.50	<0.050	<0.010	8.1	<0.025	570	<0.025	<0.050	<0.050	<0.50	<0.038	4,000	<0.15	<0.15
MCF-06B	5/9/2018	N	440-210948-4	82'-67'	71	71	<4.0	<4.0	43,000	1.1	<0.50	<0.050	<0.010	7.3	<0.025	560	<0.025	<0.050	0.052 J	<0.50	<0.038	4,300	<0.15	<0.15
MCF-06C	5/8/2018	N	440-210833-3	59'-44'	69	69	<4.0	<4.0	7,600	1.6	<0.50	<0.050	<0.010	2.6	<0.025	730	0.091	<0.050	<0.050	<0.50	<0.038	460	<0.075	<0.15

Notes

bgs	below ground surface	SU	standard units
ug/L	micrograms per liter	mS/cm	milliSiemens per centimeter
mg/L	milligrams per liter	C	degrees Celsius
mV	milliVolts	NTU	nephelometric turbidity unit
N	normal field sample	FD	field duplicate

< The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

J- The result is an estimated quantity, but the result may be biased low.

J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

UJ The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

Table C.4 Groundwater Analytical Results

Location	Sample Date	QCType	Lab SampleID	Monitoring Well Screened Interval	Dissolved Metals by SW6010B												Dissolved Metals by SW6020				SW7199	VFA-IC					
					Molybdenum	Nickel	Phosphorus	Potassium	Silicon	Silver	Sodium	Strontium	Tin	Titanium	Tungsten	Vanadium	Zinc	Antimony	Arsenic	Selenium	Thallium	Chromium, Hexavalent	Acetic Acid	Butyric Acid	Formic Acid	Lactic Acid	Propionic Acid	Pyruvic Acid
				feet bgs	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ES-13	5/9/2018	N	440-210948-5	90'-105'	5.4	<0.050	<1.0	6,400	4.7	<0.050	6,500	11	<0.50	<0.025	<0.50	<0.050	<0.12	<10	<10	50	<10	<0.25	<2.9	<2.6	<2.6	<3.1	<3.5	<19
GRTS-MW01A	5/10/2018	N	440-211094-3	60'-80'	1.2	<0.050	<1.0	2,100	12	<0.050	2,600	10	<0.50	<0.025	<0.50	<0.050	<0.12	<10	19 J	360	13 J	79	<2.9	<2.6	<2.6	<3.1	<3.5	<37
GRTS-MW01B	5/10/2018	N	440-211094-4	90'-110'	4.3	<0.050	<1.0	5,200	7.6	<0.050	6,600	11	<0.50	<0.025	<0.50	<0.050	<0.12	<10	13 J	18 J	<10	<0.25	<2.9	<2.6	<2.6	<3.1	<3.5	<19
GRTS-MW02A	5/10/2018	N	440-211094-1	60'-80'	3.3	<0.050	<1.0	1,400	12	<0.050	1,600	11	<0.50	<0.025	<0.50	<0.050	<0.12	<10	<10	43	<10	25	<2.9	<2.6	<2.6	<3.1	<3.5	<37
GRTS-MW02B	5/10/2018	N	440-211094-2	90'-110'	1.6	<0.050	<1.0	4,300	19	<0.050	4,800	12	<0.50	0.14	<0.50	<0.050	<0.12	<10	<10	<10	<10	<0.25	<2.9	<2.6	<2.6	<3.1	<3.5	<19
GRTS-MW03A	5/7/2018	FD	440-210696-3	65'-75'	0.55	<0.050	<1.0	560	19	<0.050	970	13	<0.50	<0.025	<0.50	<0.050	<0.12	<10	31	40	<10	89	<2.9	<2.6	<2.6	<3.1	<3.5	<3.7
GRTS-MW03A	5/7/2018	N	440-210696-2	65'-75'	0.51	<0.050	<1.0	540	19	<0.050	930	12	<0.50	<0.025	<0.50	<0.050	<0.12	<10	30	54	<10	89	<2.9	<2.6	<2.6	<3.1	<3.5	<3.7
GRTS-MW03B	5/7/2018	N	440-210696-1	90'-110'	1.8	<0.13	<2.5	5,200	5.1	<0.13	5,300	13	<1.3	<0.063	<1.3	<0.13	<0.30 UJ	18 J	12 J	24 J	<10	<0.25	<2.9	<2.6	<2.6	<3.1	<3.5	<74 UJ
GRTS-MW04A	5/8/2018	N	440-210833-1	70'-85'	4.4	<0.050	<1.0	3,900	6.0	<0.050	4,700	12	<0.50	<0.025	<0.50	<0.050	<0.12	<10	22	170 J-	<10	42	<2.9 UJ	<2.6 UJ	<2.6 UJ	<3.1 UJ	<3.5 UJ	<74 UJ
GRTS-MW04B	5/8/2018	N	440-210833-2	89.5'-109.5'	1.3	<0.050	<1.0	6,000	5.0	<0.050	7,600	13	<0.50	<0.025	<0.50	<0.050	<0.12	<10	<10	<10	<10	<0.25	<2.9	<2.6	<2.6	<3.1	<3.5	<74
GRTS-MW05A	5/9/2018	N	440-210948-1	60'-70'	0.87	<0.010	<0.20	950	15	<0.010	1,200	12	<0.10	<0.0050	<0.10	<0.010	<0.024	<10	16 J	48	<10	75	<5.8	<5.2	<5.2	<6.2	<7.0	<7.4 UJ
GRTS-MW05B	5/9/2018	N	440-210948-2	75'-85'	5.0	<0.050	<1.0	4,600	6.6	<0.050	4,300	11	<0.50	<0.025	<0.50	<0.050	<0.12	<10	<10	41	<10	12	<5.8	<5.2	<5.2	<6.2	<7.0	<37
MCF-06B	5/9/2018	N	440-210948-4	82'-67'	2.4	<0.050	<1.0	5,000	2.6	<0.050	4,800	9.9	<0.50	<0.025	<0.50	<0.050	<0.12	<10	<10	91	<10	<0.25	<2.9	<2.6	<2.6	<3.1	<3.5	<19
MCF-06C	5/8/2018	N	440-210833-3	59'-44'	0.36	<0.050	<1.0	380	26	<0.050	880	14	<0.50	<0.025	<0.50	<0.050	<0.12	<10	50	44	<10	70	<2.9	<2.6	<2.6	<3.1	<3.5	<3.7

Notes

bgs	below ground surface	SU	standard units
ug/L	micrograms per liter	mS/cm	milliSiemens per centimeter
mg/L	milligrams per liter	C	degrees Celsius
mV	milliVolts	NTU	nephelometric turbidity unit
N	normal field sample	FD	field duplicate

<	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
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Table C.5 Groundwater Microbial Results

Location	Sample Date	Sample ID	Sample Matrix	Monitoring Well Screened Interval	Microbial Census	Microbial Phospholipid Fatty Acid Analysis (PLFA)								
					Perchlorate reductase gene (pcrA)	Total Biomass	Proteobacteria (Monos)	Firmicutes (TerBrSats)	Anaerobic metal reducers (BrMonos)	SRB/Actinomycetes (MidBrSats)	General (Nsats)	Eukaryotes (polyenoics)	Slowed Growth	Decreased Permeability
				feet bgs	cells/gram	cells/gram	%	%	%	%	%	%	ratio cy/cis	ratio trans/cis
GRTS-MW04A	6/12/2018	GRTS-MW04A-20180612	Biotrap	70'-85'	<2.50E+02	3.73E+05	65.44	1.95	0.89	0.00	30.37	1.36	3.32	0.00
GRTS-MW04B	6/12/2018	GRTS-MW04B-20180612	Biotrap	89.5'-109.5'	<2.50E+02	5.82E+04	83.09	0.00	0.00	0.00	15.29	1.63	0.64	0.00

Notes

bgs	below ground surface
Monos	Monoenoic
TerBrSats	Terminally Branched Saturated
BrMonos	Branched Monoenoic
MidBrSats	Mid-Chain Branched Saturated
Nsats	Normal Saturated
<	Not detected

Appendix D
Groundwater Monitoring Logs

Table D.1 - Synoptic Depth to Water

Monitoring Well/ Borehole ID	Northing	Easting	Ground Surface Elevation	Top of Casing Elevation	Well Diameter	Well Total Depth	Top of Screen	Bottom of Screen	Depth to Water[1]	Groundwater Elevation[1]
			feet amsl	feet amsl	inches	feet bgs	feet bgs	feet bgs	feet bTOC	feet amsl
GRTS-MW01A	26728794.03	834737.35	1633.88	1633.49	2	80.5	60	80	47.10	1586.4
GRTS-MW01B	26728796.86	834742.46	1633.88	1633.32	2	110.5	90	110	56.45	1576.9
GRTS-MW02A	26728771.59	835074.09	1632.59	1632.04	2	80.5	60	80	56.10	1575.9
GRTS-MW02B	26728770.64	835079.15	1632.43	1631.89	2	110.5	90	110	63.91	1568.0
GRTS-MW03A	26728879.93	834947.17	1630.72	1630.18	4	75.5	65	75	53.04	1577.1
GRTS-MW03B	26728880.95	834952.89	1630.55	1630.27	4	110.5	90	110	59.75	1570.5
GRTS-MW04A	26728915.61	834839.84	1631.09	1630.70	2	85.5	70	85	50.21	1580.5
GRTS-MW04B	26728916.48	834845.04	1631.19	1630.86	2	110	89.5	109.5	56.24	1574.6
GRTS-MW05A	26728941.02	835055.82	1628.63	1628.19	2	70.5	60	70	52.75	1575.4
GRTS-MW05B	26728941.82	835060.59	1628.61	1628.23	2	85.5	75	85	55.13	1573.1
ES-13	26728998.71	834911.17	1630.62	1632.52	4	105	90	105	60.12	1572.4
MCF-06A-R	26729028.09	834929.39	1630.00	1632.77	4	373	373	333	102.86	1529.9
MCF-06B[2]	26729012.59	834930.88	1630.27	1633.06	4	85.2	82	67	57.22	1575.8
MCF-06C[2]	26729004.90	834945.76	1630.28	1633.01	4	62.3	59	44	56.96	1576.1
DBMW-6	26728948.45	834409.70	1629.55	1632.43	4	52.8	30	50	52.02	1580.4
DBMW-7	26729070.92	835304.91	1628.99	1631.61	4	73.3	50	70	57.86	1573.8
DBMW-8	26729028.15	835406.51	1628.99	1632.03	4	69.2	47.5	67.5	56.76	1575.3

Notes

amsl above mean sea level

bgs below ground surface

bTOC below top of casing

1. Depth to water measurements collected on May 25, 2018.
2. Top of casing elevation resurveyed May 9, 2018.

TETRA TECH

WELL WATER LEVEL MEASUREMENT LOG

NERT, Henderson, NV Project

Task Name: M17	Task No:	Date: 5/25/18
Task Manager	Field Sampler(s): Jesse Bunkers	Recorded by:
Equipment Model/Type: Solinst WLM ~~F30~~ 500'	Serial Number: ~~5[illegible]~~ 267441	Last Calibration Date:

Well Identification	Describe Measuring Point	Time (hrs)	Depth to Static Water Level (ft BMP)	Well Sounding Depth (ft BMP)	Condition of Well and Well Seal
ES-13	TOC	1206	60.12		Good
MCF-6B		1208	57.22		DP Good
MCF-6C		1210	56.96		Transducer Good
DBMW-6		1253	52.02		Good
DBMW-7		1219	57.86		Good
DBMW-8		1221	56.76		Good
GRTS-MW01A		1247	47.10		Good Transducer
GRTS-MW01B		1248	56.45		Good Transducer
GRTS-MW02A		1230	56.10		Good Transducer
GRTS-MW02B		1232	63.91		Good Transducer
GRTS-MW03A		1236	53.04		Good
GRTS-MW03B		1237	59.75		Good
GRTS-MW04A		1241	50.21		Good Transducer
GRTS-MW-04B		1242	56.24		Good Transducer
GRTS-MW05A		1224	52.75		Good
GRTS-MW05B		1226	55.13		Good
MCF-06A-R	V	1214	102.86		DP Good

BGS = Below Ground Surface | BMP = Below Measuring Point | MP = Measuring Point | TOC = Top of Casing (Well Riser)

TETRA TECH

CALIBRATION LOG - WATER QUALITY METER

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study | Task No.: M17 | Rental from: Silver State | Task Manager: D. Grady

Type: YSI 556 | Serial Number: 11E101026

		Pre-Calibration								Post-Calibration							
Date	Time	Temp (°C)	pH (pH = 4.0)	pH (pH = 7.0)	pH (pH = 10.0)	ORP (mV)	Cond. (mS/cm)	DO (mg/L)	Turbidity (NTU)	Temp (°C)	pH (pH = 4.0)	pH (pH = 7.0)	pH (pH = 10.0)	ORP (mV)	Cond. (mS/cm)	DO (mg/L)	Turbidity (NTU)
05/07/18	16:35	35.57	4.46	7.27	9.64	149	1.413	7.43	—	21.89	3.97	6.85	10.00	235	1.00	10.97	—
05/08/18	16:13	25.50	3.77	7.25	9.97	222.9	—	—	—	25.66	4.0	7.25	10.00	234.0	—	—	—
05/09/18	15:20	24.51	3.96	7.25	9.98	231.9	1.246	—	—	25.00	4.0	7.17	10.01	237.9	1.00	—	—

TETRA TECH

CALIBRATION LOG - WATER QUALITY METER

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study | Task No.: M17 | Rental from: SILVER STATE | Task Manager: D. Grady

Type: HORIBA U52 | Serial Number: TNMHOEV3

		Pre-Calibration								Post-Calibration							
Date	Time	Temp (°C)	pH (pH = 4.0)	pH (pH = 7.0)	pH (pH = 10.0)	ORP (mV)	Cond. (mS/cm)	DO (mg/L)	Turbidity (NTU)	Temp (°C)	pH (pH = 4.0)	pH (pH = 7.0)	pH (pH = 10.0)	ORP (mV)	Cond. (mS/cm)	DO (mg/L)	Turbidity (NTU)
5/7/2018	16:30	32.37		/	/	317	7.03	6.38	1.0		4.07		[illegible]		4.55	7.33	0.0
5/7/2018	16:37									29.64	/	/	10.10	119	4.64	8.44	0.0
5/7/2018	16:45									25.79	/	7.28	/	226	9.36	8.88	5.8
5/8/2018	16:12		4.05	/	/	295	6.52	13.37	0.0	/	4.04	/	/	/	4.59	9.43	0.0
										27.33	/	7.29	/	221	6.25	8.90	0.0
										26.01	/	/	10.05	117	3.18	8.70	0.0
5/9/2018	15:23	45.01	7.27			99	5.03	6.97	5.0		4.01	/	/	/	4.50	6.61	0.0
										30.74	/	7.24	/	135	5.88	6.59	7.9
										29.97	/	/	10.15	120	3.83	7.71	0.0

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/10/18	Well ID: MW-01A
Field Sampler(s): K. Lee				
Transducer Removal Time: —	Transducer Redeployment time: —		General Well Condition: Good	
Depth to Water (ft): 47.14	Screened Interval Top (ft): 60		Pump Intake Depth (ft):	
Well Depth (ft): 79.95	Screened/Open Interval Bottom (ft): 80		Well Diameter (in): 2	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 1156				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
1205	29.03		5.70		26.26		2.86		132.8		289		120	47.20		Brown
1210	27.47		7.20		25.51		0.58		24.0		254		110	47.24		Brown
1215	27.98		7.78		25.69		0.34		14.0		108		90	47.26		Cloudy
1220	28.43		7.77		25.92		0.40		30.2		50.8		40	49.27		Cloudy
1225	28.72		7.76		26.05		0.37		34.4		38.6		85	47.28		Cloudy
1230	28.89		7.75		26.15		0.36		38.2		31.4		85	47.28		Clear
1235	29.22		7.75		26.26		0.36		44.1		28.1		85	47.29		clear
1240	29.41		7.75		26.30		0.37		45.8		26.4		85	47.31		Clear
1245	29.26		7.75		25.99		0.40		46.2		26.0		85	47.32		clear
1250	29.41		7.75		26.05		0.42		47.9		25.5		85	47.33		Clear

Stop Purge Time: 1253	Sample Time: 1300	QA/QC Sample Time(s): —
	Sample ID: GRTS-MW01A-BL01	QA/QC Sample ID(s): —

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	40 mL VOA w/HCl	1	125 mL Plastic		500 mL Plastic		500 mL w/H_2SO_4		500 mL poly w/HNO_3		250 mL Amber Glass w/H_2SO_4 VOA
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H_2SO_4	2	250 mL poly w/HNO_3	1	250 mL Amber Glass w/~~H_3PO_4~~ HCL	3	500 mL Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN **3 CONSECUTIVE READINGS** ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 5/16/18	Well ID: GRTS-MW01B
Field Sampler(s):				
Transducer Removal Time: N/A	Transducer Redeployment time: N/A		General Well Condition: Good	
Depth to Water (ft): 56.89'	Screened Interval Top (ft): 90		Pump Intake Depth (ft): 105'	
Well Depth (ft): 110.5	Screened/Open Interval Bottom (ft): 110		Well Diameter (in): 2"	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 11:48 (START)				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
11:50	35.98		8.04		0.002		9.81		-71		351		25ml/min	56.75		Cloudy
12:10	36.35		8.12		49.3		1.00		120		192		50ml/min	56.64		Clear
12:15	36.44		8.07		49.6		0.77		122		175		25ml/min	56.64		Clear
12:20	36.60		8.07		49.8		0.66		122		141		25ml/min	56.68		clear
12:35	37.68		7.94		50.5		0.54		121		840		25ml/min	57.44		Clear
12:40	38.40		7.94		51.5		0.49		120		912		25ml/min	57.64		Clear
12:45	38.77		7.92		51.5		0.57		119		920		25ml/min	57.74		Clear
12:55	38.91		7.92		51.4		0.67		118		765		25ml/min	57.83		Clear
13:00	38.99		7.93		50.8		0.76		119		666		100ml/min	58.14		Clear
13:05	38.78		7.97		50.4		0.87		120		750		100ml/min	58.37		Clear
13:10	38.26		7.98		49.7		0.91		123		300		50 ml/min	58.50		clear
13:15	37.60		8.01		50.7		0.72		122		233		50ml/min	58.64		Clear
13:20	37.0		8.04		50.5		0.53		121		160		50ml/min	58.69		Clear
13:25	35.90		8.08		50.8		0.38		116		142		50ml/min	58.90		Clear
13:30	35.47		8.10		50.9		0.30		113		102		50ml/min	58.95		Clear

Stop Purge Time: 13:30	Sample Time: 13:30	QA/QC Sample Time(s):
	Sample ID: GRTS-MW01B-B101	QA/QC Sample ID(s):

Observations/Comments:
HACH Kit Sulfide: 0.0 mg/L **HACH Kit Ferrous Iron:** 0.0 mg/L

Bottle Set Summary

3	3x VOA w/HCl		125 mL Plastic		500 mL Plastic		500 mL w/H_2SO_4		500 mL poly w/HNO_3	250 mL Amber Glass w/H_2SO_4
1	125 mL w/EDA		250 mL Plastic		250 mL w/H_2SO_4		250 mL poly w/HNO_3		250 mL Amber Glass w/H_3PO_4	500 mL Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 CONSECUTIVE READINGS ARE WITHIN:
± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/10/18	Well ID: MW-02A
Field Sampler(s): K. Lum. C. Castellos				
Transducer Removal Time: —	Transducer Redeployment time: —		General Well Condition: Good	
Depth to Water (ft): 56.21	Screened Interval Top (ft): 60		Pump Intake Depth (ft): 73	
Well Depth (ft): 79.75	Screened/Open Interval Bottom (ft): 80		Well Diameter (in): 2	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 0743				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
0840	27.68		7.89		13.19		7.93		56.3				220	57.32		Brown
0845	27.34		7.85		16.94		6.49		45.0		783		85	57.84		Brown
0850	28.29		7.86		17.46		5.82		44.7		757		85	58.11		Brown
0855	29.18		7.86		17.84		5.52		45.2		616		85	58.49		Brown
0900	29.93		7.86		18.09		5.27		48.0				70	58.76		Brown
0905	30.07		7.87		18.09		5.16		50.2				70	58.96		Cloudy
0915	30.44		7.86		17.96		5.22		50.3		269		70	59.65		cloudy
0920	30.72		7.85		18.08		5.12		49.4		227		70	59.76		Cloudy
0925	30.82		7.86		18.13		4.92		48.8		119		70	59.86		Cloudy

Stop Purge Time: 0928	Sample Time: 0930	QA/QC Sample Time(s): —
	Sample ID: GRTS-MW02A-BL01	QA/QC Sample ID(s): —

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	~~3~~ VOA w/HCl	1	125 mL Plastic		500 mL Plastic		500 mL w/H2SO4		500 mL poly w/HNO3	250 mL Amber Glass w/H2SO4 4 VOA
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H2SO4	2	250 mL poly w/HNO3	1	250 mL Amber Glass w/~~H3PO4~~ HCL	3 ~~500 mL~~ Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN **3 CONSECUTIVE READINGS** ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 5/10/18	Well ID: GRTS-MW02B
Field Sampler(s): Kian L. and Crystal C.				
Transducer Removal Time: N/A	Transducer Redeployment time: N/A		General Well Condition: Good	
Depth to Water (ft): 62.05	Screened Interval Top (ft): 90'		Pump Intake Depth (ft): 105'	
Well Depth (ft): 110.5	Screened/Open Interval Bottom (ft): 110'		Well Diameter (in): 2"	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 8:18 START				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
9:30	29.70		8.20		44.8		6.62		139		760		50ml/min	64.78		cloudy
9:35	28.64		8.22		44.6		6.91		138		983		50ml/min	65.40		cloudy
9:40	27.84		8.20		44.5		7.03		142		1,000		50ml/min	65.66		cloudy
9:45	27.99		8.19		44.3		7.11		145		896		50ml/min	66.22		cloudy
9:50	28.09		8.17		44.3		7.38		148		765		50ml/min	66.52		cloudy
9:55	28.24		8.19		44.1		7.34		148		661		50ml/min	67.18		cloudy
10:05	28.22		8.19		43.5		7.45		150		550		50ml/min	67.45		cloudy
END																

Stop Purge Time: 10:10	Sample Time: 10:45	QA/QC Sample Time(s):
	Sample ID: GRTS-MW02B-041	QA/QC Sample ID(s):

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	3x VOA w/HCl		125 mL Plastic		500 mL Plastic		500 mL w/H_2SO_4		500 mL poly w/HNO_3	250 mL Amber Glass w/H_2SO_4
1	125 mL w/EDA		250 mL Plastic		250 mL w/H_2SO_4		250 mL poly w/HNO_3		250 mL Amber Glass w/H_3PO_4	500 mL Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 **CONSECUTIVE READINGS** ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/07/18	Well ID: GRTS-MW03A
Field Sampler(s): KIAN & CRYSTAL				
Transducer Removal Time: N/A	Transducer Redeployment time: N/A		General Well Condition: Good	
Depth to Water (ft): 53.10	Screened Interval Top (ft): 65		Pump Intake Depth (ft): 70	
Well Depth (ft): 80	Screened/Open Interval Bottom (ft): 80		Well Diameter (in): 4"	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 14:01				

Time	Temp. (°C)		pH (pH Units)		Conductivity (µS/cm) mS/cm		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
14:08	32.01		7.82		12256		3.98		-54.7		/		100 ml/min	53.25		
14:13	30.41		7.81		12147		3.17		-58.0		10.4 NTU		"	53.27		Clear
14:22	30.04		7.81		12132		2.66		-36.1		6.59 NTU		"	53.30		
14:26	29.81		7.80		12102		2.40		-21.0		8.98 NTU		"	53.34		
14:34	29.59		7.82		12085		2.34		-16.3		8.31 NTU		"	53.32		
14:39	30.07		7.82		12193		2.49		-12.5		7.82		"	53.32		
14:44	30.04		7.82		12236		2.31		-11.2		6.62		"	53.33		
14:49	30.37		7.82		12312		2.39		-10.0		6.47		"	53.35		
14:56	30.44		7.82		12.36		2.31		-10.2		5.75		"	53.34		

Stop Purge Time: 14:57

Sample Time: 1500

Sample ID: GRTS-MW03A-BL01

QA/QC Sample Time(s): GRTS-MW03A-BL01-FD

QA/QC Sample ID(s): 1510

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

6	VOA w/HCl	2	125 mL Plastic		500 mL Plastic		500 mL w/H_2SO_4		500 mL poly w/HNO_3		250 mL Amber Glass w/H_2SO_4 VOA
2	125 mL w/EDA	4	250 mL Plastic	2	250 mL w/H_2SO_4	4	250 mL poly w/HNO_3	2	250 mL Amber Glass w/H_3PO_4 HCL	6	500 mL Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 CONSECUTIVE READINGS ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/07/18	Well ID: MW-03B
Field Sampler(s): K. Law				
Transducer Removal Time: —	Transducer Redeployment time: —		General Well Condition: Good	
Depth to Water (ft): 66.11	Screened Interval Top (ft): 90		Pump Intake Depth (ft): 103	
Well Depth (ft): 110.5	Screened/Open Interval Bottom (ft): 110		Well Diameter (in): 4	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 1154				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
1223	38.57		7.93		48.3		3.49		144		23.0		120 ml/min	66.58		clear
1228	36.19		8.04		47.7		3.39		155		15.3		110	66.72		clear
1233	34.82		8.09		47.3		3.30		158		10.8		95	66.85		clear
1238	34.82		8.09		47.3		3.17		161		10.5		85	66.93		clear
1243	34.64		8.10		47.5		3.20		162		9.0		85	67.11		
1248	34.73		8.10		46.9		3.16		161		8.8		85	67.22		
1253	34.88		8.10		45.7		3.29		162		8.3		85	67.48		

Stop Purge Time: 1256

Sample Time: 1305

Sample ID: GRTS-MW03B-BL01

QA/QC Sample Time(s): 1310

QA/QC Sample ID(s): GRTS-MW03A-BL01-MS/MSD

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	VOA w/HCl	2	125 mL Plastic		500 mL Plastic		500 mL w/H2SO4		500 mL poly w/HNO_3	250 mL Amber Glass w/H_2SO_4
2	125 mL w/EDA	4	250 mL Plastic	2	250 mL w/H_2SO_4	4	250 mL poly w/HNO_3	2	250 mL Amber Glass w/~~H_3PO_4~~ HCL	6 ~~250 mL~~ Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN **3 CONSECUTIVE READINGS** ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/08/18	Well ID: GRTS-MW04A
Field Sampler(s): K. Law				
Transducer Removal Time: —	Transducer Redeployment time: —		General Well Condition: Good	
Depth to Water (ft): 50.45	Screened Interval Top (ft): 70		Pump Intake Depth (ft): 80	
Well Depth (ft): 85	Screened/Open Interval Bottom (ft): 85		Well Diameter (in): 2	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 0900				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
0915	25.81		2.26		39.64		2.10		394.0		50.6		100	51.10		Cloudy
0920	25.61		7.91		40.84		1.05		47.1		44.4		100	51.10		Cloudy
0925	25.97		7.30		41.58		0.74		134.5		14.9		100	51.25		Cloudy
0930	26.09		7.84		42.07		0.63		102.0		43.6		80	51.30		Cloudy
0935	26.02		2.31		42.41		0.71		365.9		35.6		90	51.39		Cloudy
0940	26.66		2.43		42.52		0.72		274.3		33.2		80	51.40		Cloudy
0950	27.16		7.74		42.90		0.79		95.4		26.4		80	51.43		Clear
0955	27.20		7.70		42.87		0.86		93.5		20.5		80	51.50		
1000	27.51		7.40		43.04		0.91		96.1		19.72		80	51.52		
1005	27.58		7.68		43.13		0.93		88.4		26.2		80	51.55		
1010	27.98		7.71		43.30		0.86		88.9		27.9		80	51.59		
1015	28.10		7.63		43.49		0.98		81.2		29.0		80	51.61		
1020	28.20		7.66		43.80		0.79		90.3		27.3		80	51.61		

Stop Purge Time: 1022	Sample Time: 1025	QA/QC Sample Time(s): —
	Sample ID: GRTS-MW04A	QA/QC Sample ID(s): —

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	VOA w/HCl	1	125 mL Plastic		500 mL Plastic		500 mL w/H_2SO_4		500 mL poly w/HNO_3		250 mL Amber Glass w/H_2SO_4 VOA
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H_2SO_4	2	250 mL poly w/HNO_3		250 mL Amber Glass w/H_3PO_4	3	~~500 mL~~ Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 **CONSECUTIVE READINGS** ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study | Task Manager: D. Grady | Task No: M17 | Date: 5/8/2018 | Well ID: GRTS-MW04B

Field Sampler(s): CRISTAL C. & KIAN L.

Transducer Removal Time: | Transducer Redeployment time: | General Well Condition: Good

Depth to Water (ft): 57.10' | Screened Interval Top (ft): 89.8' | Pump Intake Depth (ft): 105

Well Depth (ft): ~~110~~ 110' | Screened/Open Interval Bottom (ft): 109.5' | Well Diameter (in): 4"

Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE | GW Disposal: GW-11 | Equipment Decon. Method: Alconox/DI Rinse SOP

Purge Start Time: 8:25

Time	Temp. (°C) READ	Temp. (°C) CHANGE*	pH (pH Units) READ	pH (pH Units) CHANGE*	Conductivity (mS/cm) READ	Conductivity (mS/cm) CHANGE*	DO (mg/L) READ	DO (mg/L) CHANGE*	ORP (mV) READ	ORP (mV) CHANGE*	Turbidity (NTU) READ	Turbidity (NTU) CHANGE*	Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
8:25	STARTED															
9:30	30.30		7.76		80.4		1.16		140		93.1		25ml	57.30		CLEAR
9:40	31.30		7.79		80.0		0.94		136		49.2		25ml	57.45		CLEAR
9:45	STOP															
9:53	RESTART															
10:00	33.86		7.80		79.5		0.87		134		46.2		80ml	58.1		CLEAR
10:05	33.86		7.83		79.5		0.90		132		32.0		70ml	58.2		CLEAR
10:10	34.42		7.82		79.1		1.21		136		37.2		50ml	58.45		CLEAR
10:15	34.56		7.84		79.3		1.06		136		14.2		50ml	58.48		CLEAR
10:20	34.90		7.85		79.0		0.92		134		12.5		50ml	58.65		CLEAR
10:25	35.16		7.84		78.9		0.80		134		11.4		50ml	58.84		CLEAR
10:30	35.04		7.84		78.2		0.65		133		14.2		50ml	59.25		CLEAR
10:35	34.75		7.87		77.8		0.54		131		11.4		50ml	59.27		CLEAR
10:40	35.04		7.84		78.2		0.51		134		10.4		50ml	59.25		CLEAR
10:45	35.19		7.87		78.2		0.50		131		10.3		50ml	59.50		CLEAR

Stop Purge Time: 10:46 | Sample Time: 10:47 | QA/QC Sample Time(s): —

Sample ID: GRTS-MW04B-BL01 | QA/QC Sample ID(s): —

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	VOA w/HCl	1	125 mL Plastic	1	500 mL Plastic	1	500 mL w/H_2SO_4	1	500 mL poly w/HNO_3	1	250 mL Amber Glass w/H_2SO_4
1	125 mL w/EDA	2	250 mL Plastic	2	250 mL w/H_2SO_4	1	250 mL poly w/HNO_3	1	250 mL Amber Glass w/H_3PO_4	1	500 mL Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 CONSECUTIVE READINGS ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 5/9/18	Well ID: GRTS-MW05A
Field Sampler(s): KIAN L. AND CRYSTAL C.				
Transducer Removal Time: N/A	Transducer Redeployment time: N/A		General Well Condition: Good	
Depth to Water (ft): 52.91'	Screened Interval Top (ft): 60		Pump Intake Depth (ft): 65'	
Well Depth (ft): 80	Screened/Open Interval Bottom (ft): 70		Well Diameter (in): 2"	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 8:55				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
8:55	start															
9:00	27.09		8.31		15.9		5.33		134		875		150 ml/min	54.9'		CLOUDY
9:05	26.76		8.29		14.7		5.97		137		366		200 ml/min	55.6'		CLOUDY
9:10	26.98		8.29		14.3		5.94		137		223		250	58.2		CLEAR
9:15	27.78		8.30		14.0		5.68		139		135		50 ml/min	57.05		CLEAR
9:20	28.85		8.29		13.9		5.52		140		111		75 ml/min	56.80		CLEAR
9:25	29.30		8.28		13.7		5.47		142		90		75 ml/min	56.65		CLEAR
9:30	29.50		8.27		13.5		5.56		142		70		75 ml/min	56.61		CLEAR
9:35	29.85		8.26		13.4		5.44		141		53.8		100 ml/min	56.40		CLEAR
9:40	29.88		8.26		13.3		5.49		140		460		100 ml/min	56.35		CLEAR
9:45	29.75		8.26		13.2		5.49		139		39.6		100 ml/min	56.30		CLEAR
9:50	30.17		8.25		12.9		5.23		139		30.2		100 ml/min	56.40		CLEAR
9:55	30.56		8.22		12.7		5.20		141		25.1		100 ml/min	56.25		CLEAR
10:00	30.58		8.21		12.6		5.28		140		22.1		100 ml/min	56.25		CLEAR
10:05	30.61		8.22		12.5		5.26		141		19.3		100 ml/min	56.20		CLEAR

Stop Purge Time: 10:10	Sample Time: 10:15	QA/QC Sample Time(s): —
	Sample ID: GRTS-MW05A	QA/QC Sample ID(s): —

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	40 mL VOA w/HCl	1	125 mL Plastic	2	500 mL Plastic	2	500 mL w/H_2SO_4	2	500 mL poly w/HNO_3	2	250 mL Amber Glass w/H_2SO_4
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H_2SO_4	2	250 mL poly w/HNO_3	1	250 mL Amber Glass w/H_3PO_4	3	500 mL Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 CONSECUTIVE READINGS ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/08/10	Well ID: MW-05B
Field Sampler(s): K. Lee, C. Castellanos				
Transducer Removal Time: —	Transducer Redeployment time: —		General Well Condition: Good	
Depth to Water (ft): 57.29	Screened Interval Top (ft): 75		Pump Intake Depth (ft): 79	
Well Depth (ft): 85.30	Screened/Open Interval Bottom (ft): 85		Well Diameter (in): 2	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 0833				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
0855	26.54		7.94		38.88		17.8		53.5		119		50	57.35		Brown
0900	26.68		7.50		39.55		18.8		76.9		79		50	57.49		Brown
0905	26.90		6.69		39.98		26.7		115.8		62.2		50	57.61		Brown
0910	27.07		7.90		40.31		32.2		57.1		46.0		50	57.76		cloudy
0915	27.12		5.97		40.39		2.18		163.3		33.9		50	57.84		Cloudy
0920	27.26		7.86		36.6		2.54		59.3		29.5		50	57.92		Clear
0925	27.34		7.92		38.1		2.61		60.2		264		50	57.98		clear

Stop Purge Time: 0927	Sample Time: 0930	QA/QC Sample Time(s): —	
	Sample ID: GRTS-MW05-BL01	QA/QC Sample ID(s): —	

Observations/Comments:

HACH Kit Sulfide: 0.6 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	~~3~~ VOA w/HCl	1	125 mL Plastic		500 mL Plastic		500 mL w/H_2SO_4		500 mL poly w/HNO_3		250 mL Amber Glass w/H_2SO_4 VOA
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H_2SO_4	2	250 mL poly w/HNO_3	1	250 mL Amber Glass w/~~H_3PO_4~~ HCL	3	~~500 mL~~ Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 CONSECUTIVE READINGS ARE WITHIN:

' for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/09/18	Well ID: MCF-06B
Field Sampler(s): K. Lew				
Transducer Removal Time: 1154	Transducer Redeployment time: 1303		General Well Condition: Good	
Depth to Water (ft): 57.46	Screened Interval Top (ft): 67		Pump Intake Depth (ft): 75	
Well Depth (ft): 85.05	Screened/Open Interval Bottom (ft): 82		Well Diameter (in): 4	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 1156				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
1200	28.82		7.12		44.98		4.38		30.3				150	57.81		Clear
1205	30.18		7.03		46.53		2.04		56.1		4.68		80	58.02		↓
1210	30.35		7.02		46.86		1.76		63.6		0.89		80	58.10		
1215	30.67		6.96		47.32		1.56		61.3		0.82		80	58.26		
1220	30.64		6.90		47.40		1.37		58.1		0.71		80	58.40		
1225	30.46		6.79		47.43		1.34		55.6		0.66		80	58.59		

Stop Purge Time: 1228	Sample Time: 1230	QA/QC Sample Time(s): —
	Sample ID: MCF-06B-BL01	QA/QC Sample ID(s): —

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	~~0~~ VOA w/HCl	1	125 mL Plastic		500 mL Plastic		500 mL w/H_2SO_4		500 mL poly w/HNO_3		250 mL Amber Glass w/H_2SO_4 VOA
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H_2SO_4	2	250 mL poly w/HNO_3	1	250 mL Amber Glass w/~~H_3PO_4~~ HCl	3	~~500 mL~~ Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN 3 **CONSECUTIVE READINGS** ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 05/08/18	Well ID: MCF-06C
Field Sampler(s): ~~[illegible]~~ K. Lew				
Transducer Removal Time: 1315	Transducer Redeployment time: 1505		General Well Condition: Good	
Depth to Water (ft): 57.08	Screened Interval Top (ft): 44		Pump Intake Depth (ft): ~~58.00~~ 58.00	
Well Depth (ft): 62.20	Screened/Open Interval Bottom (ft): 59		Well Diameter (in): 2	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 1320				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
1400	29.83		7.53		14.0		3.72		158		94.0		280	57.45		Brown
1405	28.73		7.70		13.5		2.36		129		77.3		260			Brown
1410	27.69		7.71		13.7		3.38		126		64.5		240	57.55		Brown
1415	27.95		7.73		13.7		3.38		128		53.1		140	57.60		cloudy
1420	28.25		7.73		13.7		3.38		135		50.8		100	57.64		
1425	29.48		7.72		13.8		3.01		146		47.7		80	57.71		
1430	29.50		7.63		13.8		2.95		149		46.3		80	57.72		
1435	29.61		7.59		13.9		2.79		153		46.5		80	57.72		
1440	29.67		7.59		13.9		2.75		153		46.7		80	57.75		

Stop Purge Time: 1442	Sample Time: 1445	QA/QC Sample Time(s): —
	Sample ID: MCF-06C	QA/QC Sample ID(s): —

Observations/Comments:

HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	~~6~~ VOA w/HCl	1	125 mL Plastic		500 mL Plastic		500 mL w/H2SO4		500 mL poly w/HNO3		250 mL Amber Glass w/H2SO4 VoA
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H2SO4	2	250 mL poly w/HNO3	1	250 mL Amber Glass w/~~H3PO~~ HCl	3	~~500~~ mL Amber Glass

*INDICATOR PARAMETERS HAVE STABLIZED WHEN **3 CONSECUTIVE READINGS** ARE WITHIN:

± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

TETRA TECH

LOW FLOW GROUNDWATER SAMPLING LOG

NERT, Henderson, NV

Task Name: Galleria Road Treatability Study	Task Manager: D. Grady	Task No: M17	Date: 5/9/18	Well ID: ES-13
Field Sampler(s): KIAN L. AND CRYSTAL C.				
Transducer Removal Time: N/A	Transducer Redeployment time: N/A		General Well Condition: Good	
Depth to Water (ft): 59.92'	Screened Interval Top (ft): 90'		Pump Intake Depth (ft): 100'	
Well Depth (ft): 105'	Screened/Open Interval Bottom (ft): 105'		Well Diameter (in): 4"	
Pump/Tubing Type: QED Bladder Pump & TLPE/LDPE	GW Disposal: GW-11		Equipment Decon. Method: Alconox/DI Rinse SOP	
Purge Start Time: 12:15pm				

Time	Temp. (°C)		pH (pH Units)		Conductivity (mS/cm)		DO (mg/L)		ORP (mV)		Turbidity (NTU)		Purge Rate (ml/min)	Depth to Water (ft)	Cum. Vol. Purged (L)	Color/Odor
	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*	READ	CHANGE*				
12:15	start	—	—	—	—		—	—	—	—	—	—	—	—	—	—
12:30	35.50		9.39		45.6		6.32		58		18.6		50ml/min	60.48		CLEAR
12:35	31.31		9.66		48.8		6.05		39		29.4		100ml/min	60.71		CLEAR
12:40	29.86		9.76		49.3		5.52		27		28.4		100ml/min	60.75		CLEAR
12:45	29.25		9.91		49.3		4.88		10		28.4		100ml/min	61.16		CLEAR
12:50	28.91		10.07		49.0		4.17		-5		24.1		100ml/min	61.39		CLEAR
12:55	28.73		10.10		49.0		3.83		9		18.3		100ml/min	61.70		CLEAR
13:00	28.67		10.14		48.8		3.41		-12		13.5		100ml/min	61.91		CLEAR
13:05	28.38		10.13		48.7		2.96		-41		8.0		150ml/min	62.30		CLEAR
13:10	28.16		7.46		48.5		2.77		-44		7.9		150ml/min	62.35		CLEAR
13:15	28.13		7.63		48.3		2.48		-53		5.2		150ml/min	62.25		CLEAR
13:20	28.02		7.69		47.7		2.21		-57		4.3		150ml/min	63.14		CLEAR
13:25	28.90		7.70		47.7		2.10		-57		4.7		150ml/min	63.25		CLEAR
13:30	28.60		7.71		47.5		2.01		-58		2.8		150ml/min	63.35		CLEAR

Stop Purge Time: 13:30	Sample Time: 13:30	QA/QC Sample Time(s): —
	Sample ID: ES-13-0501	QA/QC Sample ID(s): —

Observations/Comments:
HACH Kit Sulfide: 0.0 mg/L HACH Kit Ferrous Iron: 0.0 mg/L

Bottle Set Summary

3	~~6x~~ VOA w/HCl	1	125 mL Plastic	0	500 mL Plastic	0	500 mL w/H_2SO_4	0	500 mL poly w/HNO_3	0	250 mL Amber Glass w/H_2SO_4
1	125 mL w/EDA	2	250 mL Plastic	1	250 mL w/H_2SO_4	2	250 mL poly w/HNO_3	1	250 mL Amber Glass w/H_3PO_4	3	~~500 mL~~ Amber Glass VOA

*INDICATOR PARAMETERS HAVE STABLIZED WHEN **3 CONSECUTIVE READINGS** ARE WITHIN:
± 0.1 for pH; ± 3% for Cond and Temp; ± 10 mv for ORP; ± 10% or <0.5 mg/L for DO; ± 10% or <10 NTU Turbidity

Appendix E
Aquifer Testing Results Technical Memorandum

TETRA TECH

TECHNICAL MEMORANDUM

To:	**Dana Grady and Ronnie Britto, Tetra Tech**
From:	Sonya Cadle, Audrey Crockett, and Ellyn Swenson, Tetra Tech
Date:	July 5, 2018
Subject:	Aquifer Testing Results – Galleria Drive Bioremediation Treatability Study

INTRODUCTION

This technical memorandum presents the results of the aquifer slug testing and point dilution tests performed as part of the hydrogeological evaluation for the Galleria Drive Bioremediation Treatability Study conducted by Tetra Tech, Inc. (Tetra Tech) on behalf of the Nevada Environmental Response.

The locations of the wells are shown in ***Figure 1***. The objective of the slug and point dilution tests was to estimate aquifer hydraulic conductivity (K) and groundwater flow velocity in the study area.

Tetra Tech, Inc.
150 S. 4th Street, Unit A, Henderson, NV 89015
Tel 702-854-2295 tetratech.com

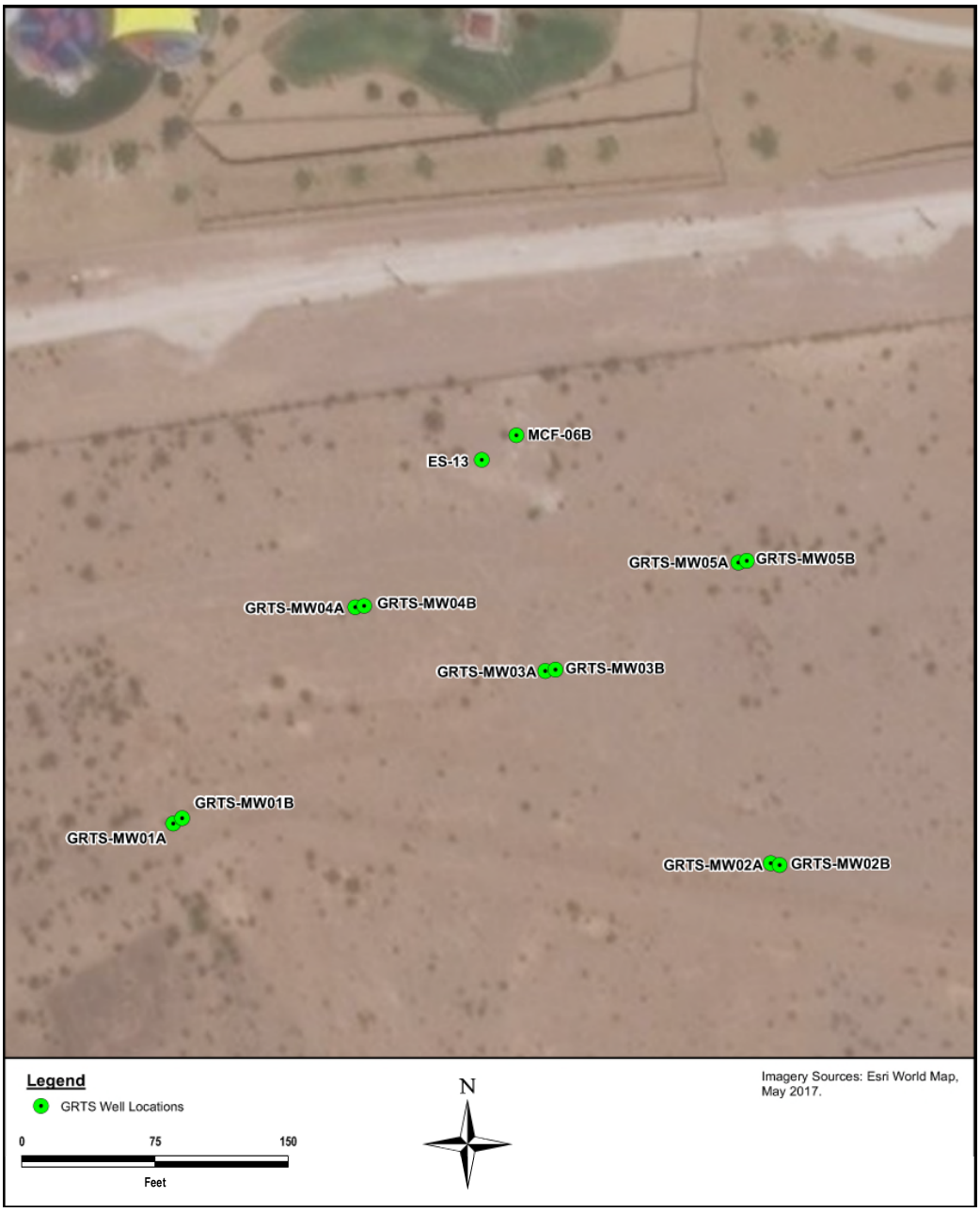


Figure 1 **Location of monitoring wells tested as part of the hydrogeologic evaluation**

SLUG TESTS

Slug testing was performed in May 2018. Well construction information is provided in ***Table 1***. The tests consisted of monitoring water level displacements caused by the insertion or removal of a solid slug from a well. Water level displacement was measured using an In-Situ Rugged TROLL 100 pressure transducer, which was programmed to collect data at one, fifteen, or sixty second time intervals, depending on the well's recovery rate. The size of the slug was selected to be consistent with the diameter of the well, as shown in ***Table 1***.

Table 1 Well Construction Information

Well	UMCf Contact (feet bgs)	Screened Interval (feet bgs)	Top of Casing (feet amsl)	Well Diameter (inches)	Slug Dimensions	
					Diameter (inches)	Length (feet)
GRTS-MW01A	27	60 - 80	1633.49	2	1.25	5
GRTS-MW01B	27	90 - 110	1633.32	2	1.25	5
GRTS-MW02A	36	60 - 80	1632.04	2	1.25	5
GRTS-MW02B	36	90 - 110	1631.89	2	1.25	5
GRTS-MW03A	43.5	65 - 75	1630.18	4	3.00	5
GRTS-MW03B	43.5	90 - 110	1630.27	4	3.00	5
GRTS-MW04A	36	70 - 85	1630.70	2	1.25	5
GRTS-MW04B	36	89.5 - 109.5	1630.86	2	1.25	5
GRTS-MW05A	39	60 - 70	1628.19	2	1.25	5
GRTS-MW05B	39	75 - 85	1628.23	2	1.25	5
ES-13	42	90 - 105	1632.52	4	1.25*	5
MCF-06B	43	90 - 105	1633.06	4	1.25*	5

Notes:
UMCf - Upper Muddy Creek Formation
bgs - below ground surface
amsl - above mean sea level
* - A smaller diameter slug was used due to apparent casing damage.

The slug test data were downloaded from the transducer and the drawdown was calculated from the downloaded data. Slug test analysis was performed using the commercially-available AQTESOLV software (HydroSOLVE 2007). The Bouwer and Rice (1976) method for analyzing slug tests in an unconfined aquifer was used to estimate hydraulic conductivity. The AQTESOLV interpretation plots are provided as Attachment 1. ***Table 2*** summarizes the results of the slug test analysis; the K values provided for each well represent a mean of the K estimates obtained from individual tests at that well. Water levels measured during the testing events are summarized in ***Table 3***.

All tested wells were screened in the Upper Muddy Creek Formation (UMCf). The estimated Ks are generally consistent with the logged lithology of the screened interval of the wells, which was primarily silt and clay with varying degrees of cementation and compaction. The estimates from the slug tests ranged from approximately 0.001 to 1.4 feet per day (ft/day). The hydraulic conductivity decreased with depth such that the UMCf (60-85 ft bgs) wells had hydraulic conductivities up to three orders of magnitude higher than the UMCf (90-110 ft bgs) wells.

Many factors can affect slug test results. Some factors determine whether the K from a slug test is representative of the overall formation K: the values estimated from slug tests are strongly influenced by the presence of a low-K well skin, drilling-induced disturbances, highly anisotropic formations, and the quality of well development (Butler 1998, Hyder and Butler 1995). Non-instantaneous or incomplete slug removal, accidental transducer or slug movement after the test began, and other factors may affect the interpretation of slug test results. Some of these factors were present in some of the slug tests, but generally when both the rising and falling head tests were analyzed, the results were consistent within each well.

Table 2 Slug Test Results

Well	Date	Mean Hydraulic Conductivity		Logged Lithology of Screened Interval
		(feet/day)	(cm/sec)	
GRTS-MW01A	5/14/2018	1.36E+00	4.79E-04	Clay to silt
GRTS-MW01B	5/15/2018	3.61E-03	1.27E-06	Clay
GRTS-MW02A	5/15/2018	1.47E-03	5.18E-07	Silt to clay
GRTS-MW02B	5/16/2018	1.70E-03	6.00E-07	Clay to sandy silt
GRTS-MW03A	5/14/2018	1.08E+00	3.82E-04	Clay
GRTS-MW03B	5/16/2018	2.18E-03	7.70E-07	Clay to silt
GRTS-MW04A	5/14/2018	8.51E-02	3.00E-05	Clay to sandy silt
GRTS-MW04B	5/15/2018	2.41E-03	8.50E-07	Silt to clay
GRTS-MW05A	5/15/2018	5.70E-02	2.01E-05	Clay
GRTS-MW05B	5/16/2018	1.37E-02	4.84E-06	Clay
ES-13	5/16/2018	9.99E-04	3.52E-07	Clay
MCF-06B	5/15/2018	2.85E-03	1.00E-06	Clay

Notes:
cm/sec - centimeters per second

Table 3 Water Levels

Well	Date	Total Depth (feet btoc)	Water Level (feet btoc)
GRTS-MW01A	5/14/2018	80.30	47.18
GRTS-MW01B	5/15/2018	110.31	57.33
GRTS-MW02A	5/15/2018	80.01	56.36
GRTS-MW02B	5/16/2018	109.91	64.23
GRTS-MW03A	5/14/2018	75.45	53.21
GRTS-MW03B	5/16/2018	111.10	60.82
GRTS-MW04A	5/14/2018	85.64	50.40
GRTS-MW04B	5/15/2018	110.41	57.17
GRTS-MW05A	5/15/2018	70.00	52.86
GRTS-MW05B	5/16/2018	85.45	55.45
ES-13	5/16/2018	107.15	60.77
MCF-06B	5/15/2018	85.15	58.16

Notes:
btoc - below top of casing

SINGLE-BOREHOLE DILUTION TESTS

A single-borehole (or point) dilution test uses the change in concentration with time of a tracer compound emplaced in a well to estimate groundwater flow velocity. The theoretical basis for the single-borehole dilution method has been summarized by Halevy et al. (1967) and Drost et al (1968). Pitrak et al. (2007) elaborated on

the use of these analytical techniques and restated the equations in somewhat simpler form. The apparent flow velocity equation from Pitrak et al. (2007) is:

$$\ln C = -\frac{2v_a}{\pi r}t + ln\ C_0$$

where:

C is the tracer concentration at time t
v_a is the apparent flow velocity
r is the borehole radius
t is time
C_0 is the initial tracer concentration

The apparent flow velocity estimated from the above equation must be adjusted by a distortion factor α to obtain actual flow velocity (Halevy et al., 1967). The distortion factor accounts for perturbations in the flow field caused by the contrast between the hydraulic properties of the well and the surrounding undisturbed aquifer. The following equation (Halevy et al., 1967) is used to estimate α:

$$\alpha = \frac{4}{1 + \left(\frac{r_1}{r_2}\right)^2 + \left(\frac{k_2}{k_1}\right)\left[1 - \left(\frac{r_1}{r_2}\right)^2\right]}$$

where

r_1 is the inner well casing radius
r_2 is the combined radius of the well casing and filter pack
k_1 is the permeability of the combined well casing and filter pack
k_2 is the permeability of the undisturbed formation

For this analysis, the filter pack and well casing were assumed to have similar permeability, since both are at least one order of magnitude greater than the formation and neither is known exactly. Furthermore, the dynamic viscosity, fluid density, and gravitational acceleration components of the hydraulic conductivity cancel in this equation, so the permeability ratio is identical to the hydraulic conductivity ratio (i.e., $K_2/K_1 = k_2/k_1$). The filter pack of each well has an estimated hydraulic conductivity of 100 ft/day; the hydraulic conductivity of the undisturbed formation was estimated from slug tests performed at each of the wells, as described above. Using the appropriate radii and the estimated hydraulic conductivity ratios, α was estimated for each well.

Groundwater in the UMCf in the study area has a specific conductance of approximately 10,000 to 60,000 microsiemens per centimeter (µS/cm), depending on the depth interval screened. It is therefore possible to use distilled water, which has a specific conductance of approximately 0 µS/cm, as a tracer for the purpose of the test. Assuming that specific conductance is directly proportional to the fraction of groundwater in the groundwater-distilled water mixture in a well, the tracer concentration can be calculated from:

$$F_{dw} = \frac{SC_0 - SC_t}{SC_0}$$

where
F_{dw} is the fraction of distilled water in the groundwater-distilled water mixture
SC_0 is the specific conductance of the groundwater
SC_t is the specific conductance of the mixture at time t

Field Procedure

The single-borehole dilution tests were performed between June 18-29, 2018. Two tests were performed at GRTS-MW03A to confirm the rapid recovery observed at the well; the second test was performed in a slightly

different portion of the screened interval but ultimately resulted in reasonably comparable estimated groundwater velocities. Specific conductance was monitored during the test using a water quality and pressure transducer (In-Situ Aqua TROLL 200) placed in the well at the center of the screened interval. The sensor calibration was checked immediately prior to performing the test in accordance with manufacturer's specifications, using a standard calibration solution.

The tracer was delivered to the well by simultaneously pumping water from the well and replacing it with distilled water. The pump was placed near the bottom of the well, and the discharge hose was connected to a container at the top of the well. The distilled water was emplaced in the well at a rate designed to equal the pump's discharge rate to minimize hydraulic head changes in the well. The water exchange continued until approximately one casing volume was removed and replaced with distilled water.

The transducer was monitored during water emplacement to ensure that the specific conductance decreased quickly and stabilized at a significantly lower value. The transducer was then allowed to remain in the well to measure recovery of specific conductance. The data were downloaded periodically until the specific conductance values stabilized at or near the original pre-test values or until significant recovery had occurred (in cases of recovery times exceeding 24 hours).

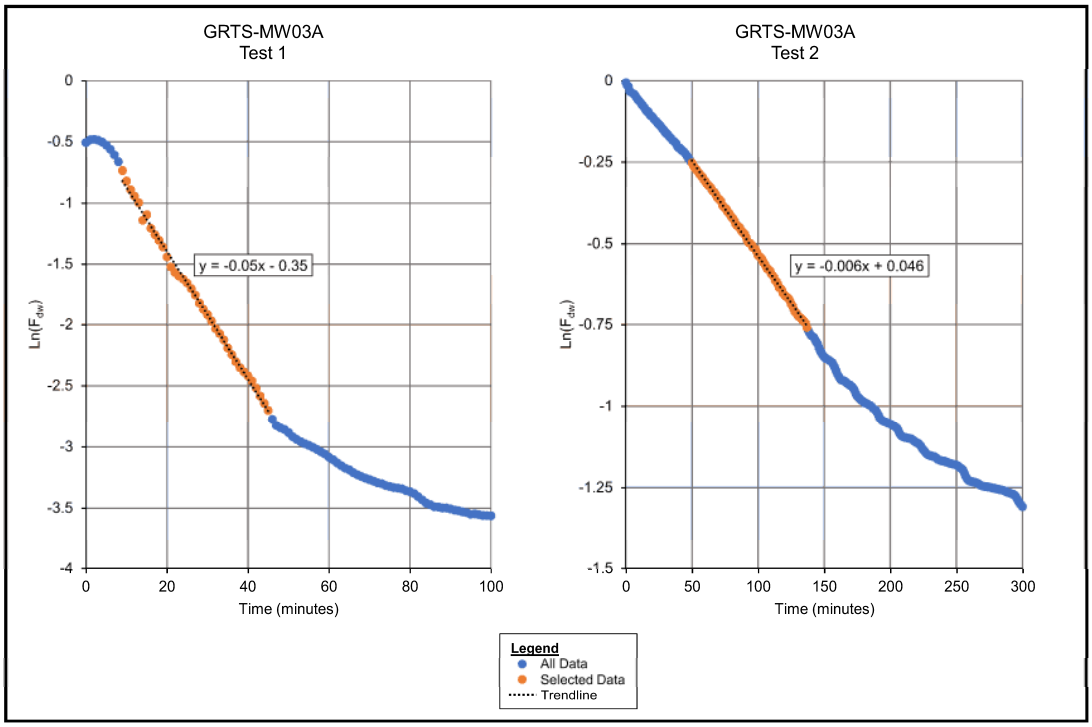
Data Interpretation

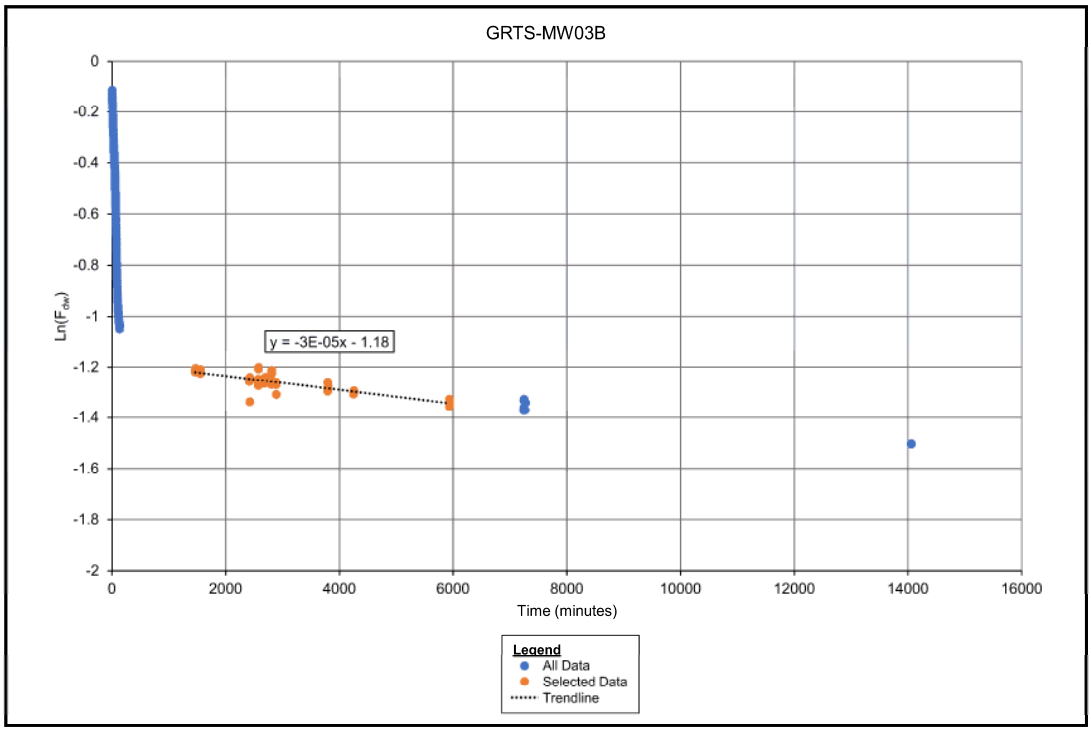
The apparent flow velocity equation can be solved graphically by plotting the natural logarithm of the tracer concentration against time, and then fitting a straight line to the data. Plots of the natural logarithm of F_{dw} vs. time for each of the wells tested are shown below.

Review of the plots of the natural logarithm of F_{dw} vs. time reveals the following:

- The data for GRTS-MW03B are sporadic and noisier than the data for GRTS-MW03A.
- The early data for GRTS-MW03A (test 1) have an anomalously shallow or positive slope. This is not observed in the data for GRTS-MW03A (test 2) or for GRTS-MW03B and is believed to be due to mixing within the borehole in the initial phases of the test.
- The middle data are relatively linear.
- The late data, which represent relatively large dilutions, are characterized by slightly shallower slopes than the middle data, and are typically concave-upward.

The missing and noisy data at GRTS-MW03B are the result of a faulty transducer which recorded spurious values when disconnected from the computer. After this issue was identified, field staff were able to obtain useable data by returning to the well and reconnecting the transducer to the computer at regular intervals, producing the small groups of data shown on the plot. The periodic downloads allowed collection of a reasonable amount of data on this very slow-recovering well, rendering repetition of the test unnecessary.





Where anomalous early-time data are present, they are interpreted to be a result of vertical mixing within the well casing, caused by rapid removal of the pump and tubing immediately after the test was initiated. The relatively linear middle portion of the curve (present in all three tests) is considered to be representative of the period when most of the tracer dilution occurred, and was therefore used for analysis. The least-squares straight lines and the equations of the lines are shown above.

Distortion factors were calculated as described above using the radii of the wells and the hydraulic conductivity of the formation estimated from the slug testing described in the previous section. Calculated distortion factors, apparent velocities estimated from the slopes of the least-squares lines, and calculated flow velocities are summarized in ***Table 4***.

Table 4 Single-Borehole Dilution Test Results

Well	Initial Time (minutes)	Initial F_{dw}	Final Time (minutes)	Final F_{dw}	Slope of Least Squares Line	Apparent Velocity (feet/day)	Distortion Factor α	Flow Velocity (feet/day)
GRTS-MW03A	9	0.48	45	0.067	-0.05	19	3.18	6
	50	0.78	137	0.47	-0.01	2	3.18	0.7
					Average Velocity	10.5		3.4
GRTS-MW03B	1464	0.30	5937	0.26	-3×10-5	0.011	3.20	3.5×10-3

Notes:
F_{dw}: Fraction of distilled water

Table 4 shows that the flow velocity in the UMCf is much greater in the shallow portion of the aquifer than in the deeper portion.

REFERENCES

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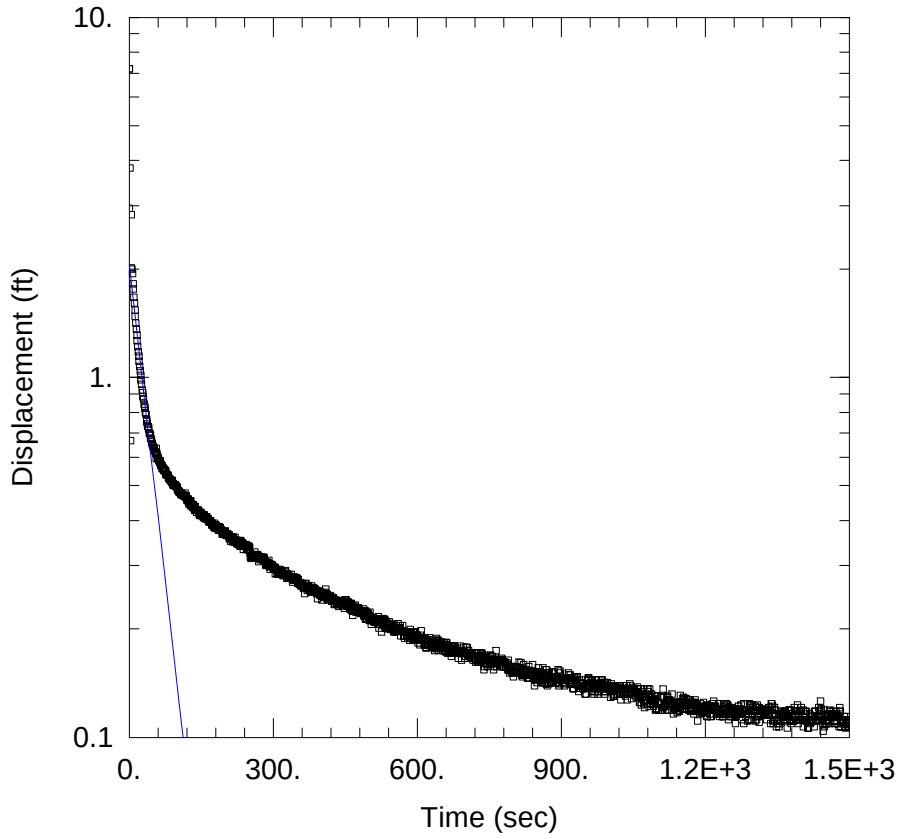
Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-52

Attachment 1
AQTESOLV Interpretation Plots



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW01A_IN1.aqt
Date: 06/07/18 Time: 12:10:08

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW01A
Test Date: 5/14/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.483 ft/day
y0 = 2.053 ft

AQUIFER DATA

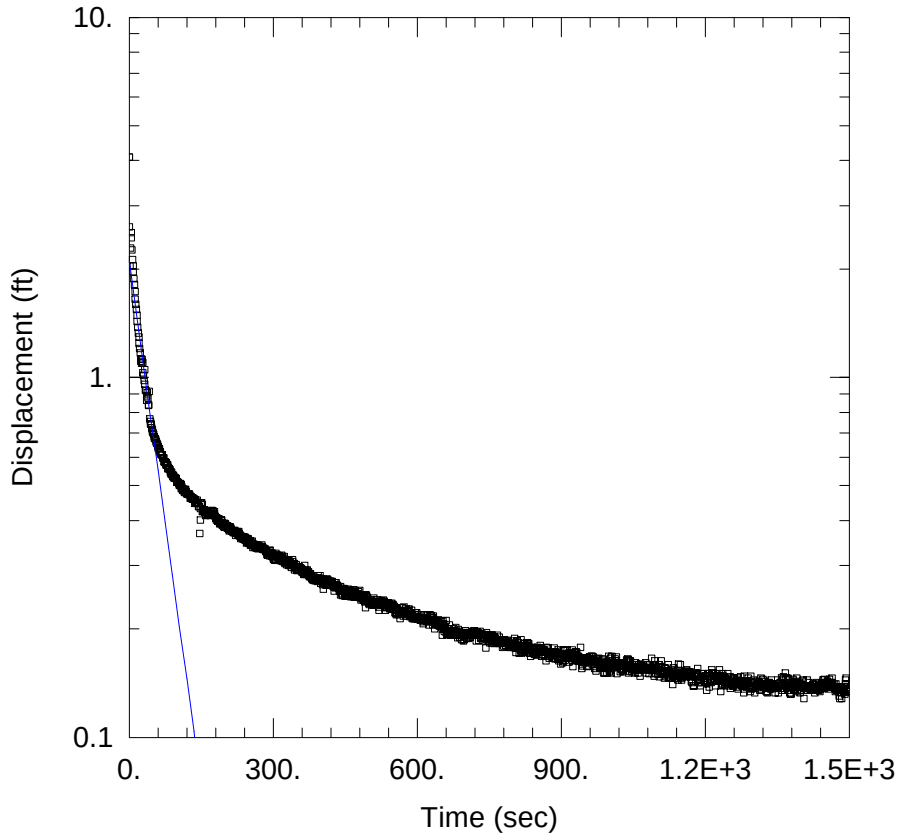
Saturated Thickness: 22.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW01A_IN1)

Initial Displacement: 7.194 ft
Total Well Penetration Depth: 33.12 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 33.12 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW01A_OUT1.aqt
Date: 06/07/18 Time: 12:10:44

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW01A
Test Date: 5/14/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.233 ft/day
y0 = 2.104 ft

AQUIFER DATA

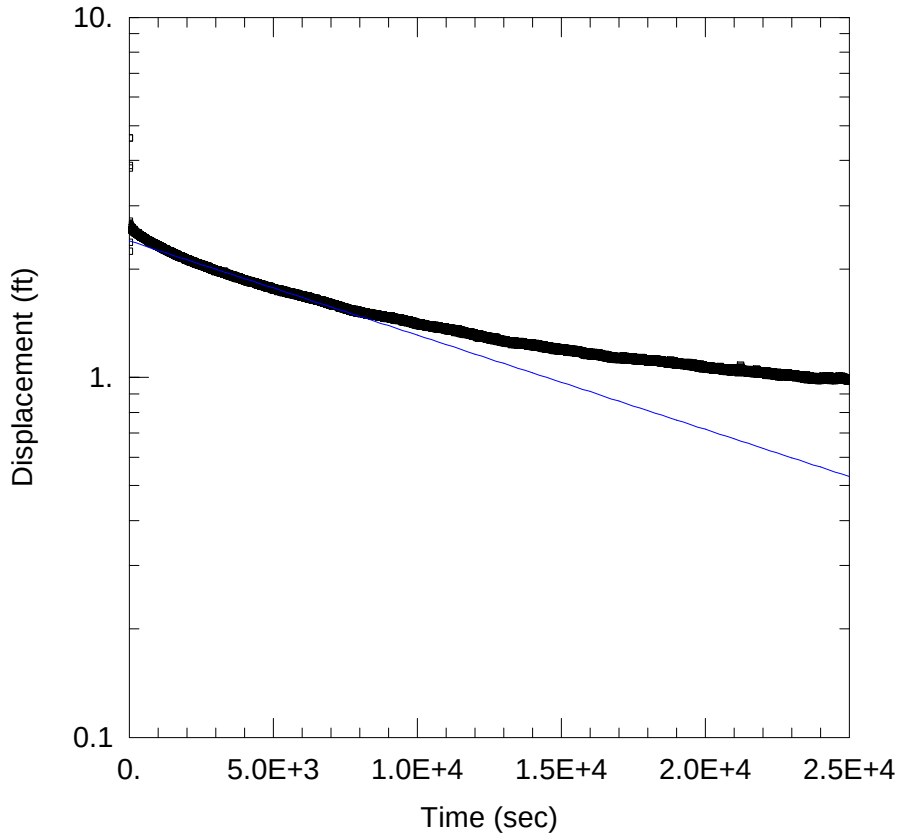
Saturated Thickness: 22.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW01A_OUT1)

Initial Displacement: 4.092 ft
Total Well Penetration Depth: 33.12 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 33.12 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW01B_IN1 - BM Revised.aqt
Date: 06/07/18 Time: 12:12:34

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW01B
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.003599 ft/day
y0 = 2.394 ft

AQUIFER DATA

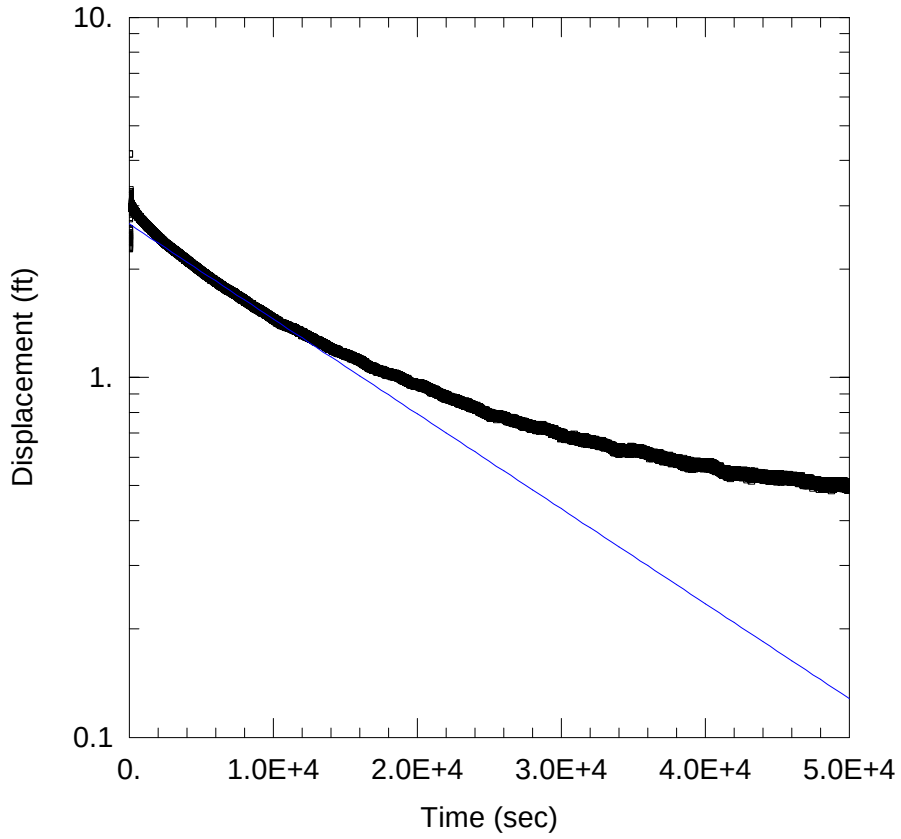
Saturated Thickness: 22. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW01B_IN1)

Initial Displacement: 4.617 ft
Total Well Penetration Depth: 52.98 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 52.98 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW01B_OUT1 - BM Revised.aqt
Date: 06/07/18 Time: 12:12:59

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW01B
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.003623 ft/day
y0 = 2.666 ft

AQUIFER DATA

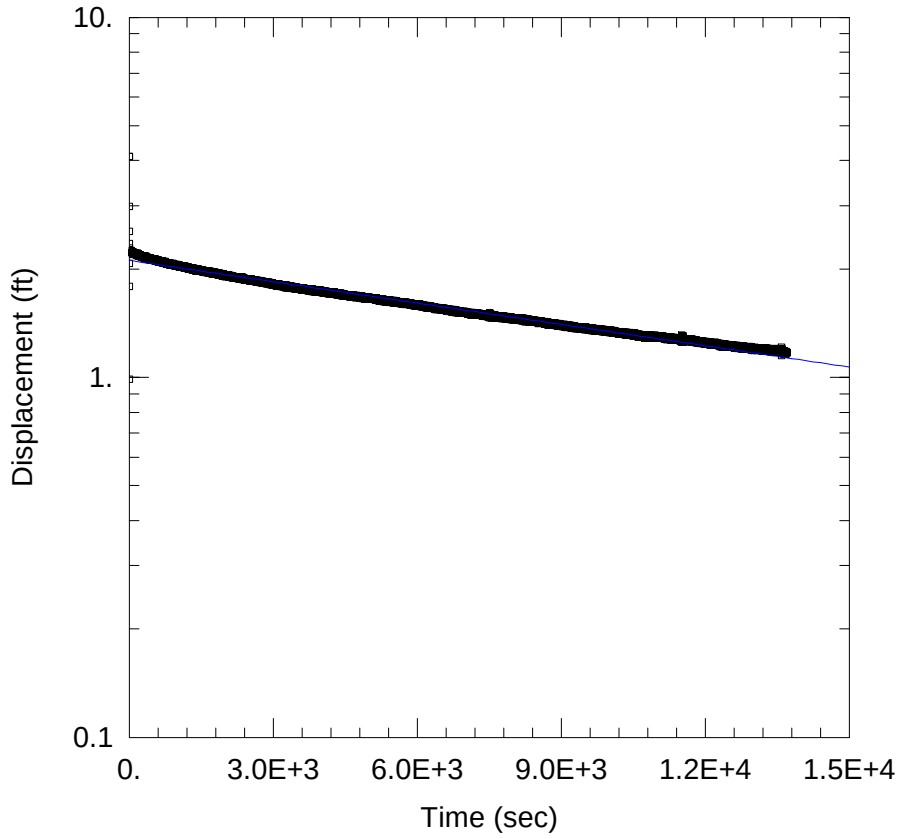
Saturated Thickness: 22. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW01B_OUT1)

Initial Displacement: 4.169 ft
Total Well Penetration Depth: 52.98 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 52.98 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW02A_IN1 - BM Revised.aqt
Date: 06/07/18 Time: 12:13:20

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW02A
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00237 ft/day
y0 = 2.111 ft

AQUIFER DATA

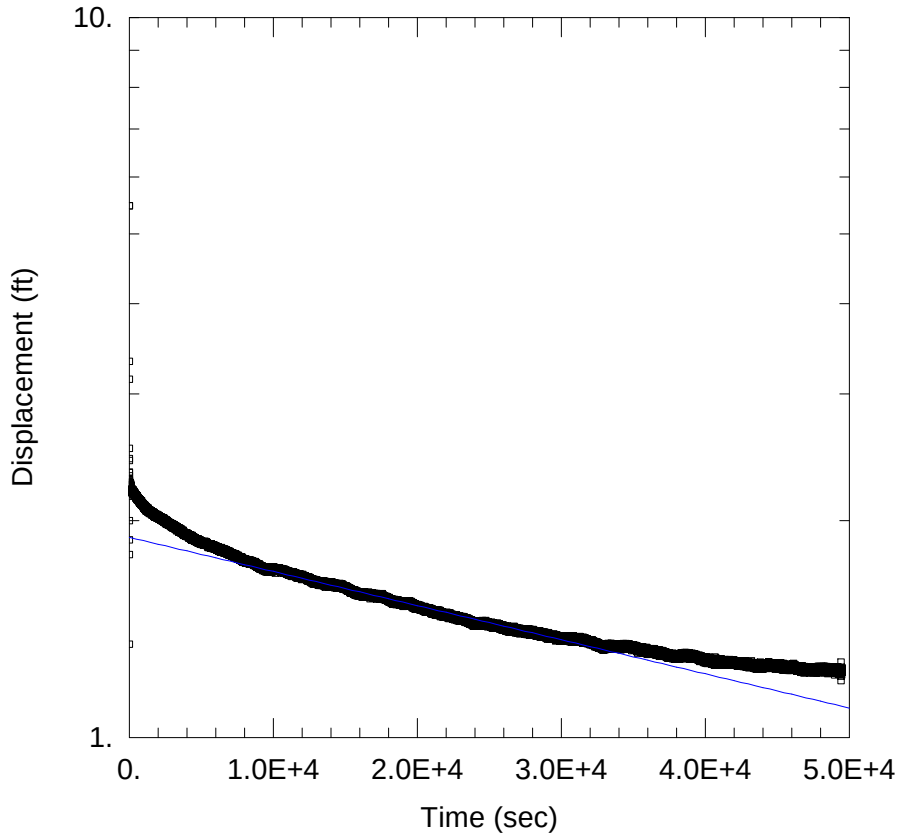
Saturated Thickness: 22.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW02A_IN1)

Initial Displacement: 4.111 ft
Total Well Penetration Depth: 23.65 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 23.65 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW02A_OUT1 - BM Revised.aqt
Date: 06/07/18 Time: 12:14:09

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW02A
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0005694 ft/day
y0 = 1.896 ft

AQUIFER DATA

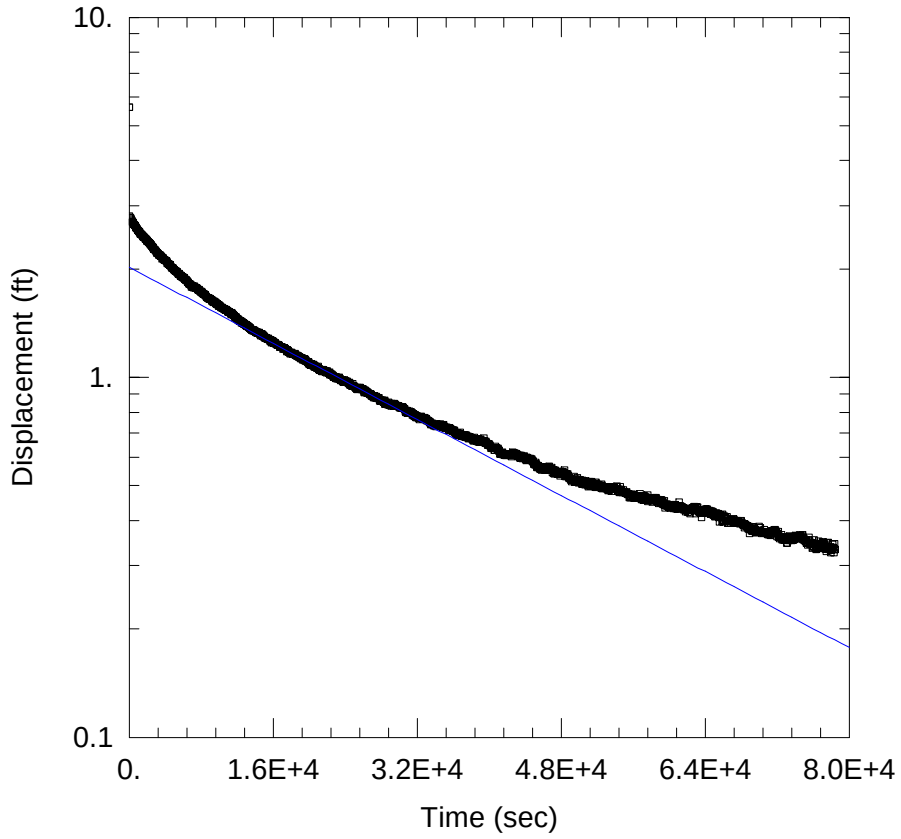
Saturated Thickness: 22.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW02A_OUT1)

Initial Displacement: 5.469 ft
Total Well Penetration Depth: 23.65 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 23.65 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW02B_IN1 - BM Revised.aqt
Date: 06/07/18 Time: 12:14:23

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW02B
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001774 ft/day
y0 = 2.023 ft

AQUIFER DATA

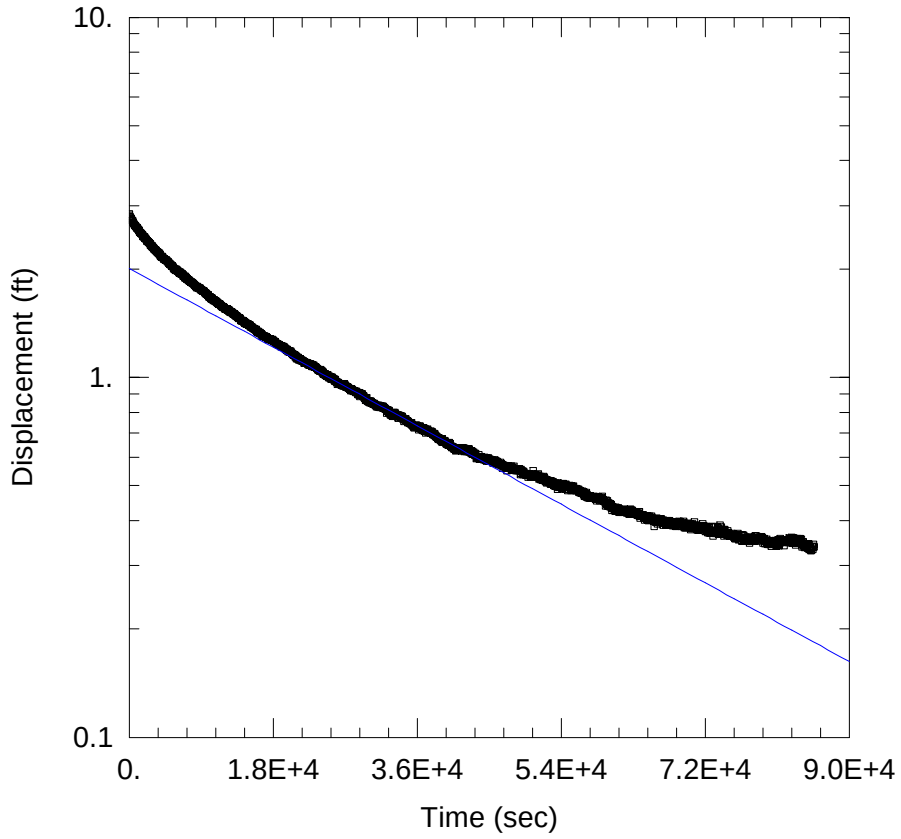
Saturated Thickness: 22.8 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW02B_IN1)

Initial Displacement: 5.633 ft
Total Well Penetration Depth: 45.68 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 45.68 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW02B_OUT1 - BM Revised.aqt
Date: 06/07/18 Time: 12:14:33

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW02B
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001629 ft/day
y0 = 2.005 ft

AQUIFER DATA

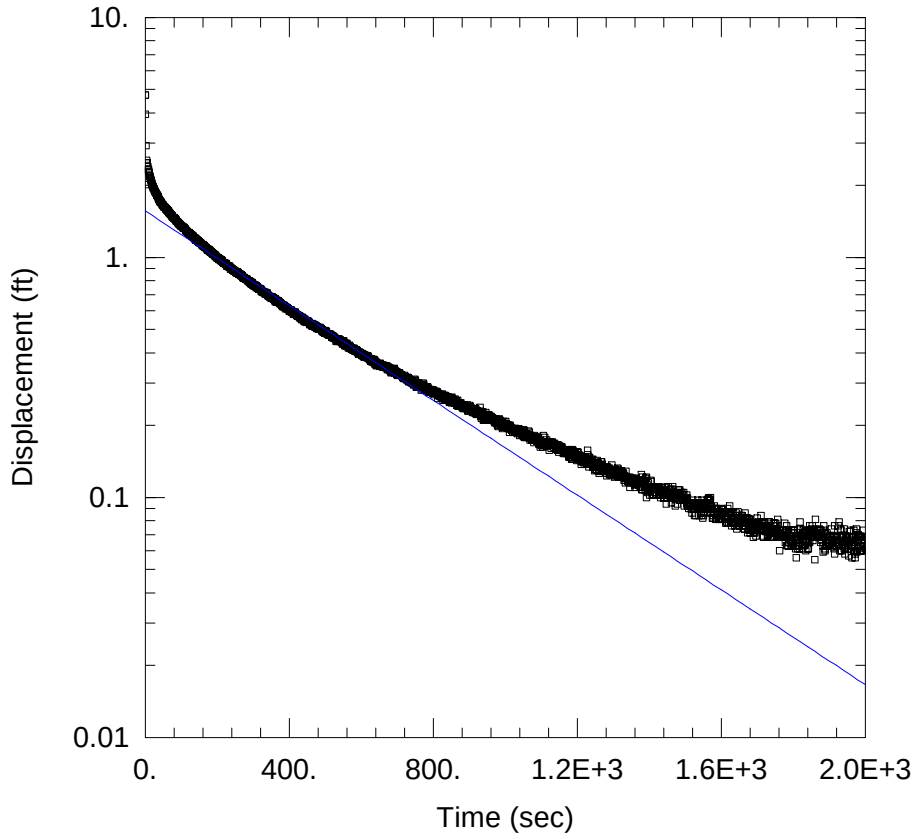
Saturated Thickness: 22.8 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW02B_OUT11)

Initial Displacement: 2.844 ft
Total Well Penetration Depth: 45.68 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 45.68 ft
Screen Length: 20. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW03A_IN1_ES.aqt
Date: 06/07/18 Time: 12:15:02

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW03A
Test Date: 5/14/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.8323 ft/day
y0 = 1.56 ft

AQUIFER DATA

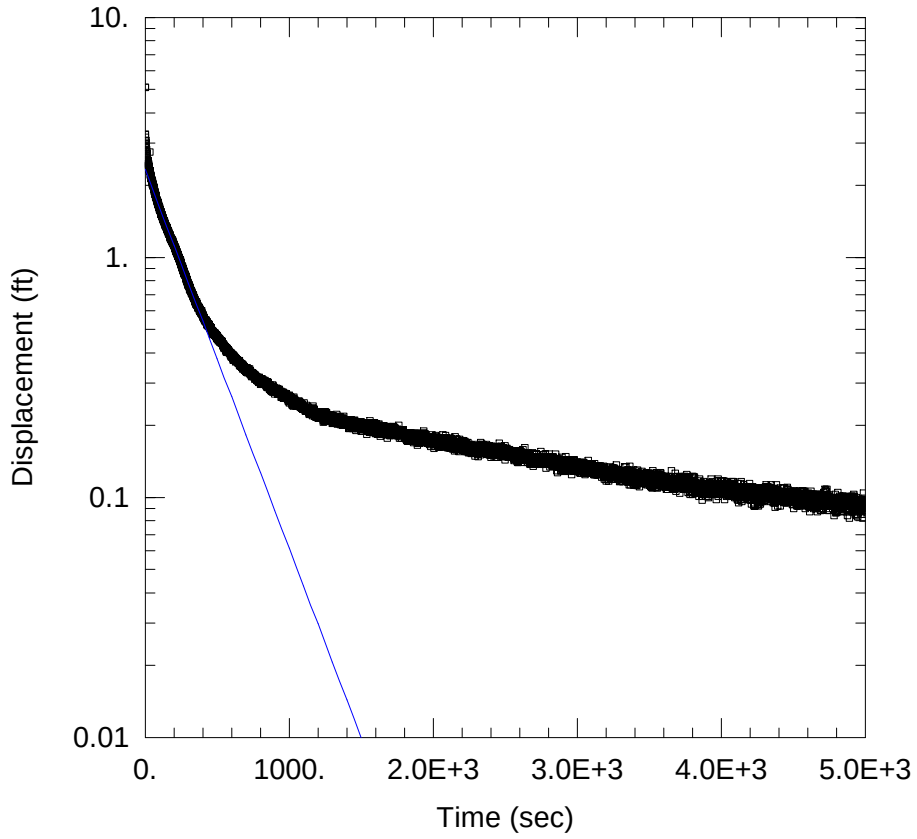
Saturated Thickness: 12. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW03A_IN1)

Initial Displacement: 4.754 ft
Total Well Penetration Depth: 22.24 ft
Casing Radius: 0.1667 ft

Static Water Column Height: 22.24 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW03A_OUT1.aqt
Date: 06/07/18 Time: 12:15:18

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW03A
Test Date: 5/14/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.331 ft/day
y0 = 2.321 ft

AQUIFER DATA

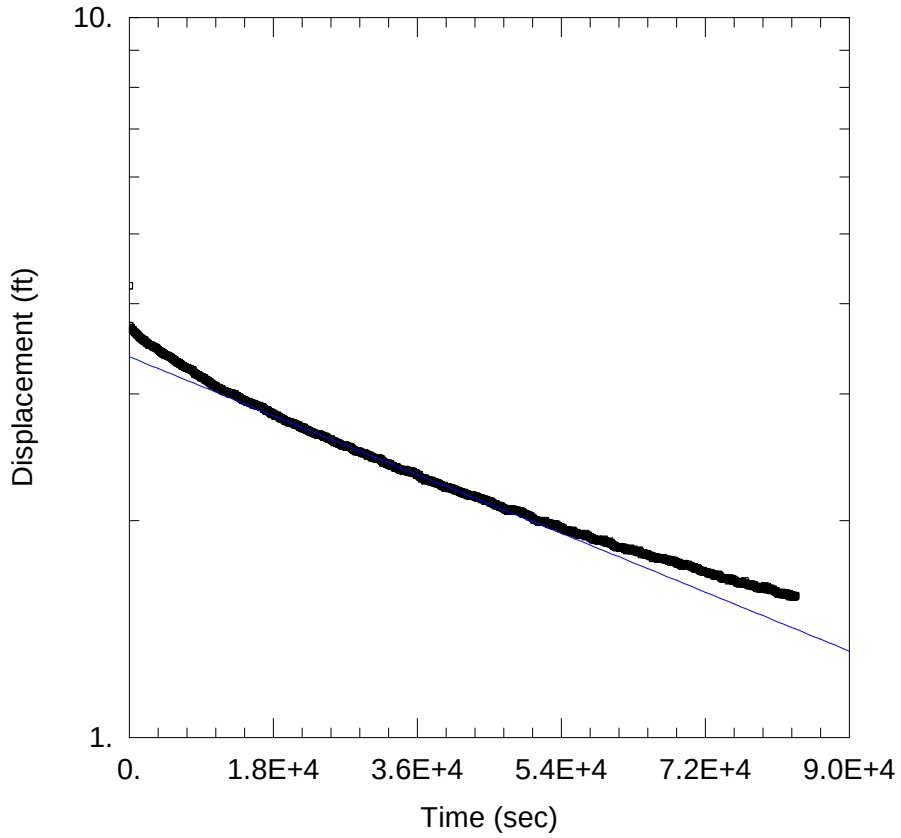
Saturated Thickness: 12. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW03A_OUT1)

Initial Displacement: 5.116 ft
Total Well Penetration Depth: 22.24 ft
Casing Radius: 0.1667 ft

Static Water Column Height: 22.24 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW03B_IN1 - BM Revised.aqt
Date: 06/07/18 Time: 12:16:36

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW03B
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.002331 ft/day
y0 = 3.377 ft

AQUIFER DATA

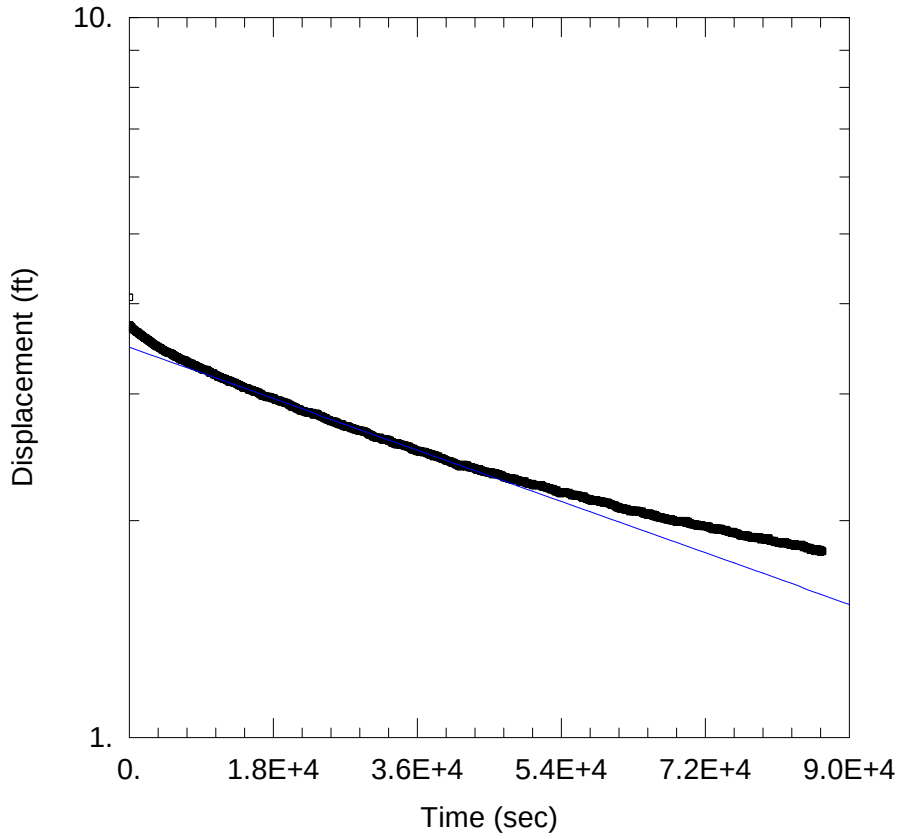
Saturated Thickness: 22.2 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW03B_IN1)

Initial Displacement: 4.241 ft
Total Well Penetration Depth: 50.28 ft
Casing Radius: 0.1667 ft

Static Water Column Height: 50.28 ft
Screen Length: 20. ft
Well Radius: 0.3333 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW03B_OUT1 - BM Revised.aqt
Date: 06/07/18 Time: 12:16:45

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW03B
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.002036 ft/day
y0 = 3.481 ft

AQUIFER DATA

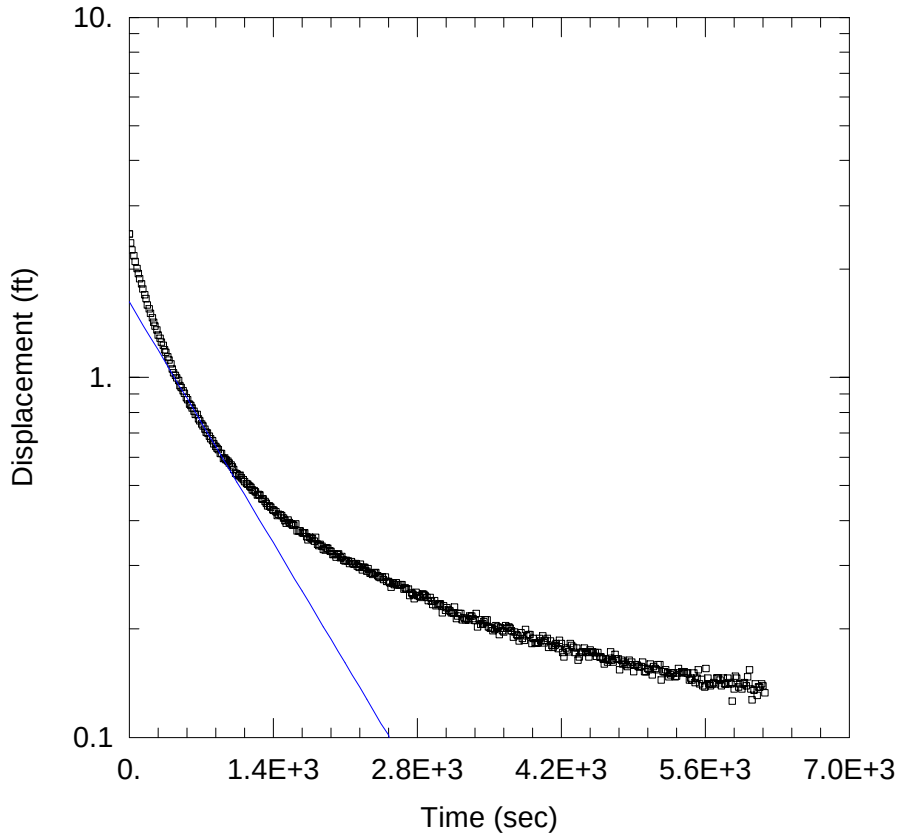
Saturated Thickness: 22.2 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW03B_OUT1)

Initial Displacement: 4.087 ft
Total Well Penetration Depth: 50.28 ft
Casing Radius: 0.1667 ft

Static Water Column Height: 50.28 ft
Screen Length: 20. ft
Well Radius: 0.3333 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW04A_IN1.aqt
Date: 06/07/18 Time: 12:17:07

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW04A
Test Date: 5/14/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.08089 ft/day
y0 = 1.622 ft

AQUIFER DATA

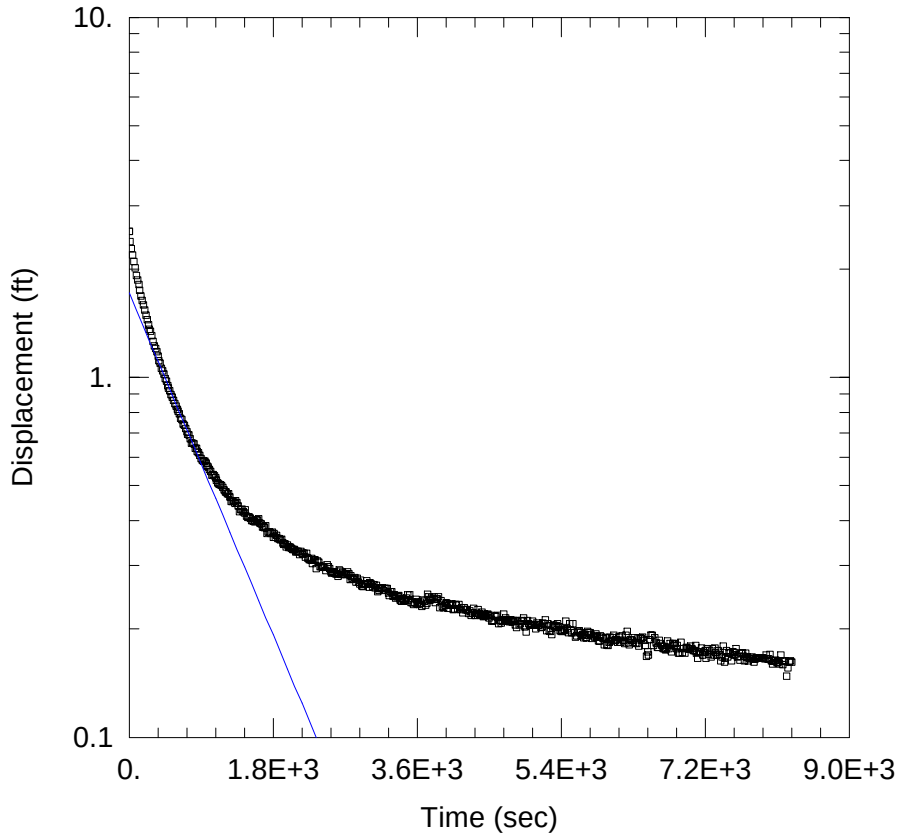
Saturated Thickness: 17. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW04A_IN1)

Initial Displacement: 2.504 ft
Total Well Penetration Depth: 35.24 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 35.24 ft
Screen Length: 15. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW04A_OUT1.aqt
Date: 06/07/18 Time: 12:17:27

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW04A
Test Date: 5/14/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.08936 ft/day
y0 = 1.718 ft

AQUIFER DATA

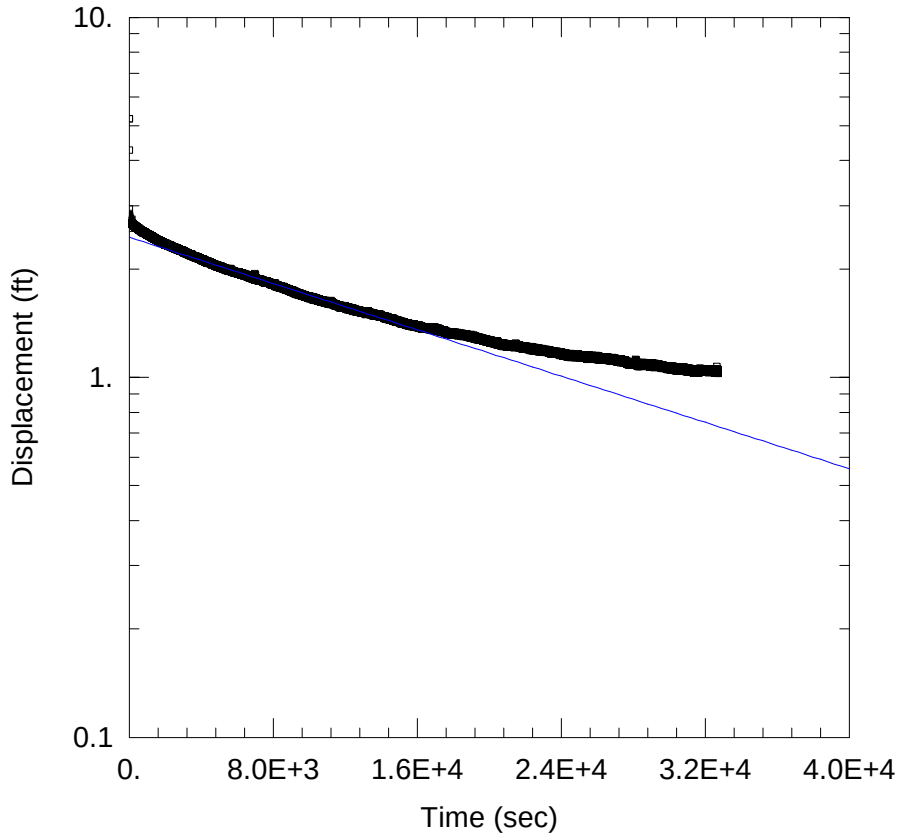
Saturated Thickness: 17. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW04A_OUT1)

Initial Displacement: 2.538 ft
Total Well Penetration Depth: 35.24 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 35.24 ft
Screen Length: 15. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW04B_IN1 - BM Revised.aqt
Date: 06/07/18 Time: 12:17:58

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW04B
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.002242 ft/day
y0 = 2.448 ft

AQUIFER DATA

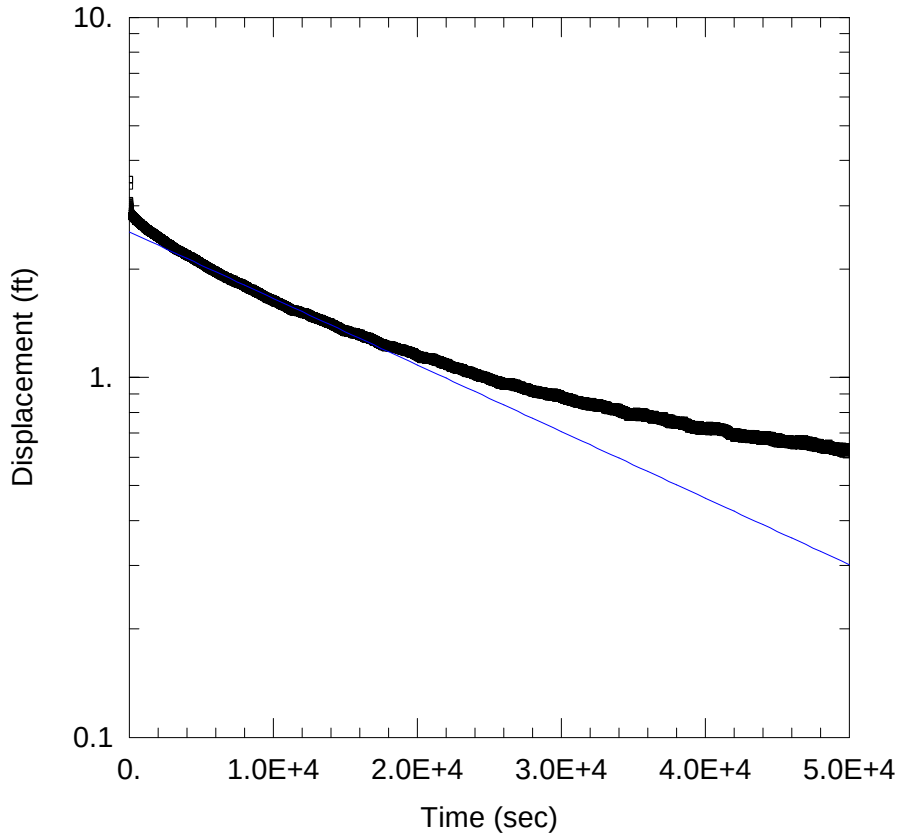
Saturated Thickness: 22.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW04B_IN1)

Initial Displacement: 5.234 ft
Total Well Penetration Depth: 53.24 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 53.24 ft
Screen Length: 19.7 ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW04B_OUT1 - BM Revised.aqt
Date: 06/07/18 Time: 12:18:23

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW04B
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.002579 ft/day
y0 = 2.537 ft

AQUIFER DATA

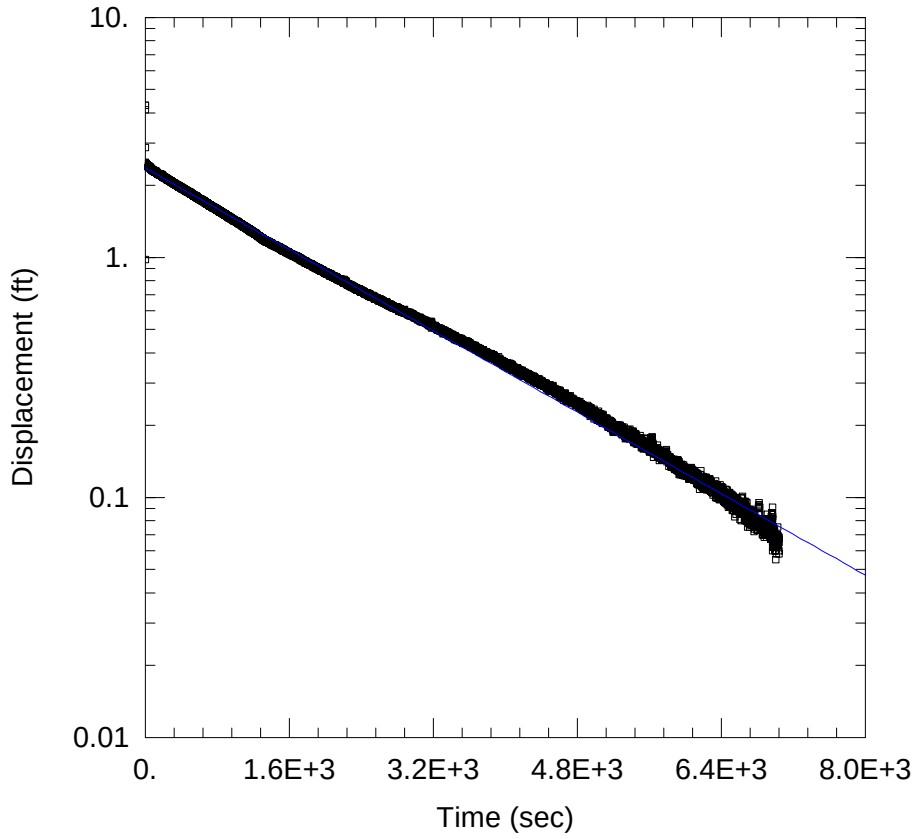
Saturated Thickness: 22.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW04B_OUT1)

Initial Displacement: 3.538 ft
Total Well Penetration Depth: 53.24 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 53.24 ft
Screen Length: 19.7 ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW05A_IN1.aqt
Date: 06/07/18 Time: 12:18:50

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW05A
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.04612 ft/day
y0 = 2.359 ft

AQUIFER DATA

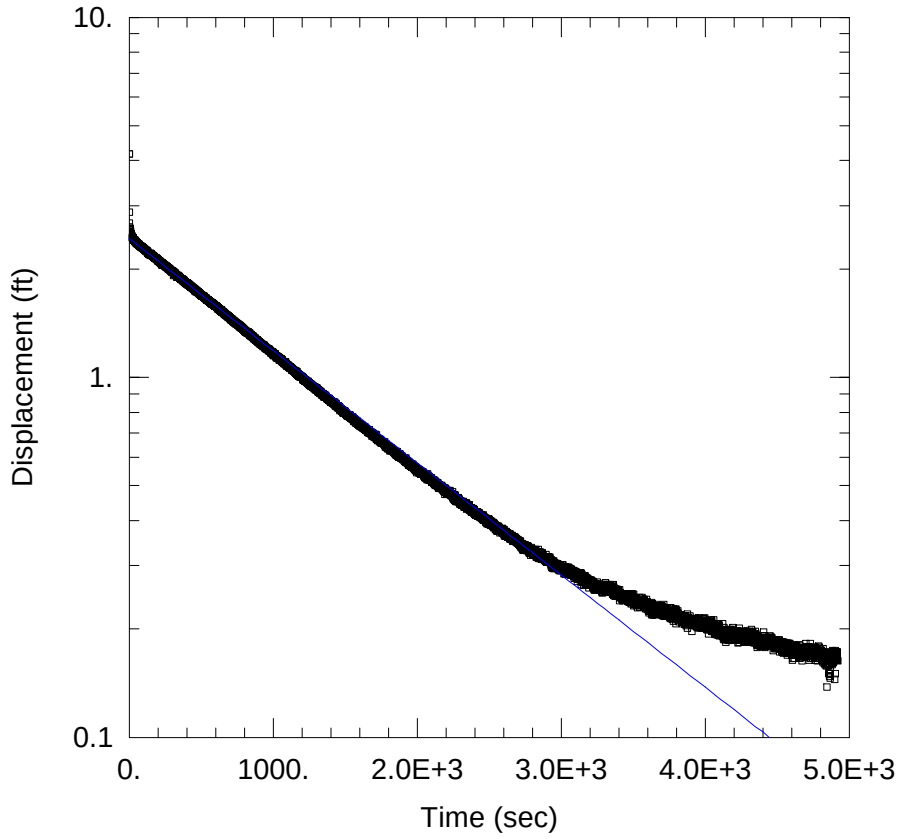
Saturated Thickness: 12. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW05A_IN1)

Initial Displacement: 4.294 ft
Total Well Penetration Depth: 17.14 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 17.14 ft
Screen Length: 10. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW05A_OUT1.aqt
Date: 06/07/18 Time: 12:19:02

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW05A
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.06778 ft/day
y0 = 2.431 ft

AQUIFER DATA

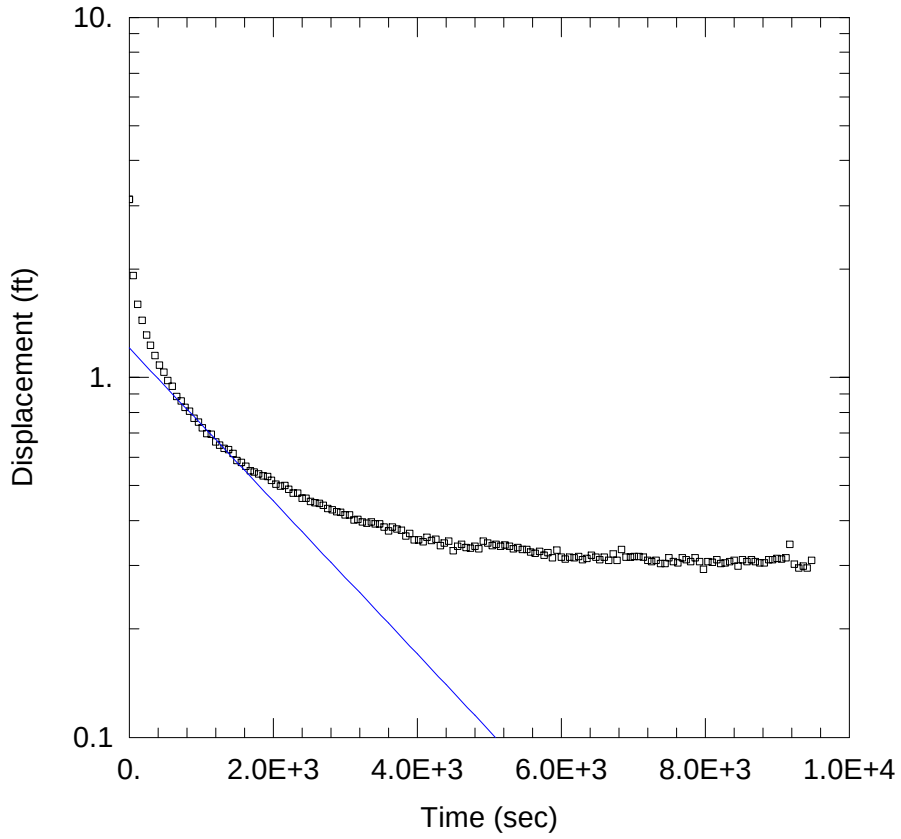
Saturated Thickness: 12. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW05A_OUT1)

Initial Displacement: 4.179 ft
Total Well Penetration Depth: 17.14 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 17.14 ft
Screen Length: 10. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW05B_IN1 - BM Revised_ES.aqt
Date: 06/07/18 Time: 12:19:28

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW05B
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.05112 ft/day
y0 = 1.208 ft

AQUIFER DATA

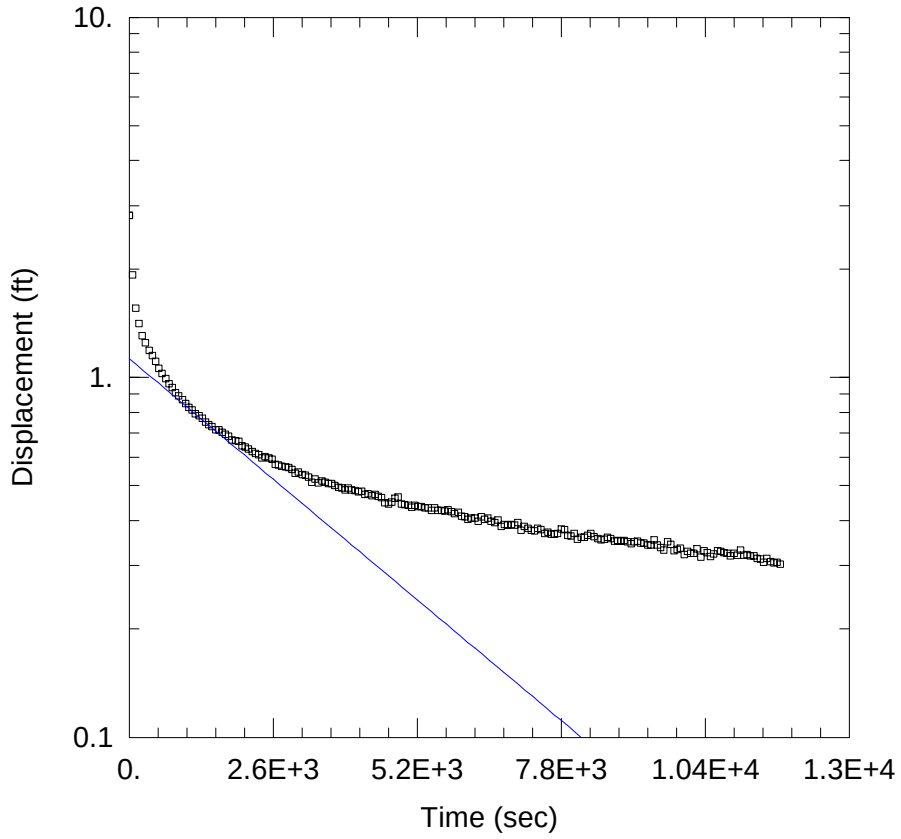
Saturated Thickness: 12. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW05B_IN1)

Initial Displacement: 3.125 ft
Total Well Penetration Depth: 30. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 30. ft
Screen Length: 10. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: \...\GRTS-MW05B_OUT1 - BM Revised_ES.aqt
Date: 06/07/18 Time: 12:19:41

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: GRTS-MW05B
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.03099 ft/day
y0 = 1.127 ft

AQUIFER DATA

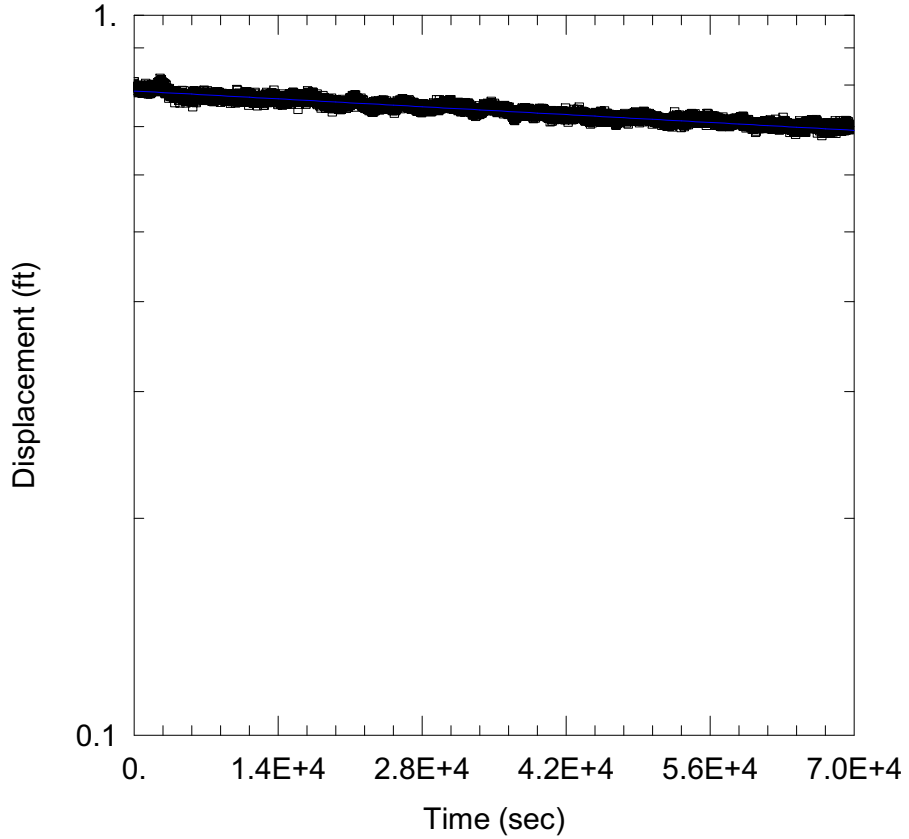
Saturated Thickness: 12. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GRTS-MW05B_OUT1)

Initial Displacement: 2.822 ft
Total Well Penetration Depth: 30. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 30. ft
Screen Length: 10. ft
Well Radius: 0.25 ft



WELL TEST ANALYSIS

Data Set: T:\...\ES-13_IN1 - BM Revised.aqt
Date: 07/05/18 Time: 10:47:27

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: ES-13
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

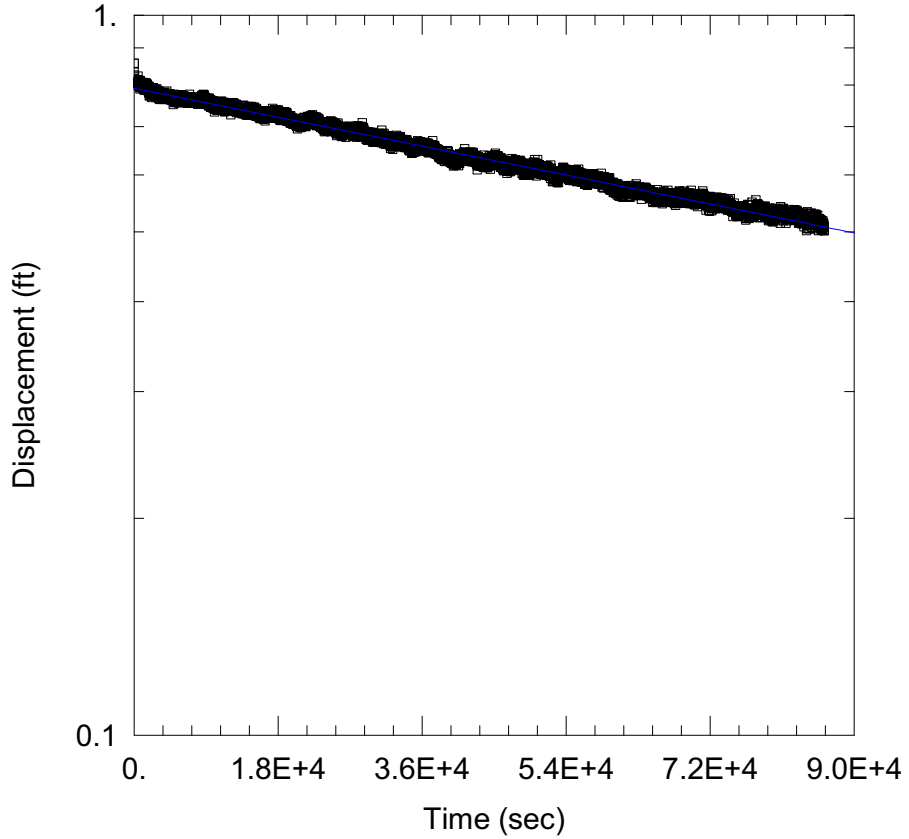
K = 0.000518 ft/day
y0 = 0.7845 ft

AQUIFER DATA

Saturated Thickness: 17. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (ES-13_IN1)

Initial Displacement: 0.808 ft
Total Well Penetration Depth: 46.38 ft
Casing Radius: 0.1667 ft
Static Water Column Height: 46.38 ft
Screen Length: 15. ft
Well Radius: 0.3333 ft



WELL TEST ANALYSIS

Data Set: T:\...\ES-13_OUT1 - BM Revised.aqt
Date: 07/05/18 Time: 10:48:32

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: ES-13
Test Date: 5/16/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00148 ft/day
y0 = 0.7913 ft

AQUIFER DATA

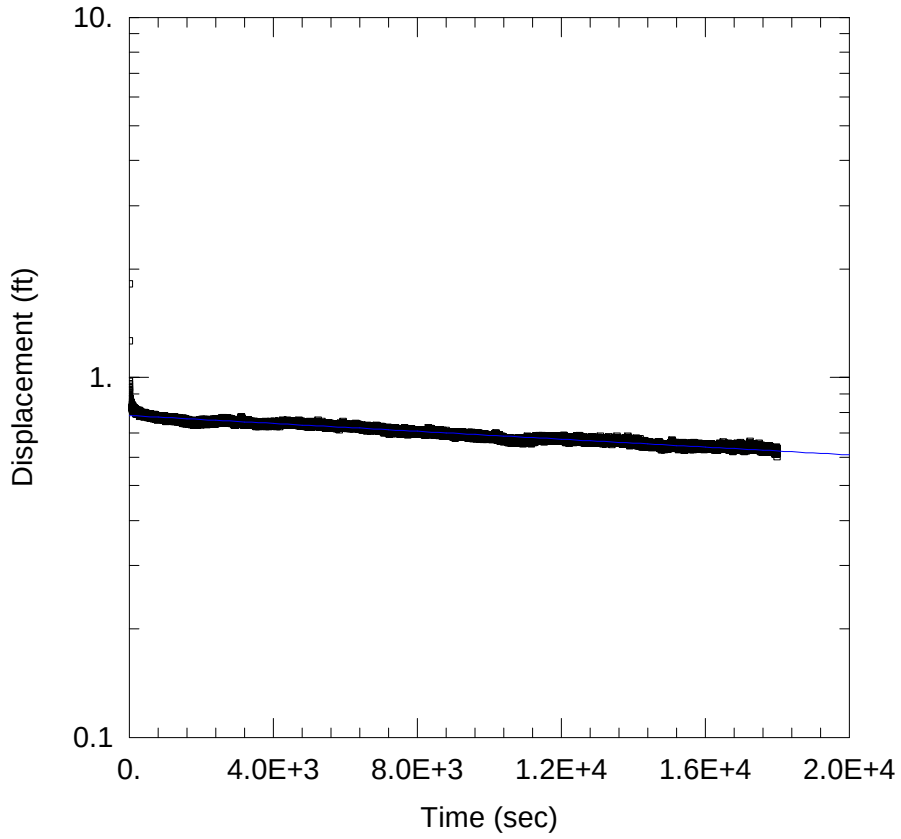
Saturated Thickness: 17. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (ES-13_OUT1)

Initial Displacement: 0.857 ft
Total Well Penetration Depth: 46.38 ft
Casing Radius: 0.1667 ft

Static Water Column Height: 46.38 ft
Screen Length: 15. ft
Well Radius: 0.3333 ft



WELL TEST ANALYSIS

Data Set: \...\MCF-06B_OUT1 - BM Revised.aqt
Date: 06/20/18 Time: 15:19:20

PROJECT INFORMATION

Company: Tetra Tech
Client: NERT
Project: 117-7502018-M17
Location: Henderson, NV
Test Well: MCF-06B
Test Date: 5/15/2018

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.002847 ft/day
y0 = 0.783 ft

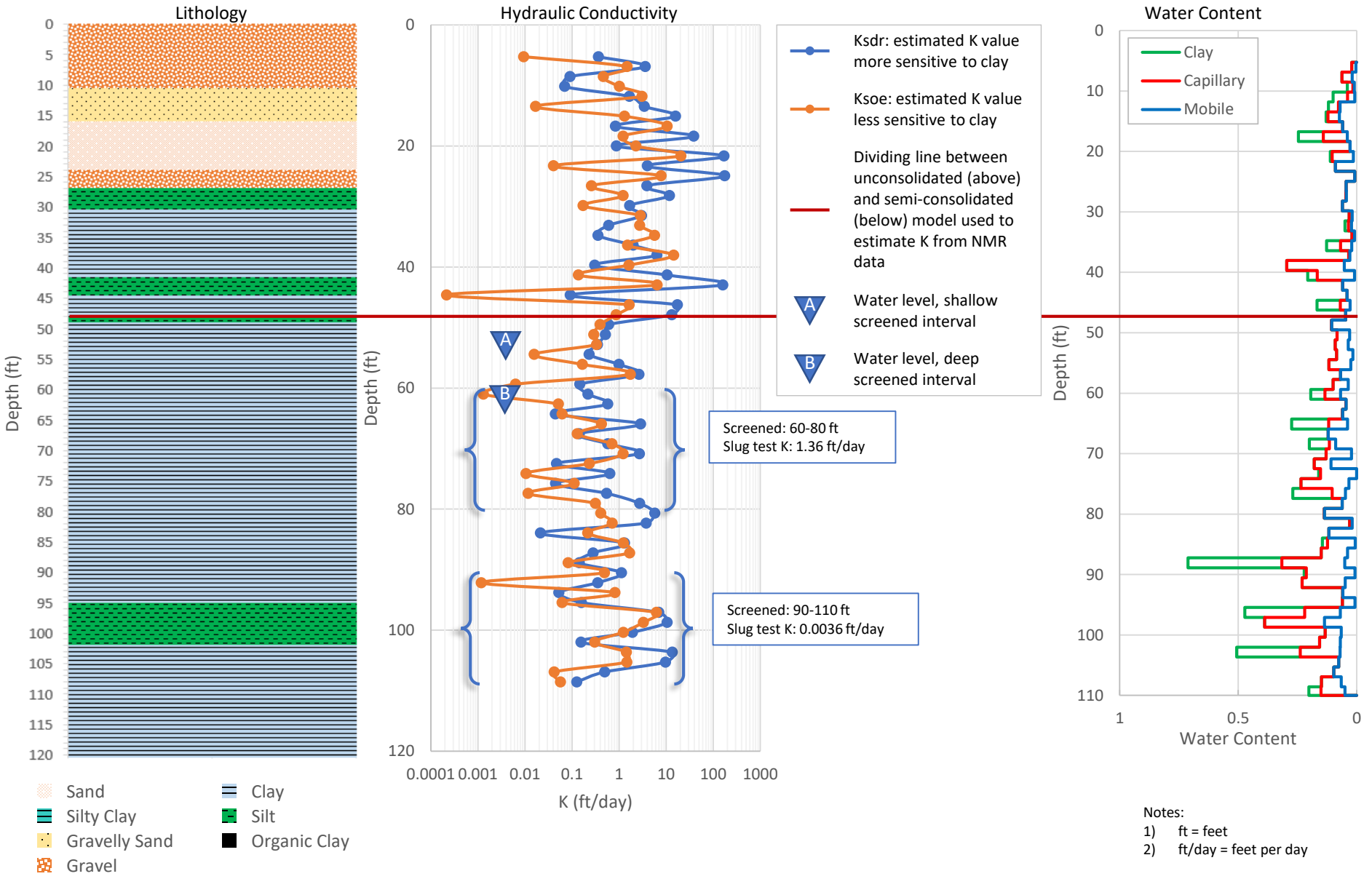
AQUIFER DATA

Saturated Thickness: 40. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MCF-06B_OUT1)

Initial Displacement: 0.975 ft
Total Well Penetration Depth: 26.99 ft
Casing Radius: 0.1667 ft
Static Water Column Height: 26.99 ft
Screen Length: 15. ft
Well Radius: 0.3333 ft

Appendix F
Nuclear Magnetic Resonance Logging Profiles



TETRA TECH
www.tetratech.com
150 S. 4th Street, Unit A
Henderson, Nevada 89015
Phone: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

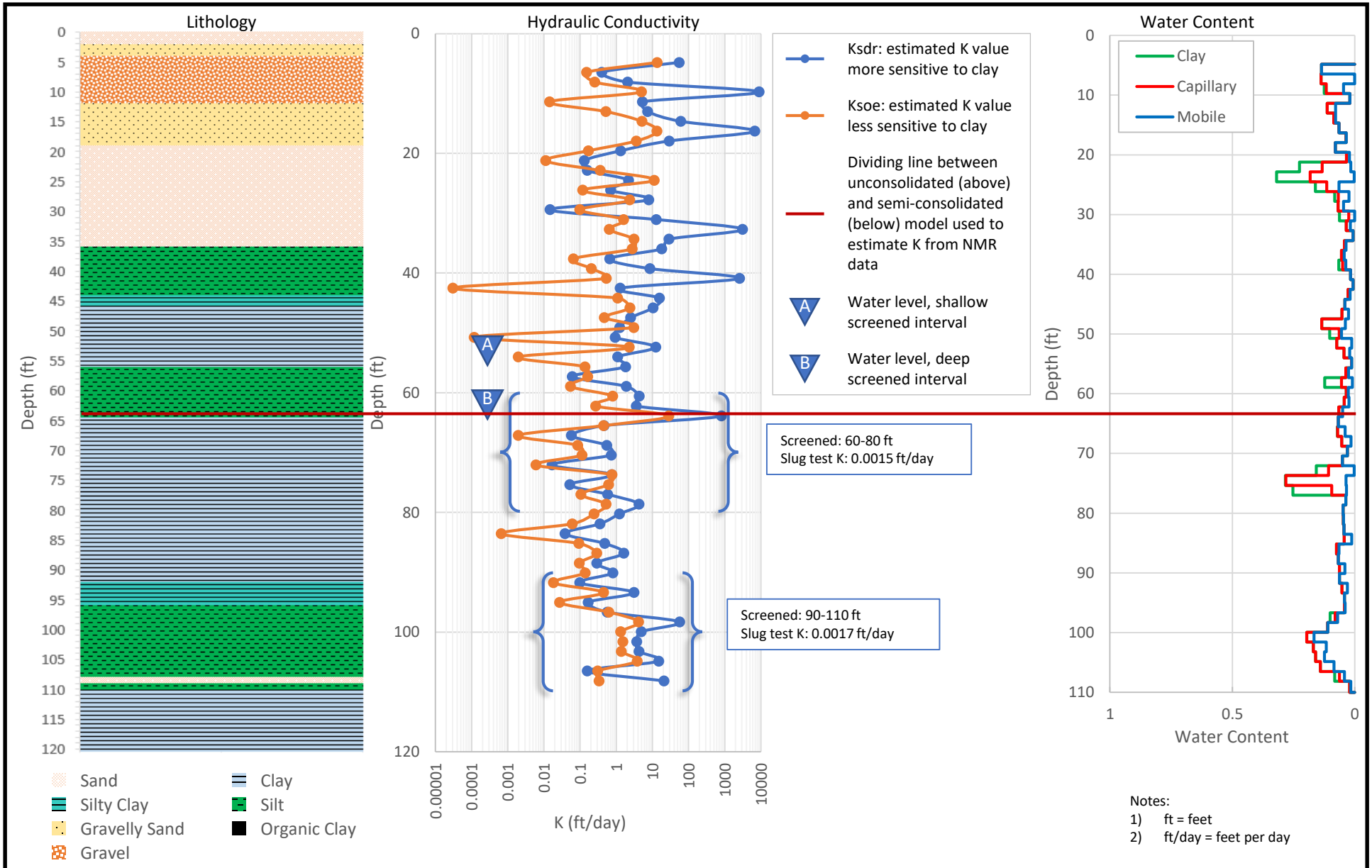
GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

SUMMARY OF NUCLEAR MAGNETIC RESONANCE LOGGING AND AQUIFER TEST RESULTS FOR GRTS-MW01A/B

Project No.:	117-7502018
Date:	JULY 9, 2018
Designed By:	ACC

Figure No.
F.1

\\tts134fs1\GEOSUP\VOL1\PROJECTS\NERTM17\NMR\NMR_Comparisons_8x11_v2.pptx



\\ths134fs1\GEOSUPVOL1\PROJECTS\NERT\M17\NMR\NMR_Comparisons_8x11_v2.pptx

TETRA TECH
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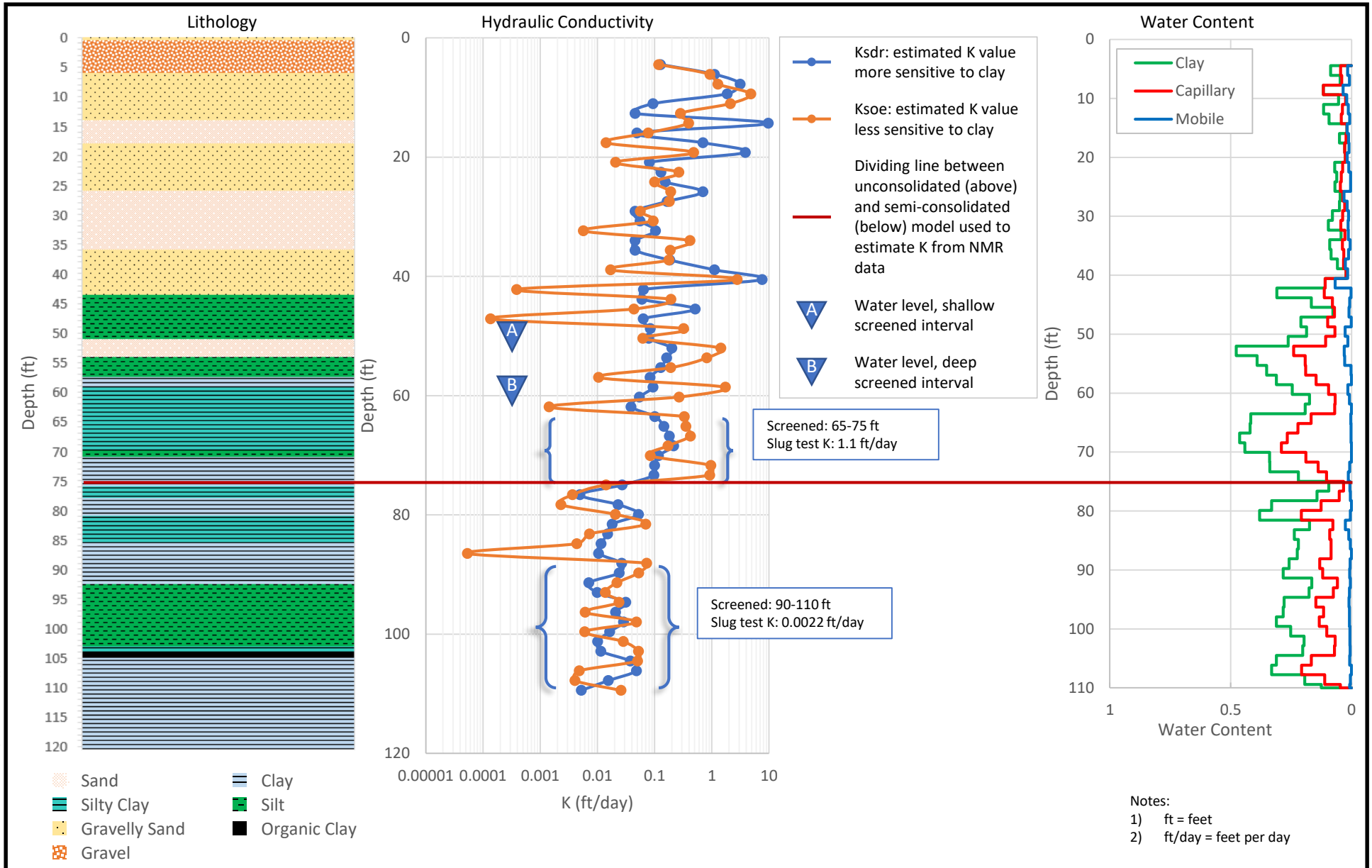
NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

SUMMARY OF NUCLEAR MAGNETIC RESONANCE LOGGING AND AQUIFER TEST RESULTS FOR GRTS-MW02A/B

Project No.:	117-7502018
Date:	JULY 9, 2018
Designed By:	ACC

Figure No.
F.2



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Phone: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

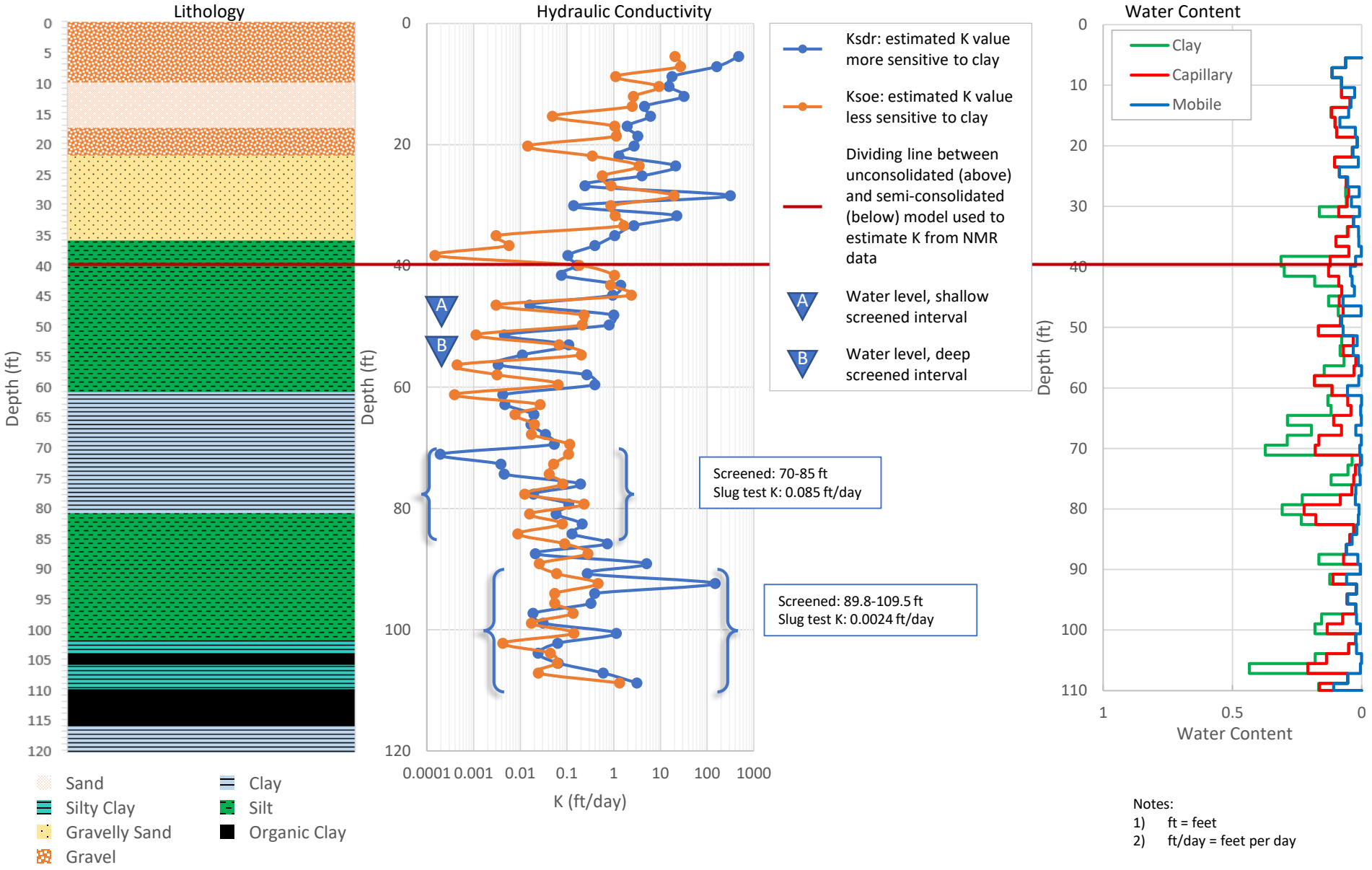
GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

SUMMARY OF NUCLEAR MAGNETIC RESONANCE LOGGING AND AQUIFER TEST RESULTS FOR GRTS-MW03A/B

Project No.:	117-7502018
Date:	JULY 9, 2018
Designed By:	ACC

Figure No.
F.3

\\ths134fs1\GEOSUPVOL1\PROJECTS\NERT\M17\NMR\NMR_Comparisons_8x11_v2.pptx



Notes:
1) ft = feet
2) ft/day = feet per day

TETRA TECH
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Phone: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

SUMMARY OF NUCLEAR MAGNETIC RESONANCE LOGGING AND AQUIFER TEST RESULTS FOR GRTS-MW04A/B

Project No.:	117-7502018
Date:	JULY 9, 2018
Designed By:	ACC

Figure No.
F.4

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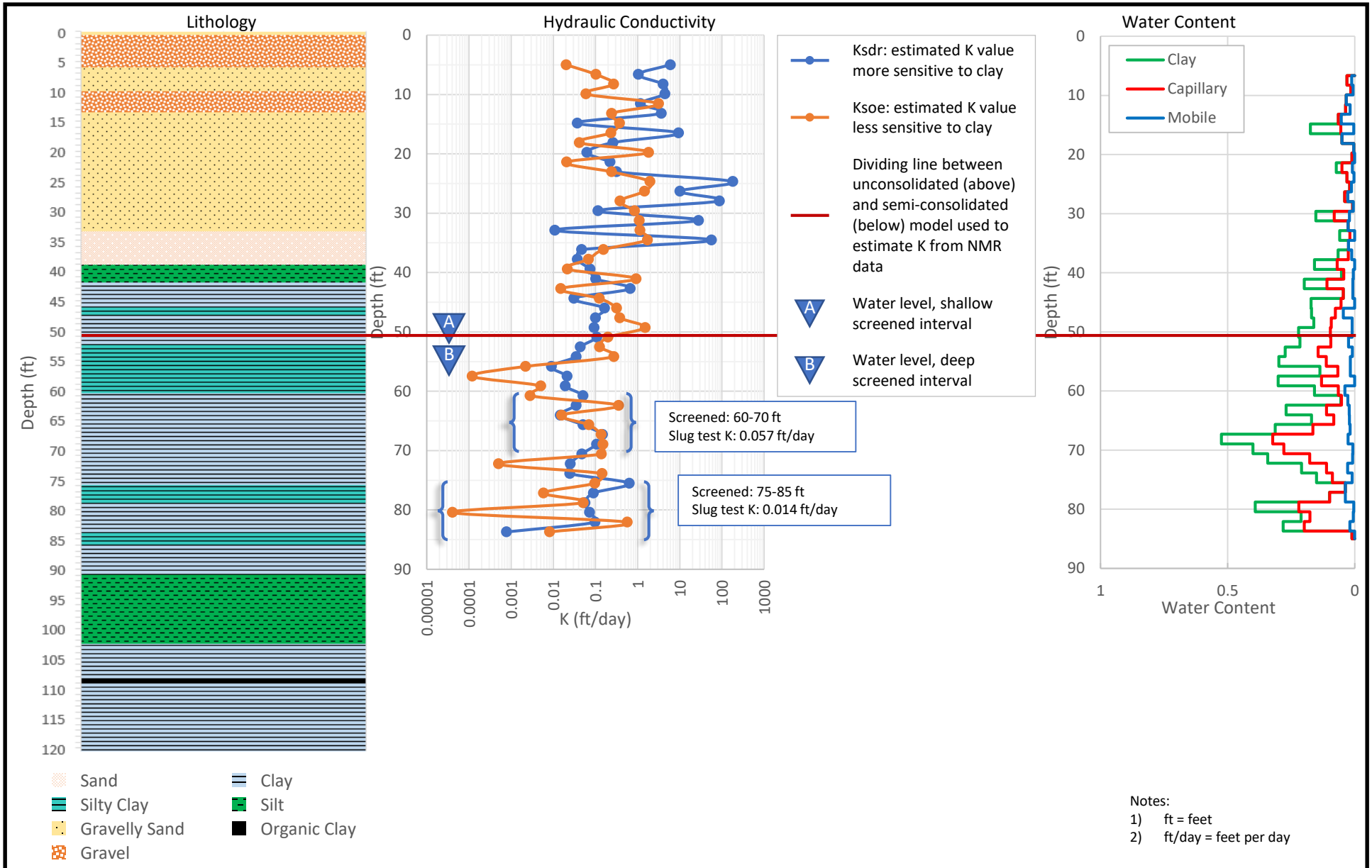

Notes:
1) ft = feet
2) ft/day = feet per day

TETRA TECH
www.tetratech.com
150 S. 4th Street, Unit A
Henderson, Nevada 89015
Phone: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

GALLERIA DRIVE BIOREMEDIATION TREATABILITY STUDY WORK PLAN ADDENDUM
HENDERSON, NEVADA

SUMMARY OF NUCLEAR MAGNETIC RESONANCE LOGGING AND AQUIFER TEST RESULTS FOR GRTS-MW05A/B

Project No.:	117-7502018
Date:	JULY 9, 2018
Designed By:	ACC

Figure No.
F.5

\\ths134fs1\GEOSUPVOL1\PROJECTS\NERT\M17\NMR\NMR_Comparisons_8x11_v2.pptx

Appendix G
Step-Rate Injection Test Report

REMEDIATION FIELD SERVICES REPORT

Galleria Drive Deep Injection Tests
Nevada Enviromental Response Trust (NERT) Site
Henderson, Nevada

Date:
September 21, 2018

Project Number:
310-18-1010

Prepared For:
Tetra-Tech Inc.
1093 Commerce Park Drive, Suite 100
Oak Ridge, Tennessee 37830

Prepared by:
Cascade Technical Services
1225 East McFadden Avenue
Santa Ana, California 92705
WWW.CASCADE-ENV.COM

CASCADE
DRILLING | TECHNICAL SERVICES

1225 East McFadden Avenue
Santa Ana, CA 92705
P 714-647-6290
WWW.CASCADE-ENV.COM

September 21, 2018
Project No. 310-18-1010

Ms. Dana Grady
Tetra-Tech Inc.
1093 Commerce Park Drive, Suite 100
Oak ridge, Tennessee 37830

Subject: Remediation Field Services Report
Step-Rate Test Injection
NERT Site
Seep Well Field
Henderson, Nevada

Dear Ms. Grady

In accordance with your request and authorization, Cascade Technical Services (Cascade) has performed remediation field services for the subject site. The field services were performed in general accordance with Cascade's proposal dated September 6, 2018.

Cascade appreciates the opportunity to provide our services to you. If you have any questions or comments regarding this report, please contact the undersigned at your convenience.

Respectfully submitted,
Cascade Technical Services

Justin Mulford
Remediation Specialist

Michael Gerber
Project Manager

Distribution: (1) Addressee (via e-mail)
JM

TABLE OF CONTENTS

Appendices

1 INTRODUCTION

Tetra-Tech Inc. (client), subcontracted Cascade Technical Services (Cascade) to perform remediation field services at the subject site located at the Seep Well Field in Henderson, Nevada. Field services were conducted in general accordance with Cascade's proposal dated September 6, 2018.

2 REMEDIATION APPROACH

A step rate injection test was performed on four existing monitoring wells located on site. The test included using potable hydrant water that was injected into the wells from a custom-built injection platform using a 3L6 Moyno progressive cavity pump through ¾ inch injection hose. The step-rate test was performed by increasing the pressure at which the water was being injected every twenty minutes in increments of 10 pounds per square inch (PSI) until maximum allowable formation pressure of 60 PSI was reached.

3 PROJECT ACTIVITIES

The following sections describe the field activities conducted at the site. The activities were conducted between September 17 and 19, 2018.

3.1 PRE-MOBILIZATION ACTIVITIES

Prior to mobilization, cascade performed multiple equipment performance and readiness tests on all its equipment intended for use on this site, this process included the calibration of all flow meters used on site. A site-specific health and safety plan was prepared to address worker and general public safety.

3.2 ONSITE ACTIVITIES

On September 17, 2018, Cascade mobilized a custom-built injection platform to the site. Prior to the commencement of field activities, a tailgate safety meeting was performed. The safety meeting was followed by a site walk to review the proposed injection points marked by the client. The injection platform was placed inside a containment berm located within an open field. Site control measures consisting of traffic cones and caution tape were implemented to delineate the work area. Spill kits and portable vacuums were placed within the work area for immediate deployment.

The scope of work performed by Cascade was a step-rate injection test performed at each of 4 existing on site monitoring wells. The 4 on site monitoring wells were screened at depths between 90 and 110 feet blow ground surface (bgs). Potable hydrant water was injected at each monitoring well to test pressure and flow rate. Pressures were increased by 10 PSI every twenty minutes until a maximum of 60 PSI was reached.

Remediation activities were successfully completed on September 19, 2018.

3.3 SITE RESTORATION

Investigation-derived waste was not generated during remediation activities at the site. Other waste (i.e. personal protective equipment, packaging materials, etc.) was collected in large trash bags and disposed as municipal solid waste.

4 LIMITATIONS

The implementation of the scope of work was performed in accordance with the clients design specification as described above (Section 2) and supporting injection logs (Appendix A). Cascade bears no responsibility for remediation results or impact to existing conditions.

APPENDIX A

Injection Summary and Logs

INJECTION FIELD LOG

PROJECT NUMBER/NAME: Tetra Tech - NERT Site - 310-18-1010

Well ID	Start Date	Start Time	End Date	End Time	Injection Interval			Initial Pressure (PSI)	Sustained Pressure (PSI)	Average Flow Rate (GPM)	% Solution Water (Gallons)	% Solution Injected (Gallons)	Total Injected (Gal)	Field Notes
GRTS-MW04B	9/18/2018	12:45 PM	9/18/2018	12:47 PM	90.0	to	110.0	1.1	2.5	7.5	15.0	15.0	15.0	Once well filled with water flow stopped.
	9/18/2018	12:47 PM	9/18/2018	12:57 PM	90.0	to	110.0	12.3	12.5	0.0	0.0	0.0	0.0	No Flow
	9/18/2018	12:57 PM	9/18/2018	1:07 PM	90.0	to	110.0	20.4	20.5	0.1	0.6	0.6	0.6	No Flow
	9/18/2018	1:07 PM	9/18/2018	1:17 PM	90.0	to	110.0	32.6	33.1	0.0	0.2	0.2	0.2	No Flow
	9/18/2018	1:17 PM	9/18/2018	1:27 PM	90.0	to	110.0	39.6	40.3	0.0	0.3	0.3	0.3	No Flow
	9/18/2018	1:27 PM	9/18/2018	1:37 PM	90.0	to	110.0	50.6	51.9	0.0	0.3	0.3	0.3	No Flow
	9/18/2018	1:37 PM	9/18/2018	1:57 PM	90.0	to	110.0	59.2	60.1	0.2	4.2	4.2	4.2	No Flow; Water settled at top of well when cap removed following injection attempt. 9/19 8:45 am. Water had returned to normal depth.
										TOTALS	**20.6**	**20.6**	**20.6**	
GRTS-MW03B	9/18/2018	2:09 PM	9/18/2018	2:12 PM	90.0	to	110.0	1.4	1.5	9.3	27.9	27.9	27.9	Once well filled with water flow stopped.. Bleed any vapor and increase pressure to 20. bleed valve 3 times-once flow drop to 0 third time moved on
	9/18/2018	2:12 PM	9/18/2018	2:22 PM	90.0	to	110.0	10.3	10.9	0.0	0.0	0.0	0.0	No Flow
	9/18/2018	2:22 PM	9/18/2018	2:32 PM	90.0	to	110.0	19.8	20.1	0.1	1.2	1.2	1.2	No Flow
	9/18/2018	2:32 PM	9/18/2018	2:42 PM	90.0	to	110.0	30.1	30.8	0.1	0.9	0.9	0.9	FIXED LEAK IN WELL HEAD; No Flow
	9/18/2018	2:48 PM	9/18/2018	3:08 PM	90.0	to	110.0	40.3	40.6	0.1	2.7	2.7	2.7	No Flow
	9/18/2018	3:08 PM	9/18/2018	3:28 PM	90.0	to	110.0	49.9	50.7	0.2	3.2	3.2	3.2	Inconsistant flow much of the volume came when PSI initially increased to 50.
	9/18/2018	3:28 PM	9/18/2018	3:42 PM	90.0	to	110.0	59.1	60.5	0.2	2.3	2.3	2.3	Could not keep slip cap on well as pressure rose. Water settled at top of well when cap removed following injection attempt. 9/19 8:45 water still had 21' to return to pre-injection depth.
										TOTALS	**38.2**	**38.2**	**38.2**	

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INJECTION FIELD LOG

PROJECT NUMBER/NAME: Tetra Tech - NERT Site - 310-18-1010

Well ID	Start Date	Start Time	End Date	End Time	Injection Interval			Initial Pressure (PSI)	Sustained Pressure (PSI)	Average Flow Rate (GPM)	% Solution Water (Gallons)	% Solution Injected (Gallons)	Total Injected (Gal)	Field Notes
GRTS-MW02B	9/19/2018	8:51 AM	9/19/2018	8:52 AM	90.0	to	110.0	0.6	0.6	15.2	15.2	15.2	15.2	Once well filled with water flow stopped.
	9/19/2018	8:52 AM	9/19/2018	9:12 AM	90.0	to	110.0	9.5	10.9	0.0	0.0	0.0	0.0	No Flow
	9/19/2018	9:12 AM	9/19/2018	9:32 AM	90.0	to	110.0	19.9	20.3	0.1	1.2	1.2	1.2	No Flow
	9/19/2018	9:32 AM	9/19/2018	9:52 AM	90.0	to	110.0	30.4	31.2	0.0	0.5	0.5	0.5	No Flow
	9/19/2018	9:52 AM	9/19/2018	10:12 AM	90.0	to	110.0	40.7	41.1	0.0	0.4	0.4	0.4	No Flow
	9/19/2018	10:12 AM	9/19/2018	10:32 AM	90.0	to	110.0	50	50.6	0.2	4.4	4.4	4.4	Inconsistant flow much of the volume came when PSI initially increased to 50.
	9/19/2018	10:32 AM	9/19/2018	10:52 AM	90.0	to	110.0	59.3	59.9	0.4	8.6	8.6	8.6	Consistant minimal flow. Water settled at top of well when cap removed following injection attempt. Showed minimal dicipation over next couple of hours.
										TOTALS	**30.3**	**30.3**	**30.3**	
GRTS-MW01B	9/19/2018	11:33 AM	9/19/2018	11:35 AM	90.0	to	110.0	1.8	2.2	1.2	14.2	14.2	14.2	Once well filled with water flow stopped.
	9/19/2018	11:35 AM	9/19/2018	11:55 AM	90.0	to	110.0	9.8	10.2	0.0	0.0	0.0	0.0	No Flow
	9/19/2018	11:55 AM	9/19/2018	12:15 PM	90.0	to	110.0	19.8	20.5	0.1	1.1	1.1	1.1	No Flow
	9/19/2018	12:15 PM	9/19/2018	12:35 PM	90.0	to	110.0	30.4	31.1	0.0	0.3	0.3	0.3	No Flow
	9/19/2018	12:35 PM	9/19/2018	12:55 PM	90.0	to	110.0	39.9	40.9	0.0	0.1	0.1	0.1	No Flow
	9/19/2018	12:55 PM	9/19/2018	1:15 PM	90.0	to	110.0	50.2	50.8	0.1	1.4	1.4	1.4	Inconsistant flow much of the volume came when PSI initially increased to 50.
	9/19/2018	1:15 PM	9/19/2018	1:35 PM	90.0	to	110.0	59.3	60.1	0.2	4.6	4.6	4.6	Consistant minimal flow. Water settled at top of well when cap removed following injection attempt
										TOTALS	**21.7**	**21.7**	**21.7**	

CASCADE
DRILLING | TECHNICAL SERVICES

APPENDIX B
Photographs

1. September 18, 2018 Pre-Injection Site Conditions

2. September 18, 2018 Pre-Injection Site Conditions

3. Site Setup and Layout

4. Site Setup and Layout

5. Site Setup and Layout

6. Site Setup and Layout

7. September 19, 2018 Post Injection and Demobilization Site Conditions

8. September 19, 2018 Post Injection and Demobilization Site Conditions