Hydrogen-Based Gas Permeable Membrane Pilot Test Results Report

Nevada Environmental Response Trust Site Henderson, Nevada

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Revision 2 – May 31, 2023

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LIST OF ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
APTwater	APTwater, LLC
AWF	Athens Road Well Field
COPC	contaminants of potential concern
DAF	dissolved air flotation
DVSR	Data Validation Summary Report
ETI	Envirogen Technologies, Inc.
EQ	equalization tank
FBR	fluidized bed reactors
FS	Feasibility Study
ft^3/day	cubic feet per day
ft^3/lb	cubic feet per pound
Gpm	gallons per minute
GWETS	groundwater extraction and treatment system
GWTP	groundwater treatment plant
H_2	hydrogen gas
HBGPM	Hydrogen-Based Gas Permeable Membrane
IX	ion exchange
IWF	Interceptor Well Field
lbs/day	pounds per day
LEL	Lower Explosive Limit
MBfR	membrane biofilm reactor
mg/L	milligrams per liter
µg/L	micrograms per liter
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
O&M	operations and maintenance
ORP	oxidation-reduction potential
PID	piping and instrumentation diagrams
PLC	programmable logic controller
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
sccm	standard cubic centimeter per minute

Acronyms/Abbreviations	Definition
SMR	steam/methane reforming
sqft	square feet
SWF	Seep Well Field
Tetra Tech	Tetra Tech, Inc.
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
Work Plan	Hydrogen-Based Gas Permeable Membrane Technology Pilot Test Work Plan

CERTIFICATION

Hydrogen-Based Gas Permeable Membrane Pilot Test Results Report

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

Nevada Environmental Response Trust (NERT) Representative Certification
I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the systems(s) or those directly responsible for gathering the information or preparing the document, or the immediate supervisor of such person(s), the information submitted and provided herein is, to the best of my knowledge and belief, true, accurate, and complete in all material respects.

Office of the Nevada Environmental Response Trust

Le Petomane XXVII, not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Signature: Jay A Steinberg Not Individually, but Solely as President of the Trustee, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Name: Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Title: Solely as President and not individually

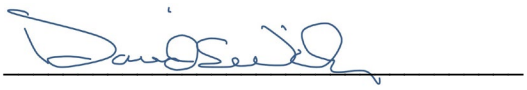
Company: Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Date: 5/30/23

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 Hydrogen-Based Gas Permeable Membrane Pilot Test Results Report.



May 31, 2023

David S. Wilson, CEM
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Date

Nevada CEM Certificate Number: 2385
Nevada CEM Expiration Date: September 19, 2024

1.0 INTRODUCTION

At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this Hydrogen-Based Gas Permeable Membrane (HBGPM) Pilot Test Results Report for the NERT site (Site) located in Clark County, Nevada. This report is being submitted to the Nevada Division of Environmental Protection (NDEP) under the Interim Consent Agreement effective February 14, 2011. This report presents a summary of the implementation, operations, and results of the HBGPM Pilot Test program (Pilot Test) for treatment of groundwater contaminated with perchlorate, chlorate, and hexavalent chromium at the Site. This Pilot Test was implemented based on the NDEP-approved *Hydrogen-Based Gas Permeable Membrane Technology Pilot Test Work Plan* (Work Plan) (Tetra Tech, 2019) and *Hydrogen-Based Gas Permeable Membrane Pilot Study System Operation Manual* (System Operation Manual) (Tetra Tech, 2020).

The HBGPM Pilot Test Results Report was initially submitted to NDEP on July 29, 2022 (Revision 0). NDEP comments on Revision 0 were received on November 16, 2022. The report was subsequently revised to address NDEP comments, with Revision 1 of the report submitted to NDEP on January 16, 2023. Additional NDEP comments were received on Revision 1 of the report on March 29, 2023. As a result, this report has been revised to address the March 2023 comments, with this May 31, 2023 version of the report referred to as Revision 2.

1.1 OBJECTIVES

The Trust is in the process of evaluating potentially applicable groundwater treatment technologies and remedial alternatives to include as part of the Feasibility Study (FS) to be completed under the Interim Consent Agreement. As of the date of this report, the NERT FS is not scheduled to begin until late 2022 or possibly later dependent upon the date and nature of comments NDEP provides NERT on the Remedial Investigation Report for Operational Unit-1 (OU-1) and OU-2 and the baseline health risk assessments for OU-1 and-OU2. Rather than default to the assumption that ex-situ groundwater remedial alternatives will rely solely on the Fluidized Bed Reactor (FBR) or Ion Exchange (IX) treatment technologies currently utilized by the Trust for treatment of groundwater as part of an ongoing removal action, the Trust desires to evaluate other technologies in the FS, such as the HBGPM system, that may be used in conjunction with FBR and/or IX, or as a stand-alone treatment option for specific discrete areas of the contaminant plume associated with the NERT site.

The primary objective of the Pilot Test was to determine if perchlorate present in extracted groundwater could be effectively treated with HBGPM technology, with treatment of hexavalent chromium as a potential secondary benefit. Specific objectives of the Pilot Test are described in detail in Section 3.1. Further evaluation of the HBGPM technology in comparison to other technologies will be addressed in the FS.

The Trust acknowledges NDEP's review comments on Revisions 0 and 1 of this report, which relate to potential optimizations of the pilot system and requests for additional full-scale design details and considerations of a hypothetical full-scale system. There are a great number of operational parameters that would be further refined and optimized using the results of this Pilot Test if this technology were to be deployed by NERT as a component of its final remedy. While this revision of the report includes details as requested by NDEP, the additional information should be considered in no way to be exhaustive, as the purpose of this report is to outline the results of the Pilot Test with a very specific set of objectives. If this technology is selected as part of the NERT final remedy, the full-scale system would be specifically designed with respect to a new set of objectives, parameters, and assumptions required to meet the remedial action objectives in the area in which NERT would be deploying the technology.

1.2 REPORT ORGANIZATION

This report is organized as follows:

- **Introduction (Section 1.0):** Provides the primary objectives of this Pilot Test and organization of this report.
- **Pilot Unit Overview (Section 2.0):** Provides an overview of the hydrogen-based gas permeable membrane technology.
- **Pilot Test Objectives and Testing Scenarios (Section 3.0):** Describes the overall Pilot Test objectives and each testing scenario.
- **Pilot Test Implementation (Section 4.0)**: Discusses the tasks completed during the pilot system installation, system start-up/shakedown, completion of test scenarios, and decommissioning.
- **System Performance and Results (Section 5.0)**: Provides an assessment of the system performance and test results.
- **Preliminary Design of Hypothetical Full-Scale System (Section 6.0):** Provides assumptions for a preliminary hypothetical full-scale system and the associated budgetary capital and operational costs.
- **Summary of Key Findings (Section 7.0):** Provides a summary of main findings from the Pilot Test.
- **References (Section 8.0):** Lists documents referenced in the preparation of this report.

2.0 PILOT TREATMENT SYSTEM OVERVIEW

This section provides descriptions of the HBGPM technology, pilot treatment system (including pilot unit containers, tanks, and piping), and general operations.

2.1 TECHNOLOGY DESCRIPTION

The HBGPM technology was developed by APTwater, LLC (APTwater), which is a privately held technology development company that offers systems utilizing oxidation or reduction processes for treatment of contaminated water. APTwater developed a patented process for the reduction of nitrate, perchlorate, chlorate, and other oxidized compounds using a proprietary hollow-fiber membrane biofilm reactor (MBfR). Perchlorate and nitrate can be reduced biologically to chloride ions and nitrogen gas, respectively, using either heterotrophic or autotrophic bacteria depending on the selected treatment process. As explained in Section 1.1, the HBGPM technology was evaluated to determine if there are advantages to using this treatment process compared to the currently used FBR treatment process. Each technology is described in more detail below. A technology comparison of HBGPM and IX has not been included in this report as the FBR is the primary treatment process used at the site.

Fluidized Bed Reactor Technology

The FBR treatment system currently operating at the NERT facility uses heterotrophic bacteria with ethanol (C_2H_5OH) as an electron donor for biological reduction of nitrate to nitrogen gas and reduction of chlorate and perchlorate to chloride ions. The chemical reaction mechanisms for the reduction processes and biomass generation in this system can be described approximately as follows:

$$ClO_4^- + 0.6\,H^+ + 0.6\,NO_3^- + 2.077\,C_2H_5OH \rightarrow Cl^- + 0.6\,C_5H_7O_2N + 1.15\,CO_2 + 4.43\,H_2O$$

$$ClO_3^- + 0.45\,H^+ + 0.45\,NO_3^- + 1.55\,C_2H_5OH \rightarrow Cl^- + 0.45\,C_5H_7O_2N + 0.85\,CO_2 + 3.3\,H_2O$$

$$NO_3^- + H^+ + 0.707\,C_2H_5OH \rightarrow 0.152\,C_5H_7O_2N + 0.424\,N_2 + 0.656\,CO_2 + 2.09\,H_2O$$

The above equations indicate that theoretically 0.96 grams of ethanol (C_2H_5OH) would reduce 1 gram of perchlorate (ClO_4^-) to chloride ion (Cl^-), that 0.85 grams of ethanol would reduce one gram of chlorate (ClO_3^-) to chloride ion (Cl^-), and that 2.32 grams of ethanol would reduce 1 gram of nitrate (NO_3^-) to nitrogen gas (N_2). The theoretical quantity of ethanol listed is not only for reduction of contaminants but also includes the ethanol requirement for biomass ($C_5H_7O_2N$) generation.

Hydrogen-Based Gas Permeable Membrane Technology

In the MBfR provided by APTwater, autotrophic microorganisms use hydrogen gas (H_2) as the electron donor to reduce nitrate to nitrogen gas and perchlorate and chlorate to chloride ions, and a range of other oxidized contaminants. The chemical reaction mechanisms for these reduction processes and biomass generation in this system can be described approximately as follows:

$$ClO_4^- + 5.5\,H_2 + 0.53\,CO_2 + 0.11\,NO_3^- + 0.11\,H^+ \rightarrow 0.11\,C_5H_7O_2N + 5.17\,H_2O + Cl^-$$

$$ClO_3^- + 4.1\,H_2 + 0.396\,CO_2 + 0.079\,NO_3^- + 0.094\,H^+ \rightarrow 0.0792\,C_5H_7O_2N + 3.87\,H_2O + Cl^-$$

$$0.35\,NO_3^- + H_2 + 0.33\,H^+ + 0.05\,CO_2 \rightarrow 0.01\,C_5H_7O_2N + 0.17\,N_2 + 1.13\,H_2O$$

The above equations indicate that theoretically 0.11 grams of hydrogen (H_2) would reduce 1 gram of perchlorate (ClO_4^-) to chloride ion (Cl^-), that 0.098 grams of hydrogen (H_2) would reduce 1 gram of chlorate (ClO_3^-) to chloride ion (Cl^-), and that 0.4 grams of hydrogen (H_2) would reduce 1 gram of nitrate (NO_3^-) to nitrogen gas (N_2). The theoretical quantity of hydrogen listed is not only for reduction of contaminants but also includes the hydrogen requirement for biomass ($C_5H_7O_2N$) generation. This indicates that theoretically less hydrogen is needed than ethanol for the same contaminant reduction.

Another potential advantage of using hydrogen as the electron donor versus carbon-based electron donor is that the amount of excess biomass generated is theoretically less than that generated when an organic compound (such as ethanol) is used as the electron donor. A system using hydrogen as the electron donor would theoretically generate less waste biomass (potentially reduced by more than 80 percent based on the formulas presented herein) compared to a system using ethanol.

Until recently, the use of hydrogen gas as an electron donor for microbial reductions was logistically impractical due to storage and safety. Today, hydrogen generators and gas control with membrane technology have advanced such that hydrogen gas delivery is not the hurdle it was previously. Hydrogen can be generated in real time and fed directly to the bioreactor, so the storage of bulk quantities of hydrogen gas is no longer needed. Hydrogen generation technologies are rapidly evolving and the most appropriate means of obtaining the hydrogen at the site and relative economic implications for a full-scale system will be evaluated in the FS or remedial design, as appropriate.

In the MBfR, pressurized hydrogen gas diffuses through the walls of the dense polypropylene hollow-fiber membrane. The hydrogen electron donor meets the contaminant electron acceptor as soon as it diffuses out of the wall, which results in a biofilm that naturally grows on the outside walls of the membrane fibers as shown on Figure 1. In theory, this approach could be more stable since the electron donor is delivered directly to the biofilm compared to FBR systems that use sand or activated carbon as media for biomass growth when appropriately scaled. With regards to distribution, there also may be less distribution delays or issues since the biofilm grows on the hollow fibers compared to an FBR system that injects the electron donor into the pump recycle in an effort to evenly distribute the donor throughout the entire bed.

The APTwater technology bundles hollow fibers together to create the high surface area required for commercial applications. The bundles are incorporated into reactors that allow separation of the gas and liquid phases. In addition to reducing perchlorate and chlorate, the HBGPM technology theoretically can reduce hexavalent chromium (Cr^{+6}) to trivalent chromium (Cr^{+3}) due to the reduction potential of Cr(VI) (Rittman, B., McCarty, P., 2001). As discussed in Section 3.1, evaluating the effectiveness of the membrane technology in reducing hexavalent chromium to trivalent chromium in the bioreactors was a secondary objective of the Pilot Test.

APTwater has demonstrated the effectiveness of this technology for perchlorate, nitrate, and chromium removal in several applications including the following:

- A pilot unit was used in Rancho Cordova, California, to treat 3 gallons per minute (gpm) water containing 14 milligrams per liter(mg/L)) perchlorate. The perchlorate was reduced to less than 4 micrograms per liter (µg/L).
- A pilot unit was used in Rialto, California, to treat 14 gpm water contaminated with nitrate and perchlorate. The initial concentration of perchlorate was 200 µg/L, which was then reduced to less than 10 µg/L.
- A pilot unit was tested in Burbank, California, to treat 3 gpm water contaminated with chromium and nitrate. Influent nitrate and hexavalent chromium concentrations were up to 9 mg/L and 6 mg/L, respectively, and effluent concentrations were reduced to less than 0.3 mg/L and 1µg/L, respectively.
- A commercial unit was designed and used in Rancho Cucamonga, California, to treat 130 gpm water containing nitrate. This unit was the first commercial unit for which APTwater received regulatory approval for treating drinking water in California.

- A 150-gpm commercial unit in La Crescenta, California was designed and installed for the La Crescenta Valley Water District. The system began operation in third quarter 2018 and is still in operation. The system treats water containing an average influent concentration of 9.7 mg/L nitrate nitrogen to a treated effluent concentration is 2.1 mg/L nitrate nitrogen, which is the targeted control limit for treatment.
- A pilot unit ran at the Ojai Valley Sanitary District to treat 20 gpm of nitrate at a concentration of 4 to18 mg/L to below 0.5 mg/L.

It should be noted that although minimal biomass and wastes were generated during the applications listed above, biomass quantification was not completed. The biomass and cleaning waste was deemed nonhazardous and was sent to the sewer for these applications.

The application of the HBGPM technology to the NERT site is more complex than previous applications listed above due to the significantly higher concentrations of nitrate, chlorate, perchlorate, and chromium as well as the presence of elevated sulfate concentrations that can interfere in the reductive process. Additionally, the above listed applications have lower flow rates than those that may be evaluated for a full-scale application at the NERT site. However, biological treatment systems are readily scalable, and larger treatment reactors may be designed to achieve the desired flow rate.

2.2 PILOT TREATMENT SYSTEM DESCRIPTION

As part of the Pilot Treatment System installed at NERT, a new pilot unit was designed and constructed by APTwater for use during the Pilot Test at the NERT site. Figures 2A and 2B present the process flow diagram for the Pilot Treatment System. Figures 3 and 4 show the layout of the pilot unit treatment and post-treatment containers, respectively. The piping and instrumentation diagrams (PIDs) for the Pilot Treatment System are included in Appendix A.

The pilot unit consisted of two 20-foot-long shipping/storage containers. The first container was called the treatment container and the second was called the post-treatment container.

The treatment container housed the following unit operations:

- Three tanks (i.e., reactors), with each tank containing two modules containing APTwater's patented MBfR and a recirculation pump to mix and homogenize the tank contents;
- A 12-inch (diameter) by 84-inch (high) cylindrical post-reactor tank;
- A hydrogen generator, including gas monitor and shut-down alarms;
- Two carbon dioxide cylinders (staged outside the container) and associated delivery system;
- A phosphate (nutrient) storage and delivery system;
- An in-line nitrate sampling and analysis system;
- A nitrogen generation, storage, and sparge system;
- Programable logic controller (PLC)-based process controls;
- Data logger;
- A remote monitoring and control system; and
- Safety alarms and system shutdown controls.

The post-treatment container contained the following unit operations:

- A surge tank that received mixed liquor (treated water and biological solids) leaving the biological reactors;
- A coagulant addition system to reduce hexavalent chromium to trivalent chromium, if necessary;
- A polymer addition system to flocculate biological solids and trivalent chromium solids;

- A lamella clarifier to settle the excess biological solids and trivalent chromium from the treated water;
- A treated water holding tank to store filtrate leaving the clarifier;
- A solids holding tank to store settled solids leaving the clarifier; and
- A cartridge filter to remove residual solids leaving the clarifier from the treated water holding tank.

Exterior to the pilot unit, additional components of the Pilot Treatment System included two influent tanks, the cleaning water holding tank, discharge piping to the GW-11 Pond, and ancillary pumps and piping. The treatment container, two influent tanks, and the holding tank were installed within secondary containment constructed of a concrete F-rail system (i.e., precast concrete highway barriers) and 30-millimeter polyvinyl chloride (PVC) liner.

2.3 GENERAL OPERATIONS

The pilot unit used for the Pilot Test contained three reactors. In general, the first reactor removed oxygen and reduced nitrate to nitrogen gas. Some chlorate and perchlorate were also reduced in the first reactor. Nitrate must be reduced before a substantial amount of chlorate or perchlorate can be reduced. In the second reactor, the majority of chlorate and perchlorate was reduced to chloride ions. The third reactor provided additional treatment capacity to reduce residual perchlorate. The water from the third reactor then entered a post-reactor tank, which was included as a polishing step, if needed.

Water flow through the pilot treatment system was controlled by a flow control valve on the inlet water line, with the desired flow rate set as a manual input to the PLC. Raw feed water was transferred to the two 20,000-gallon influent tanks. Water from the influent tanks was then pumped to the first reactor, which overflowed to the subsequent reactors. Each reactor included an independent flow-controlled recirculation system.

A hydrogen generator was used to generate hydrogen safely and effectively for the treatment process. Hydrogen was continuously metered into the hollow fibers in each reactor which diffused radially outward through the hollow fibers and into the biofilm that develops on the hollow fiber's exterior surface. The biofilm consumed the hydrogen as food using oxygen, dissolved perchlorate, chlorate, and nitrate for respiration.

The hydrogen flow to each reactor was controlled by the PLC, with the hydrogen flow set point adjusted manually based on the system data and perchlorate concentrations reported from the analytical laboratory. Hydrogen production was adjusted automatically by maintaining a back pressure on the hydrogen supply produced by the hydrogen generator system. Hydrogen was handled safely by pairing the rate of generation with the rate of consumption in the bioreactor and by venting and monitoring the areas where hydrogen was generated and used. The amount of hydrogen used during operations was in excess of the theoretical amount of hydrogen required as the purpose of the Pilot Test was to demonstrate, not optimize, the technology. While the study achieved its objectives, it is unknown what efficiencies could be achieved in future iterations of the technology If this technology were to be deployed by NERT as a component of its final remedy, there are a great number of operational parameters that would be further refined and optimized using the results of this Pilot Test.

A continuous, on-line process analyzer monitored pH, and carbon dioxide was added to control the pH around a set point as the hydrogen and contaminants in solution were consumed.

Biofilm growth is normal in any biological treatment system. Compressed nitrogen was periodically sparged into the reactor to create a mixed-phase flow through the reactor with the intent of removing the excess biomass and maintaining acceptable operating pressure conditions.

The treated water leaving the post-reactor tank was discharged into a surge tank in the post- treatment container. The post-treatment container consisted of coagulant and polymer addition systems, a lamella clarifier, and a solids holding tank. However, due to the small amount of biomass that was generated, the treated water generally bypassed the clarifier and flowed from the surge tank to the treated water tank in the post-treatment container (as further discussed in Section 5.1.1.1). Treated water was then discharged to the GW-11 pond.

3.0 PILOT TEST OBJECTIVES AND TESTING SCENARIOS

This section summarizes the detailed Pilot Test objectives and various test scenarios that were conducted during the pilot test.

3.1 PILOT TEST OBJECTIVES

The main objectives of the Pilot Test were to:

1. Demonstrate the ability of the APTwater HBGPM technology to reduce perchlorate at high concentrations (i.e., levels equal to groundwater currently extracted from the NERT Interceptor Well Field) to less than 18 μg/L, the current perchlorate discharge limit for the FBR system (treatment goal) and evaluate its ability to achieve even lower concentrations.
2. Demonstrate that using hydrogen gas as the electron donor instead of ethanol generates less excess biomass.
3. Demonstrate stable and sustainable treatment system operation and performance, including evaluation of the safety and effectiveness of the on-site hydrogen generator.

Per the System Operation Manual, if the above objectives were met, a set of assumptions for a preliminary scaled-up system will be defined to evaluate the following objectives:

1. Demonstrate that the cost of hydrogen used as an electron donor is less than the cost of ethanol.
2. Develop strategies for scaling up the treatment process under field conditions at NERT.
3. Evaluate the staffing and the operations and maintenance (O&M) needs for a full-scale system.
4. Develop the following key design and operational parameters for sizing and costing a full-scale treatment system:
    - Collect and analyze data on consumption rates (including hydrogen, nitrogen, and carbon dioxide).
    - Determine the degree of perchlorate reduction in different reactors of the pilot unit.
    - Establish individual reactor performance in terms of flux defined as pounds of total contaminants removed per square feet of membrane surface area. These data would be used to design a large-scale treatment system.
    - Establish the sparge frequency necessary to maintain stable pressure drop control and the potential for decreased treatment efficiency in the event of frequent sparging.
    - Quantify the biomass generation and establish the filtration or clarification requirements for biomass removal; and
    - Quantify the budgetary capital and operational cost estimates for the APTwater system for use in the FS.

In addition to the objectives listed above, the Pilot Test was also intended to evaluate a potential secondary benefit of hexavalent chromium reduction using the HBGPM technology. Specifically, the test evaluated if hexavalent chromium in groundwater could be reduced to trivalent chromium in the biological reactors, and if the trivalent chromium could be effectively removed from the treated groundwater using flocculation and clarification (or filtration) downstream of the reactors.

3.2 PILOT TESTING SCENARIOS

Contaminants of potential concern (COPCs) in groundwater at the site include perchlorate, chlorate, and hexavalent chromium. This Pilot Test evaluated the technology's effectiveness on reducing perchlorate, chlorate, and hexavalent chromium, under a variety of conditions. Consistent with the Work Plan, the following three testing scenarios were evaluated:

1. Test Scenario #1: Existing FBR Influent: This scenario tested the treatment of extracted groundwater representative of the existing FBR groundwater influent stream with elevated concentrations of both perchlorate and chlorate. Specifically, extracted groundwater treated in Test Scenario #1 was obtained from one of the FBR equalization tanks that receives water from the Athens Road Well Field (AWF), the Interceptor Well Field (IWF) after chromium removal by the groundwater treatment plant (GWTP), and the portion of the Seep Well Field (SWF) that is not currently treated by the IX system.
2. Test Scenario #2: Blend of AWF and IWF after Chromium Removal: This scenario was based on a potential future site condition where the groundwater in the vicinity of the SWF is treated using an in-situ treatment approach along the Las Vegas Wash or is extracted and treated through IX and the SWF no longer provides water to the FBRs for treatment. As a result, extracted groundwater tested under this scenario was a blend from the AWF and IWF after chromium pre-treatment via the GWTP in the same proportions currently generated (approximately 90% and 10%, respectively). This scenario excluded extracted groundwater from the SWF, which typically has high flow and lower perchlorate and chlorate concentrations compared to the AWF and IWF. Therefore, Test Scenario #2 evaluated groundwater containing higher perchlorate and chlorate concentrations compared to Test Scenario #1.
3. Test Scenario #3: Blend of AWF and IWF without Chromium Removal: This test scenario was intended to evaluate the HBGPM treatment system's ability to effectively treat extracted groundwater for perchlorate, chlorate, and hexavalent chromium removal simultaneously without pretreating the extracted groundwater in the GWTP to remove the hexavalent chromium first. The source of the extracted groundwater evaluated in Test Scenario #3 was identical to Test Scenario #2 (i.e., a blend from the AWF and the IWF), except the extracted groundwater from the IWF was not pretreated for chromium removal.

Pilot Test operations for each of the three test scenarios were planned for 12-week durations. Each test scenario consisted of two phases: a start-up phase (acclimation) and an operational phase (steady-state). Each of these phases is described below.

- ***Start-up Phase***: The start-up phase consisted of both acclimation and initial operation of the system to confirm operation of process equipment and establish preliminary operating parameters. The Work Plan defined steady-state conditions as the time at which the concentrations of COPCs in the system effluent (treated groundwater) stabilized and did not generally fluctuate by more than 10 percent. Two to four weeks were originally allocated within each 3-month test scenario for the start-up phase to allow for system acclimatation and achievement of steady state conditions. However, during Test Scenario #1B and Test Scenario #3, the acclimation period to achieve steady state took six to seven weeks, likely due in part to influent water temperatures variations as discussed in Section 5.
- ***Operational Phase:*** After the system reached steady state, the operational phase began. This phase included the collection of performance samples for a minimum of 4 weeks to evaluate the system's ability to reduce COPCs in groundwater. Per the Work Plan, this operational period included using the last 4 weeks of each scenario to either evaluate the effect of various operational parameters on the stability of the system or to recover the system from shock loadings and/or repairs/maintenance. Slight variations to the operational phase occurred during each scenario as follows:
    - Test Scenario #1 was extended after the pressure in the reactors rose to levels that required the system to be shut down to clean the membranes. As a result, Test Scenario #1 was divided into two scenarios, with the original test referred to as Test Scenario #1A and the extension referred

to as Test Scenario #1B. At the request of NDEP, the system was reacclimated and steady state reestablished so that the testing could continue as Test Scenario #1B.

- Additional testing on variation of operational parameters was only completed during Test Scenario #2.
- System acclimation during Test Scenario #3 took longer than expected, possibly due to higher influent water temperature, which adversely impacted COPC reduction rates.

4.0 PILOT TEST IMPLEMENTATION

The on-site Pilot Test installation began on July 7, 2020. Following completion of the pilot unit installation and system start-up operations, Pilot Test operations began on August 30, 2020 and continued for approximately 12 months, with an operational end date of August 9, 2021. Following shut down, the system was decommissioned and removed from the NERT property. This section provides an overview of the implementation, general operations, and decommissioning activities conducted as part of the Pilot Test.

4.1 PILOT TREATMENT SYSTEM INSTALLATION AND START-UP

The Pilot Treatment System was installed in an area located south of the GW-11 Pond, east of the former AP-5 process tanks, west of the FBR system, and north of the existing road as shown on Figure 5. This area was selected due to the relatively flat topography and proximity to the GW-11 Pond and nearby power source.

Site preparation activities included design and construction of required infrastructure and improvements necessary for safe installation and operation of the pilot equipment. Specifically, the pilot testing program required installation of the following equipment:

- Electrical power to operate the Pilot Treatment System;
- Two temporary 20,000-gallon frac tanks for extracted groundwater storage and one temporary 3,000-gallon holding tank, originally intended for solids recovered from the clarifier but later used to store spent cleaning solution; and
- Secondary containment constructed of a concrete F-rail system (i.e., precast concrete highway barriers) and 30-millimeter PVC liners for the pilot unit and temporary tanks.

Once the pilot unit system was built and the appropriate site infrastructure was in place, the treatment and post-treatment containers housing the pilot unit (described in Section 2.2) were shipped to the NERT property for installation.

System start-up procedures included testing all piping and connections (water, air, carbon dioxide, nitrogen, and hydrogen gas lines) to ensure there were no leaks, all electrical connections, pumps to ensure proper operation, and the PLC to ensure all systems were operating appropriately. Extracted groundwater for Test Scenario #1 was then added to the system to begin establishing biological growth and acclimation. Biomass from the existing FBR unit was used as seed sludge for the system to expedite the start-up process. During start-up, frequent samples of raw (system influent) and treated groundwater (system effluent) were collected and analyzed to determine the influent and effluent contaminant concentrations.

The installation and start-up process lasted approximately 2 months to ensure all systems were operable, confirm all controls were in place, and train a part-time operator for basic trouble-shooting and daily sampling tasks. Technical staff from APTwater were available, as necessary, to assist with pilot system installation and start-up.

4.2 GENERAL PILOT TEST OPERATIONS

Following completion of the Pilot Treatment System installation and system start-up, Pilot Test operations began on August 30, 2020. In general, the HBGPM treatment system was operated as described in Section 2.3 and as presented on Figures 2A and B through 4. Additionally, during each scenario, operational parameters such as hydrogen flow, sparging duration/frequency, air flow, nutrient dosing, and reactor sequencing were adjusted as needed to maintain or improve system performance. These system adjustments were made in response to sample results. Additional details on the operation of each scenario are presented with the Pilot Test results in Section 5.1.

In addition to general system operations, other activities, including routine inspections and maintenance (as required), collection and storage of extracted groundwater, and operational and performance sampling were conducted during the Pilot Test. This section provides an overview of those activities.

4.2.1 Inspection and Maintenance

Daily inspections of the equipment in the treatment container and the post-treatment container included the following:

- Checking water level in influent feed tanks to ensure adequate quantity of influent water exists in the tank for proper operation;
- Checking quantity of phosphoric acid and mixing up new batches as necessary;
- Inspecting online analytical instruments, sensors and transmitters, including nitrate analyzers, pH sensors, oxidation-reduction potential (ORP) sensors, level sensors, and temperature transmitters, to ensure that values were consistent with previously measured values;
- Inspecting the hydrogen generator for warning or alarm conditions;
- Checking reverse osmosis/ deionized water system conductivity reading to ensure ultrapure water generation;
- Inspecting air compressor for dew point and warning or alarm conditions;
- Checking other valves and fittings for possible leakage;
- Checking polymer tank to ensure adequate polymer solution in the tank for proper operation;
- Checking coagulant holding tank for adequate coagulant in the tank for proper operation;
- Checking cartridge filter pressure and changing cartridge if necessary; and
- Inspecting discharge pipe to GW-11 for leaks.

Regular maintenance was conducted in accordance with the System Operation Manual to keep the system operational and identify potential issues. The primary maintenance associated with the pilot unit was periodic system cleanings. Specifically, during Test Scenario #1A, a pressure increase was observed in the reactors. The pressure rise in the reactors was due to the accumulation of biomass on the membrane surfaces. The pressures in the reactors eventually reached an operational benchmark of 25 pounds per square inch (psi) during Test Scenario #1A, which indicated a system cleaning was required to achieve optimal system performance.

The pilot system was shut down for several days in order to complete the cleaning process, which consisted of adding sodium hydroxide to the reactors to raise the pH and remove the biomass from the membranes. The reactor contents were recirculated at 80 gpm using the recirculation pumps. After the sodium hydroxide solution had been recirculated for several days, samples from each reactor were collected and sent for analysis of total organic carbon (TOC) and total suspended solids (TSS), which were used to evaluate biomass quantification for each test scenario. After sample collection and neutralization with acid, the contents of each reactor were transferred to the 3,000-gallon holding tank. The reactors were then rinsed with a solution of site water and muriatic acid to reduce pH and dissolve scaling; scaling may have been caused by calcium and magnesium compounds present in the groundwater. Samples from the holding tank containing the spent cleaning solution were also collected and analyzed for TOC and TSS to assist in biomass quantification. Following completion of cleaning activities after Test Scenario #1A, the spent cleaning solution was transported and disposed of as non-hazardous waste (based on analytical testing) at the the Republic Services Apex Landfill in Clark County, Nevada. After the cleaning process, the membrance was free of biolfim; therefore, reacclimation was required.

Based on the reactor pressures observed following Test Scenarios #1B and #2, the same cleaning procedures were followed. After completion of Test Scenario #3, the system was cleaned to proceed with decommissioning. The spent cleaning solution from Test Scenario #3 was determined to be characteristically toxic hazardous waste

based on chromium concentrations and process knowledge (mass balance calculations) and was sent off site for disposal at the US Ecology, Inc. facility near Beatty, Nevada.

4.2.2 Sampling

Both operational and performance samples were collected throughout the Pilot Test. Operational samples were collected during both the start-up and operational phases to monitor and adjust treatment system operational parameters to maximize treatment effectiveness. Once the system had achieved steady state conditions, performance samples were collected and analyzed for a more comprehensive list of analytes during the operational phase to measure the technology performance relative to the Pilot Test objectives. Additional details regarding operational and performance samples are included in the subsections below.

Both operational and performance samples were collected from several locations within the treatment system (as indicated in the PIDs provided in Appendix A and described below):

- Influent samples were collected from the sample port located on the line entering the lead reactor (sample port SP-015).
- Reactor samples were collected from sample ports installed after each reactor (SP-100, SP-200, and SP-300 for the first, second, and third reactors, respectively) and from the post-reactor tank (SP-400) to measure COPC concentrations following treatment in each reactor.
- When the cartridge filter was in use, treated water samples were collected from sample ports located on the discharge line of the treated water holding tank (SP-550) before and after the cartridge filter (SP-551).

4.2.2.1 Operational Sampling Program

The Work Plan and System Operation Manual included a general guideline for operational sampling with flexibility for sampling frequency and/or parameters to be analyzed based on real-time operations and system needs for proper system operation and to meet overall Pilot Test objectives. During all test scenarios, operational samples were collected several times each week and analyzed for the primary COPC perchlorate (Method 314.0). During Test Scenario #3, which included evaluation of chromium treatment, samples were also collected at least once per week and analyzed for hexavalent chromium (Method SW7199) and total chromium (Method SW6010B). In addition to regular perchlorate and chromium operational samples, samples were also periodically analyzed for a variety of other parameters, including:

- Chlorate (Method 300.1B) and nitrate (Method 300.0) to evaluate the reduction process;
- Sulfate (Method 300.0) to evaluate sulfate reduction which can compete with perchlorate reduction;
- Ammonia as nitrogen (Method 5400-NH3) and phosphorus (Method 4500-P) to ensure proper nutrient dosing;
- Dissolved organic carbon and/or TOC (Method SM5310B), total dissolved solids (TDS) (Method SM2540C), and TSS (Method SM2540D) as part of ongoing biomass quantification and filtration requirements;
- Alkalinity (Method SM2320), hardness (Method SM2340B) and calcium (Method 200.7) to understand the optimum pH to prevent calcium carbonate from coming out of solution; and
- Chloride, fluoride, magnesium, potassium, sodium, magnesium, manganese, and iron via Methods 200.0 and 200.7 to evaluate if these chemicals were contributing to membrane fouling.

Analysis of operational samples was typically performed at Silver State Analytical Laboratories (a state-certified off-site local laboratory) under quick turnaround time for immediate use in system operational inputs; however, occasionally operational samples were sent to state-certified Test America Laboratories, Inc. d/b/a Eurofins Test America and Pace Analytical National depending on lab availability. These samples were operational and not

performance related, and therefore were not validated in accordance with the NDEP-approved Work Plan and System Operation Manual.

4.2.2.2 Performance Sampling Program

The performance sampling program was implemented in accordance with the Work Plan and System Operation Manual to evaluate if the system could achieve the Pilot Test objectives. The performance sampling and analytical program for the operational phase of each scenario is summarized in ***Table 1.*** Analysis of performance samples was performed at Test America Laboratories, Inc. d/b/a Eurofins Test America and/or Pace Analytical National on either rush or standard turn-around time.

Table 1. Pilot Test Performance Sampling Program

Parameter[1]	Perchlorate	Chlorate	Nitrate	Hexavalent Chromium[2]	Total Chromium[2]	TDS	TSS
Method	**E 314.0**	**E300.1B**	**E300.0**	**SW7199**	**SW6010B**	**SM2540C**	**TSS**
Sample Location							
Influent to Module Tanks (SP-015)	X	X	X	X	X	X	X
Module Tank 1 Effluent (SP-100)	X	X	X	-	-	-	X
Module Tank 2 Effluent (SP-200)	X	X	X	-	-	-	X
Module Tank 3 Effluent (SP-300)	X	X	X	X	X	-	X
Post-Reactor Tank Effluent (SP-400)	X	X	X	X	X	-	X
Treated Water Holding Tank Effluent (SP-550)[3]	-	-	-	X	X	-	X
Cartridge Filter Effluent (SP-551)[3]	X	X	X	X	X	X	X

Notes:
TDS – total dissolved solids
TSS – total suspended solids
[1] All parameters analyzed on a weekly basis, except for TS, which was sampled twice per week.
[2] The chromium analyses were only performed during Test Scenario #3.
[3] Samples were not collected from SP-550 and SP-551 during Test Scenarios #1B and #2 when the cartridge filter was not used.

In addition to the laboratory parameters presented in ***Table 1***, field parameters were also recorded at the same time performance samples were collected and included pH, ORP, and temperature.

4.2.2.3 Data Validation

A Data Validation Summary Report (DVSR) was prepared to assess the validity and usability of laboratory analytical data from the performance samples collected as part of the Pilot Test. Quality assurance/quality control

(QA/QC) samples were collected to aid in assessing data quality, including equipment blanks, field duplicates, and matrix spike/matrix spike duplicates.

The data were verified and validated in accordance with procedures described in the *Quality Assurance Project Plan, Revision 5* (Ramboll, 2020a), *Quality Assurance Project Plan, Revision 6* (Ramboll, 2020b), *NDEP Guidance on Data Verification and Validation Requirements* (NDEP, 2018), and the references contained therein. The samples, all aqueous, were validated to Stage 2A. The review process also used professional judgment and guidance from the USEPA National Functional Guidelines to determine the final qualifiers, which were added to the database and presented in the DVSR tables. The DVSR is provided as Appendix B to this report.

4.3 DECOMMISSIONING

Following completion of all scenario testing and following concurrence from NDEP and the Trust, decommissioning activities began on September 7, 2021 and were completed on October 15, 2021. Decommissioning consisted of the following activities:

- Draining and disconnecting the Pilot Treatment System;
- Power washing and returning rental influent tanks;
- Power washing and moving the AWF influent water tank, solids holding tank, and associated pumps to an on-site storage area;
- Decommissioning electrical components of the Pilot Treatment System and influent water collection locations;
- Removing and disposing of installed piping and secondary containment associated with the pilot system and influent water collection locations;
- Dismantling and disposing of piping to the GW-11 Pond; and
- Loading the pilot system by crane for transport back to APTwater.

5.0 SYSTEM PERFORMANCE AND RESULTS

This section presents a discussion of the system operation and performance results and evaluates the applicability and effectiveness of HBGPM for each test scenario considering the following design criteria:

- System performance (i.e., discussion of COPC removal and key operational components);
- Treatment capacity and mass flux of pilot system;
- Hydrogen consumption;
- Consumption of carbon dioxide, nitrogen, and air;
- Nutrient requirements; and
- Biomass generation.

5.1 SYSTEM PERFORMANCE

This section discusses the operational details for the removal of the COPCs for each scenario, based on analytical testing of samples. As explained in Section 4.2.2, two types of samples were collected: a) operational samples intended to monitor and adjust system operational parameters; and b) performance samples intended to measure the system performance relative to the pilot study objectives. Figures 6 through 10 present graphical depictions of perchlorate concentrations in samples from the influent water and samples of water leaving the lag reactor for operational and performance samples collected during each scenario. The data collected for all performance sampling parameters are provided in the comprehensive data tables in Appendix C (Tables C.1 through C.12). Appendix D provides the operational sampling results. The percent removal was calculated for each individual reactor (reactor effluent compared to reactor influent) and the overall system (system influent compared to lag reactor effluent referred to herein as cumulative).

In general, nearly all of the nitrate, more than 50% of chlorate and a varying percentage of perchlorate was removed in the lead reactor. Residual chlorate was either reduced or completely removed in the middle reactor and residual perchlorate was reduced in the middle and lag reactors. Specific reductions for each reactor are described below for each Test Scenario.

Results from Scenario #3, which also evaluated treatment of hexavalent chromium, indicated that hexavalent chromium was completely reduced to trivalent chromium. The trivalent chromium was partly adsorbed onto the biomass, such that the treated effluent contained low concentrations of trivalent chromium.

5.1.1 Test Scenario #1

As explained in Section 3.1, the objective of Pilot Test Scenario #1 was to evaluate treatment of extracted groundwater representative of the existing FBR groundwater influent stream that contains elevated concentrations of both perchlorate and chlorate. This influent stream consisted of extracted groundwater from the AWF and IWF after chromium removal by the GWTP, as well as a portion of the SWF that is not currently treated by the IX system. During Test Scenario #1, the system performance varied, and pressure increases were observed in the reactors that resulted in the system requiring shut down and cleaning. Based on these factors, NDEP requested that after cleaning, the system be reacclimated and reevaluated using the same influent stream in a new testing scenario. As a result, Test Scenario #1 was extended, with the original test referred to as Test Scenario #1A and the extension referred to as Test Scenario #1B. This section summarizes the results for each of these scenarios.

5.1.1.1 Test Scenario #1A

Pilot Test Scenario #1A began on August 30, 2020, upon completion of system installation and start-up. During Test Scenario #1A, bench-scale tests were conducted to identify if the addition of a coagulant and polymer would be beneficial to the settling process. The tests concluded that the coagulant and polymer were not effective in

helping the solids settle in the clarifier, which was likely due to the small quantity of biomass that was generated during treatment. As a result, the clarifier was bypassed at the start of the operational period of Test Scenario #1A and all future test scenarios due to limited solids production and the clarifier's ineffectiveness in removing such small quantities of solids from the treated water.

Performance sample collection started on September 15, 2020 and continued through November 19, 2020. Performance monitoring results for Test Scenario #1A are provided in Appendix C, Tables C.1 to C.3, and presented on Figure 6.

During Test Scenario #1A, the influent nitrate concentrations ranged from 7.9 to 9.9 mg/L, with an average concentration of 8.7 mg/L. Samples collected indicated that nitrate was significantly reduced following treatment in the lead reactor, with concentration reductions ranging from 79.8 to 99.8 percent and an average reduction of 93.1 percent. The nitrate concentrations in samples collected following treatment in the lag reactor ranged from less than the sample detection limit (0.014 mg/L) to 0.13 mg/L. This equates to a cumulative nitrate removal ranging from 98.5 to 99.9 percent.

The influent chlorate concentrations during Test Scenario #1A ranged from 54,000 to 120,000 µg/L with an average concentration of 97,750 µg/L. Samples collected following treatment in the lead reactor indicated chlorate concentration reductions ranging from 50.0 to 98.6 percent, with an average reduction of 70.5 percent. Samples collected following treatment in only the middle reactor indicated additional chlorate removal, with concentration reductions ranging from 84.8 to 99.7 percent. The chlorate concentrations in samples collected following treatment in the lag reactor averaged 88 µg/L, which equates to a cumulative chlorate removal rate of 99.7 to greater than 99.9 percent.

The influent perchlorate concentrations during Test Scenario #1A ranged from 37,000 to 73,000 µg/L, with an average concentration of 54,875 µg/L. Samples of the influent and effluent of each reactor were collected throughout the treatment process to evaluate the perchlorate removal efficiency of each reactor (lead reactor, middle reactor, and lag reactor) as a percentage of the perchlorate introduced to that reactor. These results indicated that 0 to 90.2 percent of the perchlorate that flowed into the lead reactor was removed by the lead reactor, 69.8 to 99.3 percent of the perchlorate that flowed into the middle reactor was removed by the middle reactor, and 84.8 to 99.6 percent of the perchlorate that flowed into the lag reactor was removed by the lag reactor. Overall, the cumulative perchlorate removal following treatment in all three reactors ranged from greater than 99.5 percent to greater than 99.9 percent.

The perchlorate concentrations following treatment in the lag reactor were not consistently below the treatment goal of 18 µg/L, with concentrations ranging from 0.39 to 350 µg/L, with an average value of 85.5 µg/L. The following observations were made during Test Scenario #1A that likely contributed to perchlorate concentrations in effluent water that exceeded the treatment goal:

- As shown on Figure 6, the flow rate was increased from 2 to 2.4 gpm on September 25, 2020, and then increased again to 3.5 gpm on October 6, 2020. The decisions to increase the flow rate were based on the results from the quick turnaround operational sample results that indicated the effluent perchlorate concentrations were below 18 µg/L (i.e., indicating the system was performing as intended). However, the results of performance samples collected on September 30, 2020 (but not received until mid-October), indicated that the effluent perchlorate concentrations when the system flow rate was operating at 2.4 gpm were above the 18 µg/L treatment goal for perchlorate. Based on these results, it was concluded that the flow rate was prematurely increased and at these higher influent feed rates, the system was unable to meet the treatment goal of 18 µg/L. Due to the discrepancy in laboratory results observed in Test Scenario #1A, additional QA/QC samples were collected during subsequent test scenarios to confirm data consistency.
- Pilot system influent water temperatures dropped below 70°F (degrees Fahrenheit) on multiple occasions in late October and November 2020, which may have impeded biological activity and perchlorate

reduction. Unlike the FBR system which treats water directly from the extraction well fields without extended aboveground storage, the influent water for the Pilot Test was staged in two above ground frac tanks prior to treatment and was influenced by ambient daytime and nighttime temperatures. As a result, regular evaluations of influent temperatures were incorporated.

- A large amount of organic material was observed in the influent water after the GWETS operator, Envirogen Technologies, Inc. (ETI), performed intensive multi-day GWETS pipeline pigging events in late October 2020 as part of the pipeline maintenance/cleaning associated with the FBR system. The resulting high organic loading in the influent water likely had a negative impact on the Pilot Test biological processes. As a precaution, Tetra Tech regularly coordinated with ETI during subsequent testing scenarios to avoid the collection of water for testing during and/or immediately after pigging events.
- At the start of Test Scenario #1A, the presence of hydrogen sulfide was noted within the pilot unit treatment containers, first by odor and then confirmed by a hydrogen sulfide meter. Hydrogen sulfide is typically produced during anaerobic reduction of sulfate, which is present in high concentrations in groundwater at the NERT site. Once nitrate, chlorate, and perchlorate are degraded, sulfate-reducing bacteria can grow rapidly and overtake the perchlorate-reducing bacteria. APTwater recommended the addition of air to the lag reactor to reduce or eliminate the growth of sulfate-reducing bacteria since the lag reactor contained the lowest concentrations of perchlorate. Another strategy that was used to reduce the adverse effect from the sulfate-reducing bacteria was to periodically change the reactor sequence to allow the system to rebalance. These strategies were incorporated into the remaining test scenarios. Additionally, sulfate analysis was incorporated into the operational sampling program during the remaining test scenarios to monitor for ongoing sulfate reduction. At the end of Test Scenario #1A, results from operational samples indicated that there was an average of approximately 7 percent reduction in sulfate concentrations following treatment compared to influent concentrations. Based on the limited assessment performed with respect to sulfate during this Pilot Test, additional testing would be required to fully evaluate the effects of sulfate-reducing bacteria on system performance, as well as to evaluate if system modifications (such as air sparging and/or reactor sequencing) are warranted.

5.1.1.2 Test Scenario #1B

Based on the operational issues and performance results associated with Test Scenario #1A, NDEP requested that the system be cleaned, reacclimated and reevaluated using the same influent stream in a new testing scenario. As part of Test Scenario #1B, process improvements were made based on the results and lessons learned from Test Scenario #1A (described in Section 5.1.1.1). Additionally, the cartridge filter was relocated to the system influent stream to remove inert solids in an effort to minimize pressure increases in the reactors.

Operations for Test Scenario #1B began on November 24, 2020. Due to the influent water temperatures being between 52 and 65ºF during the first two weeks in December, the acclimation process for Test Scenario #1B was slower than the previous acclimation process observed in Test Scenario #1A. As previously described, the water for the Pilot Test was staged above ground prior to use and was impacted by the colder ambient temperatures, including nighttime temperatures in the low 30sºF. Water heaters were installed on the influent lines between the frac tanks and pilot system on December 16, 2020 to maintain the influent water temperature above 70ºF during testing in the colder winter months. Following installation of the water heaters, improved system acclimation was observed in correlation with increased influent water temperatures.

Following influent temperature adjustments resulting in achievement of steady state conditions, performance sampling for Test Scenario #1B began on January 12, 2021 and ended on February 2, 2021. Although the initial influent flow rate during the performance sampling period was 2 gpm, the flow rate was reduced on January 16, 2021, to 1.5 gpm to more efficiently demonstrate system performance, a flow rate which was maintained for the remaining duration of Test Scenario #1B. Performance monitoring results for Test Scenario #1B are provided in Appendix C, Tables C.4 to C.6 and are presented on Figure 7.

During Test Scenario #1B, the influent nitrate concentrations ranged from 6.3 to 7.7 mg/L, with an average concentration of 6.9 mg/L. Samples collected indicated that nitrate was almost completely removed following treatment in the lead reactor, with concentration reductions ranging from 85.4 to 99.8 percent and an average reduction of 95.1 percent. The nitrate concentrations in the samples collected following the lag reactor were less than the sample detection limit (0.014 mg/L) in all performance samples collected during Test Scenario #1B. This equates to a cumulative nitrate removal of 99.8 percent.

Influent chlorate concentrations during Test Scenario #1B ranged from 88,000 to 110,000 µg/L, with an average concentration of 102,000 µg/L. Samples collected following treatment in the lead reactor indicated a chlorate concentration reduction ranging from 70.9 to 98.2 percent, with an average reduction of 81.3 percent. Samples collected following treatment in only the middle reactor indicated additional chlorate removal, with concentration reductions ranging from 96.8 to 99.6 percent. The chlorate concentrations in samples collected following treatment in the lag reactor averaged 55 µg/L, which equates to a cumulative chlorate removal rate of greater than 99.9 percent.

The influent perchlorate concentrations during Test Scenario #1B ranged from 45,000 to 52,000 µg/L, with an average concentration of 47,000 µg/L. Samples of the influent and effluent of each reactor were collected throughout the treatment process to evaluate the perchlorate removal efficiency of each reactor (lead reactor, middle reactor, and lag reactor) as a percentage of the perchlorate introduced to that reactor. These results indicated that 26.7 to 89.3 percent of the perchlorate that flowed into the lead reactor was removed by the lead reactor, 97.9 to 98.0 percent of the perchlorate that flowed into the middle reactor was removed by the middle reactor, and 96.0 to 99.9 percent of the perchlorate that flowed into the lag reactor was removed by the lag reactor. The cumulative perchlorate removal following treatment in all three reactors was greater than 99.9 percent.

The first performance sample collected on January 12, 2021, exceeded the targeted 18 µg/L treatment goal, with a concentration of 25 µg/L. This higher concentration was likely due to an initial higher system operational rate of 2 gpm. Based on the results of the first performance sample, the flow rate during Test Scenario #1B was reduced to 1.5 gpm on January 16, 2021, to target consistent performance in treating perchlorate concentrations to below the 18 µg/L treatment goal for the remainder of the testing period. Subsequently, the perchlorate concentrations following treatment in the lag reactor in the performance samples ranged from 0.62 to 14 µg/L with an average concentration of 6 µg/L, which indicates treatment of perchlorate to below the 18 µg/L treatment goal. In general, the unvalidated, operational samples were below sample detection limits during the operational phase with the exception of two days near the end of the scenario, possibly indicating the need for a system cleaning was approaching.

ORP measurements can indicate the strength of the reducing conditions present in the reactors (i.e., the lower the ORP measurement, the stronger the reducing conditions). As a result, the system was equipped with ORP meters in each reactor and readings were collected continuously to evaluate if the hydrogen dosing was appropriate or needed to be adjusted. During Test Scenario #1B, additional observations were made to determine whether the ORP readings in the reactors could be used as a reliable parameter to evaluate system operations. Due to high variability in ORP measurements, it was concluded that ORP is likely not an appropriate parameter to be used exclusively in ongoing operational adjustments.

In conclusion, the performance sample results from Test Scenarios #1B indicate that the pilot unit reduced perchlorate concentrations in extracted groundwater representative of the existing FBR groundwater influent stream to below the 18 µg/L treatment goal. As previously explained, lessons learned in Test Scenarios #1A and #1B resulted in operational improvements that were incorporated into subsequent test scenarios.

5.1.2 Test Scenario #2

Pilot Test Scenario #2 evaluated treatment of water from the AWF and IWF after chromium pre-treatment in the GWTP. Because of the higher concentrations present in this influent stream, the system was operated at a lower

influent flow rate of 0.75 gpm. Test Scenario #2 began on February 17, 2021 and continued through May 12, 2021. Test Scenario #2 included both an operational phase as well as an additional testing phase to evaluate maximum mass loading capacity. Performance sample collection as part of the operational phase started on March 9, 2021 and continued through April 15, 2021. Performance sampling associated with the additional testing continued through May 4, 2021. Performance monitoring results for Scenario #2 are provided in Appendix C in Tables C.7 to C.9 and are presented on Figures 8 and 9.

During Test Scenario #2, the influent nitrate concentrations ranged from 9.0 to 10.3 mg/L, with an average concentration of 9.6 mg/L. Samples collected indicated that nitrate was almost completely removed following treatment in the lead reactor, with concentration reductions ranging from 86.6 to 97.6 percent, and with an average reduction of 91.9 percent. The nitrate concentrations in samples collected following treatment through the lag reactor were less than the sample detection limits (ranging from 0.048 to 0.48 mg/L) in all performance samples collected during Test Scenario #2. This equates to a cumulative nitrate removal ranging from 94.8 to 99.9 percent.

Influent chlorate concentrations during Test Scenario #2 ranged from 163,000 to 191,000 µg/L, with an average concentration of 177,500 µg/L. Samples collected following treatment in the lead reactor indicated a chlorate reduction ranging from 52.0 to 70.8 percent, with an average reduction of 61.3 percent. Samples collected following treatment in only the middle reactor indicated additional chlorate removal, with concentration reduction rates ranging from 98.6 to greater than 99.9 percent. The chlorate concentrations in samples collected following treatment in the lag reactor were less than the sample detection limit of 24 µg/L, which equates to a cumulative chlorate removal rate of greater than 99.9 percent.

The influent perchlorate concentrations during Test Scenario #2 ranged from 79,400 to 95,700 µg/L, with an average concentration of 87,183 µg/L. Samples of the influent and effluent of each reactor were collected throughout the treatment process to evaluate the perchlorate removal efficiency of each reactor (lead reactor, middle reactor, and lag reactor) as a percentage of the perchlorate introduced to that reactor. These results indicated that 0 to 16.2 percent of the perchlorate that flowed into the lead reactor was removed by the lead reactor, 97.8 to 99.3 percent of the perchlorate that flowed into the middle reactor was removed by the middle reactor, and 97.4 to 99.0 percent of the perchlorate that flowed into the lag reactor was removed by the lag reactor. Thus, similar to Test Scenario #1B, the middle and lag reactors were consistently efficient during Test Scenario #2. Overall, the cumulative perchlorate removal following treatment in all three reactors was greater than 99.9 percent.

During the operational period of Test Scenario #2, four of the six samples collected following treatment in the lag reactor indicated perchlorate concentrations less than the 18 µg/L treatment goal. The two samples collected on March 9, 2021 and March 30, 2021 had perchlorate detections of 19.6 and 22.6 µg/L, respectively. It should be noted that split samples were collected on both sample dates, with split sample results indicating perchlorate concentrations were below the sample detection limit of 5 µg/L. Additionally, samples collected from the post-reactor tank effluent were below the sample detection limit of 0.3 µg/L on both sample dates. Lastly, the laboratory data package for the sample collected on March 9, 2021 indicated that the sample was an estimated value as the matrix interfered with the ability to make an accurate determination. Based on the results described above, it appeared that the system was able to consistently reduce the perchlorate concentration to near if not below the 18 µg/L treatment goal.

Following completion of the Test Scenario #2 operational phase, additional testing was conducted to determine the maximum mass load/treatment capacity of the pilot unit. During this additional testing, the mass load was increased by increasing both the influent flow rate (up to 2.5 gpm) and influent contaminant concentrations (up to perchlorate concentrations of 173,000 µg/L through adding additional IWF water to the influent). System inputs, including hydrogen dosage and nutrient dosages, were then adjusted in an effort to determine the maximum mass load capacity of the system. This phase of the project was defined as Test Scenario #2 Additional Testing and was performed from April 15, 2021, through May 12, 2021. Results of this additional testing phase are provided in

Appendix C in Tables C.7 to C.9 and presented on Figure 9. Because this was an additional testing phase where system inputs were varied to test the maximum mass loading capacity of the system, COPC concentrations significantly varied in samples collected from the system effluent. During this additional testing period, two of the four performance samples collected following treatment in the lag reactor indicated perchlorate concentrations less than the 18 µg/L treatment goal. These data were used to determine the maximum mass loading capacity of the system, which is discussed in greater detail in Section 5.2.

Although sulfate was added to the operational sampling program as described in Section 5.1.1.1, Test Scenario #2 also included the collection of performance samples for analysis of sulfate to quantify the amount of sulfate reduction that was occurring in the system. The influent sulfate concentrations ranged from 1,800 to 2,160 µg/L while the sulfate concentrations in samples collected following treatment in the lag reactor ranged from 1,480 to 2,130 µg/L. The average sulfate reduction across the treatment system was approximately 5%. It was concluded that while sulfate reducing bacteria may be present in the system as evidenced by an observable amount of reduction in sulfate concentrations, it did not significantly impact system performance as evidenced by continued perchlorate reduction.

In conclusion, the performance sample results from Test Scenario #2 indicated that the pilot unit could reduce high perchlorate concentrations (up to 95,700 µg/L during Test Scenario #2 and up to 173,000 µg/L during Test Scenario # 2 Additional Testing) present in the blend of extracted groundwater from the AWF and IWF after chromium pre-treatment to below the 18 µg/L treatment goal.

5.1.3 Test Scenario #3

Test Scenario #3 began on May 18, 2021; performance sample collection started on June 29, 2021 and continued through August 9, 2021. Performance monitoring results for Test Scenario #3 are provided in Appendix C, Tables C.10 to C.12 and are presented on Figure 10.

As explained in Section 3.2, the objective of Test Scenario #3 was to determine whether hexavalent chromium could be reduced to trivalent chromium in the biological reactors under anoxic conditions, and whether trivalent chromium could be removed from the treated water using clarification and/or filtration. Test Scenario #3 included a blend of water from the AWF and IWF prior to chromium pre-treatment in approximately the same proportion currently generated through groundwater pumping. During the Test Scenario #3 performance sampling period, the influent flow rate was 0.75 gpm (same as Test Scenario #2). Due to the presence of hexavalent chromium in the influent stream in Test Scenario #3, a new cartridge filter was installed in the post treatment container prior to starting this test to remove residual solids generated from treatment of hexavalent chromium.

During Test Scenario #3, the influent nitrate concentrations ranged from 11.6 to 13.6 mg/L, with an average concentration of 12.8 mg/L. Samples collected indicated that nitrate was almost completely removed following treatment in the lead reactor, with concentration reductions ranging from 94.2 to 99.6 percent, with an average reduction of 96.5 percent. The nitrate concentrations in samples collected following treatment in the lag reactor were less than the sample detection limits (ranging from 0.048 to 0.48 µg/L) in all performance samples collected during Test Scenario #3.

Influent chlorate concentrations during Test Scenario #3 ranged from 180,000 to 215,000 µg/L, with an average concentration of 202,000 µg/L. Samples collected following treatment in the lead reactor indicated a chlorate reduction ranging from 87.1 to 93.3 percent. Samples collected following treatment in only the middle reactor indicated additional chlorate concentration reductions ranging from 92.3 to 99.9 percent. The chlorate concentrations in samples collected following treatment in the lag reactor were less than the sample detection limit of 24 µg/L, which equates to a cumulative chlorate removal rate of greater than 99.9 percent.

The influent perchlorate concentrations during Test Scenario #3 ranged from 80,600 to 97,700 µg/L, with an average concentration of 93,000 µg/L. Samples of the influent and effluent of each reactor were collected throughout the treatment process to evaluate the perchlorate removal efficiency of each reactor (lead reactor,

middle reactor, and lag reactor) as a percentage of the perchlorate introduced to that reactor. These results indicated that 52.3 to 63.9 percent of the perchlorate that flowed into the lead reactor was removed by the lead reactor, 66.9 to greater than 99.9 percent of the perchlorate that flowed into the middle reactor was removed by the middle reactor, and 0.0 to greater than 99.9 percent of the perchlorate that flowed into the lag reactor was removed by the lag reactor. Overall, the cumulative perchlorate removal following treatment in all three reactors was greater than 99.9 percent.

Perchlorate concentrations in performance samples following treatment in the lag reactor were less than 18 µg/L during the performance sampling period for Test Scenario #3 except for one sample. The performance sample collected on July 8, 2021 following treatment in the lag reactor indicated a perchlorate concentration of 43.2 µg/L, which was likely a result from elevated influent water temperatures impeding the biological reductive processes. Specifically, during routine process monitoring, it was noted that the influent water temperature exceeded 100°F multiple times during June and July 2021. These temperature increases coincided with perchlorate concentrations exceeding 18 µg/L in the operational samples collected following treatment in the biological reactors. As previously noted in Section 5.1.1.1, unlike a full-scale system, the water for the pilot study was being stored above ground prior to use, and therefore, was impacted by the surrounding ambient temperatures (which exceeded 110°F multiple times during June and July 2021). Several corrective measures were implemented to reduce the influent water temperatures. Corrective measures included wrapping and raising the influent line above the secondary containment floor and installing a chiller on the influent feed line to cool the incoming influent water. Following successful installation of the chiller, the influent water temperature was consistently observed at temperatures below 100°F. Correspondingly, performance sample results indicated perchlorate concentrations below 18 µg/L (Figure 10).

The hexavalent chromium concentrations in the influent ranged from 273 µg/L to 514 µg/L, with an average concentration of 379 µg/L, while the total chromium in the influent water ranged from 381 µg/L to 493 µg/L, with an average concentration of 434 µg/L. These concentrations indicated that hexavalent chromium represented approximately 90 percent of total chromium present in the influent. Samples collected following treatment in the lag reactor indicated that hexavalent chromium concentrations were less than the sample detection limit of 0.15 µg/L, demonstrating that hexavalent chromium was completely reduced in the biological reactors (Figure 11). Additionally, the total chromium concentrations in samples collected following the lag reactor ranged from an estimated 5.9 to 18.6 µg/L, which indicates that trivalent chromium was retained in the pilot unit and did not leave the system with the treated water. Sample results showed very little chromium in the effluent, and it was determined that neither coagulation/flocculation nor clarification was needed for residual chromium removal following treatment. It should also be noted that although trivalent chromium was likely adsorbed to the membranes, the concentration of trivalent chromium adsorbed on the membrane surface would be insignificant in comparison to biomass adsorbed on to the membrane surface.

In conclusion, the performance sample results from Test Scenario #3 indicate that the pilot unit can reduce high perchlorate concentrations (up to 97,700 µg/L) present in the blend of water from the AWF and IWF to below the 18 µg/L treatment goal and reduce hexavalent chromium to below sample detection limits. However, the spent cleaning solution from Test Scenario #3 was determined to be characteristically toxic hazardous waste based on hexavalent chromium concentrations and required disposal as hazardous waste.

5.2 TREATMENT CAPACITY AND MASS FLUX OF PILOT SYSTEM

Mass loading capacity and mass flux are key components in evaluating the HBGPM technology for future applicability and scale-up. This section presents a summary of the calculations and results for mass loading capacity and mass flux in each of the scenarios tested. It should be noted that the mass loading capacity and mass flux of the pilot unit for each scenario were measured during the operational phase once the system was acclimated. To estimate the mass capacity and mass flux of the treatment system to be used for the scale-up of the treatment system (further presented in Section 6.0), only the performance results where the system was

operating as intended (i.e., perchlorate concentrations following treatment in the lag reactor met the treatment goal of 18 µg/L) were used. This was to ensure that the mass treatment capacity and mass flux of the pilot system were calculated under stable operating conditions, as opposed to non-stable conditions when corrective measures were being implemented during the testing phase (such as before installation of a chiller to reduce the influent water temperature).

Because hydrogen was not optimized in the study, mass loading was the preferred design basis for the hypothetical design. If the technology is further evaluated in the future, hydrogen optimization testing could be performed. A full-scale system design based on hydrogen consumption on a per pollutant basis could be completed once that future data is obtained and potential contaminant concentration ranges in the influent are known,

5.2.1 Mass Loading Capacity

Mass loading capacity evaluates the mass loading of key COPCs in the extracted groundwater that the system can treat to regulatory discharge limits, where applicable. Although only perchlorate required treatment to achieve a regulatory discharge limit, chlorate and nitrate concentrations also had an impact on the total capacity of the treatment system. Therefore, all three COPCs (perchlorate, chlorate, and nitrate) were included in this evaluation. It is noted that hexavalent chromium was not included in the mass loading calculations from Test Scenario #3 due to the concentrations and resulting mass loading being substantially lower relative to perchlorate, chlorate, and nitrate.

The equation used for calculating mass loading capacity in pounds per day (lbs/day) is as follows:

$$Mass\ Loading\ Capacity\ = \frac{(Q \times 1440\ \times \rho_w)}{1{,}000{,}000} \times\ C_f$$

Where:

Q is flow rate in gallons per minute;

ρ_w is the density of water in pounds per gallon; and

C_f is the concentration of the influent feed in parts per million.

Table 2 presents a summary of the results from the mass loading capacity calculations for each scenario.

Table 2. Summary of Mass Loading Capacity Estimates

Test Scenario	*Q* (gpm)	C_f (mg/L)	Average Mass Loading Capacity (lbs/day)
#1A	1.90	143	3.30
#1B	1.50	161	2.90
#2	0.75	276	2.49
#3	0.75	312	2.81
Overall Operational Phase Average	1.20	223	2.87
#2 - Additional Testing[1]	1.25	576	8.64

Notes:
Q – Flow Rate
gpm – gallons per minute
C_f – Total concentration of influent feed
mg/L – parts per million
lbs/day – pounds per day
[1]As described in Section 5.1.2, additional testing was performed as part of Test Scenario #2 to evaluate the maximum mass load capacity.

As presented in ***Table 2***, the overall operational phase from the three scenarios indicated an average mass loading capacity of 2.87 lbs/day. Although the overall objective of the Pilot Test was to determine if the HBGPM system could effectively treat perchlorate concentrations to below the treatment goal of 18 µg/L, limited additional testing was performed as part of Test Scenario #2 to evaluate the maximum mass loading capacity of the system using increased flow rates and concentrations. Results from this additional testing phase indicated that the pilot unit had an average mass loading capacity of 8.64 lbs/day, which is three times greater than the average mass loading calculated for the other test scenarios. The results from the additional testing indicate that the system may be capable of operating at higher mass loadings. However, this short-term test did not allow for demonstration of continued stable and sustainable performance at these higher mass loading rates. As a result, additional optimization testing would be required to confirm if the system could effectively treat perchlorate concentrations to below the 18 µg/L treatment goal at the higher mass loading rate on a consistent basis.

5.2.2 Treatment System Flux

The treatment system flux is a key parameter used in the design of a full-scale treatment system and evaluates contaminant mass removed in each reactor with respect to the surface area of modules in the individual reactor. The pilot system consisted of three reactors, with each reactor containing two modules. Each module had a surface area of 1,539 square feet (sqft), resulting in a total module area in each reactor of 3,078 sqft. The mass flux also represents the reaction rate in every reactor and is defined as follows:

$$Reaction\ Rate = Flux\ = \frac{Mass\ of\ Contaminants\ Removed}{Day\ \times Membrane\ Surface\ Area\ \ (ft^2)}$$

The equation above was used along with the total module surface area of 9,234 sqft for the total mass flux through the system. ***Table 3*** presents a summary of the results from the mass flux calculations for each scenario.

Table 3. Summary of Mass Flux Through Each Reactor

Test Scenario	Mass Flux (lbs/day ft^2)			
	Lead	Middle	Lag	Total
#1A	7.73E-04	2.81E-04	1.26E-06	3.52E-04
#1B	6.82E-04	2.54E-04	5.37E-06	3.14E-04
#2	3.63E-04	4.41E-04	2.99E-06	2.69E-04
#3	7.33E-04	1.63E-04	1.51E-05	3.04E-04
Average	6.38E-04	2.85E-04	6.18E-06	3.10E-04
#2 – Additional Testing	9.29E-04	5.95E-04	4.89E-05	5.25E-04

Notes:
lbs/day ft^2 – pounds per day per square foot

As presented in ***Table 3***, the lead reactor generally had the largest mass flux, while the lag reactor had the smallest. This was expected as higher concentrations are available for treatment in the lead reactor due to high influent concentrations, while lower concentrations of COPCs are transferred through the lag reactor for final treatment after passing through the previous lead and middle reactors. Similar to the mass loading capacity, the mass flux from the Scenario #2 Additional Testing phase indicated a higher calculated mass flux than the other test scenarios. The Scenario #2 Additional Testing indicated that the pilot unit had a total mass flux of 5.25x10^{-4} lbs/day-ft^2, which is approximately 1.7 times greater than the average mass flux calculated for the other test scenarios.

5.3 HYDROGEN CONSUMPTION

As previously explained in Section 2.1, the HBGPM technology uses hydrogen gas as the electron donor to reduce nitrate to nitrogen gas and perchlorate and chlorate to chloride ions, as well as a range of other oxidized contaminants. The hydrogen is also used for biomass synthesis. For all test scenarios, the lead and middle reactors received similar quantities of hydrogen while the lag reactor received less hydrogen due to lower concentrations of total contaminants in the influent stream flowing to the lag reactor. In an attempt to improve system performance, the hydrogen flow was periodically adjusted during system operation. However, no efforts were made to optimize the hydrogen consumption since that was not an objective of the Pilot Test. Therefore, additional optimization testing of a range of hydrogen feed rates is recommended prior to design of a full-scale system if HBGPM technology is selected as part of the NERT final remedy.

The equations shown in Section 2.1 were used in conjunction with the influent contaminant concentrations to calculate the theoretical total hydrogen dosing requirements for the process for perchlorate, chlorate, and nitrate individually. ***Table 4*** presents a summary of the total average theoretical and actual hydrogen requirements for each test scenario. The actual hydrogen used will always be greater than the theoretical amount as the rate of mass transfer limits the amount of hydrogen that is captured by the biomass before hydrogen is lost to the atmosphere. It is noted that only the data sets that indicated perchlorate concentrations from the lag reactor at less than 18 µg/L (i.e., treatment goal achieved and system performing as required) were used in calculations associated with the hydrogen requirements.

Table 4. Average Theoretical Hydrogen Requirements and Actual Hydrogen Consumption for Each Scenario

Test Scenario	Total Contaminant		Hydrogen						Actual Hydrogen Used Above Theoretical Requirement (%)
	Concentration (mg/L)	Mass Loading (lbs/day)	Theoretical Requirement			Actual Use			
			sccm	mg/L	lbs/day	sccm	mg/L	lbs/day	
#1A	143	3.30	1,404	17	0.40	2,977	38	0.84	130%
#1B	161	2.90	1,180	19	0.33	2,064	32	0.58	75%
#2	276	2.49	993	31	0.28	1,577	49	0.45	59%
#3	314	2.81	1,139	36	0.32	1,793	56	0.51	57%
Overall	223	2.87	1,179	26	0.33	2,103	44	0.59	80%
#2 – Additional Testing	576	8.64	3,362	63	0.95	5,012	94	1.42	61%

Notes:
lbs/day – pounds per day
sccm- standard cubic centimeter per minute
mg/L – milligrams per liter

As noted in Section 2.3, the amount of hydrogen used during operations was in excess of the theoretical amount of hydrogen required as the purpose of the Pilot Test was to demonstrate, not optimize, the technology. While the study achieved its objectives, it is unknown what efficiencies could be achieved in future iterations of the technology If this technology were to be deployed by NERT as a component of its final remedy, there are a great number of operational parameters that would be further refined and optimized using the results of this Pilot Test.

Table 4 shows that the average theoretical hydrogen requirement ranged from 0.28 to 0.40 lbs/day, while the actual hydrogen use ranged from 0.45 to 0.84 lbs per day. This indicates that on average, the system required 80% more hydrogen to achieve the perchlorate degradation to below the 18 µg/L treatment goal than was theoretically calculated to be required. The Test Scenario #2 Additional Testing indicated that the system required 61% more hydrogen to achieve perchlorate degradation to below the 18 µg/L treatment goal than was theoretically calculated to be required. However, since hydrogen solubility in water is approximately 18 mg/L, a portion of the excess hydrogen is hydrogen that is lost by dissolving in the water and may represent a significant portion of the difference between the theoretical and actual dose. It is acknowledged that this loss might not be insignificant in the context of a full-scale design and will be further evaluated in the forthcoming FS if the technology advances through the required screening steps.

5.4 CONSUMPTION OF CARBON DIOXIDE, NITROGEN, AND AIR

Carbon dioxide, nitrogen, and air are all used in the system for various controls of the treatment process. Specifically, each constituent is used in the process as follows:

- Carbon dioxide: When nitrate is reduced biologically to nitrogen gas in the treatment process, hydroxide ions are generated resulting in an increase in the pH. In order to provide bulk and localized pH control, carbon dioxide was added to the hollow fibers within the reactors to keep the pH within the range of 7.3 to 8.0.
- Nitrogen: Biomass is generated during the treatment process, which can accumulate on the reactor membranes and result in a pressure increase within the reactors. Nitrogen was sparged daily into each reactor during the Pilot Test to slough off the excess biomass and minimize this pressure increase. The frequency and duration of nitrogen sparging in the reactors were adjusted throughout the operational period in an effort to minimize pressure buildup.
- Air: Groundwater at the NERT site contains high concentrations of sulfate, and the creation of anoxic conditions during the treatment process can reduce sulfate to hydrogen sulfide and result in growth of sulfate-reducing bacteria. APTwater recommended the addition of air to the lag reactor to reduce the potential for sulfate-reducing bacteria to overtake the perchlorate-reducing bacteria.

A summary of the carbon dioxide, nitrogen, and air added to the reactors when the system was operating as intended (i.e., perchlorate concentrations following treatment in the lag reactor met the treatment goal of 18 µg/L) is provided in Appendix E, Table E.1. Noteworthy findings include the following:

- The average carbon dioxide consumption for the various test scenarios ranged from approximately 12.6 to 17.7 cubic feet per day (ft^3/day), which equates to an average carbon dioxide consumption per pound of total COPC (perchlorate, nitrate and chlorate) of 5.5 cubic feet per pound (ft^3/lb). Carbon dioxide added at these rates successfully maintained a system pH ranging from 7.3 to 8.0.
- The average nitrogen amount that was used by the system during each test scenario ranged from 252 ft^3/day to 392 ft^3/day, which equates to an average nitrogen addition per pound of total COPC of 121 ft^3/lb. The active sparge time in the reactors ranged from 30 to 90 seconds at a sparge rate of 28 cubic feet per minute. The initial sparge frequency was twice per day but was increased to four times per day in an attempt to minimize pressure rise in the reactors. It is noted that despite nitrogen sparging, the pressure still gradually increased in the reactors to levels that required chemical cleaning after each test scenario. Additional testing and evaluations will be required by APTwater to determine the appropriate nitrogen sparge rates (or other remedy) to minimize pressure buildup in the reactors. APTwater is also currently conducting a trial on a pilot module at its facility that does not require chemical cleaning and is designed for improved water flow and sparge distribution.
- The largest quantity of air was added to the lag reactor during Test Scenario #1A, for which air flow ranged from 222 standard cubic centimeter per minute (sccm) to 1,800 sccm (average of 1,187 sccm);

this equates to an average of 16.9 ft^3 of air per pound of total COPC. In subsequent test scenarios, the air flow to the lag reactor was reduced to improve perchlorate removal in the lag reactor. In Test Scenarios #1B and #2, the average air flow was 100 sccm and 138 sccm, respectively, resulting in an average of 1.8 and 2.8 ft^3 of air per pound of total COPC. Air was not added to the lag reactor during Test Scenario #3 due to compressor malfunction which prevented air addition. Efforts were made by both Tetra Tech and APTwater to repair or replace the compressor. However, due to the ongoing COVID pandemic and supply chain issues, required replacement materials and subcontractors were not available during the short testing time period. As discussed in Section 5.1, some evidence of sulfate reduction was observed during all test scenarios; however, it is unclear whether this significantly impacted system performance.

5.5 NUTRIENT REQUIREMENTS

Although biomass requires nutrients to grow, anoxic and anaerobic biological processes require fewer nutrients than aerobic processes. The key nutrients that are generally needed for anaerobic biological processes are phosphorous and nitrogen. Phosphoric acid was added to the nutrient process delivery system to provide a source of phosphorus during all scenarios within the pilot unit at a concentration ranging from 1 mg/L to 1.5 mg/L. Elevated nitrate levels were present in the influent water so additional nitrogen was not added during Test Scenarios #1A, #1B, and 2, since it was not a limiting nutrient.

As part of the operational sampling performed for each scenario, samples were periodically collected and analyzed for total phosphorous for continued evaluation of nutrient requirements during system operations. If the residual phosphorous in the treated water leaving the lag reactor was at concentrations less than 0.5 mg/L, additional nutrients were added as needed to compensate for the consumption.

Due to the slow acclimation observed during Test Scenario #3, additional operational samples were collected and analyzed for ammonia as nitrogen. Concentrations of ammonia as nitrogen were less than sample detection limits (0.1 mg/L) indicating that nitrogen could be a limiting nutrient. As a result, ammonium sulfate (equivalent to 1 mg/L ammonia as nitrogen) was continuously added to the influent water via the nutrient delivery system. Shortly after the addition of ammonium sulfate as well as other system modifications previously discussed in Section 5.1.3, the system acclimation was completed, and the performance sampling began. Based on observations from this pilot study, periodic evaluation of nitrogen concentrations may be beneficial in a full-scale operation to observe that nitrogen is not a limiting nutrient for perchlorate reduction.

5.6 BIOMASS GENERATION

As explained in Section 2.1, the biological reduction of perchlorate, chlorate, and nitrate in an anoxic process, in which molecular oxygen is absent, generates biomass. Theoretically, when hydrogen is used as the electron donor in the biological reduction process, the quantity of biomass that is generated is less than when organic compounds (such as ethanol) are used as electron donors. This section provides an overview of the process used to quantify both the theoretical and actual amount of biomass produced during the HBGPM testing scenarios as well as a comparison of those data to the existing FBR system. The data used for this assessment are included in Appendix F.

5.6.1 Biomass Generation

Both the theoretical biomass and actual biomass generation were calculated for evaluating the biomass produced during the Pilot Test scenarios. The chemical equations provided in Section 2.1 present the theoretical biomass synthesis when hydrogen is used as the electron donor. Using these equations and the average COPC influent concentrations for each test scenario, the theoretical biomass generated from the HBGPM was calculated for each test scenario.

The TSS data collected for each test scenario were used to calculate the actual biomass generated during the Pilot Test. The original intent of the post-treatment design was for the solids to be captured in the clarifier and then be pumped to the solids holding tank, which would allow for the flow rate and composition of the settled solids to be used to estimate excess biomass produced during system operations. However, as discussed in Section 5.1.1.1, the clarifier was bypassed due to low concentrations of TSS leaving the lag reactor. Therefore, the actual biomass generated during each test scenario was quantified using the influent and effluent TSS results; the quantity of solids collected in the cartridge filter (when used); and results from the TSS and TOC analyses of the spent cleaning solution at the end of each scenario. The equation used to calculate the actual biomass generated is provided below.

$$Biomass = S_{OUT} + S_M - S_{IN}$$

Where:

$Biomass$ $\left(\frac{mg}{L}\right)$ represents the actual biomass generated;

S_{OUT} $\left(\frac{mg}{L}\right)$ represents the suspended solids out of the system including both TSS in the final effluent stream leaving the system and the solids collected in the cartridge filter (when used);

S_M $(\frac{mg}{L})$ represents the solids accumulated in the membrane from the start of each scenario to the end of the scenario when the membrane was cleaned; and

S_{IN} $(\frac{mg}{L})$ represents the average of the influent TSS concentrations.

S_M was calculated using both TOC and TSS results from samples collected during system cleaning at the completion of each scenario and the volume of water that was processed during the scenario. It should be noted that the sample result for TOC was adjusted to calculate the biomass in the spent cleaning solution associated with TOC because organic carbon accounts for only 53 percent of the biomass molecular weight (chemical formula $C_5H_7NO_2$). The accumulated biomass was calculated using both sets of results since the TOC and TSS results from samples collected from the three reactors and from cleaning solution samples collected from the holding tank differed greatly.

Table 5 presents the actual and theoretical biomass generation for each scenario.

Table 5. Actual and Theoretical Biomass Generation for Each Scenario

Test Scenario #	Actual Biomass Concentration (mg/L)			Theoretical (mg/L)	Actual (Average)/ Theoretical	Actual Biomass (kg)	
	Calculated Using Reactor Data	Calculated Using Holding Tank Data	Average Biomass			Calculated Using Reactor Data	Calculated Using Holding Tank Data
1A	6.3	11.9	9.1	19.3	0.47	8.3	15.8
1B	3.8	6.3	5.0	18.4	0.27	2.6	4.3
2	20.3	23.0	21.6	32.1	0.67	9.2	10.5
3	32.3	NA	32.3	36.2	0.89	11.1	NA

Notes:
mg/L – milligrams per liter
NA – not applicable for Test Scenario 3 as holding tank was not used during cleaning process due to the hazardous nature of the water

As expected, the biomass generation during Test Scenarios #1A and #1B were somewhat similar, with average concentrations ranging from 5.0 to 9.1 mg/L with an average of 7.0 mg/L. Biomass concentrations in a treatment process are directly proportional to COPC concentrations; therefore, the biomass generated in Test Scenarios #2

and #3 were higher as the total influent COPC concentrations were higher. The actual biomass generated from process operations has also been calculated based on the varying operational times and amount of water treated through the system and is provided in Table 5 for informational purposes.

The ratio of actual to theoretical biomass for the pilot test ranged from 0.27 to 0.89 for the various test scenarios, which was expected since the biomass goes through endogenous respiration and gets partially degraded the longer the biomass spends in the reactors. In the APTwater pilot system, since the majority of biomass accumulates on the membrane surfaces, the biomass loss due to endogenous respiration is high.

5.6.2 Comparison to FBR Biomass Generation

As part of the on-going FBR operations, ETI measures biomass concentrations at the entrance to the dissolved air floatation (DAF) unit before chemicals are used to precipitate solids and remove them in the DAF unit. During the precipitation process, ferric chloride and polymers are used at the DAF unit to coagulate and flocculate the solids before the filter press is used to dewater the solids prior to disposal. In evaluating the biomass generation associated with the existing FBR system, data from August 2020 through February 2021 was used (Appendix F, Table F-3). This time period coincides with the time period for completing Test Scenarios #1A and #1B which used the same influent water as the FBR system. The average biomass concentration at the DAF unit during this period was 15.9 mg/L, which is more than double the average calculated actual biomass for Test Scenarios #1A and #1B of 7.0 mg/L.

The theoretical biomass generation of the FBR system was calculated using the equations in Section 2.1. The average total COPC influent concentration of 150.4 mg/L (perchlorate, chlorate, and nitrate) based on the results from Test Scenarios #1A and #1B was used in the equations. The theoretical biomass of the FBR system is calculated to be 99.9 mg/L, which is higher than the theoretical biomass generated by the HBGPM system for the same time frame (19.3 mg/L for Test Scenario #1A and 18.4 mg/L for Test Scenario #1B).

6.0 HYPOTHETICAL DESIGN OF FULL-SCALE SYSTEM

As described in the System Operation Manual (Tetra Tech, 2020) and summarized in Section 3.1, upon completion of the primary Pilot Test objectives, an additional set of objectives were to be evaluated with respect to a hypothetical scaled-up system. Specifically, those objectives are as follows:

- Demonstrate whether the cost of hydrogen used as an electron donor might be less than the cost of ethanol.
- Develop a preliminary set of strategies for scaling up the treatment process under field conditions at NERT.
- Evaluate the potential staffing and O&M needs for a full-scale system.
- Quantify the budgetary capital and operational cost estimates for an APTwater system for use in the FS.

This section evaluates a hypothetical full-scale system with respect to the objectives presented above. The costs presented herein should be considered for informational purposes only. During the FS, costs related to the various potential components of the NERT final remedy will be presented for relative comparisons with -30/+50 percent accuracy and evaluated consistent with EPA FS guidance inclusive of the non-cost criteria. The cost evaluation presented herein should not be used to directly compare the treatment costs of a hypothetical system to the current iteration of the on-site GWETS, as such technology comparisons will be accomplished through the NERT FS. Cost comparisons included in this section are strictly hypothetical and made only for the purpose of satisfying the Work Plan objective.

The hypothetical scaled-up HBGPM system described below assumed that the large-scale system has the same system configuration as the pilot unit and utilized data from the Pilot Test. This means that the large-scale system described herein was designed with three reactors operated as lead, middle, and lag reactors. However, it is noted that very limited testing was performed to optimize system performance, and therefore more tests would be necessary to determine the optimal ranges of key system parameters including COPC mass loadings and ORP, hydrogen, carbon dioxide and nutrient consumption rates, and sparging strategies/frequencies, should HBGPM technology be selected as a component of the NERT final remedy. The Trust acknowledges NDEP's review comments on Revisions 0 and 1 of this report, which relate to potential optimizations of the pilot system and requests for additional full-scale design details and considerations of a hypothetical full-scale system. There are a great number of operational parameters that would be further refined and optimized using the results of this Pilot Test if this technology were to be deployed by NERT as a component of its final remedy. While this revision of the report includes details as requested by NDEP, the additional information should be considered in no way to be exhaustive, as the purpose of this report is to outline the results of the Pilot Test with a very specific set of objectives. If this technology is selected as part of the NERT final remedy, the full-scale system would be specifically designed with respect to a new set of objectives, parameters, and assumptions required to meet the remedial action objectives in the area in which NERT would be deploying the technology.

6.1 DESIGN BASIS FOR A HYPOTHETICAL FULL-SCALE HBGPM SYSTEM

As indicated above, a set of objectives have been established with respect to a hypothetical scaled-up HBGPM treatment system. It should be noted that the NERT FS has yet to be conducted; therefore, it is not practical at this time to determine where or how this technology could be used if it were to be selected as a component of the NERT final remedy. Accordingly, the basis for this hypothetical design included the following generic key design components:

- **Design Flow:** A design flow of 1,000 gpm of extracted groundwater, which is similar to the current FBR system operations. The hypothetical design basis mass loading for each COPC is shown in ***Table 6***.

- **Design Basis:** Analytical data from samples collected during the pilot testing of Test Scenarios #1A and #1B were used as the basis for contaminant concentrations and mass loading for the hypothetical treatment system. The influent to the system was assumed to be similar to the influent stream currently treated in the existing FBR system, which includes extracted groundwater from the AWF, IWF after chromium removal by the GWTP, and the portion of the SWF that is not currently treated by the ion exchange system. As demonstrated in Test Scenario #3, this hypothetical HBGPM design could also reduce hexavalent chromium in extracted groundwater, which would eliminate the need for pretreatment by the GWTP, but likely with increased waste disposal costs. As presented in Section 4.2.1, the spent cleaning solution from Test Scenario #3 was determined to be characteristically toxic hazardous waste so hazardous waste disposal may be required if a full-scale HBGPM system was used for chromium treatment. As a result, additional assessment of cleaning requirements and disposal would be required.

Table 6. Mass Loading for Hypothetical HBGPM System Scale-Up Design

Parameter	Concentration [1] (mg/L)	Mass Loading (lb/day)	Theoretical Hydrogen Requirement (lb/day)
COPC Loading at Flow Rate of 1,000 gpm			
Perchlorate	52	628	70.0
Chlorate	99	1,191	117.9
Nitrate	8	96	8.9
Total Contaminant	**159**	**1,915**	**196.9**

Notes:
[1]Concentrations determined based on average influent data collected during performance sampling in Test Scenarios #1A and #1B (See Appendix C). It should be noted that if this technology is selected as part of the NERT final remedy, the full-scale system would be specifically designed with respect to a new set of objectives, parameters (including actual influent concentrations), and assumptions required to meet the remedial action objectives in the area in which NERT would be deploying the technology.
mg/L - milligrams per liter
lb/day - pounds per day
gpm – gallons per minute

6.2 REACTION RATES FOR REDUCTION OF CONTAMINANTS

As explained in Section 2.1, reduction of COPCs in the HBGPM Treatment System occurred on the membrane surfaces within the lead, middle, and lag reactors. As a result, the surface area of the membranes was considered a key design parameter in the hypothetical design of a full-scale HBGPM system. The membrane requirements for the full-scale design were calculated using the data collected during the Pilot Test for the average mass flux from Test Scenarios #1A and #1B, which were the scenarios representative of the existing FBR groundwater influent stream. The relationship used to determine the number of reactor modules is as follows:

$$Modules\ Required\ = \frac{Projected\ Full-Scale\ Mass\ Loading}{Calculated\ Mass\ Flux\ for\ Reactor\ During\ the\ Pilot\ Test}$$

Based on the equation above, the hypothetical full-scale treatment system would require a minimum of 3,740 modules for treatment of perchlorate concentrations to below the criterion of 18 µg/L. ***Table 7*** presents a summary of the calculated membrane requirements for a hypothetical full-scale system.

Table 7. Mass Flux and Module Requirements for Hypothetical Full-Scale Design

Parameter	System Total
Average Calculated Mass Flux from Test Scenarios #1A and #1B (lbs/day ft^2)	3.33 X 10^{-4}
Projected Full-Scale Mass Loading (lbs/day for 1,000 gpm feed)	1,915
Membrane Area (ft^2)	5,755,195
Membrane Area Per Module (ft^2)	1,539
Total Modules (Minimum Required)	**3,740**

Notes:
lbs/day ft^2 – pounds per day per square foot
lbs/day - pounds per day
ft^2 – square foot

6.3 DESCRIPTION OF THE HYPOTHETICAL TREATMENT SYSTEM

The hypothetical HBGPM system was designed based on the performance sampling results to simulate the reactor configuration of the Pilot Treatment System. As discussed earlier, the hypothetical HBGPM system would be comprised of a lead, middle, and lag reactor (to match the basic design of the Pilot System) to treat the 1,000-gpm feed with a total mass load of 1,915 lbs/day (similar to the influent feed water for the current FBR system). The primary components of the hypothetical system would include:

- Influent feed equalization tank and nutrient delivery system;
- Three reactors, which contain the patented APTwater hollow-fiber membranes modules;
- Three recirculation pumps;
- Hydrogen generation and delivery system;
- Carbon dioxide delivery system;
- Nitrogen gas delivery system;
- Effluent filtration system including a sludge dewatering system;
- PLC based process control; and
- Remote monitoring with safety and shutdown alarms and data logging.

A process flow diagram for the hypothetical HBGPM System treatment process is shown on Figure 12. A more detailed description of each component of the design is provided below.

6.3.1 Influent Feed Equalization Tank and Nutrient Delivery System

In this hypothetical system, extracted groundwater would be directed to a filtration system to remove inert solids that are expected to be in the influent and then to an equalization tank to reduce the fluctuations in flow and composition of the influent water. Although the need for an equalization tank would be further assessed during the detailed design process, an equalization tank has been included in the hypothetical design to provide a conservative estimate. For purposes of design, the equalization tank would be an approximately 1.5-million-gallon carbon steel tank (or equivalent), with the size selected to provide a minimum of 24 hours of holding capacity (a common rule of thumb for sizing equalization tanks) if the system operated at full capacity with a flow rate of 1,000 gpm. The equalization tank would be operated at approximately 65 to 70 percent capacity, which equates to 975,000 to 1,050,000 gallons, to provide some storage capacity for flow control. The water level in the equalization tank would be kept constant via a modulating control valve with a recirculation line to regulate water flow into the treatment system. An influent pump with flow meter would be installed at the discharge of the equalization tank to measure the influent flow rate to the reactors during operation. Lastly, prior to pumping the

influent water from the equalization tank to the lead reactor, nutrients in the form of phosphoric acid or other phosphate compounds, if required, would be dosed into the feed using two metering pumps.

6.3.2 Biological Reactors and Recirculation Pumps

In this hypothetical system, three 120,000-gallon reactors (lead, middle, and lag reactors) containing APTwater's patented hollow-fiber membranes would be used for groundwater treatment. Based on the results presented in ***Table 7***, a minimum of 3,740 modules would be required in this hypothetical full-scale system to treat perchlorate with an influent flow rate of 1,000 gpm to below the 18 µg/L discharge criterion. This results in a minimum of 1,247 modules in each of the three reactors, which would be installed in individual sections within each reactor for individualized control during cleaning operations. Each section of the reactor would consist of 104 modules oriented in eight rows of 13 modules each, resulting in 12 sections required to achieve treatment to the discharge criteria. One additional section of modules would be added within each reactor to compensate for the treatment capacity loss during module cleaning. This addition would result in a total of 13 sections, each containing 104 modules, for a grand total of 1,352 modules per reactor. Therefore, the total number of modules for the treatment system would be 4,056.

Each reactor would have a recirculation pump, which would recirculate water at a rate of 12,500 gpm to a pulse manifold system to evenly distribute the water to each of the modules within the reactor. Use of the pulse manifold would reduce pumping costs with no reduction in performance because the modules would only need a short agitation of flow rather than a continuous flow of water through the module. This design configuration would reduce pumping rates by approximately 75 percent.

6.3.3 Hydrogen Generation and Delivery System

Hydrogen gas would be injected into each of the three reactors during the treatment process. During this hypothetical design, research was performed to identify technologies capable of generating hydrogen on-site. This resulted in an evaluation of both electrolysis and steam/methane reforming (SMR). Electrolysis is a process in which electricity is used to break water molecules into hydrogen and oxygen. Current SMR technology typically allows for a smaller footprint and cost. SMR technology also has an added benefit that carbon dioxide is generated, which would eliminate the need to deliver and store carbon dioxide in on-site storage tanks. However, improved electrolysis technologies are rapidly evolving.

The hydrogen generation technology selected will have a significant cost implication in a full-scale system and must be thoughtfully considered. Because hydrogen generation technologies are rapidly evolving, a separate cost-benefit analysis would be required to evaluate the capital and long-term operation and maintenance requirements of an on-site hydrogen generation system at the time of design if selected as a component of the NERT final remedy. This cost-benefit analysis should include an evaluation of the availability, type, and quality of feedwater required for hydrogen generation. For purposes of this hypothetical design, the current unit price rate of liquified hydrogen with an onsite hydrogen storage system was used in the cost estimating process.

The theoretical hydrogen requirement for each reactor to Reduce an influent feed with the COPC concentrations shown in ***Table 6*** to below the target concentration of 18 µg/L in the lag reactor was calculated to be 225 lb/day. It was assumed that for a hypothetical full-scale HBGPM system, hydrogen would need to be generated at an excess of 50 percent of the theoretical quantity to achieve the 18 µg/L discharge criterion. Note that the assumed 50 percent excess hydrogen usage for the hypothetical full-scale system is lower than the overall average hydrogen consumption of 80 percent reported during the Pilot Test and described in Section 5.3. Optimization of the hydrogen dosing was not completed as part of this pilot testing, and several performance samples from each test scenario showed the system could meet discharge limits when operating at approximately 50 percent excess hydrogen. Additionally, APTwater has indicated that it continues to work on several system optimization measures that may improve overall treatment effectiveness. Using a 50 percent excess, the hydrogen requirement for the hypothetical system would result in a projected hydrogen consumption of 337.5 lbs/day. Hydrogen flow would be

dosed into the reactors based on the influent feed rate. Each reactor would have a dedicated hydrogen flow controller and flowmeter, and the hydrogen dosing ratio would be adjusted by the PLC over time, based on operational data to maximize treatment capacity while minimizing potential sulfate reduction. The hydrogen would pass through a manifold after the flow controller to allow for distribution to each of the modules.

6.3.4 Carbon Dioxide Delivery System

Carbon dioxide would be used within the hypothetical system to buffer elevated pH conditions that could develop during nitrate reduction in the treatment process. It was estimated that the hypothetical system would require approximately 11,010 ft^3/day of carbon dioxide based on Pilot Test results. Carbon dioxide would be injected to the hollow membrane fibers for local pH control and dosed based on the hydrogen flow rate (typically 10 percent of hydrogen flow rate). Carbon dioxide would also be added to the lead, middle, and lag recirculation pumps, with the rates adjusted based on the pH readings from the discharge lines. Each reactor would have its own pH/carbon dioxide flow control loop so that if pH rises above the setpoint, additional carbon dioxide would be added to the reactor to lower pH.

6.3.5 Nitrogen Gas and Air Delivery Systems

As biological reduction occurs within the reactors, additional bacterial cells are generated. As a result, nitrogen gas would be periodically injected into the recirculation loops to help control the population of biomass in each module and reduce accumulation of excess biomass on membrane surfaces. For the hypothetical system, nitrogen would be generated on site via an air/nitrogen separator installed downstream of a 75 hp air compressor. Modules would be sparged with nitrogen gas at approximately 70 psi gauge pressure. It was assumed the nitrogen sparge duration and frequency would be approximately 30 to 90 seconds per sparge and four sparges per day, similar to the Pilot Test operations. The sparge frequency and duration would be controlled by the PLC and optimized during system operation. Using the Pilot Test data, it was estimated that the hypothetical system would require approximately 212,600 ft^3/day of nitrogen. However, as discussed in Section 6.4.3 below, APTwater is currently testing an improved nitrogen sparging system that may change the operational strategies for the nitrogen sparge system.

In addition to nitrogen, air would be added to the lag reactor to minimize overgrowth of sulfate-reducing bacteria. Using the average air consumption rates observed during Test Scenarios #1A and #1B, the air consumption for a full-scale treatment system was estimated to be 17,900 ft^3/day.

6.3.6 Effluent Filtration

Treated water from the lag reactor of the hypothetical system would be pumped through two parallel multi-media filters to remove residual concentration of biological solids from the treated water prior to discharge. The two filter beds, which would be comprised of sand or zeolite, would be expected to have over 99 percent recovery. While one filter is being backwashed using water from the equalization tank, the second filter would be in operation to remove solids from the treated water. Operation of the filters would be controlled based on the pressure readings across the filter bed. When the pressure reaches a preset value, the filter would be shut down and taken out of operation and the second filter would be put back online. The filters will be backwashed with clean treated water holding tank.

The backwash from the filters would be sent to a 40,000-gallon backwash tank. It was estimated that the media filters would be backwashed four times per day, each time generating approximately 7,500 gallons of backwash, and the settled sludge in the backwash tank cone bottom would be approximately 20 percent of the backwash waste. Therefore, assuming 20 mg/L of TSS in the lag reactor, a 1,000-gpm treatment system would generate approximately 30,000 gallons per day of backwash containing approximately 950 mg/L of TSS. A diluted polymer solution would be added to the backwash water entering the backwash holding tank to help flocculate the solids for faster settling and easier dewatering. A decant pump would then send the clarified water from the backwash

tank to the equalization tank and settled solids would be sent to a centrifuge with a 25-gpm capacity to be dewatered. The centrifuge would be designed to operate 4 hours per day to produce a solids cake with approximately 18 to 20 percent solids content which should pass the paint filter test. The centrate would be recycled to the equalization tank, and the solid cake from the centrifuge would be sent off site for disposal.

6.3.7 Maintenance of the Membrane Modules

As described in Section 4.2.1, over time, biomass accumulates over membrane surfaces resulting in a gradual pressure increase in the reactors that can adversely impact membrane performance. APTwater believes that when the pressure reaches a preset value of 25 psi and the system is operated under these conditions for an extended period of time, the structural integrity of the membranes may be compromised. As a result, one section of modules from each reactor of the hypothetical system would be taken out of operation and chemically cleaned once every 12 weeks (based on Pilot Test results indicating a pressure increase to these levels after each 12-week scenario). The hypothetical system includes an additional section of modules within each reactor to compensate for the treatment capacity loss during module cleaning. In other words, in the operation of this hypothetical system, the remaining sections of modules will continue to treat the influent water while other modules are being cleaned. A 25 percent sodium hydroxide solution stored in a 5,000-gallon holding tank would be used to clean the membranes. During cleaning, the high pH solution would be recirculated in the predetermined sections of the reactors for several days to dissolve or dislodge most of the biomass accumulated on the membrane surfaces. Recirculation would be continued until the module pump discharge pressure stops decreasing. Once the pressure has stopped decreasing, the spent caustic solution would be sent to a 35,000-gallon carbon steel tank to be stored prior to off-site disposal.

6.3.8 System Monitoring and Control

The hypothetical system would be designed with a high degree of automation to enable system operators to control a wide variety of operating parameters via a touch-sensitive Human Machine Interface. There would be a lower explosive limit (LEL) sensor over each module basin to measure the atmosphere above each basin for hydrogen. If the hydrogen concentration exceeded 25 percent of the LEL for hydrogen, the system would shut down and an alarm notification would be sent to the operator.

Each reactor of the hypothetical system would be equipped with devices to monitor operational parameters including pH probes, ORP probes, nitrate analyzer, and hydrogen flow controllers. Each of the 13 sections within the reactors would be equipped with an open/close control valve to allow for isolating each section during the cleaning process. In addition, six level transmitters would be installed throughout the system in the equalization tank, reactors, backwash tank, and spent caustic tank. Although temperature control was required during the Pilot Test due to small-scale operations that included storage of water in above-ground holding tanks, temperature control of the equalization tank was not included in the hypothetical full-scale treatment system design since the influent water would be stored in an equalization tank with less than 24 hours of holding capacity. During detailed design of a full-scale system, if such technology was selected as a component of the NERT final remedy, a heat balance would be required to determine if temperature control measures would be required. Sample ports would be installed at several locations in the hypothetical system to collect samples of raw, intermediate, and treated water and to analyze for perchlorate, chlorate, nitrate, TSS, and other parameters that may be needed.

6.4 PRELIMINARY COST ESTIMATE

A preliminary cost estimate was developed to quantify the budgetary capital and operational costs for a hypothetical full-scale HBGPM treatment system with a basis of design as discussed in Sections 6.1 through 6.3. Additional system optimizations, as discussed in Section 6.4.3, could reduce the budgetary capital and operational costs. It should be noted that the costs presented herein should be considered for informational purposes only. During the FS, costs related to the various potential components of the NERT final remedy will be

presented for relative comparisons with -30/+50 percent accuracy consistent with EPA FS guidance. If this technology is selected as part of the NERT final remedy, the full-scale system would be specifically designed with respect to a new set of objectives, parameters, and assumptions required to meet the remedial action objectives in which NERT would be deploying the technology.

6.4.1 Capital Costs

A summary of the capital cost associated with the hypothetical full-scale HBGPM is provided in ***Table 8***, with an itemized breakdown of costs that includes the type, size/capacity, construction material, and function provided in Appendix G, Table G.1. Major equipment and instrumentation prices were developed by contacting vendors, discussing the project specifics, and getting preliminary estimates for the equipment. Tetra Tech used a rough order of magnitude cost for smaller equipment and instruments based on experience and quotes from previous projects. Commercially accepted factors were used for other cost elements including mechanical, electrical, civil, structural engineering, start-up, and operation. Finally, a contingency of 25 percent was added to the total cost to account for project unknowns during the preliminary stages of the project development; however, this contingency may not fully capture cost escalation associated with the current inflationary environment, supply chain restrictions and other factor associated with the current global economic conditions. The total cost for equipment and instruments in 2022 dollars was estimated at $18,309,000.

Table 8. Summary of Equipment and Instrumentation Cost for Hypothetical Full-Scale Implementation

Equipment	Description	Approximate Cost
Tanks	Equalization Tank Lead, Middle, and Lag Reactors Caustic Holding Tank Spent Caustic Holding Tank Backwash Holding Tank Carbon Dioxide Tank Treated Water Holding Tank[1]	$5,825,000
Other Equipment	Pretreatment Filtration System[1] Nitrogen Separator/Nitrogen Tanks Centrifuge Membrane Modules Air Compressor Polymer Additional System Media Filter	$10,776,000
Pumps	Influent Pump Reactor Recirculation Pump Cleaning Solution Recirculation Pump Raw Caustic Transfer Pump Spent Caustic Pump Backwash Pump Decant Pump Centrate Pump Nutrient Metering Pump	$1,094,000
Instruments	Various	$614,000
	TOTAL HYPOTHETICAL EQUIPMENT COST	**$18,309,000**

[1] Budgetary cost. Pricing not obtained by vendor.

The estimated capital costs for hypothetical full-scale implementation are shown in ***Table 9***. A 1,000-square-foot building was included for laboratory space and analytical testing. Piping modifications to the existing extraction well system were not included in this cost. Commercially accepted factors were used to estimate the installation costs based on a percentage of the total equipment costs. A contingency of 25 percent of total project cost was

included to account for project uncertainties; however, this contingency may not fully capture cost escalation associated with the current inflationary environment, supply chain restrictions and other factor associated with the current global economic conditions. The total preliminary capital cost estimate for a full-scale HBGPM system was estimated at $42,502,000 in 2023 dollars.

Table 9. Estimated Capital Costs for Hypothetical Full-Scale Implementation

Item	Factor		Qty
Equipment			
Equipment Subtotal (See ***Table 8***)			$18,309,000
Laboratory Building			$200,000
Start-up/Training	2%	of Equipment Subtotal	$367,000
Taxes	7%	of Equipment Subtotal	$1,282,000
Freight	5%	of Equipment Subtotal	$916,000
		Total Hypothetical Equipment Costs	**$21,074,000**
Installation Labor			
Mechanical Installation	12%	of Total Equipment Costs	$2,529,000
Electrical Installation	6%	of Total Equipment Costs	$1,265,000
Instruments and Controls	5%	of Total Equipment Costs	$1,054,000
Structural Installation	3%	of Total Equipment Costs	$633,000
Site Civil Work	3%	of Total Equipment Costs	$633,000
		Total Hypothetical Installation Costs	**$6,144,000**
Other Construction Costs			
Mobilization/Demobilization	13%	of Total Installation Cost	$795,000
		Total Hypothetical Other Construction Costs	**$795,000**
		Total Hypothetical Construction Cost (including Equipment, Installation and Other Construction Costs)	**$27,983,000**
Engineering/Construction Administration			
Design/Engineering	8%	of Total Construction Cost	$2,239,000
Construction Admin	7%	of Total Construction Cost	$1,400,000
Contractor OH&P	8.5%	of Total Construction Cost	$2,379,000
		Total Hypothetical Project Administration Cost	**$6,018,000**
		Total Hypothetical Project Cost	**$34,001,000**
Other			
Contingency	25%	of Total Project Cost	$8,501,000
		TOTAL HYPOTHETICAL CAPITAL COST	**$42,502,000**

6.4.2 Operating Cost Estimate

The total estimated annual operating cost estimate for the hypothetical full-scale HBGPM system was estimated at $4,367,000 in 2022 dollars. The primary components of the operation and maintenance costs are detailed in ***Table 10*** and include the following:

- Power cost, which assumed $0.0765 per kwh and was based on the anticipated system horsepower requirements and average 2021 rates from NV Energy;
- Hollow-fiber membrane module replacement cost, which assumed replacement every 7 years to ensure optimum performance (based on discussions with various membrane vendors and consultation with APTwater regarding past experience);
- Hydrogen cost, which was estimated at $1.50 per pound based on information provided by AirGas;
- Carbon dioxide costs, which was estimated at $0.30 per pound based on information provided by AirGas;
- Nitrogen cost, which was determined using the horsepower requirement of the nitrogen booster pump to produce the required nitrogen for the system;
- Polymer cost, which was based on using 5 lb/day of polymer to settle solids in 30,000 gallons per day of backwash at a concentration of approximately 20 mg/L TSS;
- Cleaning solution costs, which was based on quantities used in the Pilot Test cleaning process and assumed 100 gallons of 25% raw caustic and 100 gallons of sulfuric acid would be used in each reactor section during each cleaning;
- Spent caustic disposal cost, which was based on quarterly cleaning of each section that would generate approximately 10,000 gallons of non-hazardous waste per section during cleaning;
- Dewatered solids cake disposal cost as non-hazardous waste at an off-site landfill, which assumed that the treated water would contain no more than 20 mg/L TSS resulting in backwash water from the media filter being dewatered to result in up to 18 to 20 percent solids cake; and
- Maintenance cost, which was assumed to be 2 percent of the capital costs.

The operating cost estimate does not include the operations staff, which would likely consist of a minimum of two people, 24 hours per day, 7 days a week.

Table 10. Estimated Annual Operating Costs for Hypothetical Full-Scale Implementation

Cost Element	Description	Quantity	Units	Unit Cost	Total Cost	Percent of Total Cost
Power						
1. Pumps	Various Pumps	1,520	hp	$0.0765/kwh	$760,000	17.4%
2. Compressor	Air Compressor for Nitrogen Generation	75	hp	$0.0765/kwh	$7,000	0.2%
3. Nitrogen Booster	Booster pump for nitrogen	100	hp	$0.0765/kwh	$9,000	0.2%
4. Centrifuge	Dewater solids	50	hp	$0.0765/kwh	$5,000	0.1%
Hydrogen Cost[1]	Air Gas quote	350	lbs/day	$1.50/lb	$192,000	4.4%
Carbon Dioxide Costs	Air Gas quote	1,356	lbs/day	$0.30/lb	$149,000	3.4%

Cost Element	Description	Quantity	Units	Unit Cost	Total Cost	Percent of Total Cost
Module Replacement Cost[2]	Total 4,501 modules	578	per year	$2,000/ module	$1,156,000	26.5%
Polymer Cost	Flocculate solids in Backwash	5.0	lb/day	$4/lb	$8,000	0.2%
Maintenance Cost	Estimated at 2% of capital cost	2.0	%	$42,159,000	$844,000	19.3%
Cleaning Solution	25% caustic and acid	28,800	gal	$2.50/gal	$72,000	1.6%
Spent Caustic Disposal [3]	Three reactors-each section cleaned once per week	1,440,000	gal/year	$0.80/gal	$1,152,000	26.4%
Solids Disposal	Dewatered cake from centrifuge	0.667	tons/day	$50/ton	$13,000	0.3%
				Total Annual Cost:	**$4,367,000**	**100%**

Notes:
gal – gallon
gpm – gallons per minute
ft – feet
hp – horsepower
lb/day – pounds per day
[1] As noted in Section 6.3.3, additional research is required to determine the optimal hydrogen generation for a full-scale design.
[2] This cost has been annualized based on a 7-year replacement cycle.
[3] The spent caustic disposal assumes off-site disposal at a Republic Services facility. The disposal costs could be significantly reduced if disposal at a publicly owned treatment works were allowed.

The largest cost components of the hypothetical system are module replacement cost (26.5 percent of total operating cost), spent caustic disposal, (26.4 percent of total operating cost), power cost (17.9 percent of total operating cost) and maintenance (19.3 percent of total operating cost). The remaining operating cost elements are each less than 5 percent of total operating cost.

6.4.3 System Optimization

The design presented above is based on the performance sample results of each scenario of the Pilot Test and similar configuration of lead, middle, and lag reactors in the pilot system. However, the main objectives of the Pilot Test were to show stable and sustainable performance; consequently, limited testing was performed to optimize the system operation and determine the maximum mass loading and flux capacity of the system. The limited optimization testing performed as part of Test Scenario #2 Additional Testing suggested a higher mass loading and flux is possible, which would reduce the number of modules needed. Additional pilot testing would likely result in a more optimized, less expensive full-scale system. Additionally, there are several key system improvements APTwater has identified and is actively pursuing. These improvements include development of modules that do not require chemical cleaning, development of larger modules with more surface area, and reconfiguration of module placement to maximize surface loading. APTwater believes that these improvements will reduce the construction and operating cost of a full-scale system. A brief description of these improvements is included below.

APTwater is currently pilot testing a module configuration and sparging process that will not require cleaning. This module configuration has an improved water flow and sparge distribution design. The nitrogen sparge has direct channels molded into the core tube giving access to every water flow channel. This configuration creates an

effective sparge that scours excess biomass while maintaining optimum reduction control. The pilot testing of this new module design is not associated with or funded by NERT and began on June 1, 2021 and is on-going.

The HBGPM technology relies on the available surface area to reduce contaminants. The modules that were used in this pilot system were 6 feet long and 12 inches in diameter each with 143 m^2 of available surface area. If more surface area were added per module, the ratio of reduction capability would increase relative to the module footprint area. APTwater is developing a 24-inch diameter module that is 7 feet in length in an effort to accomplish this objective. This larger module would increase the available surface area over seven times while only increasing the module footprint by four times. With fewer modules, less power would be required to recirculate water through them and reactor volumes would decrease. This development is not associated with or funded by NERT.

The hypothetical full-scale system described in Section 6.3 assumed an equal number of modules in each reactor. Analytical data generated from the pilot system showed most of the reduction took place in the lead reactor position, including at the highest mass loading evaluated as part of the pilot test. Based on these results, theoretically more modules could be placed in the lead reactor to maximize system loading and reduce the system footprint. However, additional testing would be required to prove that this concept would be successful at achieving the 18 µg/L discharge criterion.

More testing and research would be required to determine the maximum mass loading of the system and optimal hydrogen dosing and to incorporate the above improvements into a full-scale design. However, it is likely the full-scale system discussed above could be optimized, resulting in an appreciable reduction in the capital and operating cost estimates presented herein. While no additional efforts are being completed at this time, NERT might pursue such additional evaluations in connection with the FS process.

6.5 COST COMPARISON FOR HYDROGEN VS ETHANOL

This section compares the hypothetical cost of hydrogen used as an electron donor to the cost of ethanol per pound of total contaminants removed (including perchlorate, chlorate, and nitrate). The equations shown in Section 2.1 were used to calculate the quantities of ethanol and hydrogen consumed per pound of perchlorate, chlorate, and nitrate in ***Table 11*** below. As explained in Section 6.3, it was assumed that hydrogen was used at 50 percent excess above the theoretical value. Assuming the unit cost for ethanol is $0.78/lb and for hydrogen is $1.50/lb (based on quote from AirGas), the cost of ethanol to treat one pound of total contaminant was calculated to be $0.76/lb while the cost of hydrogen to treat one pound of total contaminant was calculated to be $0.27/lb.

Table 11. Cost Comparison of Electron Donors

Parameter	Mass	Electron Donor (lbs/day)		Electron Donor Cost ($/lb)		Electron Donor Cost ($/yr)	
	lbs/day	Ethanol	Hydrogen	Ethanol	Hydrogen	Ethanol	Hydrogen
Perchlorate	628	603	104	$0.75	$0.25	$172,400	$57,000
Chlorate	1,191	1,017	175	$0.67	$0.22	$290,700	$96,100
Nitrate	96	223	59	$1.82	$0.92	$63,700	$32,200
Total:	1,915	1,843	338	$0.75	$0.27	$526,800	$185,300

Notes:
lbs/day – pounds per day
$/lb – cost of electron donor per pound of contaminant treated
$/yr – cost of electron donor per year

Table 11 presents a preliminary price comparison based on the hypothetical system developed for costing purposes as required by the Work Plan. These numbers are not intended for comparison with the actual operating

costs for the existing FBR plant. Should this technology be selected for further evaluation, detailed analyses will be performed in accordance with FS guidance to identify budgetary electron donor costs.

7.0 SUMMARY OF KEY FINDINGS

This section presents a summary of the overall Pilot Test results and draws conclusions on the success of the Pilot Test in treating perchlorate-contaminated groundwater with respect to the objectives described in Section 3.1.

Overall, this Pilot Test demonstrated that the HBGPM technology is capable of reducing perchlorate present in extracted groundwater to very low concentrations, including reduction of perchlorate concentrations to less than the 18 µg/L treatment goal. In addition, and consistent with Work Plan, a hypothetical design and cost basis for a full-scale treatment system was prepared since the results of the Pilot Test were favorable. However, since the final remedy has not been selected and the design criteria are likely to substantially change during the completion of the FS, this cost estimate should not be used for any reason other than recognizing the order of magnitude costs associated with this technology given the current groundwater extraction rates and COPC concentrations.

The main findings and conclusions with respect to the project objectives are presented below:

- Perchlorate concentrations were reduced to below the 18 µg/L treatment goal in the majority of the samples collected during the performance periods in Test Scenarios #1B, #2 and #3, thus demonstrating that the technology is capable of achieving the goal. Despite the operational issues experienced during Test Scenario #1A (as described in Section 5.1.1.1), perchlorate concentrations were reduced to below 18 µg/L in half of the samples collected during the performance period. Results from Test Scenario #2 Additional Testing indicated that the pilot unit had a mass loading capacity of up to 8.64 lbs/day. However, additional testing would be required to confirm stable and sustainable performance at this mass loading rate as well determine the maximum mass loading rate achievable by this system.
- Hexavalent chromium was completely reduced to below the sample detection limit of 0.15 ug/L in the biological reactors in Test Scenario #3.
- The study demonstrated that using hydrogen as the electron donor generates less biomass that using ethanol as the electron donor.
- Results of all testing scenarios indicated that stable and sustainable operations of an HBGPM system can be achieved following an initial acclimation period. However, as expected for a pilot scale system, there was variability in the system performance and further testing would be recommended as part of system optimization prior to full-scale design.
- The cost of hydrogen used as an electron donor in the HBGPM system is less than the cost of ethanol used in the current FBR system. The cost of ethanol to treat one pound of total contaminant was calculated to be approximately $0.75/lb while the cost of hydrogen to treat one pound of total contaminant was calculated to be approximately $0.27/lb, which represents a 65% reduction in electron donor costs. Using an assumed total mass load of 1,915 lbs/day, the total electron donor costs for one year of operation was estimated to be $185,300 using hydrogen vs $526,800 using ethanol.
- A hypothetical design and associated capital and operating cost were prepared by scaling up the pilot test to treat a 1,000-gpm feed with a total mass load of 1,915 lbs/day (similar to the influent feed water for the current FBR system). The estimated total preliminary capital cost and annual operating cost estimates for the hypothetical full-scale HBGPM system was estimated to be $42,502,000 and $4,367,000 in 2022 dollars, respectively. It should be noted that if a full-scale HBGPM system were installed, additional testing should be performed prior to final design to fully evaluate the optimal mass loading/mass flux for final design of the required number and configuration of membranes as well as determination of the optimal hydrogen usage. Additionally, research and/or testing would be required to determine the most appropriate hydrogen generation method, nitrogen sparging requirements, and cleaning procedures. The hydrogen generation technology will have a significant cost implication in a full-scale system. It should be noted that the costs presented herein should be considered only for informational purposes only and

should not be interpreted as actual cost estimates for system construction. The final remedy has not been selected and the design criteria are likely to substantially change during the completion of the FS. During the FS, costs related to the various potential components of the NERT final remedy will be presented for relative comparisons with -30/+50 accuracy consistent with EPA FS guidance.

Based on the above, the objectives for the pilot study were achieved. Meaningful data and operational experience with the hydrogen-based gas permeable membrane technology were collected during this pilot study. Data from this results report will be carried forward for further evaluation and refinement during the FS, as appropriate. If this technology is considered for full-scale implementation, additional testing and research should be performed to provide data with respect to but not limited to the following:

- Confirmation that stable and sustainable performance can be achieved (i.e., treatment of perchlorate concentrations at higher mass loading rates to below the 18 μg/L treatment goal);
- Evaluation of the optimal ranges of key system parameters including COPC mass loadings, ORP, and consumption rates for hydrogen, carbon dioxide and nutrients; and
- Assessment of the most appropriate hydrogen source or generation method, sparging requirements, cleaning procedures, and safety.

8.0 REFERENCES

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Ramboll. (2020b). *Quality Assurance Project Plan, Revision 6, Nevada Environmental Response Trust Site, Henderson, Nevada.*

Rittman, B., McCarty, P., 2001. *Environmental Biotechnology, Principles and Applications*.

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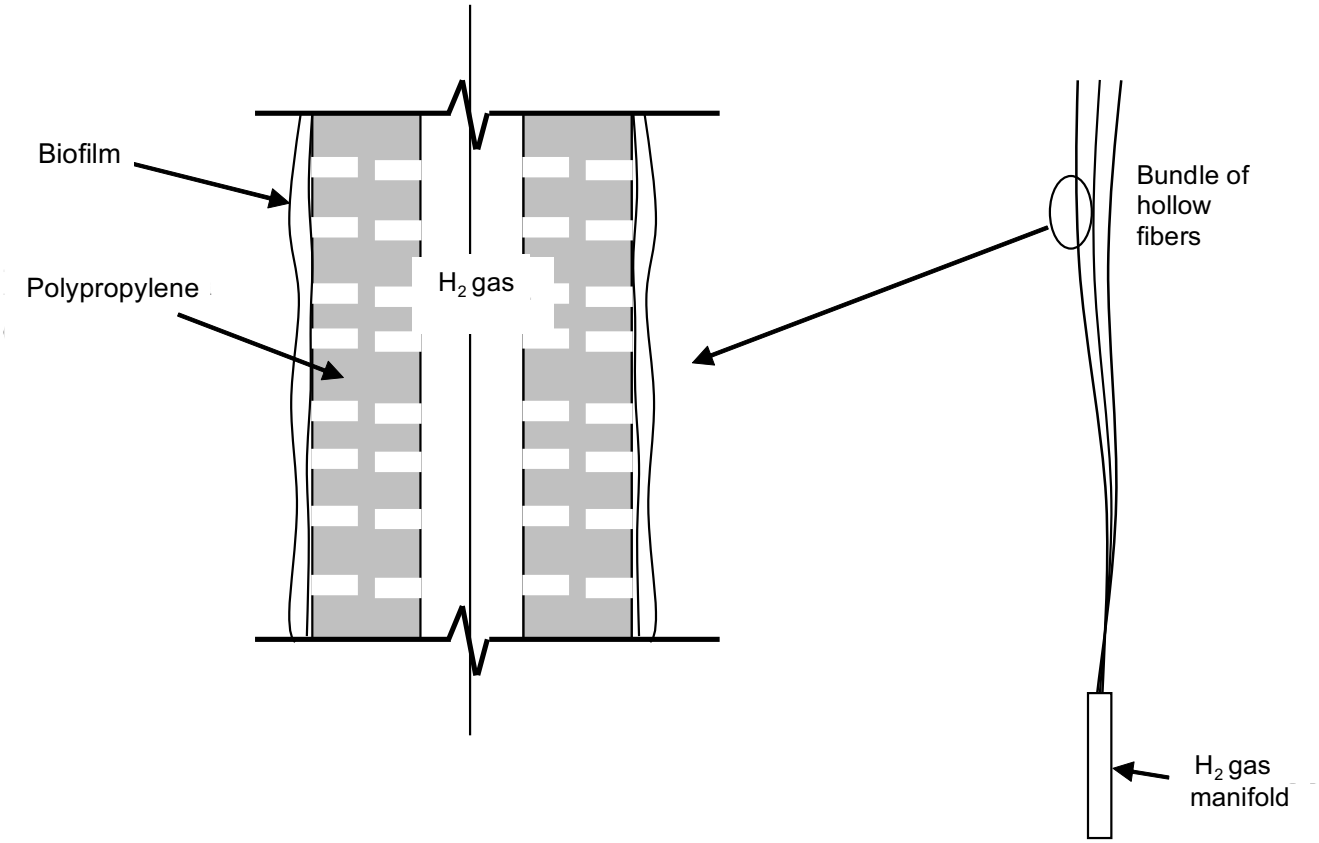
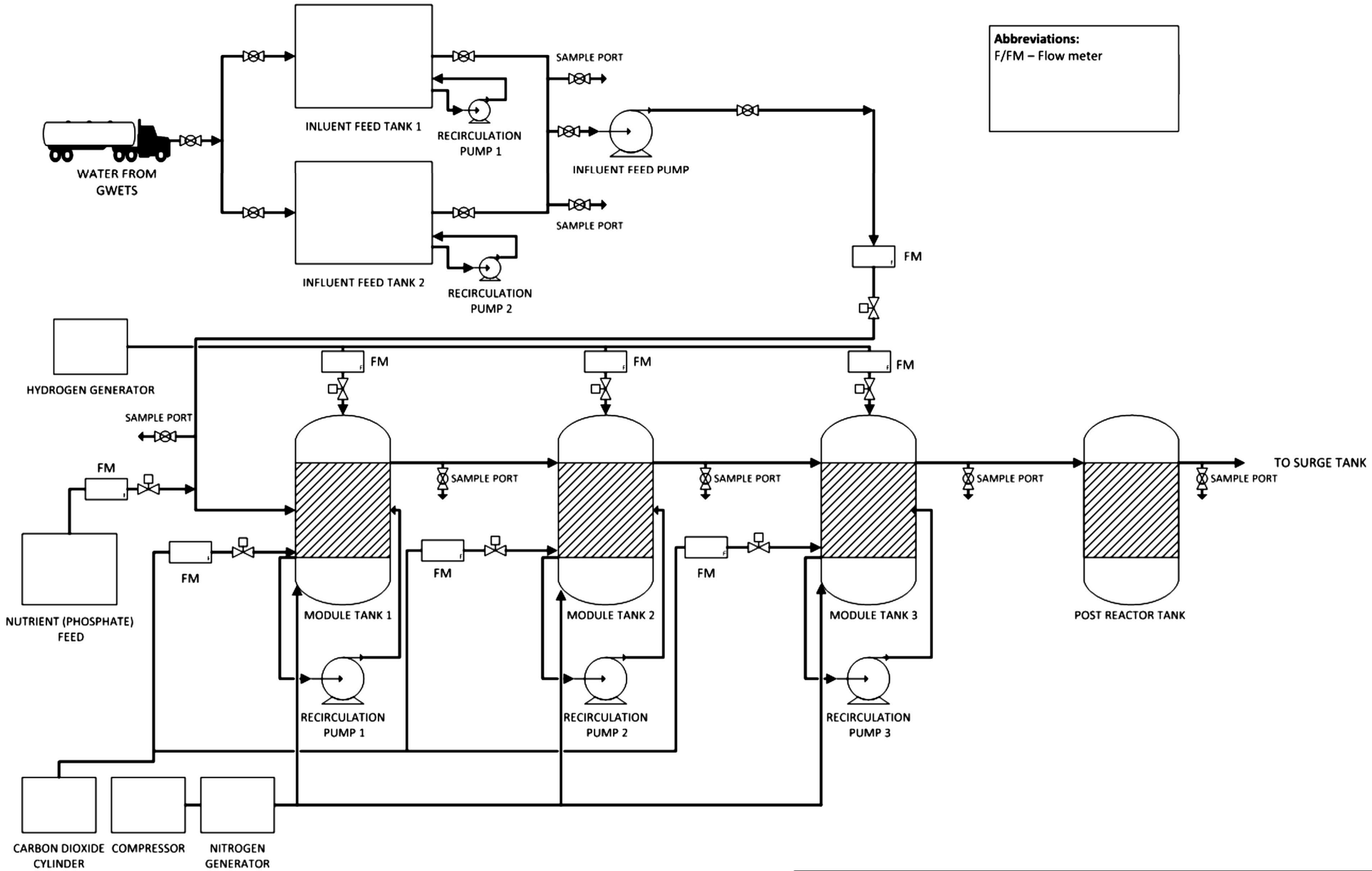
Tetra Tech. (2020). *Hydrogen-Based Gas Permeable Membrane Pilot Study System Operation Manual.*

Figures



TETRA TECH www.tetratech.com 150 S. 4th Street, Unit A Henderson, Nevada 89015 Phone: (702) 854-2293	**NEVADA ENVIRONMENTAL RESPONSE TRUST** HYDROGEN-BASED GAS PERMEABLE MEMBRANE PILOT TEST RESULTS REPORT HENDERSON, NEVADA **APT WATER HOLLOW-FIBER MEMBRANE BIOFILM REACTOR HOLLOW-FIBER CONFIGURATION**	Project No.: **117-7502020-M26** Date: NOV 19, 2021 Designed By: AAM Figure No. **1**



DOCUMENT PATH: D:\NERT\MXD\FIGURE 2A .MXD

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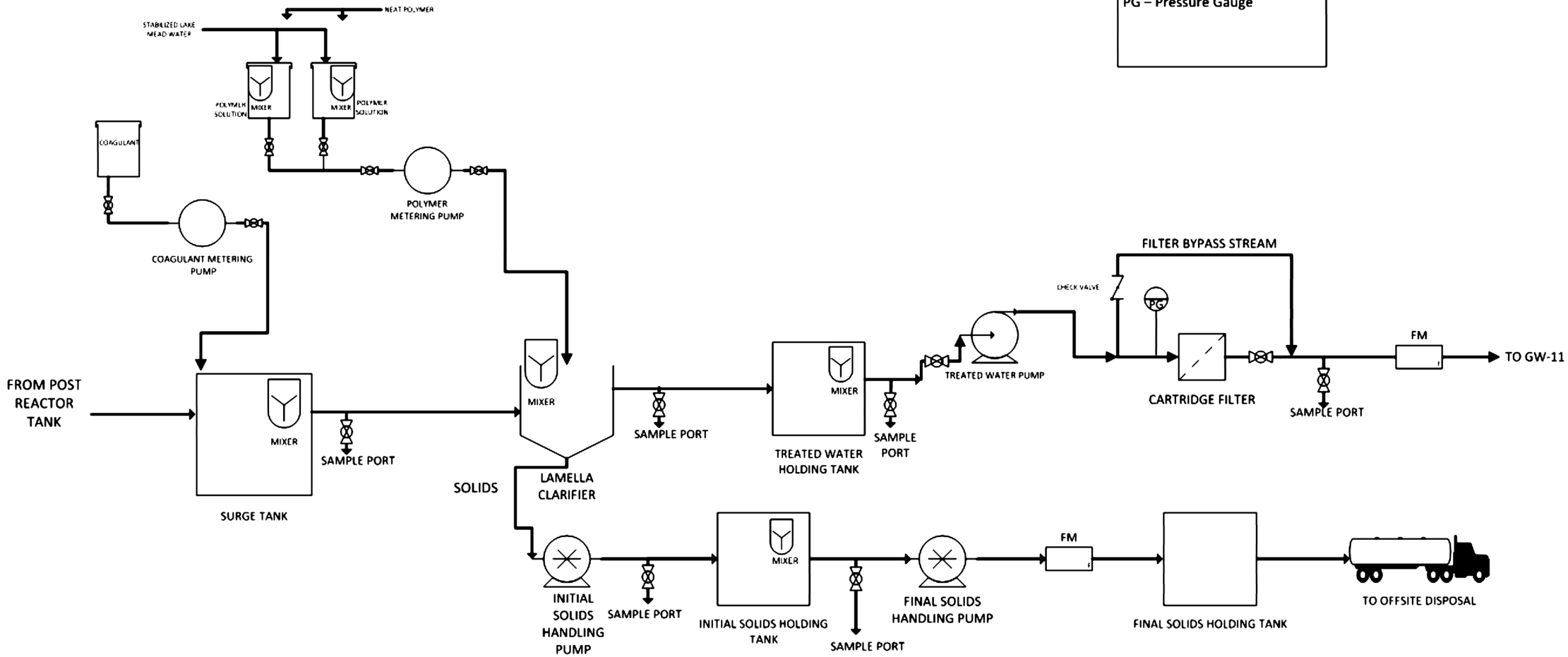
NEVADA ENVIRONMENTAL RESPONSE TRUST

HYDROGEN-BASED GAS PERMEABLE MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

PROCESS FLOW DIAGRAM
1 0F 2

Project No.: 117-7502020-M26
Date: NOVEMBER 23, 2021
Designed By: AAM
Figure No.
2A

Abbreviations:
F/FM – Flow meter
PG – Pressure Gauge



DOCUMENT PATH: D:\NERT\MXD\FIGURE 2B.MXD

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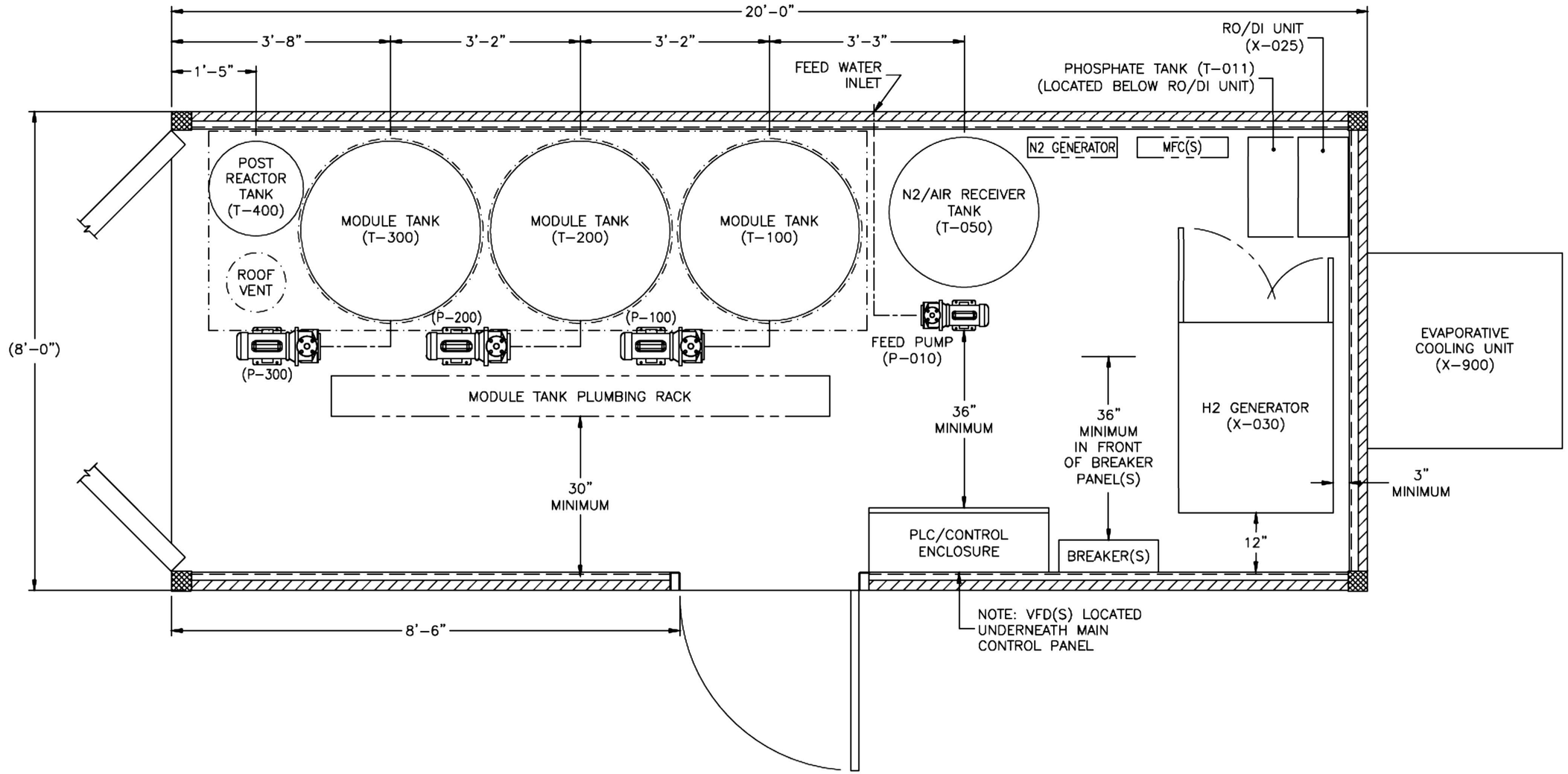
NEVADA ENVIRONMENTAL RESPONSE TRUST

HYDROGEN-BASED GAS PERMEABLE MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

PROCESS FLOW DIAGRAM
2 0F 2

Project No.:117-7502020-M26
Date: NOVEMBER 23, 2021
Designed By: AAM

Figure No.
2B



DOCUMENT PATH: D:\NERT\MXD\FIGURE 3.MXD

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NEVADA ENVIRONMENTAL RESPONSE TRUST

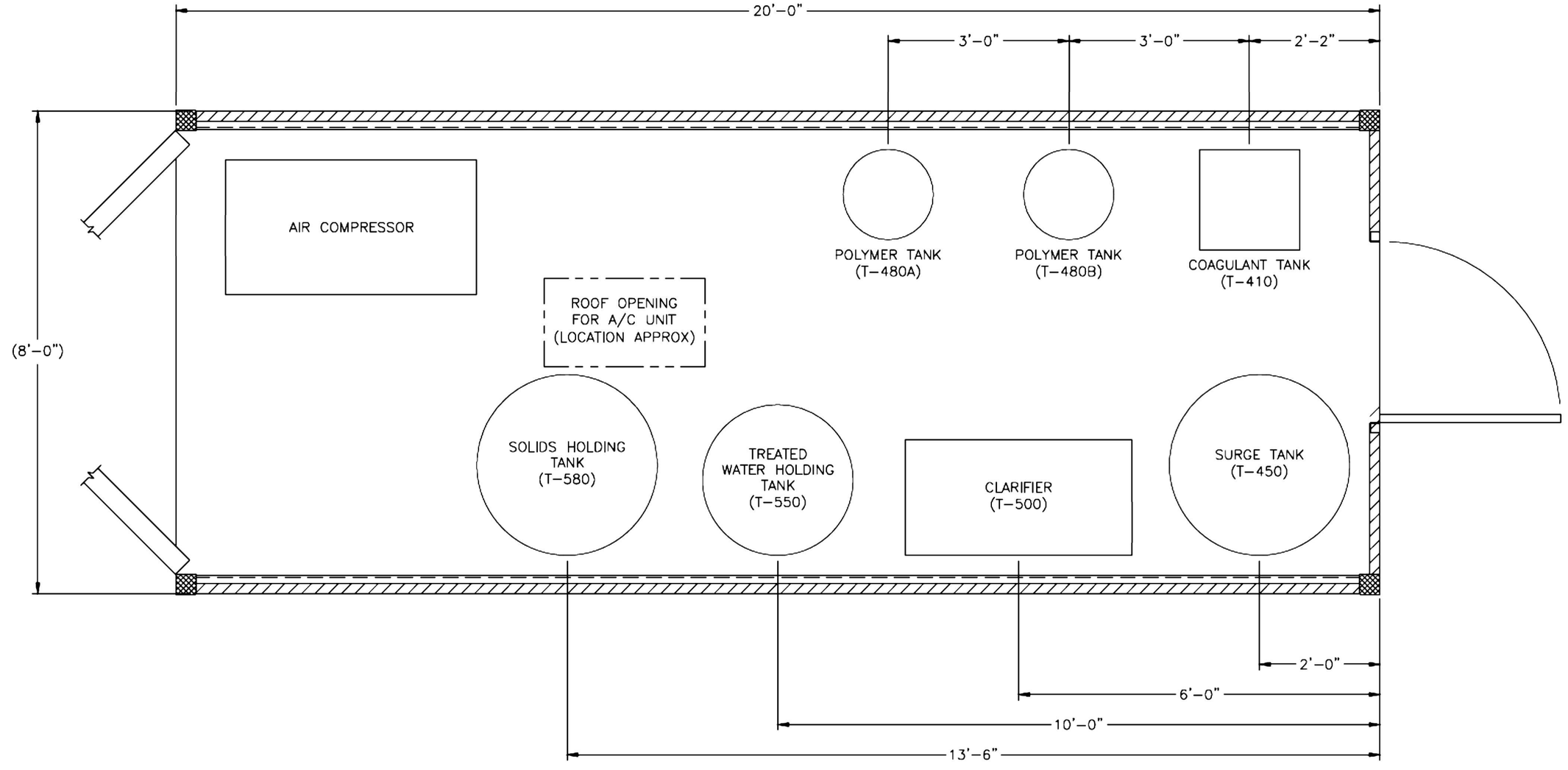
HYDROGEN-BASED GAS PERMEABLE MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

TREATMENT CONTAINER LAYOUT

Project No.: 117-7502020-M26
Date: NOVEMBER 23, 2021
Designed By: AAM
Figure No.
3

ABBREVIATION LIST:

N2 = NITROGEN
H2 = HYDROGEN
PLC = PROGRAMMABLE LOGIC CONTROLLER
P = PUMP
RO/DI = REVERSE OSMOSIS/DE-IONIZED WATER
T = TANK
VFS = VARIABLE FREQUENCY DRIVE
X = GENERATOR



DOCUMENT PATH: D:\NERT\MXD\FIGURE 4.MXD

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NEVADA ENVIRONMENTAL RESPONSE TRUST

HYDROGEN-BASED GAS PERMEABLE MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

POST TREATMENT CONTAINER LAYOUT

Project No.: 117-7502020-M26
Date: NOVEMBER 23, 2021
Designed By: AAM
Figure No.
4

Imagery Source: Esri World Map, May 2017.

D:\NERT\MXD\Figure 5 Pilot Treatment Location.mxd

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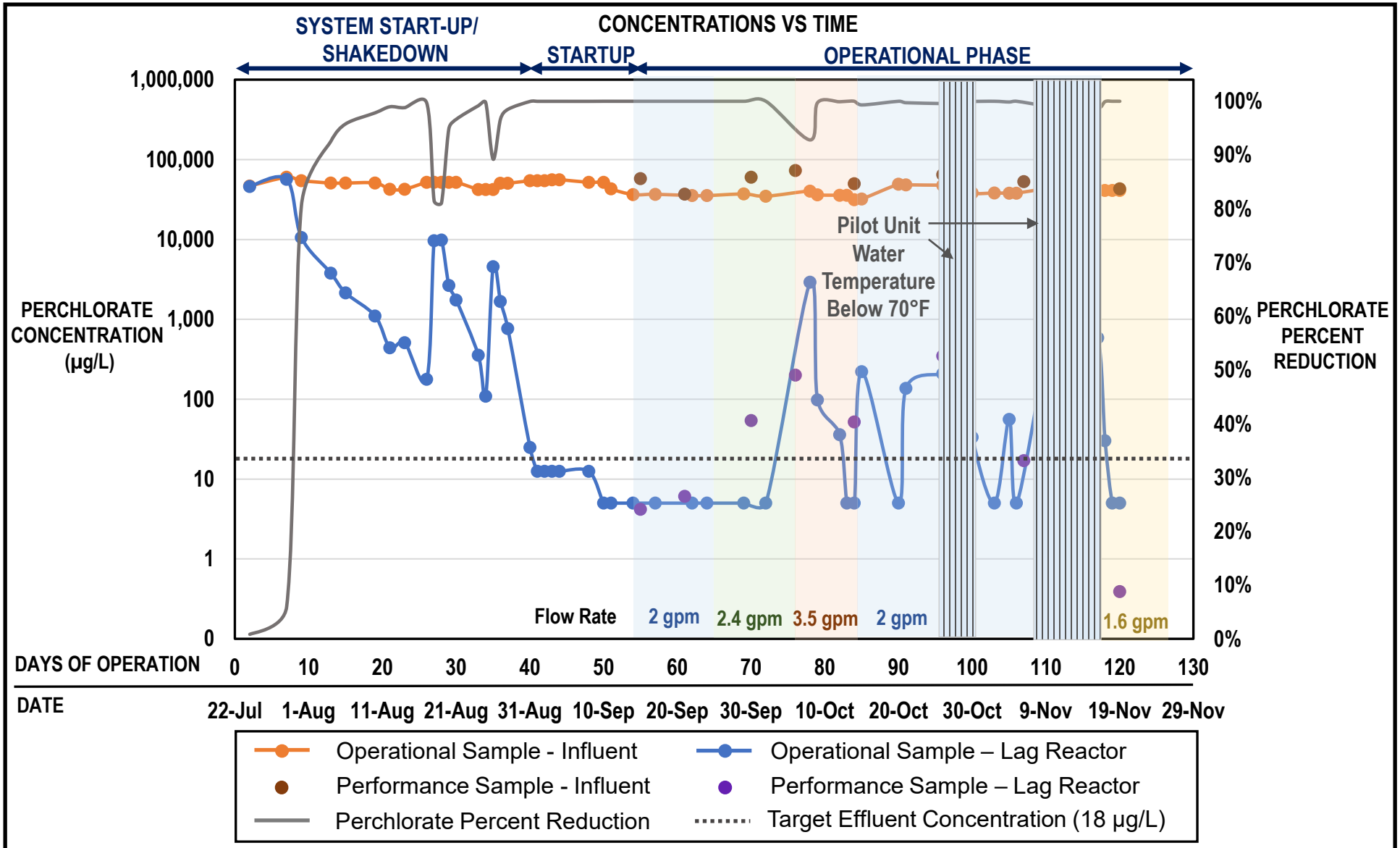
NEVADA ENVIRONMENTAL RESPONSE TRUST

HYDROGEN-BASED GAS PERMEABLE MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

PILOT TREATMENT SYSTEM LOCATION

Project No.: 117-7502020-M26
Date: NOVEMBER 23, 2021
Designed By: AAM

Figure No.
5



Abbreviations: µg/L – microgram per liter gpm – gallons per minute F - Fahrenheit

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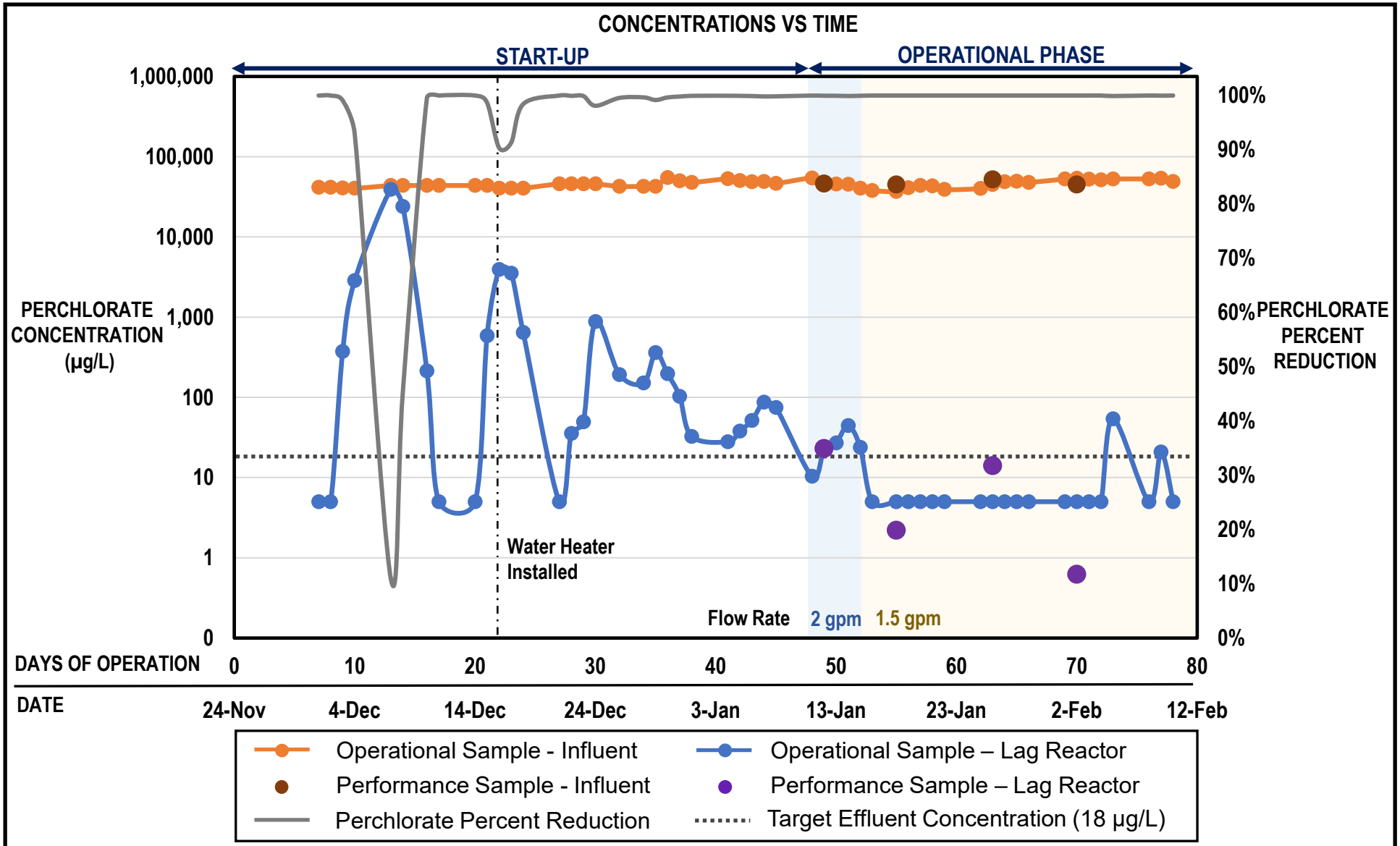
NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

HYDROGEN-BASED PERMEABLE GAS MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

TEST SCENARIO #1A – PERFORMANCE MONITORING RESULTS

Project No.:	117-7502020-M26
Date:	JULY 26, 2022
Designed By:	JMD

Figure No.
6



Abbreviations: µg/L – microgram per liter gpm – gallons per minute

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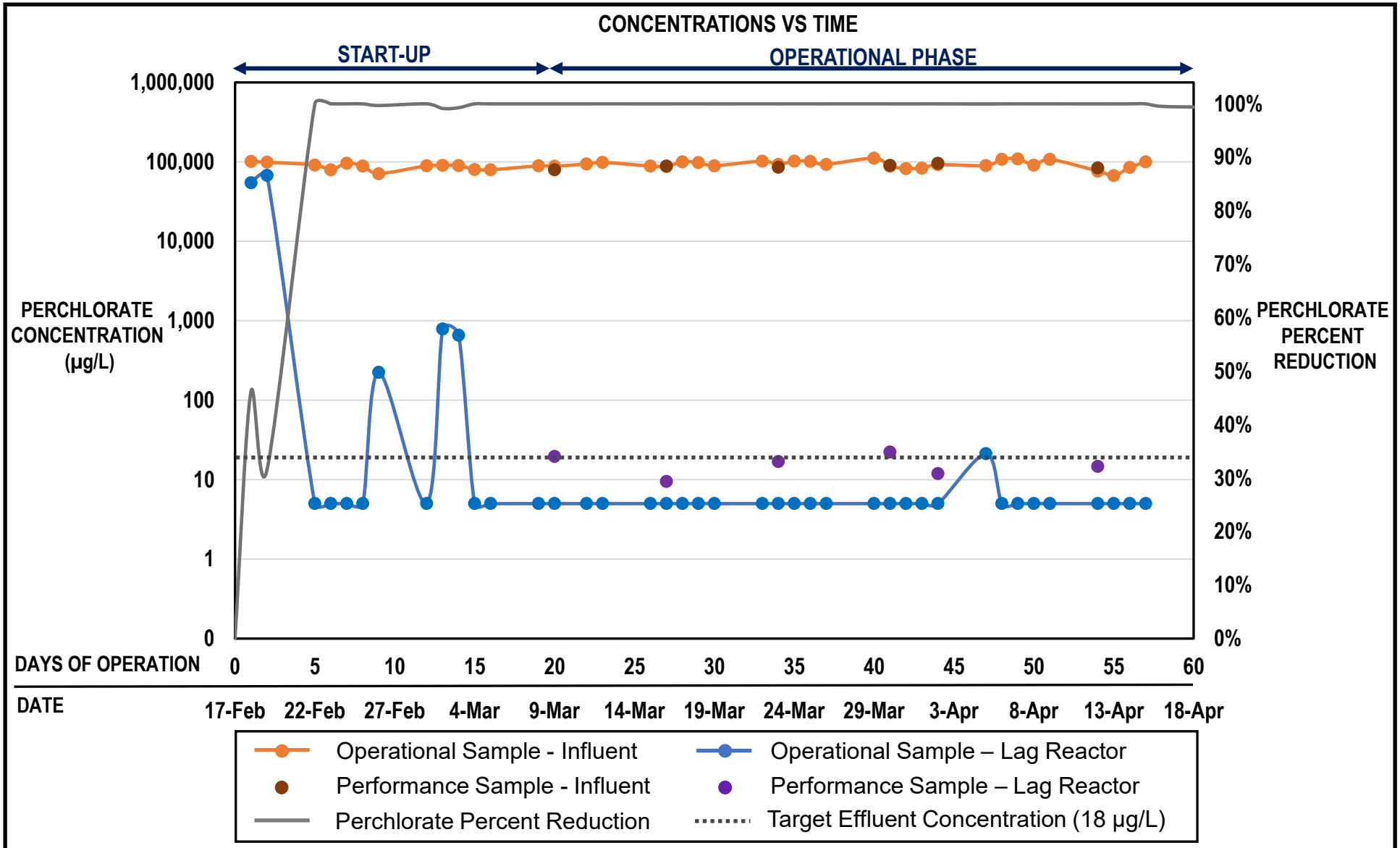
NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

HYDROGEN-BASED PERMEABLE GAS MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

TEST SCENARIO #1B – PERFORMANCE MONITORING RESULTS

Project No.:	117-7502020-M26
Date:	JULY 26, 2022
Designed By:	JMD

Figure No.
7



1. The flow rate maintained throughout the Test Scenario #2 operational phase was 0.75 gallons per minute.
Abbreviations: µg/L – microgram per liter

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NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

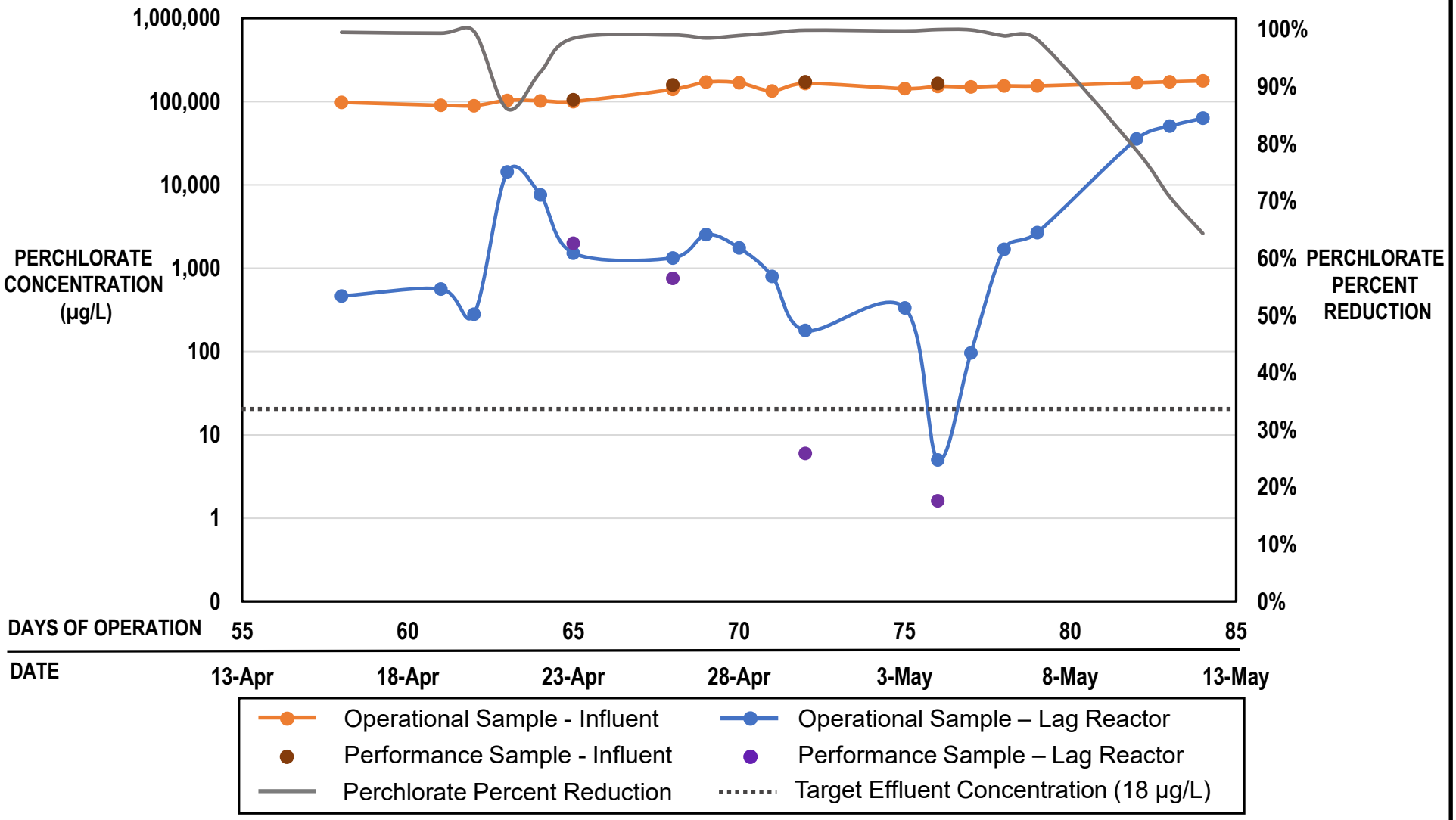
HYDROGEN-BASED PERMEABLE GAS MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

TEST SCENARIO #2 – PERFORMANCE MONITORING RESULTS

Project No.:	117-7502020-M26
Date:	JULY 26, 2022
Designed By:	JMD

Figure No.
8

CONCENTRATIONS VS TIME



1. The flow rate and mass loading rate were adjusted throughout Test Scenario #2 - Additional Testing to determine the maximum treatment capacity of the pilot unit.
Abbreviations: µg/L – microgram per liter

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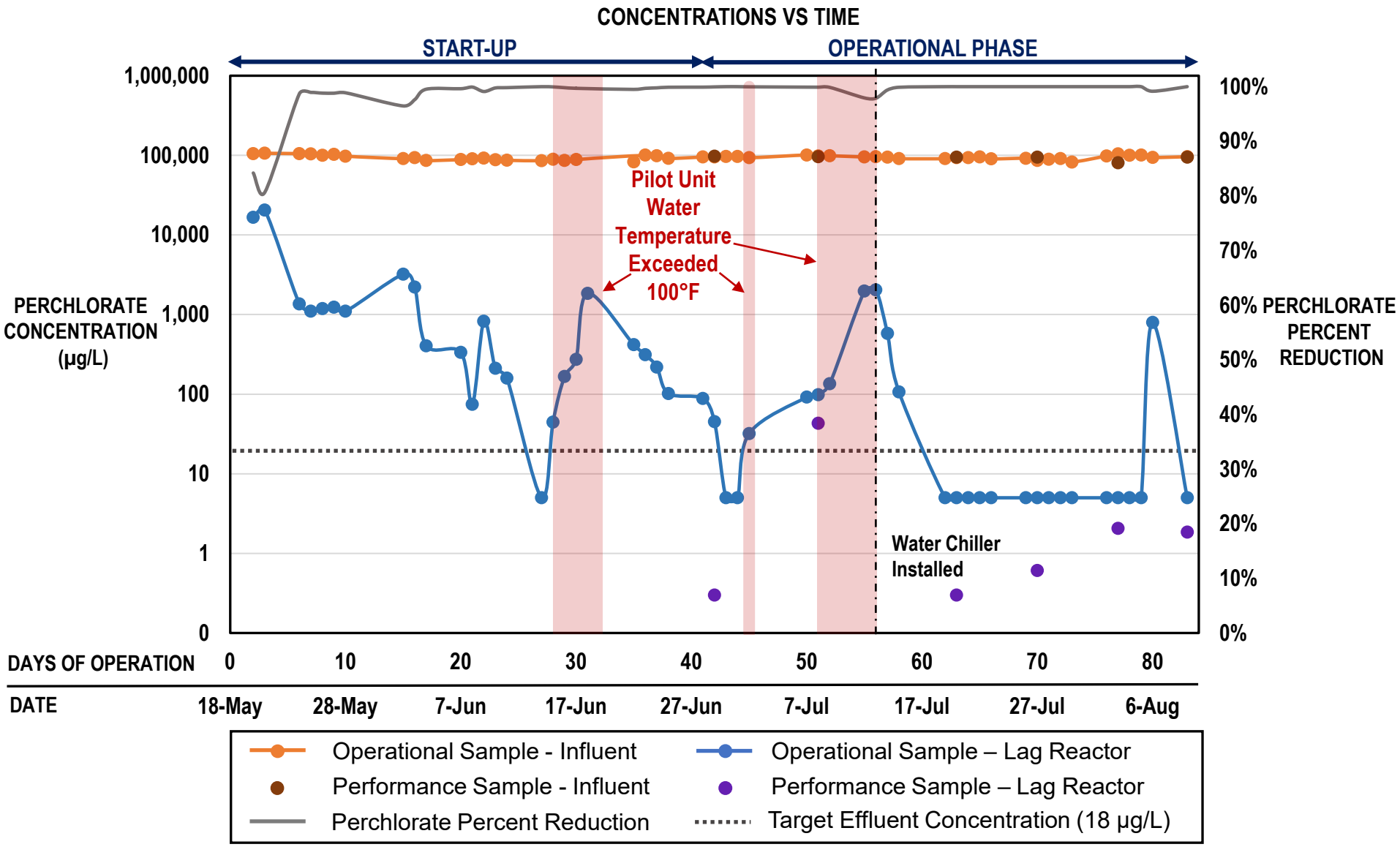
NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

HYDROGEN-BASED PERMEABLE GAS MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

TEST SCENARIO #2 – ADDITIONAL TESTING - PERFORMANCE MONITORING RESULTS

Project No.:	117-7502020-M26
Date:	JULY 26, 2022
Designed By:	JMD

Figure No.
9



1. The flow rate maintained throughout the Test Scenario #3 operational phase was 0.75 gallons per minute.
Abbreviations: µg/L – microgram per liter F - Fahrenheit

\\tts134fs1\SUP-Projects\BLD01\520225_NERT\Hydrogen Based Gas Permeable Membrane Treatability Study\8. Phase 7 Reporting\Current Draft\Figures\M26 Figures Report Format.pptx

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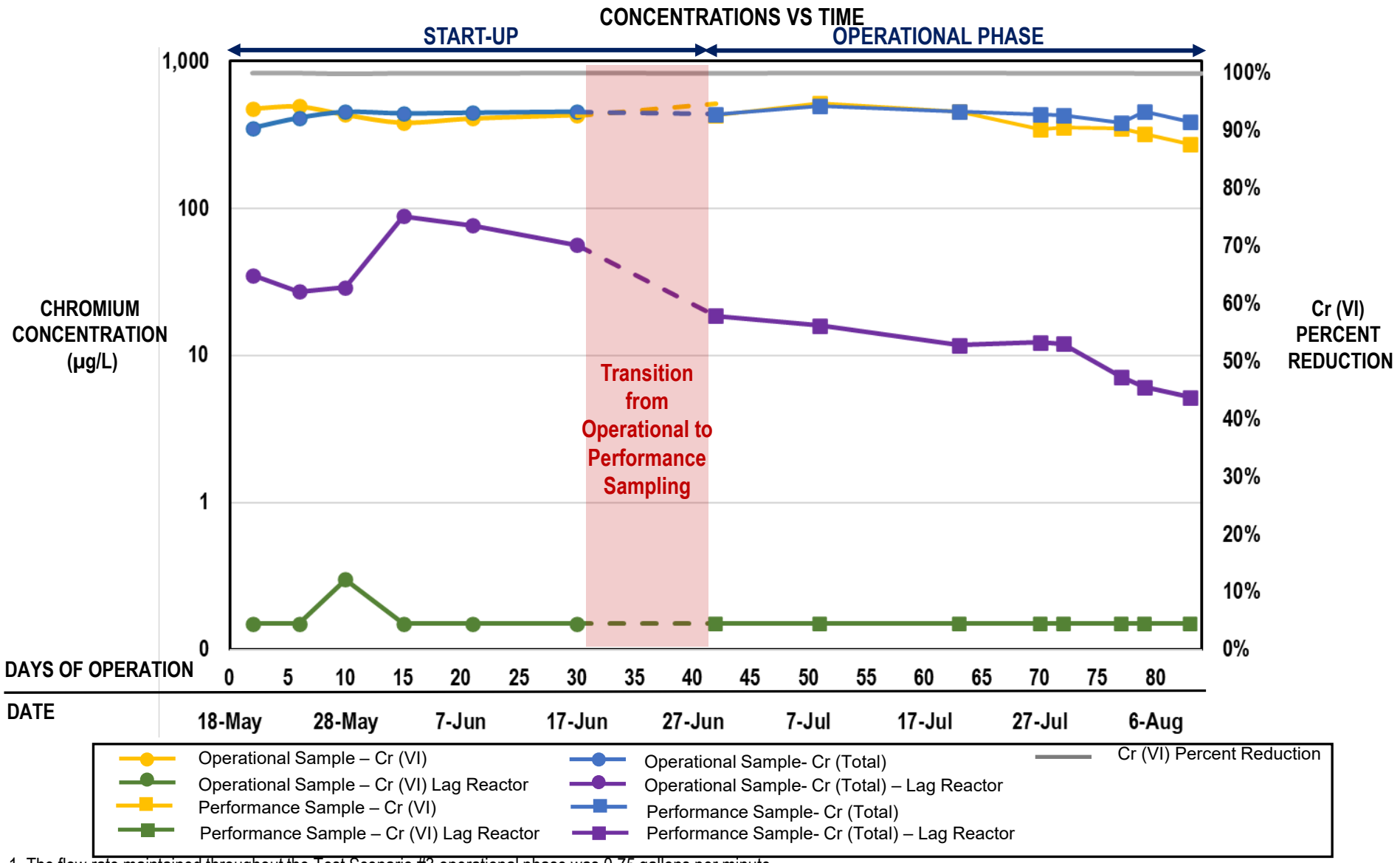
NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

HYDROGEN-BASED PERMEABLE GAS MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

TEST SCENARIO #3 – PERFORMANCE MONITORING RESULTS

Project No.:	117-7502020-M26
Date:	JULY 26, 2022
Designed By:	JMD

Figure No.
10



1. The flow rate maintained throughout the Test Scenario #3 operational phase was 0.75 gallons per minute.
Abbreviations: µg/L – microgram per liter

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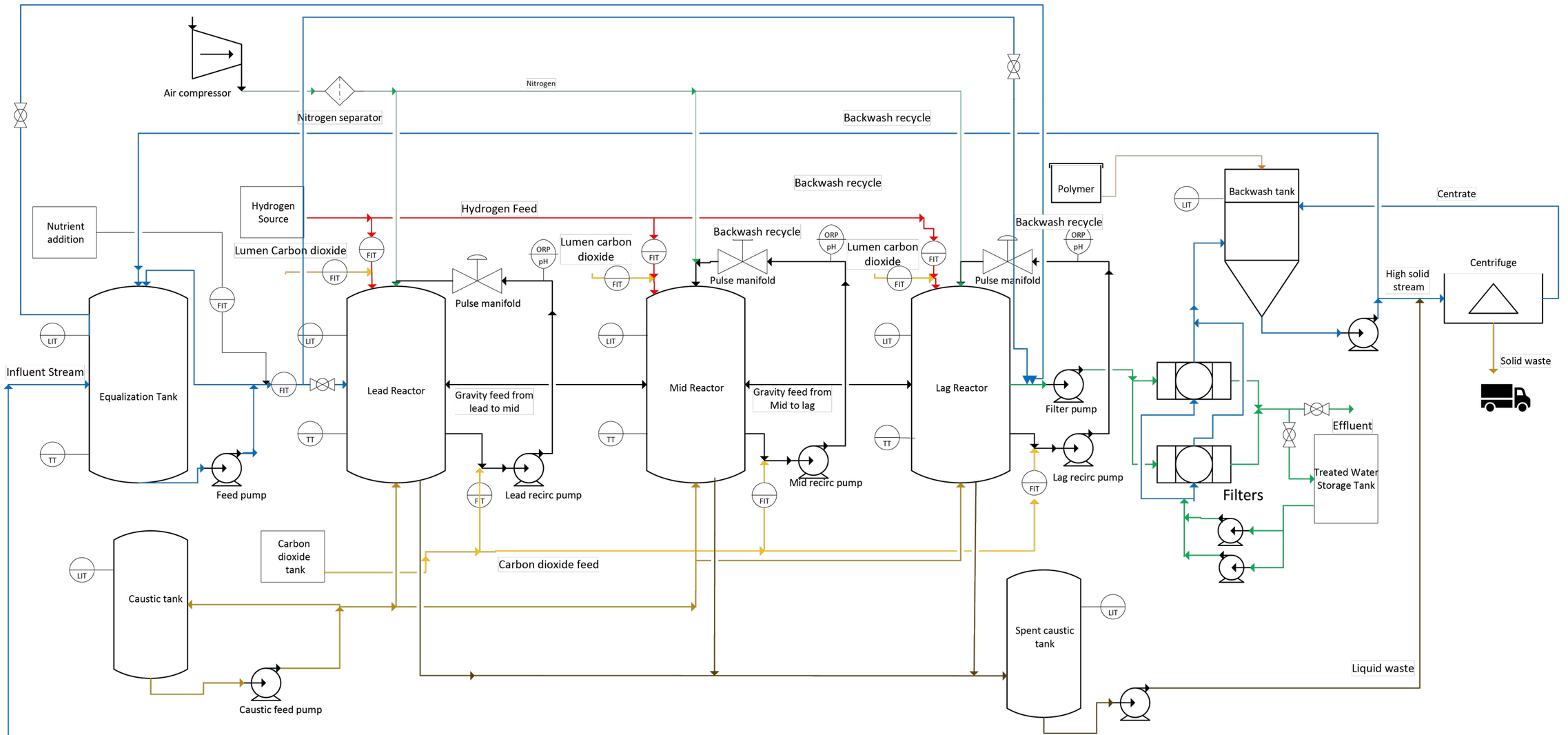
NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

HYDROGEN-BASED PERMEABLE GAS MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

TEST SCENARIO #3 – PERFORMANCE MONITORING RESULTS

Project No.:	117-7502020-M26
Date:	JULY 26, 2022
Designed By:	JMD/AR

Figure No.
11



Legend

FIT = Flow transmitter
TT = Temperature transmitter
LIT = Level transmitter
ORP = ORP meter transmitter
pH = pH meter transmitter

NOTE:

THE HYPOTHETICAL SYSTEM INCLUDES AN ADDITIONAL SECTION OF MODULES WITHIN EACH REACTOR TO COMPENSATE FOR THE TREATMENT CAPACITY LOSS DURING MODULE CLEANING. THE REMAINING SECTIONS OF MODULES WILL CONTINUE TO TREAT THE INFLUENT WATER WHILE OTHER MODULES ARE BEING CLEANED.

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NEVADA ENVIRONMENTAL RESPONSE TRUST

HYDROGEN-BASED GAS PERMEABLE MEMBRANE PILOT TEST RESULTS REPORT
HENDERSON, NEVADA

HYPOTHETICAL FULL-SCALE SYSTEM PROCESS FLOW DIAGRAM

PROJ: 117-7502020-M26
DATE: December 30, 2022
DESN: LAW

Figure No.
12

Bar Measures 1 inch

Appendix A
Pilot Treatment System Process and Instrumentation Diagrams

VALVES/PUMPS/EQUIPMENT

- 2-WAY BALL VALVE
- 2-WAY BALL VALVE (CONTROL)
- 3-WAY BALL VALVE
- 3-WAY BALL VALVE (CONTROL)
- 2-WAY GATE VALVE
- NEEDLE VALVE
- CHECK VALVE
- BUTTERFLY VALVE
- PRESSURE RELIEF VALVE
- ROTAMETER
- GAS FILTER
- Y-STRAINER
- CHEMICAL MIXER
- EDUCTOR
- CENTRIFUGAL PUMP
- BLOWER
- METERING PUMP
- PERISTALTIC PUMP
- INLINE PUMP
- 2-WAY ACTUATED BALL VALVE (PNEUMATIC)
- 2-WAY ACTUATED BALL VALVE (ELECTRIC)
- 2-WAY ACTUATED BALL VALVE (MOTORIZED)
- 3-WAY ACTUATED BALL VALVE (PNEUMATIC)
- 3-WAY ACTUATED BALL VALVE (ELECTRIC)
- 3-WAY ACTUATED BALL VALVE (MOTORIZED)
- BUTTERFLY VALVE (PNEUMATIC)
- FORWARD PRESSURE REGULATOR
- BACK PRESSURE REGULATOR
- ROTAMETER W/FLOW CONTROL
- BASKET STRAINER
- CARTRIDGE FILTER
- STATIC MIXER
- FAN
- HEAT EXCHANGER
- COOLING UNIT
- MASS FLOW CONTROLLER
- VENT VALVE

- GAS STORAGE TANK
- LIQUID STORAGE TANK
- LIQUID STORAGE TANK W/SECONDARY CONTAINMENT
- CALIBRATION CYLINDER

PROCESS/INSTRUMENTATION

- ANALOG INPUT
- ANALOG OUTPUT
- DIGITAL INPUT
- DIGITAL OUTPUT
- ETHERNET
- INTERLOCK
- INSTRUMENT (LOCAL MOUNT)
- INSTRUMENT (PANEL MOUNT)
- INSTRUMENT W/TRANSMITTER
- INSTRUMENT W/REMOTE TRANSMITTER

PIPE SYMBOLS

- CONCENTRIC REDUCER
- ECCENTRIC REDUCER
- CAP/PLUG
- FLEX COUPLING/JOINT
- FLANGE/DISCONNECT POINT
- TIE POINT
- DIRECTIONAL FLOW ARROW

ABBREVIATIONS

AE	ANALOG ELEMENT
AI	ANALOG INDICATOR, ANALOG INPUT
AIT	ANALOG INDICATOR W/TRANSMITTER
AO	ANALOG OUTPUT
AT	ANALOG TRANSMITTER
B	BLOWER
BPR	BACK PRESSURE REGULATOR
BV	BALL VALVE, BUTTERFLY VALVE
C	COMPRESSOR
CDA	CLEAN DRY AIR
CI	CAST IRON
CL	CALIBRATION COLUMN
CO2	CARBON DIOXIDE
CV	CHECK VALVE
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
DP	DRIVE PANEL
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
DS	DISCONNECT SWITCH
DV	DRAIN VALVE
E	EDUCTOR
ETH	ETHERNET
F	FILTER, FAN
FCIT	FLOW CONTROLLER
FCV	FLOW CONTROL VALVE
FE	FLOW ELEMENT
FI	FLOW INDICATOR
FIT	FLOW INDICATOR W/TRANSMITTER
FIV	FLOW INDICATOR W/CONTROL VALVE
FPR	FORWARD PRESSURE REGULATOR
FS	FLOW SWITCH
FSH	FLOW SWITCH (HIGH)
FSL	FLOW SWITCH (LOW)
H2	HYDROGEN
HS	HAND SWITCH
HTX	HEAT EXCHANGER
LP	LOAD PANEL
LS	LIQUID LEVEL SWITCH
LSH	LIQUID LEVEL SWITCH (HIGH)
LSL	LIQUID LEVEL SWITCH (LOW)
LT	LEVEL TRANSMITTER
MCP	MAIN CONTROL PANEL
MX	MIXER
N2	NITROGEN
P	PUMP
PCV	PRESSURE CONTROL VALVE
PE	POLYETHYLENE
PI	PRESSURE INDICATOR
PIV	ISOLATION VALVE, PRESSURE INDICATOR
PT	PRESSURE TRANSMITTER
PTV	ISOLATION VALVE, PRESSURE TRANSMITTER
PWR	POWER
S	GAS LIQUID SEPARATOR
SP	SAMPLE VALVE, SAMPLE POINT
SSTL	STAINLESS STEEL
STL	STEEL
STR	STRAINER
SV	SOLENOID VALVE
T	TANK, TRANSFORMER
TI	TEMPERATURE INDICATOR
TP	TIE POINT
TS	TEMPERATURE SWITCH
TSH	TEMPERATURE SWITCH (HIGH)
TSL	TEMPERATURE SWITCH (LOW)
UTV	UTILITY VALVE
VFD	VARIABLE FREQUENCY DRIVE
VV	VENT VALVE
X	GENERATOR
XV	ACTUATED VALVE

NOTE:
CONTACT PROJECT ENGINEER FOR ABBREVIATIONS NOT LISTED HERE.

ISSUED FOR CUSTOMER REVIEW

REV	DESCRIPTION	DATE	NAME
4	GENERAL CHANGES	07/20/20	LT
3	GENERAL CHANGES	01/14/20	LT
2	UPDATED PER INTERNAL REVIEW	11/12/19	LT
1	ISSUED FOR CUSTOMER REVIEW	10/18/19	LT

REVISION HISTORY

APTwater
Clean Water. No Waste.

CLIENT: TETRA TECH

PROJECT: 03585

LOCATION: HENDERSON, NV

TITLE: P&ID LEGEND

DRAWN	LT	10/18/19
DESIGN	DF	10/15/19
CHECKED		
APPROVED		
INVENTORY ID:		N/A
NEXT ASSEMBLY:		N/A

SIZE: D
DRAWING NO.: 0358530P000
REV: 4
SCALE: N/A
FILE:0358530P000-R4
SHEET 1 OF 1

TIE POINT SCHEDULE				
TP #	Process	Size	Connection Type	Material
TP-1	Influent Water	1"	150# Flange	SCH 80 PVC
TP-2	Treated Water	1"	150# Flange	SCH 80 PVC
TP-3	Phosphoric Acid	N/A	Manual fill	N/A

SYSTEM TAG DESIGNATORS

000 – GENERAL EQUIPMENT
010 – FEED SYSTEM
050 – AIR DELIVERY SYSTEM
100/200 – MODULE SYSTEM
110/210 – MODULE DRAIN SYSTEM
115/215 – H2/CO2 BLEND SYSTEM
120/220 – CO2 SYSTEM
130/230 – H2 SYSTEM
800 – EFFLUENT SYSTEM

ISSUED FOR CUSTOMER REVIEW

REV	DESCRIPTION	DATE	NAME
4	GENERAL CHANGES	07/20/20	LT
3	GENERAL CHANGES	01/14/20	LT
2	UPDATED PER INTERNAL REVIEW	11/12/19	LT
1	ISSUED FOR CUSTOMER REVIEW	10/18/19	LT

REVISION HISTORY

APTwater
Clean Water. No Waste.

CLIENT: TETRA TECH

PROJECT: 03585

LOCATION: HENDERSON, NV

TITLE: P&ID COVER SHEET

DO NOT SCALE DRAWING

DRAWN	LT	10/18/19
DESIGN	DF	10/15/19
CHECKED		
APPROVED		
INVENTORY ID:		N/A
NEXT ASSEMBLY:		N/A

SIZE D | DRAWING NO. 0358530P001 | REV 4

SCALE: N/A | FILE:0358530P001-R4 | SHEET 1 OF 8

ARO-NITE CONTAINER

FROM RO/DI UNIT
RO WATER
SHEET 6

TP 3

FROM SOURCE
PHOSPHORIC ACID
BY OTHERS

TEMPORARY CONNECTION

VENT/FILL

CL-011
CALIBRATION CYLINDER

TUBE, ø3/8", PE (CLEAR)

T-011
PHOSPHATE STORAGE TANK
(5 GALLON)

BV-012

TUBE, ø3/8", PE

BV-011

ø1/4" PERISTALTIC PUMP FLEX TUBING

P-011
PHOSPHATE PUMP

M

AO

TUBE, ø1/4", PE

TUBE, ø1/4", PE

BV-013

1/4"x3/8"

ø1/4" PERISTALTIC PUMP FLEX TUBING

VFD ENCLOSURE

DI
DO
AO

VFD 010
VFD 100
VFD 200
VFD 300

FROM P-010
FROM P-100 (SHEET 3)
FROM P-200 (SHEET 3)
FROM P-300 (SHEET 3)

BY OTHERS ← → BY APTWATER

FROM SOURCE
INFLUENT WATER
BY OTHERS

P-001

(OVERFLOW) PIPE, 3", SCH 80, PVC

T-001
FEED TANK
(BY OTHERS)

PIPE, 1", SCH 80, PVC

TP 1

PIPE, 1", SCH 80, PVC

1"x1 1/4"

BV-010

TO VFD ENCLOSURE

P-010

BV-015

AI

PI 010

PT 010

PIV-010

F-010

PIPE, 1", SCH 80, PVC

1"x1/2"

CV-015

CV-011

BV-014

1"x1/2"

AI

FIT 015

FE 015

0-6.6 GPM

1/2"x1"

BV-163

SP-015

SAMPLE

PIPE, 1", SCH 80, PVC

PIPE, 1 1/2", SCH 80, PVC

1"x1 1/2"

TO MODULE TANK (T-300)
INFLUENT WATER (MODULES)
SHEET 4

PIPE, 1 1/2", SCH 80, PVC

1"x1 1/2"

TO MODULE TANK (T-100)
INFLUENT WATER (MODULES)
SHEET 4

TUBE, ø1/2", PE, BLACK

TO NITRATE ANALYZEER
INFLUENT WATER (NITRATE ANALYZER)
SHEET 3

BV-060

TUBE, ø1/2", PE, BLACK

FROM NITRATE ANALYZEER
INFLUENT WATER (NITRATE ANALYZER)
SHEET 3

FROM SOURCE
INFLUENT WATER
BY OTHERS

P-002

(OVERFLOW) PIPE, 3", SCH 80, PVC

T-002
FEED TANK
(BY OTHERS)

BY OTHERS ← → BY APTWATER

ISSUED FOR CUSTOMER REVIEW

APTwater
Clean Water. No Waste.

CLIENT:	TETRA TECH
PROJECT: 03585	LOCATION: HENDERSON, NV
TITLE:	P&ID FEED SYSTEM
SIZE: D	DRAWING NO.: 0358530P001
REV:	4
SCALE: N/A	FILE:0358530P001-R4
SHEET	2 OF 8

ISSUED FOR CUSTOMER REVIEW

NITRATE ANALYZER PANEL

FROM H2/CO2 ENCLOSURE — CO2 — SHEET 7
TUBE, ø1/4" PE
CV-121 BV-121 1/4"x1/2"
MODULE DRAIN VENT — SHEET 4
TUBE, ø1/4" PFA
CV-110 1/4"x1/2"
FROM pH/ORP ANALYZER — INFLUENT WATER (ANALYZER) — SHEET 3
TUBE, 1/2", PE, BLACK
PE/PFA → 316 SSTL
TUBE, ø1/2", 0.049 WALL, 316 SSTL

TO VFD ENCLOSURE (SHEET 2)
P-100
1 1/4"x2"
2"x1 1/2"
BV-101
2"x1/2"
2"x1/2"
PIPE, 2", SCH 80, PVC
AI
FIT 100
FE 100
0-160 GPM
TO MODULE (R-100) INFLUENT WATER SHEET 4
TUBE, ø1/2", PE, BLACK
BV-170
BV-160
BV-100
PIPE, 2", SCH 80, PVC
FROM MODULE TANK (T-100) INFLUENT WATER SHEET 4

BV-171
AIT 170 / AE 170 pH
AIT 171 / AE 171 ORP
PIPE, 1/2", SCH 80 PVC
SP-170
SAMPLE
BV-172
TUBE, 1/2", PE, BLACK
TO PUMP SUCTION (P-100) INFLUENT WATER (ANALYZER) SHEET 3

DO
S
PIPE, 1/2", SCH 80 PVC
BV-161
SV-160
AI
AIT 160
AE 160
N03
FI 160
1/2"x3/8"
3/8"x1/2"
TUBE, ø3/8", PE, BLACK
SP-160
BV-162
TUBE, 1/2", PE, BLACK
TO INFLUENT PUMP DISCHARGE INFLUENT WATER (NITRATE ANALYZER) SHEET 2

FROM INFLUENT SAMPLE INFLUENT WATER (NITRATE ANALYZER) SHEET 2
BV-061
SV-060

FROM H2/CO2 ENCLOSURE — CO2 — SHEET 7
TUBE, ø1/4" PE
CV-221 BV-221 1/4"x1/2"
MODULE DRAIN VENT — SHEET 4
TUBE, ø1/4" PFA
CV-210 1/4"x1/2"
FROM pH/ORP ANALYZER — INFLUENT WATER (ANALYZER) — SHEET 3
TUBE, 1/2", PE, BLACK
PE/PFA → 316 SSTL
TUBE, ø1/2", 0.049 WALL, 316 SSTL

TO VFD ENCLOSURE (SHEET 2)
P-200
1 1/4"x2"
2"x1 1/2"
BV-201
2"x1/2"
2"x1/2"
PIPE, 2", SCH 80, PVC
AI
FIT 200
FE 200
0-160 GPM
TO MODULE (R-200) INFLUENT WATER SHEET 4
TUBE, ø1/2", PE, BLACK
BV-270
BV-260
BV-200
PIPE, 2", SCH 80, PVC
FROM MODULE TANK (T-200) INFLUENT WATER SHEET 4

BV-271
AIT 270 / AE 270 pH
AIT 271 / AE 271 ORP
PIPE, 1/2", SCH 80 PVC
SP-270
SAMPLE
BV-272
TUBE, 1/2", PE, BLACK
TO PUMP SUCTION (P-200) INFLUENT WATER (ANALYZER) SHEET 3

DO
S
PIPE, 1/2", SCH 80 PVC
BV-261
SV-260

FROM EFFLUENT SAMPLE EFFLUENT WATER (NITRATE ANALYZER) SHEET 5
BV-861
SV-860

(FUTURE)

FROM H2/CO2 ENCLOSURE — CO2 — SHEET 7
TUBE, ø1/4" PE
CV-321 BV-321 1/4"x1/2"
MODULE DRAIN VENT — SHEET 4
TUBE, ø1/4" PFA
CV-310 1/4"x1/2"
FROM pH/ORP ANALYZER — INFLUENT WATER (ANALYZER) — SHEET 3
TUBE, 1/2", PE, BLACK
PE/PFA → 316 SSTL
TUBE, ø1/2", 0.049 WALL, 316 SSTL

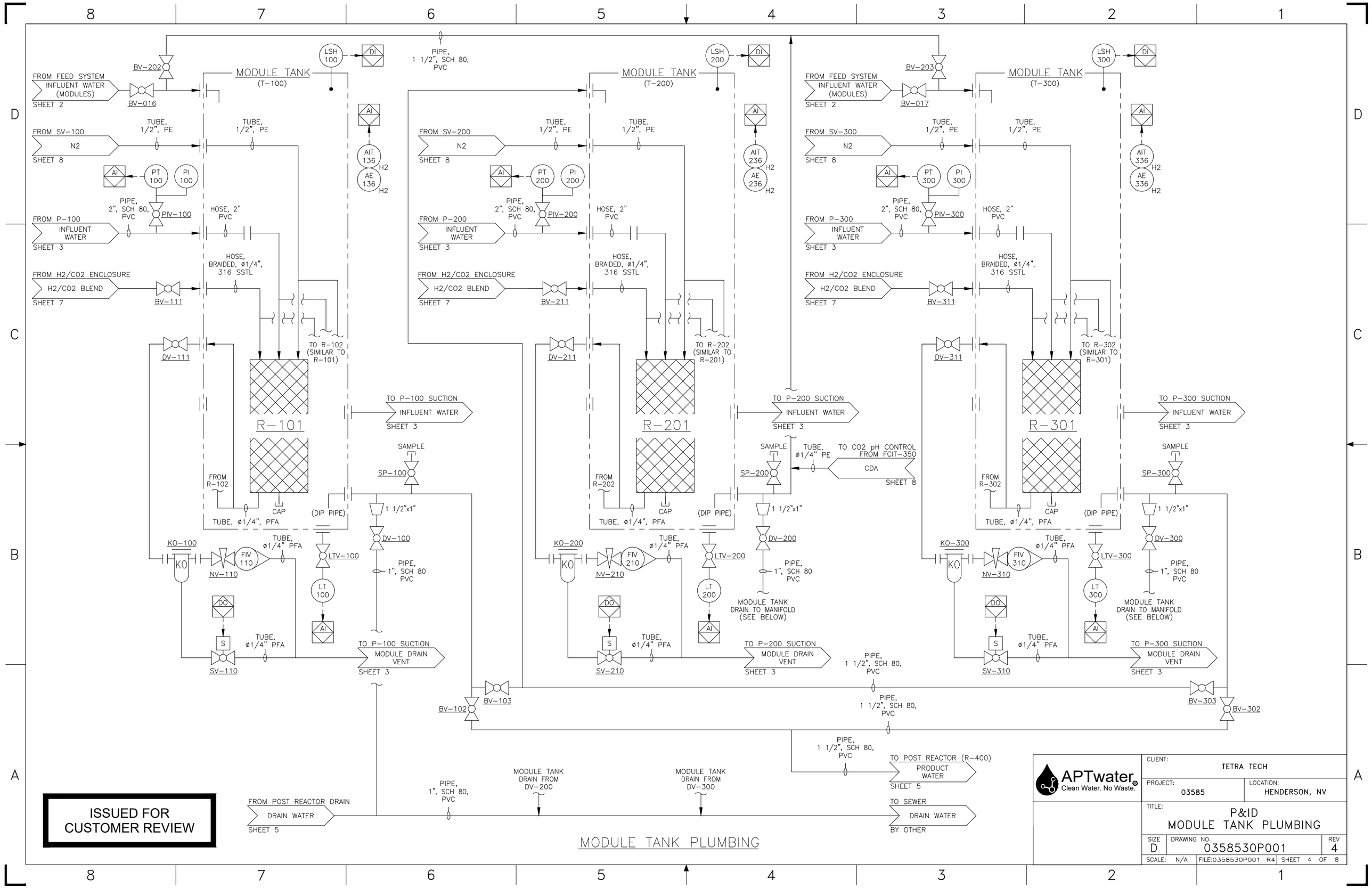
TO VFD ENCLOSURE (SHEET 2)
P-300
1 1/4"x2"
2"x1 1/2"
BV-301
2"x1/2"
2"x1/2"
PIPE, 2", SCH 80, PVC
AI
FIT 300
FE 300
0-160 GPM
TO MODULE (R-300) INFLUENT WATER SHEET 4
TUBE, ø1/2", PE, BLACK
BV-370
BV-360
BV-300
PIPE, 2", SCH 80, PVC
FROM MODULE TANK (T-300) INFLUENT WATER SHEET 4

BV-371
AIT 370 / AE 370 pH
AIT 371 / AE 371 ORP
PIPE, 1/2", SCH 80 PVC
SP-370
SAMPLE
BV-372
TUBE, 1/2", PE, BLACK
TO PUMP SUCTION (P-300) INFLUENT WATER (ANALYZER) SHEET 3

DO
S
PIPE, 1/2", SCH 80 PVC
BV-361
SV-360

APTwater
Clean Water. No Waste.

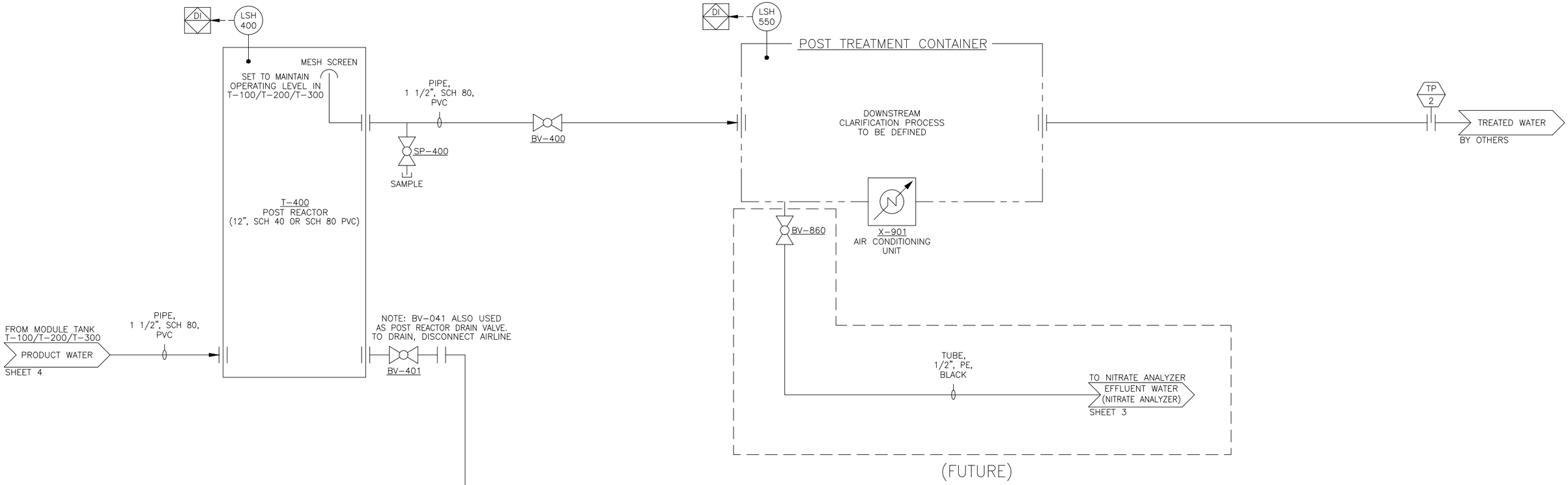
CLIENT:	TETRA TECH
PROJECT: 03585	LOCATION: HENDERSON, NV
TITLE:	P&ID MODULE FEED PLUMBING
SIZE: D	DRAWING NO.: 0358530P001
REV:	4
SCALE: N/A	FILE:0358530P001-R4
SHEET	3 OF 8



ISSUED FOR CUSTOMER REVIEW

APTwater
Clean Water. No Waste.

CLIENT:	TETRA TECH
PROJECT: 03585	LOCATION: HENDERSON, NV
TITLE:	P&ID MODULE TANK PLUMBING
SIZE: D	DRAWING NO.: 0358530P001
REV:	4
SCALE: N/A	FILE:0358530P001-R4
SHEET	4 OF 8



ISSUED FOR CUSTOMER REVIEW

APTwater
Clean Water. No Waste.

CLIENT:	TETRA TECH
PROJECT: 03585	LOCATION: HENDERSON, NV
TITLE:	P&ID EFFLUENT SYSTEM
SIZE: D	DRAWING NO.: 0358530P001
REV:	4
SCALE: N/A	FILE:0358530P001-R4
SHEET	5 OF 8

CONTAINER PROCESS ROOM

TUBE, ø1/4", PE, CLEAR

TO PHOSPHATE STORAGE STORAGE TANK (T-011)

RO WATER

SHEET 2

VENT TO OUTSIDE

TO PLC

AI

1/2"x1/4"

ASH 030 H2

AE 030 H2

I

KO-030

AI

PT 030

PTV-030

DO

S

TUBE, ø1/4", 0.035 WALL, 316 SSTL

TO H2 MFC(S)

H2

SHEET 7

FROM SOURCE

CITY WATER

BY OTHERS

UTV-025

UTILITY

X-025 RO/DI UNIT

(DI WATER)

TUBE, ø1/4", PE, CLEAR

X-030 H2 GENERATOR

BV-030

(RECYCLE)

FPR-030 SET @ 70 PSIG

XV-030

TO SEWER

REJECT

BY OTHERS

FIT 900

AI

AMBIENT AIR

COOLED AIR

X-900 EVAPORATIVE COOLING UNIT

TUBE, ø1/4" PE

TO CO2 MFC(S)

CO2

SHEET 7

FPR-020 SET @ 70 PSIG

BV-020

DO

LOW FAN SPEED

HIGH FAN SPEED

WATER PUMP

CO2 CYLINDERS (BY OTHERS)

ISSUED FOR CUSTOMER REVIEW

APTwater Clean Water. No Waste.

CLIENT:	TETRA TECH
PROJECT: 03585	LOCATION: HENDERSON, NV
TITLE:	P&ID H2/CO2 SUPPLY
SIZE: D	DRAWING NO.: 0358530P001
REV:	4
SCALE: N/A	FILE:0358530P001-R4
SHEET	6 OF 8

TO CO2 pH CONTROL @ P-100 SUCTION
CO2
SHEET 3
TUBE, ø1/4" PE
TUBE, ø1/4", 0.035 WALL, 316 SSTL
TO MODULES R-100
H2/CO2 BLEND
SHEET 4

TO CO2 pH CONTROL @ P-200 SUCTION
CO2
SHEET 3
TUBE, ø1/4" PE
TUBE, ø1/4", 0.035 WALL, 316 SSTL
TO MODULES R-200
H2/CO2 BLEND
SHEET 4

TO CO2 pH CONTROL @ P-300 SUCTION
CO2
SHEET 3
TUBE, ø1/4" PE
TUBE, ø1/4", 0.035 WALL, 316 SSTL
TO MODULES R-300
H2/CO2 BLEND
SHEET 4

H2/CO2 MFC PANEL

TUBE, ø1/4" PE

AI FLOW
AO SP
AI
PT 130
PTV-130
TUBE, ø1/4", 0.035 WALL, 316 SSTL
FC
FT
S
FCIT-130
H2 MFC
CV-130

AI FLOW
AO SP
DO
TUBE, ø1/4", 0.035 WALL, 316 SSTL
FCIT-115
CO2 MFC (BLEND)
CV-115
XV-115
316 SSTL → PE

AI FLOW
AO SP
DO
FCIT-120
CO2 MFC (pH CONTROL)
CV-120
XV-120
PTV-120
PT 120
AI
316 SSTL
PFA
TUBE, ø1/4" PE

TUBE, ø1/4", 0.035 WALL, 316 SSTL

TUBE, ø1/4" PE

AI FLOW
AO SP
AI
PT 230
PTV-230
TUBE, ø1/4", 0.035 WALL, 316 SSTL
FCIT-230
H2 MFC
CV-230

AI FLOW
AO SP
DO
TUBE, ø1/4", 0.035 WALL, 316 SSTL
FCIT-215
CO2 MFC (BLEND)
CV-215
XV-215
316 SSTL → PE

AI FLOW
AO SP
DO
FCIT-220
CO2 MFC (pH CONTROL)
CV-220
XV-220
316 SSTL
PFA
TUBE, ø1/4" PE

TUBE, ø1/4" PE

AI FLOW
AO SP
AI
PT 330
PTV-330
TUBE, ø1/4", 0.035 WALL, 316 SSTL
FCIT-330
H2 MFC
CV-330

AI FLOW
AO SP
DO
TUBE, ø1/4", 0.035 WALL, 316 SSTL
FCIT-315
CO2 MFC (BLEND)
CV-315
XV-315
316 SSTL → PE

AI FLOW
AO SP
DO
FCIT-320
CO2 MFC (pH CONTROL)
CV-320
XV-320
316 SSTL
PFA
TUBE, ø1/4" PE

TUBE, ø1/4", 0.035 WALL, 316 SSTL

TUBE, ø1/4" PE
FROM CO2 CYLINDER
CO2
SHEET 6

TUBE, ø1/4", 0.035 WALL, 316 SSTL
FROM H2 GENERATOR
H2
SHEET 6

ISSUED FOR CUSTOMER REVIEW

APTwater
Clean Water. No Waste.

CLIENT:	TETRA TECH
PROJECT: 03585	LOCATION: HENDERSON, NV
TITLE:	P&ID H2/CO2 DELIVERY
SIZE: D	DRAWING NO.: 0358530P001
REV:	4
SCALE: N/A	FILE:0358530P001-R4
SHEET	7 OF 8

AIR COMPRESSOR ROOM

COMPRESSOR

DI FAULT

DO ENABLE

C-040 COMPRESSOR/DRYER

S

AMBIENT AIR

PIPE, 3/4", SCH 80, 316 SSTL

PIPE, 1/2", SCH 80, GALVANIZED STEEL

3/4"x1/4"

3/4"x1/2"

BV-054

SEWER

TUBE, ø1/4", PE

AI

AIT 050 02

AE 050 02

SET @ 200psi

PRV-050

AI

PT 050

N2/AIR RECEIVER TANK

PIPE, 1/2", SCH 80, GALVANIZED STEEL

BV-050

T-050

BV-051

DV-050

DRAIN

FPR-050 SET @ 70 PSIG

AI

PI 051

PT 051

PTV-051

M

BV-053

PIPE, 1/2", SCH 80, GALVANIZED STEEL

CV-041

N2 GENERATOR PANEL

PI 040

PIV-040

TUBE, ø3/8", 0.049 WALL, 316 SSTL

(FUTURE)

PI 041

PIV-041

F-040

BV-040

CARBON FILTER

1/2"x3/8"

R-040 MEMBRANE MODULE

R-041 MEMBRANE MODULE

3/8"x1/2"

NV-042

SP-042

SAMPLE

BV-041

TUBE, ø1/4" PE

AI

AO

FLOW

SP

FC

FT

S

FPR-350 SET @ 40 PSIG

FCIT-350

CV-350

BV-350

TUBE, ø1/4" PE

TO TANK T-200 EFFLUENT

CDA

SHEET 4

N2 DELIVERY MANIFOLD

DO

S

SV-100

TUBE, ø1/2", PE

TO MODULE TANK (T-100)

N2

SHEET 4

DO

S

SV-200

TUBE, ø1/2", PE

TO MODULE TANK (T-200)

N2

SHEET 4

DO

S

SV-300

TUBE, ø1/2", PE

TO MODULE TANK (T-300)

N2

SHEET 4

DO

S

SV-400

TUBE, ø1/2", PE

TO POST REACTOR (T-400)

N2

SHEET 4

ISSUED FOR CUSTOMER REVIEW

APTwater
Clean Water. No Waste.

CLIENT: TETRA TECH

PROJECT: 03585

LOCATION: HENDERSON, NV

TITLE: P&ID CDA/N2 DELIVERY SYSTEM

SIZE D | DRAWING NO. 0358530P001 | REV 4

SCALE: N/A | FILE:0358530P001-R4 | SHEET 8 OF 8

NOTES:

1. METERING PUMP IS STOPPED ON LOW INFLUENT FLOW TO THE PLANT.

NEAT POLYMER

CONTAINER , FIELD

NOTE 1

HS SC

T-410 COAGULANT SYSTEM

SPD

P-410 METERING PUMP

3/8"x1/4"

CV-410

BV-410

TUBE, 1/4", PE

S/S

HS

M-480A

M-480B

T-480A NEAT POLYMER TANK

T-480B NEAT POLYMER TANK

BV-481A

BV-481B

BV-480A

BV-480B

BV-480D

BV-480C

PIPE, 1", SCH 80 PVC

PIPE, 1", SCH 80 PVC

PIPE, 1", SCH 80 PVC

STABILIZED LAKE MEAD WATER

BV-483

BV-485

CV-480

P-480 METERING PUMP

BV-484

BV-482

POLYMER BATCH SYSTEM

TUBE, 1/4", PE

TUBE, 1/4", PE

PAH

LSHH

LI

SHUT DOWN SIGNAL TO INFLUENT PUMP

SC

VFD 500

M-500

BV-486

M-450

PIPE, 1 1/2", SCH 80 PVC

FROM POST REACTOR TANK IN TREATMENT CONTAINER

BV-402

PIPE, 1", SCH 80 PVC

SP-450

PIPE, 1/4", SCH 80 PVC

SAMPLE PORT

T-450 SURGE TANK

2"x1"

PIPE, 1", SCH 80 PVC

PIPE, 1/4", SCH 80 PVC

SP-500

SAMPLE PORT

T-500 LAMELLA CLARIFIER

2"x1"

BV-586

LIT 550

M-550

T-550 TREATED WATER HOLDING TANK NO 1

PIPE, 1 1/4", SCH 80 PVC

BV-550

SP-550

SAMPLE PORT

PIPE, 1", SCH 80 PVC

PIPE, 1/4", SCH 80 PVC

VFD 550

P-550 TREATED WATER PUMP

CV-550

BV-551

PIPE, 1", SCH 80 PVC

PI

PT

CV-551

BV-555

BV-552

F-550 CARTRIDGE FILTER

BV-554

BV-553

FI

FQ

FIT FM-550

PIPE, 1", SCH 80 PVC

BV-557

SP-551

PIPE, 1/4", SCH 80 PVC

SAMPLE PORT

1"x2"

PIPE, 2", SCH 80 PVC

BV-556

TO GW-11

PIPE, 1", SCH 80 PVC

PIPE, 1/2", SCH 80 PVC

BV-580

1"x1/2"

P-580 INITIAL SOLIDS HANDLING PUMP

1"x1/2"

CV-580

BV-581

PIPE, 1", SCH 80 PVC

PIPE, 1", SCH 80 PVC

SP-580

SAMPLE PORT

PIPE, 1/4", SCH 80 PVC

LAH

LIT 580

M-580

T-580 INITIAL SOLIDS HOLDING TANK

PIPE, 1", SCH 80 PVC

BV-582

BV-583

1"x1 1/4"

P-581 FINAL SOLIDS HANDLING PUMP

1"x3/4"

CV-581

BV-584

FIT FM-580

BV-585

PIPE, 1", SCH 80 PVC

SP-581

SAMPLE PORT

PIPE, 1/4", SCH 80 PVC

T-581 FINAL SOLIDS HOLDING TANK

PIPE, 1", SCH 80 PVC

DISPOSAL

Abbreviations:

HS - Hand Switch
SC - Speed Control
SPD - Speed
S/S - Start/Stop
PAH - High Pressure Alarm
PI - Pressure Indicator
PT - Pressure Transmitter
LI - Level Indicator
LIT - Level Indicator Transmitter
LAH - High Level Alarm
LSHH - High-High Level Switch
FM - Flow Meter
FI - Flow Indicator
FIT - Flow Indicator Transmitter
FQ - Flow Totalizer
M - Mixer
BV- Ball Valve
CV- Check Valve

F - Cartridge Filter
P - Pump
T - Tank
SP - Sampling Point
VFD - Variable Frequency Drive

TETRA TECH
www.tetratech.com
1899 POWERS FERRY ROAD SE, SUITE 400
ALTANTA, GA 30339
PH: 770.850.0949 FAX: 770.850.0950

MARK	DATE	DESCRIPTION	BY

NERT PILOT PLANT

POST TREATMENT SYSTEM P&ID

PROJ:	200-01299-2002
DESN:	RAK
DRWN:	RWP
CHKD:	RAK

I-101

Bar Measures 1 inch, otherwise drawing not to scale

Appendix B
Data Validation Summary Report (DVSR ID: Tetra Tech-M26-2021)

Data Validation Summary Report
(DVSR ID: TetraTech-M26-2021)
Hydrogen-Based Gas Permeable Membrane Pilot Test Results Report

Nevada Environmental Response Trust Site
Henderson, Nevada

PREPARED FOR

Nevada Environmental Response Trust
35 E. Wacker Drive, Suite 690
Chicago, IL 60601

PRESENTED BY

Tetra Tech, Inc.
150 S. 4th Street, Unit A
Henderson, NV 89015

May 31, 2023

TABLE OF CONTENTS

LIST OF TABLES

APPENDICES

LIST OF ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
BW	blank water
CCB	continuing calibration blank
CCV	continuing calibration verification
DL	detection limit
DMC	deuterated monitoring compound
DOC	dissolved organic carbon
DQO	data quality objectives
DUP	duplicate
DVSR	data validation summary report
EB	equipment blank
EDD	electronic data delivery
FD	field duplicate
ICAL	initial calibration
ICB	initial calibration blank
ICS	interference check samples
LCS	laboratory control sample
mg/L	milligrams per liter
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate
NORM	normal field sample
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
NFG	USEPA National Functional Guidelines
%C	percent completeness
%D	percent difference or drift
%R	percent recovery
%RSD	percent relative standard deviation
PARCCS	precision, accuracy, representativeness, comparability, completeness, sensitivity
Pilot Study	Hydrogen-Based Gas Permeable Membrane Pilot Study
PQL	practical quantitation limit
QA	quality assurance
QAPP	quality assurance project plan

Acronyms/Abbreviations	Definition
QC	quality control
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SQL	sample quantitation limit
TDS	total dissolved solids
Tetra Tech	Tetra Tech, Inc.
TOC	total organic carbon
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
µg/L	micrograms per liter
WS	source water

1.0 INTRODUCTION

On behalf of the Nevada Environmental Response Trust (NERT), Tetra Tech, Inc. (Tetra Tech) has prepared this Data Validation Summary Report (DVSR) to assess the validity and usability of laboratory analytical data from the samples associated with the Hydrogen-Based Gas Permeable Membrane Pilot Test (Pilot Test) for the NERT site, located in Clark County, Nevada. Sampling protocol can be found in *Hydrogen-Based Gas Permeable Membrane Pilot Study System Operation Manual* (Tetra Tech, 2020). Tetra Tech collected and validated 300 source water and 8 equipment blank samples from September 2020 through August 2021 as part of the Pilot Test activities.

Eurofins TestAmerica, Inc. and Pace Analytical provided laboratory analytical services. The analyses were performed by the methods shown in Table 1.

The laboratory assigns job numbers, also called sample delivery groups (SDGs), to all samples. The samples associated with quality assurance/quality control (QA/QC) are designed to document the data quality of the samples in each sampling round or within an SDG. Table 2 cross-references each validated sample with its laboratory analysis, SDG, collection date, Tetra Tech sample ID, laboratory sample ID, QC type, matrix, and stage of validation. Samples in Table 2 are submitted in the DVSR electronic data deliverable (EDD) along with associated, unvalidated field readings. The EDD contains 308 samples consisting of 300 validated source water samples and 8 validated equipment blanks.

The laboratory analytical data were verified and validated in accordance with procedures described in the *Quality Assurance Project Plan, Revision 5* (Ramboll, 2020a), *Quality Assurance Project Plan, Revision 6* (Ramboll, 2020b), *NDEP Guidance on Data Verification and Validation Requirements* (NDEP, 2018a), and the references contained therein. The samples, all aqueous, were validated to Stage 2A. The review process uses professional judgment and National Functional Guidelines (NFG) guidance to determine the final qualifiers, which are added to the database and presented in the DVSR tables.

The validation checklists are found in Appendix 1. Laboratory data packages may be found in Appendix 2. A database of the analytical results following protocol outlined in *NDEP Guidance on Unified Chemical Electronic Data Deliverable Format* (NDEP, 2018b) is provided in Appendix 3.

This report summarizes the QA/QC evaluation of the data using precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) relative to the project data quality objectives (DQOs). This report provides a quantitative and qualitative assessment of the data and identifies potential sources of error, uncertainty, and bias that may affect the overall usability of the data.

2.0 PRECISION AND ACCURACY OF ENVIRONMENTAL DATA

Environmental data quality depends on sample collection procedures, analytical methods and instrumentation, documentation, and sample matrix properties. Both sampling procedures and laboratory analyses contain potential sources of uncertainty, error, and/or bias, which may affect the overall quality of a measurement. Errors for sample data may result from incomplete equipment decontamination, inappropriate sampling techniques, sample heterogeneity, improper filtering, and improper preservation. The accuracy of analytical results is dependent on selecting appropriate analytical methods, maintaining equipment properly, and complying with QC requirements. The sample matrix also is an important factor in the ability to obtain precise and accurate results within a given medium.

Environmental and laboratory QA/QC samples provide information on the effects of sampling procedures and evaluate laboratory contamination, laboratory performance, and matrix effects. Field QA/QC samples include equipment blanks (EBs), field duplicates (FDs), and matrix spike/matrix spike duplicates (MS/MSDs). Laboratory QA/QC samples include method blanks, laboratory control samples (LCSs), laboratory duplicates (DUP), and additional MS/MSDs needed to meet method requirements.

2.1 PRECISION

Precision is a measure of the agreement of analytical results under a given set of conditions. It is a quantity that is not measured directly but is calculated from concentrations. Precision can be expressed as the relative percent difference (RPD) between two measurements:

$$RPD = \frac{(C1 - C2)*100}{(C1 + C2)/2}$$

where:
C1 = reported concentration for the sample
C2 = reported concentration for the duplicate

Precision can be expressed as the percent relative standard deviation (%RSD) between three or more measurements:

$$\%RSD = (s/\bar{a})*100$$

where:
%RSD = percent relative standard deviation
s = standard deviation
$\bar{a}$ = mean of replicate analyses

Precision is assessed by calculating %RSD during an initial calibration (ICAL) and RPD from the percent recoveries of the spiked compounds for each sample in the MS/MSD pair. In the absence of an MS/MSD pair, a laboratory duplicate can be analyzed as an alternative means of assessing precision. An additional measure of sampling precision is obtained by collecting and analyzing FD samples, which are compared using the RPD results as the evaluation criteria.

MS and MSD samples are field samples which have been spiked by the laboratory with target analytes prior to preparation and analysis. These samples measure the appropriateness of the analytical method and effectiveness in recovering target analytes from a specific environmental matrix. The LCS sample is spiked with the same target analytes as the MS/MSD using an interference-free matrix instead of a field sample aliquot. The LCS measures laboratory efficiency in recovering target analytes in the absence of matrix interferences. It is used to verify that the analyses are being performed in control.

The laboratory analyzes laboratory replicates. A field sample is analyzed and an unspiked duplicate of that sample is also analyzed. The data reviewer compares the reported results of the primary analysis and the laboratory duplicate and calculates RPDs to assess laboratory precision.

Calibration precision is determined by calculating %RSD. Laboratory and field sampling precision are evaluated by calculating RPDs for field sample duplicate pairs, if collected. The sampler collects two field samples at the same location and under identical conditions. The laboratory then analyzes the samples under identical conditions.

An RPD outside the allowed limit between MS/MSD samples or DUP samples indicates imprecision. Imprecision is the variance in the consistency with which the laboratory arrives at a reported result. The actual analyte concentration may be higher or lower than the reported result.

Possible causes of poor precision include sample heterogeneity, sample matrix interference, improper sample collection or handling, inconsistent sample preparation, instrument column fouling, and poor instrument stability. In duplicate pairs, results may be reported in either the primary or duplicate samples at levels below the practical quantitation limit (PQL) or non-detected. Since these values are estimated, RPD exceedances from these duplicate pairs do not suggest a significant impact to data quality.

2.2 ACCURACY

Accuracy is a measure of the closeness of agreement between a measured value and the true value of an analytical parameter. It may be used to identify bias in each measurement system. Recoveries outside acceptable QC limits may be caused by factors such as instrumentation, analyst error, or matrix interference. Accuracy is assessed through the analysis of continuing calibrations, MS, MSD, LCS, and surrogates. In some cases, samples from multiple SDGs were within one QC batch and therefore are associated with the same laboratory QC samples. Accuracy is determined using the percent recovery (%R) of MS and LCS analyses.

Percent recovery is calculated using the following equation:

$$\%R = (A-B)/C \times 100$$

where:
A = measured concentration in the spiked sample
B = measured native concentration in the unspiked sample
C = concentration of the spike

The percent recovery of each analyte spiked in MS/MSD samples and LCS is evaluated with the acceptance criteria specified by the quality assurance project plans (QAPPs) and laboratory limits. Spike recoveries outside the acceptable QC accuracy limits provide an indication of bias, where the reported data may overestimate or underestimate the actual concentration of compounds detected or quantitation limits reported for environmental samples.

2.3 REPRESENTATIVENESS

Representativeness is a qualitative parameter that expresses the degree to which the sample data are characteristic of a population. It is evaluated by reviewing the QC results of blanks, samples, and holding times. Positive detects of compounds in the blank samples identify compounds that may have been introduced into the samples during sample collection, transport, preparation, or analysis. The QA/QC blanks collected and analyzed are method blanks, calibration blanks, and EBs.

A method blank is a laboratory grade water or solid matrix that contains the method reagents and has undergone the same preparation and analysis as the environmental samples. The method blank provides a measure of the combined contamination derived from the laboratory source water, glassware, instruments, reagents, and sample

preparation steps. Method blanks are prepared for each sample of a similar matrix extracted by the same method at a similar concentration level.

Several methods require the use of initial calibration blanks (ICBs) and continuing calibration blanks (CCBs). ICBs and CCBs are laboratory-grade water samples that are analyzed at the beginning, during, and at the end of sample analysis runs. The frequency is dependent on the analytical method. These blanks estimate residual contaminants from the previous sample or standards analysis and measure baseline shifts that commonly occur in emission and absorption spectroscopy.

EBs consist of analyte-free water poured over or through the sample collection equipment. The water is collected in a sample container for laboratory analysis. These blanks are collected after the sampling equipment is decontaminated; they are used to measure effectiveness of the decontamination procedure. EBs are collected and analyzed for all target analytes.

Contaminants found in both the environmental sample and the blank sample are assumed to be laboratory artifacts if one or both values are less than the PQL, or if a sample result and blank contaminant value are greater than the PQL and the sample result is less than 10 times the blank contaminant value.

Holding times are evaluated to assure that the sample integrity is intact for accurate sample preparation and analysis. Holding times are specific for each method and matrix analyzed. Holding time exceedance can cause loss of sample constituents due to biodegradation, precipitation, volatilization, and chemical degradation. Sample results for analyses that were performed after the method holding time are qualified according to NDEP requirements using the qualifiers and bias recommendations found in the NFGs.

2.4 COMPARABILITY

Comparability is a qualitative characteristic that defines the extent to which the data for a chemical parameter measurement are consistent with, and may be compared with, data from other sampling events. Comparability is dependent upon the design of the sampling plans and execution of activities consistent with approved plans. Factors affecting comparability include sample collection and handling techniques, matrix type, and analytical method. Comparability is achieved using standard techniques to collect representative samples, consistent application of analytical method protocols, and use of appropriate units in reporting analytical results. Comparability is also dependent upon other PARCCS criteria, because only when precision, accuracy, and representativeness are known can datasets be compared with confidence.

2.5 COMPLETENESS

Completeness is defined as the percentage of acceptable sample results compared to the total number of sample results. Completeness is evaluated to determine if an acceptable amount of usable data was obtained so that a valid scientific site assessment can be completed. Completeness equals the total number of sample results for each fraction minus the total number of rejected sample results divided by the total number of sample results multiplied by 100. As specified in the project DQOs, the goal for completeness for target analytes in each analytical fraction is 90 percent.

Percent completeness is calculated using the following equation:

$$\%C = (T - R)/T \times 100$$

where:
%C = percent completeness
T = total number of sample results
R = total number of rejected sample results

Completeness is also determined by comparing the planned number of samples per method and matrix as specified in the QAPPs, with the number determined above. In cases where multiple results are reported for a

single analyte due to dilutions or re-analysis using a single method, the most technically sound value will be reported, and the other result will be qualified “R”. Data rejected in favor of alternate results are not used in the completion calculation.

2.6 SENSITIVITY

Sensitivity is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. It is generally used to describe the instrument detection limits (DLs) or PQLs established to meet project DQOs. The method detection limit (MDL) represents the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Sample quantitation limits (SQLs) are adjusted MDL values that reflect sample-specific actions, such as dilutions or varying aliquot sizes. The laboratory data reports show MDL in place of the SQL. The MDL was adjusted to reflect the sample analysis conditions. The PQL is the minimum concentration that can be reported based on the analysis of a specific matrix. The PQL is often the lowest acceptable calibration point for the analyte.

For this project, the laboratory data reports show reporting limit (RL) in place of the PQL. The laboratory reported detected analytes down to the adjusted MDL/SQL. All results reported between the SQL and PQL were qualified “J” by the laboratory. Sample results are compared to method and field quality blank results to identify possible effects of laboratory background and field procedures on sensitivity.

3.0 VALIDATION RESULTS AND PARCCS

This section discusses the validation results and the associated PARCCS criteria. Before conducting the PARCCS evaluation, the analytical data were validated to Stage 2A.

Samples not meeting the acceptance criteria were denoted with a validation qualifier that indicates a deficiency with the data. Table 3 contains validation qualifiers used in data validation.

When more than one validation qualifier is applicable to a data point, the final validation qualifier applied is based on the following hierarchy:

R > J	R takes precedence over the J qualifier.
J+	The high bias (J+) qualifier is applied to detected results only.
J > J+ or J-	The unbiased (J) qualifier supersedes biased (J+ or J-) qualifiers since it is not possible to assess the direction of the potential bias.
J = J+ plus J-	Adding biased (J+ or J-) qualifiers with opposite signs results in an unbiased qualifier (J).
UJ = U plus J	The UJ qualifier is used when a non-detected (U) flag is added to a (J) flag.

Table 4 identifies the QC elements reviewed for Stage 2A validation. The actual elements are method-dependent.

Table 5 lists the reason codes used. Reason codes explain why data were qualified and identify possible limitations of data use. Reason codes are cumulative except when one of the flags is R. In that case, only the reason code associated with the R flag is used.

Table 6 presents the overall qualified results after the validation qualifiers and associated reason codes were applied.

3.1 PRECISION

3.1.1 Instrument Calibration

The objective of the ICAL is to ensure that an instrument can produce acceptable qualitative and quantitative data by determining the ratio of instrument response to analyte concentration. %RSD is often used to evaluate ICAL results and provides a means of evaluating precision within an analytical system.

ICAL data are not reviewed during Stage 2A validation.

3.1.2 MS/MSD and Laboratory Duplicate Samples

Two total suspended solids (TSS) results were qualified for laboratory duplicate RPD outliers. The following TSS results were qualified "J": SP-015-WK05A in SDG 550-150946-1 and SP-015-WK08A in SDG 550-153405-1. Duplicate RPDs for SP-015-WK05A and SP-015-WK08A were 67 percent and 61 percent, respectively. The limit is 10 percent. The results are found in Table 6 with reason code “ld”. No data were qualified for MS/MSD RPD outliers.

3.1.3 Field Duplicate Samples

For results > 5X the PQL, the FDs were evaluated for acceptable precision with RPDs. For water samples, the allowable RPD is 30 percent. For results < 5X the PQL, samples were evaluated by the difference between the two measurements. Six results were qualified for FD imprecision. In SDG 550-157025-1, TSS was qualified "J"

and “UJ” in SP-015-20210122-FEED and SP-015-20210122-FEED-FD, respectively. The difference between the two values exceeded the PQL. In SDG L1380668, TSS was qualified "J" in SP-100-20210720-LEAD and SP-100-20210720-LEAD-FD. The RPD between the results was 85 percent. In SDG L1388446, TSS was qualified "J" in SP-015-20210809 and SP-015-20210809 -FD. The RPD between the results was 42 percent. Results qualified for FD imprecision are found in Table 6 with reason code “fd”.

3.2 ACCURACY

3.2.1 Calibration and Continuing Calibration

As stated previously, the objective of ICAL is to ensure that an instrument can produce acceptable qualitative and quantitative data by determining the ratio of instrument response to analyte concentrations. Typically, inorganic methods use regression models for initial calibration. Regression may also be used in organic analyses. The correlation coefficient indicates the linearity of the calibration curve. The coefficient of determination is an overall measure of the accuracy of the regression calibration curve. The objective of continuing calibration is to ensure that the instrument continues to meet the sensitivity and linearity criteria throughout each analytical sequence. Initial and continuing calibration verification (CCV) results provide a means of evaluating accuracy. Percent difference or drift (%D), percent recovery (%R), correlation coefficient, and coefficient of determination are the parameters used to measure the effectiveness of instrument calibration. %R and %D are used to verify the ongoing calibration acceptability of the analytical system.

Calibration data are not reviewed during Stage 2A validation.

3.2.2 MS/MSD Samples

Several MS/MSD %Rs were outside of acceptance criteria shown in the QAPPs. MS/MSD %R exceedances can be found in Table 7. Analytes that were present in the parent sample in concentrations greater than 4 times the amount spiked were not qualified and are not shown in the table. In cases where the recoveries were high and the parent sample was non-detect, no qualification was applied. Qualifiers were applied to parent samples only, unless FD samples or samples of known similarity were analyzed in the same SDG. Table 7 contains the spiked parent sample only. Per the inorganic NFG, MS/MSD recoveries < 30 percent result in rejection of the non-detected data point. In cases where dilutions caused the low recoveries, the data were not rejected or qualified. The effect of dilution on matrix spike recoveries is determined on a case-by-case-basis using professional judgment, knowledge of the laboratory’s procedures, and input from the laboratory. For some analyses, the laboratory may dilute the sample prior to preparation for analyses and prior to addition of the matrix spike compounds. The laboratory also approaches this on a case-by-case basis. Twelve results were qualified for MS and/or MSD %Rs. The results qualified for MS/MSD recoveries can be found in Table 6 with reason code “m”.

As stated in the beginning of Section 3.0, the unbiased “J” qualifier supersedes biased qualifiers since it is not possible to assess the direction of the potential bias. For four perchlorate samples in SDG L1385599, the validator used professional judgment to apply the “J-“ qualifier. Perchlorate recoveries were very low in the spiked parent samples. The validator concluded the result may be biased low despite uncertainty associated with detections below the PQL, which are usually qualified “J” in validation.

3.2.3 LCS Samples

Two results were qualified for LCS %R outliers. In SDG L1382360, TSS in SP-550-20210722 and SP-551-20210722 were qualified “J+” for high recovery in the associated LCS. The results qualified for LCS recoveries can be found in Table 6 with reason code “l”.

3.2.4 Serial Dilutions

The serial dilution is used to determine whether physical or chemical interferences exist due to matrix. Most serial dilution %Ds were less than 10 percent as required in the inorganic NFG. One SW-6010B result was qualified for high %D in the serial dilution. In SDG L1383184, a serial dilution was analyzed on SP-015-20210727. The %D for total chromium was 10.6 percent. Total chromium in SP-015-20210727 was qualified “J” and can be found in Table 6 with reason code “sd”.

3.2.5 Interference Check Samples

Interference check samples (ICS) are analyzed in the following methods: EPA 314.0, SW-6010B, and SW-6020A. All interference check %Rs met acceptance criteria of 80 to 120 percent.

3.2.6 Surrogates

Surrogates are added to samples analyzed by EPA 300.1 by Eurofins TestAmerica to measure the efficiency of the analytical method. The acceptance limits are 90 to 115 percent. In SDG 550-156702-1, surrogate recovery was high in SP-200-20210118, at 136 percent. In SDG 550-157683-1, surrogate recoveries were high in SP-200-20210202 and SP-400-20210202, at 215 percent and 289 percent, respectively. Chlorate results in the three samples were qualified “J+” and can be found in Table 6 with reason code “s”.

3.2.7 Analyte Quantitation and Target Identification

SP-300-20210316-LAG was analyzed twice for chlorate at 1x and 10x dilutions. Both results were non-detect. Since both results met QC criteria, the 1x dilution result was used because of the lower PQL. The 10x dilution result was assigned a validation qualifier “R” and is shown with reason code “brr” in Table 6. Data rejected in favor of alternate results such as dilution runs are not used in the completion calculation.

3.3 REPRESENTATIVENESS

3.3.1 Sample Preservation and Holding Times

Sample preservation and holding times were evaluated to verify compliance with the analytical methods. Qualified results in Table 6 are designated with reason codes “h” for holding time and “pH” for preservation.

In SDG L1327057, four total organic carbon (TOC) results were qualified for both preservation and holding time infractions. The TOC analyses were not on the chain-of-custody and were requested after submittal to the lab. Using aliquots of unpreserved samples, the laboratory adjusted the pH of the samples to pH < 2 prior to analysis. Since the samples were not analyzed within the 4-hour holding time for unpreserved samples, the holding time was grossly exceeded. One TOC result was qualified “J-“ in validation. Three TOC results were qualified “J” in validation because of the presence of another quality issue.

Seven dissolved organic carbon (DOC) results were qualified “J-“ or “J” for missed holding time. DOC was qualified “J” in some cases because of the presence of another quality issue.

Six nitrate samples were analyzed past their 48-hour holding time. The nitrate results were qualified “J-“ for detects and “UJ” for non-detects. They are designated with reason code “h” in Table 6.

The preservation exceedances are shown in Table 8. The holding time exceedances are shown in Table 9.

3.3.2 Blanks

Method blanks, ICBs, CCBs, and EBs were analyzed to evaluate representativeness. The concentration of an analyte in any blank was used for data qualification. If contaminants were detected in a blank, the blank concentration was compared to the sample results. If the analyte was not detected in the sample, no qualification was applied to the sample. If the sample concentration was greater than 10 times the amount in the blank, after dilutions were considered, no qualification was applied.

For concentrations detected in the sample below the PQL, the sample result was qualified “J”. Based on hierarchy of validation qualification, the “J” qualifier, in this case applied to detected results below the PQL, supersedes the positive bias associated with blank contamination. For concentrations detected in the sample above the PQL and less than 10 times the amount in the blank, the sample result was qualified “J+”.

Calibration blanks are not reviewed during Stage 2A validation.

3.3.2.1 Method Blanks

DOC and TOC were detected in method blanks. Sixteen DOC and TOC sample results were qualified because of analytes found in both the samples and the laboratory blanks. Qualified results are shown in Table 6 with reason codes “bl”. Laboratory blank detections that resulted in qualification are shown in Table 10.

3.3.2.2 Equipment Blanks

There were several detections in the EBs. Eleven results were qualified because of EB detections. The qualified results are shown in Table 6 with reason code “be”.

EB detections that resulted in qualification are shown in Table 11 with the associated samples. EBs may not appear in the same SDG as their associated samples.

3.4 COMPARABILITY

The laboratory used standard analytical methods for all analyses. In all cases, the SQLs attained were at or below the PQLs. Target compounds detected below the PQLs were flagged “J” by the laboratory and should be considered estimated. All 51 results detected between the SQL and PQL are shown with reason code “sp” in Table 6. The comparability of the data is acceptable.

3.5 COMPLETENESS

The overall completeness level attained for the field samples and EBs is 100 percent and meets the project goal of 90 percent. The percentage was calculated as the total number of accepted (non-rejected) sample results divided by the total number of sample results multiplied by 100. Completeness by method is presented in Table 12. Data rejected in favor of alternate results such as dilution runs are not used in the completion calculation.

3.6 SENSITIVITY

Instrument sensitivity was determined to be technically acceptable. Due to high analyte concentrations and matrix effects, many analytical runs were analyzed at dilutions. For diluted analyses, SQLs and PQLs were elevated.

4.0 SUMMARY

The sample data were qualified for multiple data issues. Sample results were qualified for imprecision between samples and their laboratory or field duplicates. Sample results were qualified for %Rs of LCSs, MS and/or MSD samples, and surrogates, and for %D in a serial dilution. These issues affect accuracy. Qualifications that affected representativeness include blank contamination, holding time exceedances, and preservation infractions. Comparability was achieved by using approved sampling and analytical methods. The evaluation established that the project completeness levels were met. The sensitivity of the analytical methods was affected by the matrix of the samples. Dilutions raised the associated PQLs in many samples. The overall completeness level attained for the field samples and EBs is 100 percent

The analytical data quality assessment for the analytical results generated during the Hydrogen-Based Gas Permeable Membrane Pilot Test at the NERT site in Clark Country, Nevada, established that the overall project requirements and completeness levels were met.

5.0 REFERENCES

Nevada Division of Environmental Protection (NDEP). (2018a). *NDEP Guidance on Data Verification and Validation Requirements*. July 13.

NDEP. (2018b). *NDEP Guidance on Unified Chemical Electronic Data Deliverable Format*. July 13.

Ramboll. (2020a). *Quality Assurance Project Plan, Revision 5, Nevada Environmental Response Trust Site, Henderson, Nevada.*

Ramboll. (2020b). *Quality Assurance Project Plan, Revision 6, Nevada Environmental Response Trust Site, Henderson, Nevada.*

Tetra Tech. (2020). *Hydrogen-Based Gas Permeable Membrane Pilot Study System Operation Manual.*

Tables

Table 1 Analytical Methods

Method	Parameters	Number of Water Samples	Number of Soil Samples
EPA 300.0	Nitrate [as N]	167	0
EPA 300.0	Sulfate	59	0
EPA 300.1	Chlorate	176	0
EPA 314.0	Perchlorate	180	0
SM2540C	Total Dissolved Solids [TDS]	61	0
SM2540D	Total Suspended Solids [TSS]	292	0
SM5310B	Dissolved Organic Carbon	13	0
SM5310B	Total Organic Carbon	13	0
SW-6010B	Total Chromium	49	0
SW-7199	Chromium [VI]	49	0

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
550-149122-1/2	SP-015-WK01A	550-149122-1	WS	NORM	9/15/20	Stage 2A	X	X	X	X	X			
550-149122-1/2	SP-100-WK01A LAG	550-149122-2	WS	NORM	9/15/20	Stage 2A	X	X	X		X			
550-149122-1/2	SP-200-WK01A	550-149122-3	WS	NORM	9/15/20	Stage 2A	X	X	X		X			
550-149122-1/2	SP-300-WK01A LEAD	550-149122-4	WS	NORM	9/15/20	Stage 2A	X	X	X		X			
550-149122-1/2	SP-400-WK01A	550-149122-5	WS	NORM	9/15/20	Stage 2A	X	X	X		X			
550-149122-2	SP-550-WK01A	550-149122-6	WS	NORM	9/15/20	Stage 2A					X			
550-149122-1/2	SP-551-WK01A	550-149122-7	WS	NORM	9/15/20	Stage 2A	X	X	X	X	X			
550-149122-1/2	SP-551-WK01A-FD	550-149122-8	WS	FD	9/15/20	Stage 2A	X	X	X	X	X			
550-149122-1	FIELD-WK01A-EB	550-149122-9	BW	EB	9/15/20	Stage 2A	X	X	X					
550-149508-1	SP-015-WK01B	550-149508-1	WS	NORM	9/18/20	Stage 2A					X			
550-149508-1	SP-100-WK01B LAG	550-149508-2	WS	NORM	9/18/20	Stage 2A					X			
550-149508-1	SP-200-WK01B	550-149508-3	WS	NORM	9/18/20	Stage 2A					X			
550-149508-1	SP-200-WK01B-FD	550-149508-4	WS	FD	9/18/20	Stage 2A					X			
550-149508-1	SP-300-WK01B LEAD	550-149508-5	WS	NORM	9/18/20	Stage 2A					X			
550-149508-1	SP-400-WK01B	550-149508-6	WS	NORM	9/18/20	Stage 2A					X			
550-149508-1	SP-550-WK01B	550-149508-7	WS	NORM	9/18/20	Stage 2A					X			
550-149508-1	SP-551-WK01B	550-149508-8	WS	NORM	9/18/20	Stage 2A					X			
550-149511-1/2	SP-015-WK02A	550-149511-1	WS	NORM	9/21/20	Stage 2A	X	X	X	X	X			
550-149511-1/2	SP-100-WK02A LAG	550-149511-2	WS	NORM	9/21/20	Stage 2A	X	X	X		X			
550-149511-1/2	SP-200-WK02A	550-149511-3	WS	NORM	9/21/20	Stage 2A	X	X	X		X			
550-149511-1/2	SP-200-WK02A-FD	550-149511-4	WS	FD	9/21/20	Stage 2A	X	X	X		X			
550-149511-1/2	SP-300-WK02A LEAD	550-149511-5	WS	NORM	9/21/20	Stage 2A	X	X	X		X			
550-149511-1/2	SP-400-WK02A	550-149511-6	WS	NORM	9/21/20	Stage 2A	X	X	X		X			
550-149511-2	SP-550-WK02A	550-149511-7	WS	NORM	9/21/20	Stage 2A					X			
550-149511-1/2	SP-551-WK02A	550-149511-8	WS	NORM	9/21/20	Stage 2A	X	X	X	X	X			
550-149784-1	SP-015-WK02B	550-149784-1	WS	NORM	9/25/20	Stage 2A					X			
550-149784-1	SP-100-WK02B LAG	550-149784-2	WS	NORM	9/25/20	Stage 2A					X			
550-149784-1	SP-200-WK02B	550-149784-3	WS	NORM	9/25/20	Stage 2A					X			
550-149784-1	SP-300-WK02B LEAD	550-149784-4	WS	NORM	9/25/20	Stage 2A					X			
550-149784-1	SP-400-WK02B	550-149784-5	WS	NORM	9/25/20	Stage 2A					X			
550-149784-1	SP-550-WK02B	550-149784-6	WS	NORM	9/25/20	Stage 2A					X			
550-149784-1	SP-551-WK02B	550-149784-7	WS	NORM	9/25/20	Stage 2A					X			
550-150009-1	SP-015-WK03A	550-150009-1	WS	NORM	9/30/20	Stage 2A	X	X	X	X	X			
550-150009-1	SP-100-WK03A LAG	550-150009-2	WS	NORM	9/30/20	Stage 2A	X	X	X		X			
550-150009-1	SP-200-WK03A	550-150009-3	WS	NORM	9/30/20	Stage 2A	X	X	X		X			
550-150009-1	SP-300-WK03A LEAD	550-150009-4	WS	NORM	9/30/20	Stage 2A	X	X	X		X			
550-150009-1	SP-400-WK03A	550-150009-5	WS	NORM	9/30/20	Stage 2A	X	X	X		X			
550-150009-1	SP-550-WK03A	550-150009-6	WS	NORM	9/30/20	Stage 2A					X			
550-150009-1	SP-551-WK03A	550-150009-7	WS	NORM	9/30/20	Stage 2A	X	X	X	X	X			
550-150206-1	SP-015-WK03B	550-150206-1	WS	NORM	10/2/20	Stage 2A					X			
550-150206-1	SP-100-WK03B LAG	550-150206-2	WS	NORM	10/2/20	Stage 2A					X			
550-150206-1	SP-200-WK03B	550-150206-3	WS	NORM	10/2/20	Stage 2A					X			
550-150206-1	SP-300-WK03B LEAD	550-150206-4	WS	NORM	10/2/20	Stage 2A					X			

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
550-150206-1	SP-400-WK03B	550-150206-5	WS	NORM	10/2/20	Stage 2A					X			
550-150206-1	SP-400-WK03B-FD	550-150206-6	WS	FD	10/2/20	Stage 2A					X			
550-150206-1	SP-550-WK03B	550-150206-7	WS	NORM	10/2/20	Stage 2A					X			
550-150206-1	SP-551-WK03B	550-150206-8	WS	NORM	10/2/20	Stage 2A					X			
550-150303-1	SP-015-WK04A	550-150303-1	WS	NORM	10/6/20	Stage 2A	X	X	X	X	X			
550-150303-1	SP-100-WK04A LAG	550-150303-2	WS	NORM	10/6/20	Stage 2A	X	X	X		X			
550-150303-1	SP-200-WK04A	550-150303-3	WS	NORM	10/6/20	Stage 2A	X	X	X		X			
550-150303-1	SP-300-WK04A LEAD	550-150303-4	WS	NORM	10/6/20	Stage 2A	X	X	X		X			
550-150303-1	SP-400-WK04A	550-150303-5	WS	NORM	10/6/20	Stage 2A	X	X	X		X			
550-150303-1	SP-550-WK04A	550-150303-6	WS	NORM	10/6/20	Stage 2A					X			
550-150303-1	SP-551-WK04A	550-150303-7	WS	NORM	10/6/20	Stage 2A	X	X	X	X	X			
550-150303-1	SP-551-WK04A-FD	550-150303-8	WS	FD	10/6/20	Stage 2A	X	X	X	X	X			
550-150767-1	SP-015-WK04B	550-150767-1	WS	NORM	10/9/20	Stage 2A					X			
550-150767-1	SP-015-WK04B-FD	550-150767-2	WS	FD	10/9/20	Stage 2A					X			
550-150767-1	SP-100-WK04B-LAG	550-150767-3	WS	NORM	10/9/20	Stage 2A					X			
550-150767-1	SP-200-WK04B	550-150767-4	WS	NORM	10/9/20	Stage 2A					X			
550-150767-1	SP-300-WK04B-LEAD	550-150767-5	WS	NORM	10/9/20	Stage 2A					X			
550-150767-1	SP-400-WK04B	550-150767-6	WS	NORM	10/9/20	Stage 2A					X			
550-150767-1	SP-550-WK04B	550-150767-7	WS	NORM	10/9/20	Stage 2A					X			
550-150767-1	SP-551-WK04B	550-150767-8	WS	NORM	10/9/20	Stage 2A					X			
550-150946-1	SP-015-WK05A	550-150946-1	WS	NORM	10/14/20	Stage 2A	X	X	X	X	X			
550-150946-1	SP-100-WK05A-LAG	550-150946-2	WS	NORM	10/14/20	Stage 2A	X	X	X		X			
550-150946-1	SP-200-WK05A	550-150946-3	WS	NORM	10/14/20	Stage 2A	X	X	X		X			
550-150946-1	SP-300-WK05A-LEAD	550-150946-4	WS	NORM	10/14/20	Stage 2A	X	X	X		X			
550-150946-1	SP-400-WK05A	550-150946-5	WS	NORM	10/14/20	Stage 2A	X	X	X		X			
550-150946-1	SP-550-WK05A	550-150946-6	WS	NORM	10/14/20	Stage 2A					X			
550-150946-1	SP-551-WK05A	550-150946-7	WS	NORM	10/14/20	Stage 2A	X	X	X	X	X			
550-150946-1	FIELDQC-WK05A-EB	550-150946-8	BW	EB	10/14/20	Stage 2A	X	X	X					
550-151054-1	SP-015-20201015-FEED_ET	550-151054-1	WS	NORM	10/15/20	Stage 2A		X	X					
550-151054-1	SP-200-20201015-MID_ET	550-151054-2	WS	NORM	10/15/20	Stage 2A		X	X					
550-151054-1	SP-300-20201015-LAG_ET	550-151054-3	WS	NORM	10/15/20	Stage 2A		X	X					
550-151744-1/2	SP-015-WK06A	550-151744-1	WS	NORM	10/26/20	Stage 2A		X	X	X	X			
550-151744-1/2	SP-100-WK06A-LEAD	550-151744-2	WS	NORM	10/26/20	Stage 2A		X	X		X			
550-151744-1/2	SP-200-WK06A	550-151744-3	WS	NORM	10/26/20	Stage 2A		X	X		X			
550-151744-1/2	SP-300-WK06A-LAG	550-151744-4	WS	NORM	10/26/20	Stage 2A		X	X		X			
550-151744-1/2	SP-400-WK06A	550-151744-5	WS	NORM	10/26/20	Stage 2A		X	X		X			
550-151744-2	SP-550-WK06A	550-151744-6	WS	NORM	10/26/20	Stage 2A					X			
550-151744-1/2	SP-551-WK06A	550-151744-7	WS	NORM	10/26/20	Stage 2A		X	X	X	X			
550-152610-1	SP-015-WK07A	550-152610-1	WS	NORM	11/6/20	Stage 2A	X	X	X	X	X			
550-152610-1	SP-100-WK07A-LEAD	550-152610-2	WS	NORM	11/6/20	Stage 2A	X	X	X		X			
550-152610-1	SP-200-WK07A	550-152610-3	WS	NORM	11/6/20	Stage 2A	X	X	X		X			
550-152610-1	SP-300-WK07A-LAG	550-152610-4	WS	NORM	11/6/20	Stage 2A	X	X	X		X			
550-152610-1	SP-400-WK07A	550-152610-5	WS	NORM	11/6/20	Stage 2A	X	X	X		X			

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
550-152610-1	SP-550-WK07A	550-152610-6	WS	NORM	11/6/20	Stage 2A					X			
550-152610-1	SP-551-WK07A	550-152610-7	WS	NORM	11/6/20	Stage 2A	X	X	X	X	X			
550-153405-1	SP-015-WK08A	550-153405-1	WS	NORM	11/19/20	Stage 2A	X	X	X	X	X			
550-153405-1	SP-100-WK08A-LEAD	550-153405-2	WS	NORM	11/19/20	Stage 2A	X	X	X		X			
550-153405-1	SP-200-WK08A	550-153405-3	WS	NORM	11/19/20	Stage 2A	X	X	X		X			
550-153405-1	SP-300-WK08A-LAG	550-153405-4	WS	NORM	11/19/20	Stage 2A	X	X	X		X			
550-153405-1	SP-400-WK08A	550-153405-5	WS	NORM	11/19/20	Stage 2A	X	X	X		X			
550-153405-1	SP-550-WK08A	550-153405-7	WS	NORM	11/19/20	Stage 2A					X			
550-153405-1	SP-551-WK08A	550-153405-8	WS	NORM	11/19/20	Stage 2A	X	X	X	X	X			
550-156121-1	SP-015-01122021	550-156121-1	WS	NORM	1/12/21	Stage 2A	X	X	X		X			
550-156121-1	SP-100-01122021-LAG	550-156121-2	WS	NORM	1/12/21	Stage 2A	X	X	X		X			
550-156121-1	SP-200-01122021	550-156121-3	WS	NORM	1/12/21	Stage 2A	X	X	X		X			
550-156121-1	SP-300-01122021-LEAD	550-156121-4	WS	NORM	1/12/21	Stage 2A	X	X	X		X			
550-156121-1	SP-400-01122021	550-156121-5	WS	NORM	1/12/21	Stage 2A	X	X	X		X			
550-156472-1	SP-015-20210114-FEED(E)	550-156472-1	WS	NORM	1/14/21	Stage 2A			X					
550-156472-1	SP-300-20210114-LEAD(E)	550-156472-2	WS	NORM	1/14/21	Stage 2A			X					
550-156472-1	SP-200-20210114-MID(E)	550-156472-3	WS	NORM	1/14/21	Stage 2A			X					
550-156472-1	SP-100-20210114-LAG(E)	550-156472-4	WS	NORM	1/14/21	Stage 2A			X					
550-156702-1	SP-015-20210118	550-156702-1	WS	NORM	1/18/21	Stage 2A	X	X	X	X	X			
550-156702-1	SP-100-20210118-LAG	550-156702-2	WS	NORM	1/18/21	Stage 2A	X	X	X		X			
550-156702-1	SP-200-20210118	550-156702-3	WS	NORM	1/18/21	Stage 2A	X	X	X		X			
550-156702-1	SP-300-20210118-LEAD	550-156702-4	WS	NORM	1/18/21	Stage 2A	X	X	X		X			
550-156702-1	SP-400-20210118	550-156702-5	WS	NORM	1/18/21	Stage 2A	X	X	X	X	X			
550-157025-1	SP-015-20210122-FEED	550-157025-1	WS	NORM	1/22/21	Stage 2A					X			
550-157025-1	SP-015-20210122-FEED-FD	550-157025-2	WS	FD	1/22/21	Stage 2A					X			
550-157025-1	SP-100-20210122-LAG	550-157025-3	WS	NORM	1/22/21	Stage 2A					X			
550-157025-1	SP-200-20210122-MID	550-157025-4	WS	NORM	1/22/21	Stage 2A					X			
550-157025-1	SP-300-20210122-LEAD	550-157025-5	WS	NORM	1/22/21	Stage 2A					X			
550-157025-1	SP-400-20210122-POST	550-157025-6	WS	NORM	1/22/21	Stage 2A					X			
550-157183-1	SP-015-20210126	550-157183-1	WS	NORM	1/26/21	Stage 2A	X	X	X	X	X			
550-157183-1	SP-100-20210126-LAG	550-157183-2	WS	NORM	1/26/21	Stage 2A	X	X	X		X			
550-157183-1	SP-200-20210126	550-157183-3	WS	NORM	1/26/21	Stage 2A	X	X	X		X			
550-157183-1	SP-300-20210126-LEAD	550-157183-4	WS	NORM	1/26/21	Stage 2A	X	X	X		X			
550-157183-1	SP-400-20210126	550-157183-5	WS	NORM	1/26/21	Stage 2A	X	X	X	X	X			
550-157183-1	SP-400-20210126-FD	550-157183-6	WS	FD	1/26/21	Stage 2A	X	X	X	X	X			
550-157183-1	FIELDQC-20210126-EB	550-157183-7	BW	EB	1/26/21	Stage 2A	X	X	X					
550-157268-1	SP-015-20210127-FEED	550-157268-1	WS	NORM	1/27/21	Stage 2A					X			
550-157268-1	SP-100-20210127-LAG	550-157268-2	WS	NORM	1/27/21	Stage 2A					X			
550-157268-1	SP-200-20210127-MID	550-157268-3	WS	NORM	1/27/21	Stage 2A					X			
550-157268-1	SP-300-20210127-LEAD	550-157268-4	WS	NORM	1/27/21	Stage 2A					X			
550-157268-1	SP-400-20210127-POST	550-157268-5	WS	NORM	1/27/21	Stage 2A					X			
550-157457-1	SP-015-20210129-FEED	550-157457-1	WS	NORM	1/29/21	Stage 2A					X			
550-157457-1	SP-100-20210129-LAG	550-157457-2	WS	NORM	1/29/21	Stage 2A					X			

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
550-157457-1	SP-100-20210129-LAG-FD	550-157457-3	WS	FD	1/29/21	Stage 2A					X			
550-157457-1	SP-200-20210129-MID	550-157457-4	WS	NORM	1/29/21	Stage 2A					X			
550-157457-1	SP-300-20210129-LEAD	550-157457-5	WS	NORM	1/29/21	Stage 2A					X			
550-157457-1	SP-400-20210129-POST	550-157457-6	WS	NORM	1/29/21	Stage 2A					X			
550-157683-1	SP-015-20210202	550-157683-1	WS	NORM	2/2/21	Stage 2A	X	X	X	X	X			
550-157683-1	SP-100-20210202-LAG	550-157683-2	WS	NORM	2/2/21	Stage 2A	X	X	X		X			
550-157683-1	SP-200-20210202	550-157683-3	WS	NORM	2/2/21	Stage 2A	X	X	X		X			
550-157683-1	SP-300-20210202-LEAD	550-157683-4	WS	NORM	2/2/21	Stage 2A	X	X	X		X			
550-157683-1	SP-400-20210202	550-157683-5	WS	NORM	2/2/21	Stage 2A	X	X	X	X	X			
550-157816-1	SP-015-20210203-FEED	550-157816-1	WS	NORM	2/3/21	Stage 2A					X			
550-157816-1	SP-100-20210203-LAG-C	550-157816-2	WS	NORM	2/3/21	Stage 2A					X			
550-157816-1	SP-100-20210203-LAG-G	550-157816-3	WS	NORM	2/3/21	Stage 2A					X			
550-157816-1	SP-200-20210203-MID	550-157816-4	WS	NORM	2/3/21	Stage 2A					X			
550-157816-1	SP-300-20210203-LEAD	550-157816-5	WS	NORM	2/3/21	Stage 2A					X			
550-157816-1	SP-400-20210203-POST	550-157816-6	WS	NORM	2/3/21	Stage 2A					X			
550-157970-1	SP-015-20210205-FEED	550-157970-1	WS	NORM	2/5/21	Stage 2A					X			
550-157970-1	SP-100-20210205-LAG-C	550-157970-2	WS	NORM	2/5/21	Stage 2A					X			
550-157970-1	SP-100-20210205-LAG-G	550-157970-3	WS	NORM	2/5/21	Stage 2A					X			
550-157970-1	SP-200-20210205-MID	550-157970-4	WS	NORM	2/5/21	Stage 2A					X			
550-157970-1	SP-300-20210205-LEAD	550-157970-5	WS	NORM	2/5/21	Stage 2A					X			
550-157970-1	SP-400-20210205-POST	550-157970-6	WS	NORM	2/5/21	Stage 2A					X			
L1324982/L1327057	SP-015-20210309	L1324982-01/L1327057-01	WS	NORM	3/9/21	Stage 2A	X	X	X	X	X	X		
L1324982/L1327057	SP-100-20210309-LEAD	L1324982-02/L1327057-02	WS	NORM	3/9/21	Stage 2A	X	X	X		X			
L1324982/L1327057	SP-200-20210309	L1324982-03/L1327057-03	WS	NORM	3/9/21	Stage 2A	X	X	X		X			
L1324982/L1327057	SP-300-20210309-LAG	L1324982-04/L1327057-04	WS	NORM	3/9/21	Stage 2A	X	X	X		X	X		
L1324982/L1327057	SP-400-20210309	L1324982-05/L1327057-05	WS	NORM	3/9/21	Stage 2A	X	X	X	X	X			
L1327057	SP-300-20210309-LAG-C1	L1327057-06	WS	NORM	3/9/21	Stage 2A					X	X		
L1327057	SP-300-20210309-LAG-C2	L1327057-07	WS	NORM	3/9/21	Stage 2A					X	X		
L1327680/L1327700	SP-015-20210316	L1327680-01/L1327700-01	WS	NORM	3/16/21	Stage 2A	X	X	X	X	X	X		
L1327680/L1327700	SP-100-20210316-LEAD	L1327680-02/L1327700-02	WS	NORM	3/16/21	Stage 2A	X	X	X		X			
L1327680/L1327700	SP-200-20210316	L1327680-03/L1327700-03	WS	NORM	3/16/21	Stage 2A	X	X	X		X			
L1327680/L1327700	SP-300-20210316-LAG	L1327680-04/L1327700-04	WS	NORM	3/16/21	Stage 2A	X	X	X		X	X		
L1327680/L1327700	SP-400-20210316	L1327680-05/L1327700-06	WS	NORM	3/16/21	Stage 2A	X	X	X	X	X			
L1327700	SP-300-20210316-LAG-C	L1327700-05	WS	NORM	3/16/21	Stage 2A					X	X		
L1328684	SP-015-20210318	L1328684-01	WS	NORM	3/18/21	Stage 2A					X			
L1328684	SP-100-20210318-LEAD	L1328684-02	WS	NORM	3/18/21	Stage 2A					X			
L1328684	SP-200-20210318	L1328684-03	WS	NORM	3/18/21	Stage 2A					X			
L1328684	SP-300-20210318-LAG	L1328684-04	WS	NORM	3/18/21	Stage 2A					X			
L1328684	SP-300-20210318-LAG-C	L1328684-05	WS	NORM	3/18/21	Stage 2A					X			
L1328684	SP-400-20210318	L1328684-06	WS	NORM	3/18/21	Stage 2A					X			
L1329924/L1329928	SP-015-20210323	L1329924-01/L1329928-01	WS	NORM	3/23/21	Stage 2A	X	X	X	X	X	X		
L1329924/L1329928	SP-100-20210323-LEAD	L1329924-02/L1329928-02	WS	NORM	3/23/21	Stage 2A	X	X	X		X			
L1329924/L1329928	SP-200-20210323	L1329924-03/L1329928-03	WS	NORM	3/23/21	Stage 2A	X	X	X		X			

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
L1329924/L1329928	SP-200-20210323-FD	L1329924-04/L1329928-04	WS	FD	3/23/21	Stage 2A	X	X	X		X			
L1329924/L1329928	SP-300-20210323-LAG	L1329924-05/L1329928-05	WS	NORM	3/23/21	Stage 2A	X	X	X	X	X	X		
L1329924	SP-300-20210323-LAG-C	L1329924-06	WS	NORM	3/23/21	Stage 2A					X	X		
L1329924/L1329928	SP-400-20210323	L1329924-07/L1329928-06	WS	NORM	3/23/21	Stage 2A	X	X	X	X	X			
L1331343	SP-015-20210325	L1331343-01	WS	NORM	3/25/21	Stage 2A					X			
L1331343	SP-100-20210325-LEAD	L1331343-02	WS	NORM	3/25/21	Stage 2A					X			
L1331343	SP-200-20210325	L1331343-03	WS	NORM	3/25/21	Stage 2A					X			
L1331343	SP-300-20210325-LAG	L1331343-04	WS	NORM	3/25/21	Stage 2A					X			
L1331343	SP-300-20210325-LAG-C	L1331343-05	WS	NORM	3/25/21	Stage 2A					X			
L1331343	SP-400-20210325	L1331343-06	WS	NORM	3/25/21	Stage 2A					X			
L1331343	SP-400-20210325-FD	L1331343-07	WS	FD	3/25/21	Stage 2A					X			
L1332403/L1332405	SP-015-20210330	L1332403-01/L1332405-01	WS	NORM	3/30/21	Stage 2A	X	X	X	X	X	X		
L1332403/L1332405	SP-100-20210330-LEAD	L1332403-02/L1332405-02	WS	NORM	3/30/21	Stage 2A	X	X	X		X			
L1332403/L1332405	SP-200-20210330	L1332403-03/L1332405-03	WS	NORM	3/30/21	Stage 2A	X	X	X		X			
L1332403/L1332405	SP-300-20210330-LAG	L1332403-04/L1332405-04	WS	NORM	3/30/21	Stage 2A	X	X	X		X	X		
L1332403/L1332405	SP-400-20210330	L1332403-05/L1332405-06	WS	NORM	3/30/21	Stage 2A	X	X	X	X	X			
L1332403/L1332405	FIELDQC-20210330-EB	L1332403-06/L1332405-07	BW	EB	3/30/21	Stage 2A	X	X	X					
L1332405	SP-300-20210330-LAG-C	L1332405-05	WS	NORM	3/30/21	Stage 2A					X	X		
L1333481	SP-015-20210401	L1333481-01	WS	NORM	4/1/21	Stage 2A					X			
L1333481	SP-100-20210401-LEAD	L1333481-02	WS	NORM	4/1/21	Stage 2A					X			
L1333481	SP-200-20210401	L1333481-03	WS	NORM	4/1/21	Stage 2A					X			
L1333481	SP-300-20210401-LAG	L1333481-04	WS	NORM	4/1/21	Stage 2A					X			
L1333481	SP-300-20210401-LAG-C	L1333481-05	WS	NORM	4/1/21	Stage 2A					X			
L1333481	SP-400-20210401	L1333481-06	WS	NORM	4/1/21	Stage 2A					X			
L1333934/L1333945	SP-015-20210402	L1333934-01/L1333945-01	WS	NORM	4/2/21	Stage 2A	X	X	X					
L1333934/L1333945	SP-100-20210402-LEAD	L1333934-02/L1333945-02	WS	NORM	4/2/21	Stage 2A	X	X	X					
L1333934/L1333945	SP-200-20210402	L1333934-03/L1333945-03	WS	NORM	4/2/21	Stage 2A	X	X	X					
L1333934/L1333945	SP-300-20210402-LAG	L1333934-04/L1333945-04	WS	NORM	4/2/21	Stage 2A	X	X	X					
L1333934/L1333945	SP-400-20210402	L1333934-05/L1333945-05	WS	NORM	4/2/21	Stage 2A	X	X	X					
L1337606/L1337611	SP-015-20210412	L1337606-01/L1337611-01	WS	NORM	4/12/21	Stage 2A	X	X	X	X	X			
L1337606/L1337611	SP-100-20210412-LEAD	L1337606-02/L1337611-02	WS	NORM	4/12/21	Stage 2A	X	X	X		X			
L1337606/L1337611	SP-200-20210412	L1337606-03/L1337611-03	WS	NORM	4/12/21	Stage 2A	X	X	X		X			
L1337606/L1337611	SP-300-20210412-LAG	L1337606-04/L1337611-04	WS	NORM	4/12/21	Stage 2A	X	X	X		X			
L1337606/L1337611	SP-400-20210412	L1337606-05/L1337611-06	WS	NORM	4/12/21	Stage 2A	X	X	X		X			
L1337611	SP-300-20210412-LAG-C	L1337611-05	WS	NORM	4/12/21	Stage 2A					X			
L1339737	SP-015-20210415	L1339737-01	WS	NORM	4/15/21	Stage 2A					X			
L1339737	SP-100-20210415-LEAD	L1339737-02	WS	NORM	4/15/21	Stage 2A					X			
L1339737	SP-200-20210415	L1339737-03	WS	NORM	4/15/21	Stage 2A					X			
L1339737	SP-300-20210415-LAG	L1339737-04	WS	NORM	4/15/21	Stage 2A					X			
L1339737	SP-300-20210415-LAG-C	L1339737-05	WS	NORM	4/15/21	Stage 2A					X			
L1339737	SP-400-20210415	L1339737-06	WS	NORM	4/15/21	Stage 2A					X			
L1343573/L1343579	SP-015-20210423	L1343573-01/L1343579-01	WS	NORM	4/23/21	Stage 2A	X	X	X	X	X			
L1343573/L1343579	SP-015-20210423-FD	L1343573-02/L1343579-02	WS	FD	4/23/21	Stage 2A	X	X	X	X	X			

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
L1343573/L1343579	SP-100-20210423-LEAD	L1343573-03/L1343579-03	WS	NORM	4/23/21	Stage 2A	X	X	X		X			
L1343573/L1343579	SP-200-20210423	L1343573-04/L1343579-04	WS	NORM	4/23/21	Stage 2A	X	X	X		X			
L1343573/L1343579	SP-300-20210423-LAG	L1343573-05/L1343579-05	WS	NORM	4/23/21	Stage 2A	X	X	X		X			
L1343573/L1343579	SP-400-20210423	L1343573-06/L1343579-06	WS	NORM	4/23/21	Stage 2A	X	X	X	X	X			
L1344499/L1344581	SP-015-20210426	L1344499-02/L1344581-01	WS	NORM	4/26/21	Stage 2A	X	X	X	X	X			
L1344499/L1344581	SP-100-20210426-LEAD	L1344499-04/L1344581-02	WS	NORM	4/26/21	Stage 2A	X	X	X		X			
L1344499/L1344581	SP-200-20210426	L1344499-06/L1344581-03	WS	NORM	4/26/21	Stage 2A	X	X	X		X			
L1344499/L1344581	SP-300-20210426-LAG	L1344499-08/L1344581-04	WS	NORM	4/26/21	Stage 2A	X	X	X		X			
L1344499/L1344581	SP-400-20210426	L1344499-10/L1344581-05	WS	NORM	4/26/21	Stage 2A	X	X	X	X	X			
L1346567	SP-015-20210430	L1346567-01	WS	NORM	4/30/21	Stage 2A	X	X	X	X	X			
L1346567	SP-100-20210430-LEAD	L1346567-02	WS	NORM	4/30/21	Stage 2A	X	X	X		X			
L1346567	SP-200-20210430	L1346567-03	WS	NORM	4/30/21	Stage 2A	X	X	X		X			
L1346567	SP-300-20210430-LAG	L1346567-04	WS	NORM	4/30/21	Stage 2A	X	X	X		X			
L1346567	SP-400-20210430	L1346567-05	WS	NORM	4/30/21	Stage 2A	X	X	X	X	X			
L1349117	SP-015-20210504	L1349117-01	WS	NORM	5/4/21	Stage 2A	X	X	X	X	X			
L1349117	SP-100-20210504-LEAD	L1349117-02	WS	NORM	5/4/21	Stage 2A	X	X	X		X			
L1349117	SP-200-20210504	L1349117-03	WS	NORM	5/4/21	Stage 2A	X	X	X		X			
L1349117	SP-300-20210504-LAG	L1349117-04	WS	NORM	5/4/21	Stage 2A	X	X	X		X			
L1349117	SP-400-20210504	L1349117-05	WS	NORM	5/4/21	Stage 2A	X	X	X	X	X			
L1349117	SP-400-20210504-FD	L1349117-06	WS	FD	5/4/21	Stage 2A	X	X	X	X	X			
L1372443	SP-015-20210629	L1372443-01	WS	NORM	6/29/21	Stage 2A	X	X	X	X	X		X	X
L1372443	SP-100-20210629-LEAD	L1372443-02	WS	NORM	6/29/21	Stage 2A	X	X	X		X			
L1372443	SP-200-20210629	L1372443-03	WS	NORM	6/29/21	Stage 2A	X	X	X		X			
L1372443	SP-300-20210629-LAG	L1372443-04	WS	NORM	6/29/21	Stage 2A	X	X	X		X		X	X
L1372443	SP-400-20210629	L1372443-05	WS	NORM	6/29/21	Stage 2A	X	X	X		X		X	X
L1372443	SP-550-20210629	L1372443-06	WS	NORM	6/29/21	Stage 2A	X	X	X		X		X	X
L1372443	SP-551-20210629	L1372443-07	WS	NORM	6/29/21	Stage 2A	X	X	X	X	X		X	X
L1375849	SP-015-20210708	L1375849-01	WS	NORM	7/8/21	Stage 2A	X	X	X	X	X		X	X
L1375849	SP-300-20210708-LEAD	L1375849-02	WS	NORM	7/8/21	Stage 2A	X	X	X		X			
L1375849	SP-200-20210708	L1375849-03	WS	NORM	7/8/21	Stage 2A	X	X	X		X			
L1375849	SP-100-20210708-LAG	L1375849-04	WS	NORM	7/8/21	Stage 2A	X	X	X		X		X	X
L1375849	SP-400-20210708	L1375849-05	WS	NORM	7/8/21	Stage 2A	X	X	X		X		X	X
L1375849	SP-550-20210708	L1375849-06	WS	NORM	7/8/21	Stage 2A					X		X	X
L1375849	SP-551-20210708	L1375849-07	WS	NORM	7/8/21	Stage 2A	X	X	X	X	X		X	X
L1380668	SP-015-20210720	L1380668-01	WS	NORM	7/20/21	Stage 2A	X	X	X	X	X		X	X
L1380668	SP-100-20210720-LEAD	L1380668-02	WS	NORM	7/20/21	Stage 2A	X	X	X		X			
L1380668	SP-100-20210720-LEAD-FD	L1380668-03	WS	FD	7/20/21	Stage 2A	X	X	X		X			
L1380668	SP-200-20210720	L1380668-04	WS	NORM	7/20/21	Stage 2A	X	X	X		X			
L1380668	SP-300-20210720-LAG	L1380668-05	WS	NORM	7/20/21	Stage 2A	X	X	X		X		X	X
L1380668	SP-400-20210720	L1380668-06	WS	NORM	7/20/21	Stage 2A	X	X	X		X		X	X
L1380668	SP-550-20210720	L1380668-07	WS	NORM	7/20/21	Stage 2A					X		X	X
L1380668	SP-551-20210720	L1380668-08	WS	NORM	7/20/21	Stage 2A	X	X	X	X	X		X	X
L1380668	FIELDQC-20210720-EB	L1380668-09	BW	EB	7/20/21	Stage 2A	X	X	X	X	X		X	X

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
L1382360	SP-015-20210722	L1382360-01	WS	NORM	7/22/21	Stage 2A					X			
L1382360	SP-100-20210722-LEAD	L1382360-02	WS	NORM	7/22/21	Stage 2A					X			
L1382360	SP-200-20210722	L1382360-03	WS	NORM	7/22/21	Stage 2A					X			
L1382360	SP-300-20210722-LAG	L1382360-04	WS	NORM	7/22/21	Stage 2A					X			
L1382360	SP-400-20210722	L1382360-05	WS	NORM	7/22/21	Stage 2A					X			
L1382360	SP-550-20210722	L1382360-06	WS	NORM	7/22/21	Stage 2A					X			
L1382360	SP-551-20210722	L1382360-07	WS	NORM	7/22/21	Stage 2A					X			
L1383184	SP-015-20210727	L1383184-01	WS	NORM	7/27/21	Stage 2A	X	X	X	X	X		X	X
L1383184	SP-100-20210727-LEAD	L1383184-02	WS	NORM	7/27/21	Stage 2A	X	X	X		X			
L1383184	SP-200-20210727	L1383184-03	WS	NORM	7/27/21	Stage 2A	X	X	X		X			
L1383184	SP-300-20210727-LAG	L1383184-04	WS	NORM	7/27/21	Stage 2A	X	X	X		X		X	X
L1383184	SP-400-20210727	L1383184-05	WS	NORM	7/27/21	Stage 2A	X	X	X		X		X	X
L1383184	SP-400-20210727-FD	L1383184-06	WS	FD	7/27/21	Stage 2A	X	X	X		X		X	X
L1383184	SP-550-20210727	L1383184-07	WS	NORM	7/27/21	Stage 2A					X		X	X
L1383184	SP-551-20210727	L1383184-08	WS	NORM	7/27/21	Stage 2A	X	X	X	X	X		X	X
L1383184	FILEDQC-20210727-EB	L1383184-09	BW	EB	7/27/21	Stage 2A	X	X	X	X	X		X	X
L1383980/L1384019	SP-015-20210729	L1383980-01/L1384019-01	WS	NORM	7/29/21	Stage 2A					X		X	X
L1383980/L1384019	SP-015-20210729-FD	L1383980-02/L1384019-03	WS	FD	7/29/21	Stage 2A					X		X	X
L1383980	SP-100-20210729-LEAD	L1383980-03	WS	NORM	7/29/21	Stage 2A					X			
L1383980	SP-200-20210729	L1383980-04	WS	NORM	7/29/21	Stage 2A					X			
L1383980/L1384019	SP-300-20210729-LAG	L1383980-05/L1384019-04	WS	NORM	7/29/21	Stage 2A					X		X	X
L1383980/L1384019	SP-400-20210729	L1383980-06/L1384019-05	WS	NORM	7/29/21	Stage 2A					X		X	X
L1383980/L1384019	SP-550-20210729	L1383980-07/L1384019-06	WS	NORM	7/29/21	Stage 2A					X		X	X
L1383980/L1384019	SP-551-20210729	L1383980-08/L1384019-07	WS	NORM	7/29/21	Stage 2A					X		X	X
L1383980/L1384019	FIELDQC-20210729-EB	L1383980-09/L1384019-08	BW	EB	7/29/21	Stage 2A					X		X	X
L1385599	SP-015-20210803	L1385599-01	WS	NORM	8/3/21	Stage 2A	X	X	X	X	X		X	X
L1385599	SP-100-20210803-LEAD	L1385599-02	WS	NORM	8/3/21	Stage 2A	X	X	X		X			
L1385599	SP-200-20210803	L1385599-03	WS	NORM	8/3/21	Stage 2A	X	X	X		X			
L1385599	SP-300-20210803-LAG	L1385599-04	WS	NORM	8/3/21	Stage 2A	X	X	X		X		X	X
L1385599	SP-300-20210803-LAG-FD	L1385599-05	WS	FD	8/3/21	Stage 2A	X	X	X		X		X	X
L1385599	SP-400-20210803	L1385599-06	WS	NORM	8/3/21	Stage 2A	X	X	X		X		X	X
L1385599	SP-550-20210803	L1385599-07	WS	NORM	8/3/21	Stage 2A					X		X	X
L1385599	SP-551-20210803	L1385599-08	WS	NORM	8/3/21	Stage 2A	X	X	X	X	X		X	X
L1385599	FIELDQC-20210803-EB	L1385599-09	BW	EB	8/3/21	Stage 2A	X	X	X	X	X		X	X
L1386879/L1386900	SP-015-20210805	L1386879-01/L1386900-01	WS	NORM	8/5/21	Stage 2A					X		X	X
L1386879/L1386900	SP-015-20210805-FD	L1386879-02/L1386900-02	WS	FD	8/5/21	Stage 2A					X		X	X
L1386879	SP-100-20210805-LEAD	L1386879-03	WS	NORM	8/5/21	Stage 2A					X			
L1386879	SP-200-20210805	L1386879-04	WS	NORM	8/5/21	Stage 2A					X			
L1386879/L1386900	SP-300-20210805-LAG	L1386879-05/L1386900-03	WS	NORM	8/5/21	Stage 2A					X		X	X
L1386879/L1386900	SP-400-20210805	L1386879-06/L1386900-04	WS	NORM	8/5/21	Stage 2A					X		X	X
L1386879/L1386900	SP-550-20210805	L1386879-07/L1386900-05	WS	NORM	8/5/21	Stage 2A					X		X	X
L1386879/L1386900	SP-551-20210805	L1386879-08/L1386900-06	WS	NORM	8/5/21	Stage 2A					X		X	X
L1388446	SP-015-20210809	L1388446-01	WS	NORM	8/9/21	Stage 2A	X	X	X	X	X		X	X

Table 2 Sample Cross-Reference

SDG	Sample ID	Lab Sample ID	Matrix	QC Type	Sample Date	Validation Stage	EPA 300.0	EPA 300.1	EPA 314.0	SM2540C	SM2540D	SM5310B	SW-6010B Total	SW-7199 Total
L1388446	SP-015-20210809-FD	L1388446-02	WS	FD	8/9/21	Stage 2A	X	X	X	X	X		X	X
L1388446	SP-100-20210809-LEAD	L1388446-03	WS	NORM	8/9/21	Stage 2A	X	X	X		X			
L1388446	SP-200-20210809	L1388446-04	WS	NORM	8/9/21	Stage 2A	X	X	X		X			
L1388446	SP-300-20210809-LAG	L1388446-05	WS	NORM	8/9/21	Stage 2A	X	X	X		X		X	X
L1388446	SP-400-20210809	L1388446-06	WS	NORM	8/9/21	Stage 2A	X	X	X		X		X	X
L1388446	SP-550-20210809	L1388446-07	WS	NORM	8/9/21	Stage 2A					X		X	X
L1388446	SP-551-20210809	L1388446-08	WS	NORM	8/9/21	Stage 2A	X	X	X	X	X		X	X

Table 3 Validation Qualifiers and Definitions

Validation Qualifier	Definition
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.
NJ	The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value is the estimated concentration in the sample.
U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
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 4 Validation Checks for Stage 2A

Verification and Validation Checks	Stage 2A
Documentation identifies the laboratory receiving and conducting analyses, and includes documentation for all samples submitted by the project or requester for analyses.	X
Requested analytical methods were performed and the analysis dates are present.	X
Requested target analyte results are reported along with the original laboratory data qualifiers and data qualifier definitions for each reported result (and the uncertainty of each result and clear indication of the type of uncertainty reported if required, e.g., for radiochemical analyses).	X
Requested target analyte result units are reported (along with their associated uncertainty units if required, e.g., for radiochemical analyses).	X
Requested reporting limits for all samples are present and results at and below the requested (required) reporting limits are clearly identified (including sample detection limits if required).	X
Sampling dates (including times if needed), date and time of laboratory receipt of samples, and sample conditions upon receipt at the laboratory (including preservation, pH, and temperature) are documented.	X
For radiochemical analyses, the sample-specific critical values (sometimes called "critical level," "decision level," or "detection threshold") and sample-specific minimum detectable value, activity, or concentration for all samples are reported, and results at and below the requested (required) critical values are clearly identified.	X
For radiochemical analyses, the chemical yield (if applicable to the method) and reference date and time (especially for short lived isotopes) are reported for all samples (as appropriate).	X
Sample results are evaluated by comparing sample conditions upon receipt at the laboratory (e.g., preservation checks) and sample characteristics (e.g., percent moisture) to the requirements and guidelines present in national or regional data validation documents, analytical method(s), or contract.	X
Requested methods (handling, preparation, cleanup, and analytical) are performed.	X
Method dates (including dates, times and duration of analysis for radiation counting measurements and other methods, if needed) for handling (e.g., Toxicity Characteristic Leaching Procedure), preparation, cleanup and analysis are present, as appropriate.	X
Sample-related QC data and QC acceptance criteria (e.g., method blanks, surrogate recoveries, deuterated monitoring compound (DMC) recoveries, laboratory control sample (LCS) recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries, serial dilutions, post digestion spikes, standard reference materials) are provided and linked to the reported field samples (including the field quality control samples such as trip and equipment blanks).	X
Requested spike analytes or compounds (e.g., surrogate, DMCs, LCS spikes, post digestion spikes) have been added, as appropriate.	X
Sample holding times (from sampling date to preparation and preparation to analysis) are evaluated.	X
Frequency of QC samples is checked for appropriateness (e.g., one LCS per 20 samples in a preparation batch).	X
Sample results are evaluated by comparing holding times and sample-related QC data to the requirements and guidelines present in national or regional data validation documents, analytical method(s) or contract.	X

Table 5 Reason Codes

Reason Code	Description of Qualification
a	Qualified due to low abundance (radiochemical activity)
be	Qualified due to equipment blank contamination
bf	Qualified due to field blank contamination
bl	Qualified due to lab blank contamination
bt	Qualified due to trip blank contamination
bp	Qualified due to pump blank contamination (for wells without dedicated pumps)
br	Qualified due to filter blank contamination (aqueous hexavalent chromium and dissolved sample fractions)
brr	Better result was reported
c	Qualified due to calibration problems
cp	Qualified due to insufficient ingrowth (radiochemical only)
dc	Dual column confirmation % difference exceeded
e	Sample concentration exceeded the calibration range
fd	Qualified due to field duplicate imprecision
h	Qualified due to holding time exceedance
i	Qualified due to internal standard areas or retention times
k	Qualified as Estimated Maximum Possible Concentrations (dioxins and PCB congeners)
l	Qualified due to LCS recoveries
ld	Qualified due to lab duplicate imprecision (matrix duplicate, MSD, LCSD)
m	Qualified due to matrix spike recoveries
nb	Qualified due to negative lab blank contamination (nondetect results only)
nd	Qualified due to non-detected target analyte
o	Other
p	Qualified as a false positive due to contamination during shipping
pH	Sample preservation not within acceptance range
q	Qualified due to quantitation problem
s	Qualified due to surrogate recoveries
sd	Serial dilution did not meet control criteria
sp	Detected value reported between SQL and PQL (MDL and RL)
st	Sample receipt temperature exceeded
t	Qualified due to elevated helium tracer concentrations
vh	Headspace detected in aqueous sample containers submitted for volatile analysis
x	Qualified due to low % solids
z	Qualified due to interference check sample results

Table 6 Results Qualified During Validation

SDG	Sample ID	Sample Date	Method	Total or Dissolved	Parameter	Result	Units	Lab Qualifier	SQL	PQL	Validator Qualifier	Reason Code	Reason Code Definition
550-149122-1	SP-100-WK01A LAG	9/15/20	EPA 300.0	Total	Nitrate [as N]	0.13	mg/L		0.014	0.050	J+	be	EB
550-149122-1	SP-100-WK01A LAG	9/15/20	EPA 300.1	Total	Chlorate	90	ug/L	J	20	200	J	be,sp	EB, Detect < PQL
550-149122-1	SP-300-WK01A LEAD	9/15/20	EPA 300.0	Total	Nitrate [as N]	0.29	mg/L		0.014	0.050	J+	be	EB
550-149122-1	SP-400-WK01A	9/15/20	EPA 300.1	Total	Chlorate	70	ug/L	J	20	200	J	be,sp	EB, Detect < PQL
550-149122-1	FIELD-WK01A-EB	9/15/20	EPA 300.1	Total	Chlorate	15	ug/L	J	2.0	20	J	sp	Detect < PQL
550-150946-1	SP-015-WK05A	10/14/20	SM2540D	Total	Total Suspended Solids	18	mg/L		0	5.0	J	ld	Lab RPD
550-150946-1	SP-200-WK05A	10/14/20	EPA 300.0	Total	Nitrate [as N]	1.3	mg/L		0.028	0.10	J+	be	EB
550-150946-1	SP-300-WK05A-LEAD	10/14/20	EPA 300.0	Total	Nitrate [as N]	0.059	mg/L		0.014	0.050	J+	be	EB
550-151744-1	SP-300-WK06A-LAG	10/26/20	EPA 314.0	Total	Perchlorate	350	ug/L	F1	6.3	20	J-	m	MS Recovery
550-152610-1	SP-300-WK07A-LAG	11/6/20	EPA 300.1	Total	Chlorate	24	ug/L	J	10	100	J	sp	Detect < PQL
550-153405-1	SP-015-WK08A	11/19/20	SM2540D	Total	Total Suspended Solids	15	mg/L		0	5.0	J	ld	Lab RPD
550-153405-1	SP-200-WK08A	11/19/20	EPA 300.1	Total	Chlorate	30	ug/L	J	10	100	J	sp	Detect < PQL
550-153405-1	SP-300-WK08A-LAG	11/19/20	EPA 300.1	Total	Chlorate	19	ug/L	J	10	100	J	sp	Detect < PQL
550-153405-1	SP-300-WK08A-LAG	11/19/20	EPA 314.0	Total	Perchlorate	0.39	ug/L	J	0.31	1.0	J	sp	Detect < PQL
550-153405-1	SP-400-WK08A	11/19/20	EPA 314.0	Total	Perchlorate	0.71	ug/L	J	0.31	1.0	J	sp	Detect < PQL
550-153405-1	SP-551-WK08A	11/19/20	EPA 314.0	Total	Perchlorate	0.59	ug/L	J	0.31	1.0	J	sp	Detect < PQL
550-156121-1	SP-100-01122021-LAG	1/12/21	EPA 300.1	Total	Chlorate	72	ug/L	J	10	100	J	sp	Detect < PQL
550-156121-1	SP-400-01122021	1/12/21	EPA 300.1	Total	Chlorate	69	ug/L	J	10	100	J	sp	Detect < PQL
550-156472-1	SP-200-20210114-MID(E)	1/14/21	EPA 314.0	Total	Perchlorate	440	ug/L	J	310	1000	J	sp	Detect < PQL
550-156472-1	SP-100-20210114-LAG(E)	1/14/21	EPA 314.0	Total	Perchlorate	75	ug/L	J	31	100	J	sp	Detect < PQL
550-156702-1	SP-200-20210118	1/18/21	EPA 300.1	Total	Chlorate	64	ug/L	S1+	9.8	40	J+	s	Surrogate Recovery
550-157025-1	SP-015-20210122-FEED	1/22/21	SM2540D	Total	Total Suspended Solids	11	mg/L		0	5.0	J	fd	FD
550-157025-1	SP-015-20210122-FEED-FD	1/22/21	SM2540D	Total	Total Suspended Solids	0	mg/L	U	0	5.0	UJ	fd	FD
550-157683-1	SP-100-20210202-LAG	2/2/21	EPA 314.0	Total	Perchlorate	0.62	ug/L	J	0.31	1.0	J	sp	Detect < PQL
550-157683-1	SP-200-20210202	2/2/21	EPA 300.1	Total	Chlorate	120	ug/L		9.8	40	J+	s	Surrogate Recovery
550-157683-1	SP-400-20210202	2/2/21	EPA 300.1	Total	Chlorate	45	ug/L		9.8	40	J+	s	Surrogate Recovery
550-157683-1	SP-400-20210202	2/2/21	EPA 314.0	Total	Perchlorate	0.85	ug/L	J	0.31	1.0	J	sp	Detect < PQL
L1324982	SP-300-20210309-LAG	3/9/21	EPA 314.0	Total	Perchlorate	19.6	ug/L	J5	0.300	4.00	J+	m	MS Recovery
L1327057	SP-015-20210309	3/9/21	SM5310B	Dissolved	Dissolved Organic Carbon	3060	ug/L	B T8	106	1000	J	bl,h	Lab Blank, Holding Time
L1327057	SP-015-20210309	3/9/21	SM5310B	Total	Total Organic Carbon	2230	ug/L	B	102	1000	J	bl,h,pH	Lab Blank, Holding Time, Preservation
L1327057	SP-300-20210309-LAG	3/9/21	SM5310B	Dissolved	Dissolved Organic Carbon	4450	ug/L	B T8	106	1000	J	bl,h	Lab Blank, Holding Time
L1327057	SP-300-20210309-LAG	3/9/21	SM5310B	Total	Total Organic Carbon	4780	ug/L		102	1000	J-	h,pH	Holding Time, Preservation
L1327057	SP-300-20210309-LAG-C1	3/9/21	SM5310B	Dissolved	Dissolved Organic Carbon	5500	ug/L	T8	106	1000	J-	h	Holding Time
L1327057	SP-300-20210309-LAG-C1	3/9/21	SM5310B	Total	Total Organic Carbon	5210	ug/L	B	102	1000	J	bl,h,pH	Lab Blank, Holding Time, Preservation
L1327057	SP-300-20210309-LAG-C2	3/9/21	SM5310B	Dissolved	Dissolved Organic Carbon	6080	ug/L	T8	106	1000	J-	h	Holding Time
L1327057	SP-300-20210309-LAG-C2	3/9/21	SM5310B	Total	Total Organic Carbon	5440	ug/L	B	102	1000	J	bl,h,pH	Lab Blank, Holding Time, Preservation
L1327700	SP-015-20210316	3/16/21	EPA 300.0	Total	Nitrate [as N]	9360	ug/L	J	4800	10000	J	sp	Detect < PQL
L1327700	SP-015-20210316	3/16/21	SM2540C	Total	Total Dissolved Solids	7200000	ug/L	Q	200000	200000	J-	h	Holding Time
L1327700	SP-015-20210316	3/16/21	SM5310B	Dissolved	Dissolved Organic Carbon	2960	ug/L	B	106	1000	J+	bl	Lab Blank
L1327700	SP-015-20210316	3/16/21	SM5310B	Total	Total Organic Carbon	2220	ug/L	B	102	1000	J+	bl	Lab Blank
L1327700	SP-300-20210316-LAG	3/16/21	EPA 300.1	Total	Chlorate	240	ug/L	U	240	500	R	brr	Better result reported
L1327700	SP-400-20210316	3/16/21	SM2540C	Total	Total Dissolved Solids	7080000	ug/L	Q	200000	200000	J-	h	Holding Time
L1329924	SP-015-20210323	3/23/21	SM5310B	Dissolved	Dissolved Organic Carbon	2170	ug/L	B	106	1000	J+	bl	Lab Blank
L1329924	SP-015-20210323	3/23/21	SM5310B	Total	Total Organic Carbon	2540	ug/L	B	102	1000	J+	bl	Lab Blank
L1329924	SP-300-20210323-LAG	3/23/21	SM5310B	Dissolved	Dissolved Organic Carbon	3790	ug/L	B	106	1000	J+	bl	Lab Blank
L1329924	SP-300-20210323-LAG	3/23/21	SM5310B	Total	Total Organic Carbon	4210	ug/L	B	102	1000	J+	bl	Lab Blank
L1329924	SP-300-20210323-LAG-C	3/23/21	SM5310B	Dissolved	Dissolved Organic Carbon	3910	ug/L	B	106	1000	J+	bl	Lab Blank
L1329928	SP-400-20210323	3/23/21	EPA 314.0	Total	Perchlorate	1.39	ug/L	J	0.300	4.00	J	sp	Detect < PQL
L1332405	SP-015-20210330	3/30/21	SM5310B	Dissolved	Dissolved Organic Carbon	2380	ug/L	B Q	106	1000	J	bl,h	Lab Blank, Holding Time
L1332405	SP-300-20210330-LAG	3/30/21	SM5310B	Dissolved	Dissolved Organic Carbon	3720	ug/L	B Q	106	1000	J	bl,h	Lab Blank, Holding Time
L1332405	SP-300-20210330-LAG	3/30/21	SM5310B	Total	Total Organic Carbon	4090	ug/L	B	102	1000	J+	bl	Lab Blank
L1332405	SP-300-20210330-LAG-C	3/30/21	SM5310B	Dissolved	Dissolved Organic Carbon	3910	ug/L	Q	106	1000	J-	h	Holding Time

Table 6 Results Qualified During Validation

SDG	Sample ID	Sample Date	Method	Total or Dissolved	Parameter	Result	Units	Lab Qualifier	SQL	PQL	Validator Qualifier	Reason Code	Reason Code Definition
L1332405	SP-300-20210330-LAG-C	3/30/21	SM5310B	Total	Total Organic Carbon	4620	ug/L	B	102	1000	J+	bl	Lab Blank
L1333945	SP-100-20210402-LEAD	4/2/21	EPA 300.0	Total	Nitrate [as N]	696	ug/L	J	480	1000	J	sp	Detect < PQL
L1337606	SP-400-20210412	4/12/21	EPA 314.0	Total	Perchlorate	0.300	ug/L	U J6	0.300	4.00	UJ	m	MS Recovery
L1343579	SP-100-20210423-LEAD	4/23/21	EPA 300.0	Total	Nitrate [as N]	807	ug/L	J	480	1000	J	sp	Detect < PQL
L1344499	SP-100-20210426-LEAD	4/26/21	EPA 300.0	Total	Nitrate [as N]	670	ug/L	J	480	1000	J	sp	Detect < PQL
L1346567	SP-100-20210430-LEAD	4/30/21	EPA 300.0	Total	Nitrate [as N]	983	ug/L	J	480	1000	J	sp	Detect < PQL
L1349117	SP-015-20210504	5/4/21	EPA 300.0	Total	Nitrate [as N]	13500	ug/L	T8	480	1000	J-	h	Holding Time
L1349117	SP-100-20210504-LEAD	5/4/21	EPA 300.0	Total	Nitrate [as N]	480	ug/L	U T8	480	1000	UJ	h	Holding Time
L1349117	SP-200-20210504	5/4/21	EPA 300.0	Total	Nitrate [as N]	480	ug/L	U T8	480	1000	UJ	h	Holding Time
L1349117	SP-300-20210504-LAG	5/4/21	EPA 300.0	Total	Nitrate [as N]	480	ug/L	U T8	480	1000	UJ	h	Holding Time
L1349117	SP-300-20210504-LAG	5/4/21	EPA 314.0	Total	Perchlorate	1.62	ug/L	J J5	0.300	4.00	J	m,sp	MS Recovery, Detect < PQL
L1349117	SP-400-20210504	5/4/21	EPA 300.0	Total	Nitrate [as N]	480	ug/L	U T8	480	1000	UJ	h	Holding Time
L1349117	SP-400-20210504-FD	5/4/21	EPA 300.0	Total	Nitrate [as N]	480	ug/L	U T8	480	1000	UJ	h	Holding Time
L1349117	SP-400-20210504-FD	5/4/21	EPA 314.0	Total	Perchlorate	1.12	ug/L	J	0.300	4.00	J	sp	Detect < PQL
L1372443	SP-550-20210629	6/29/21	EPA 314.0	Total	Perchlorate	35.6	ug/L	J5	0.300	4.00	J+	m	MS Recovery
L1372443	SP-550-20210629	6/29/21	SW-7199	Total	Chromium [VI]	0.358	ug/L	J	0.150	0.500	J	sp	Detect < PQL
L1372443	SP-551-20210629	6/29/21	SW-7199	Total	Chromium [VI]	0.185	ug/L	J	0.150	0.500	J	sp	Detect < PQL
L1380668	SP-100-20210720-LEAD	7/20/21	SM2540D	Total	Total Suspended Solids	6700	ug/L		2500	2500	J	fd	FD
L1380668	SP-100-20210720-LEAD-FD	7/20/21	SM2540D	Total	Total Suspended Solids	2700	ug/L		2500	2500	J	fd	FD
L1382360	SP-550-20210722	7/22/21	SM2540D	Total	Total Suspended Solids	4200	ug/L	J4	2500	2500	J+	l	LCS Recovery
L1382360	SP-551-20210722	7/22/21	SM2540D	Total	Total Suspended Solids	7730	ug/L	J4	3330	3330	J+	l	LCS Recovery
L1383184	SP-015-20210727	7/27/21	SW-6010B	Total	Chromium	431	ug/L	O1	1.40	10.0	J	sd	Serial Dilution
L1383184	SP-300-20210727-LAG	7/27/21	EPA 314.0	Total	Perchlorate	0.612	ug/L	J	0.300	4.00	J	sp	Detect < PQL
L1383184	SP-400-20210727	7/27/21	EPA 314.0	Total	Perchlorate	1.59	ug/L	J	0.300	4.00	J	sp	Detect < PQL
L1383184	SP-400-20210727-FD	7/27/21	EPA 314.0	Total	Perchlorate	1.33	ug/L	J	0.300	4.00	J	sp	Detect < PQL
L1383184	SP-550-20210727	7/27/21	SW-7199	Total	Chromium [VI]	0.150	ug/L	U J6	0.150	0.500	UJ	m	MS Recovery
L1383184	SP-551-20210727	7/27/21	EPA 314.0	Total	Perchlorate	0.336	ug/L	J	0.300	4.00	J	sp	Detect < PQL
L1385599	SP-100-20210803-LEAD	8/3/21	EPA 300.0	Total	Nitrate [as N]	760	ug/L	J	480	1000	J	sp	Detect < PQL
L1385599	SP-300-20210803-LAG	8/3/21	EPA 314.0	Total	Perchlorate	2.07	ug/L	J J6	0.300	4.00	J-	m,sp	MS Recovery, Detect < PQL
L1385599	SP-300-20210803-LAG	8/3/21	SW-6010B	Total	Chromium	7.16	ug/L	J	1.40	10.0	J	be,sp	EB, Detect < PQL
L1385599	SP-300-20210803-LAG-FD	8/3/21	EPA 314.0	Total	Perchlorate	2.11	ug/L	J J6	0.300	4.00	J-	m,sp	MS Recovery, Detect < PQL
L1385599	SP-300-20210803-LAG-FD	8/3/21	SW-6010B	Total	Chromium	6.85	ug/L	J	1.40	10.0	J	be,sp	EB, Detect < PQL
L1385599	SP-400-20210803	8/3/21	EPA 314.0	Total	Perchlorate	0.535	ug/L	J J6	0.300	4.00	J-	m,sp	MS Recovery, Detect < PQL
L1385599	SP-400-20210803	8/3/21	SW-6010B	Total	Chromium	6.72	ug/L	J	1.40	10.0	J	be,sp	EB, Detect < PQL
L1385599	SP-550-20210803	8/3/21	SW-6010B	Total	Chromium	8.16	ug/L	J	1.40	10.0	J	be,sp	EB, Detect < PQL
L1385599	SP-551-20210803	8/3/21	EPA 314.0	Total	Perchlorate	0.541	ug/L	J J6	0.300	4.00	J-	m,sp	MS Recovery, Detect < PQL
L1385599	SP-551-20210803	8/3/21	SW-6010B	Total	Chromium	7.87	ug/L	J	1.40	10.0	J	be,sp	EB, Detect < PQL
L1385599	FIELDQC-20210803-EB	8/3/21	SW-6010B	Total	Chromium	3.59	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1386900	SP-300-20210805-LAG	8/5/21	SW-6010B	Total	Chromium	6.10	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1386900	SP-400-20210805	8/5/21	SW-6010B	Total	Chromium	4.88	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1386900	SP-550-20210805	8/5/21	SW-6010B	Total	Chromium	5.26	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1386900	SP-551-20210805	8/5/21	SW-6010B	Total	Chromium	4.60	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1388446	SP-015-20210809	8/9/21	SM2540D	Total	Total Suspended Solids	8600	ug/L		2500	2500	J	fd	FD
L1388446	SP-015-20210809-FD	8/9/21	SM2540D	Total	Total Suspended Solids	5600	ug/L		2500	2500	J	fd	FD
L1388446	SP-300-20210809-LAG	8/9/21	EPA 300.0	Total	Nitrate [as N]	480	ug/L	U J3 J5	480	1000	UJ	m	MS Recovery
L1388446	SP-300-20210809-LAG	8/9/21	EPA 314.0	Total	Perchlorate	1.85	ug/L	J J6	0.300	4.00	J	m,sp	MS Recovery, Detect < PQL
L1388446	SP-300-20210809-LAG	8/9/21	SW-6010B	Total	Chromium	5.19	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1388446	SP-400-20210809	8/9/21	SW-6010B	Total	Chromium	5.35	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1388446	SP-550-20210809	8/9/21	SW-6010B	Total	Chromium	6.31	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1388446	SP-550-20210809	8/9/21	SW-7199	Total	Chromium [VI]	0.334	ug/L	J	0.150	0.500	J	sp	Detect < PQL
L1388446	SP-551-20210809	8/9/21	SW-6010B	Total	Chromium	6.14	ug/L	J	1.40	10.0	J	sp	Detect < PQL
L1388446	SP-551-20210809	8/9/21	SW-7199	Total	Chromium [VI]	0.381	ug/L	J	0.150	0.500	J	sp	Detect < PQL

Table 7 MS/MSD Recovery Exceedances

SDG	Spiked Sample	Lab Sample ID	Method	Total or Dissolved	Parameter	MS Recovery (%)	MSD Recovery (%)	Acceptance Range (%)
550-151744-1	SP-300-WK06A-LAG	550-151744-4	EPA 314.0	Total	Perchlorate	82	78	80-120
L1324982	SP-300-20210309-LAG	L1324982-04	EPA 314.0	Total	Perchlorate	186	Not analyzed	80-120
L1337606	SP-400-20210412	L1337606-05	EPA 314.0	Total	Perchlorate	73.8	Not analyzed	80-120
L1349117	SP-300-20210504-LAG	L1349117-04	EPA 314.0	Total	Perchlorate	183	Not analyzed	80-120
L1372443	SP-550-20210629	L1372443-06	EPA 314.0	Total	Perchlorate	171	Not analyzed	80-120
L1383184	SP-550-20210727	L1383184-07	SW-7199	Total	Chromium [VI]	84.6	88	90-110
L1385599	SP-300-20210803-LAG	L1385599-04	EPA 314.0	Total	Perchlorate	30.1	30.3	80-120
L1385599	SP-300-20210803-LAG-FD	L1385599-05	EPA 314.0	Total	Perchlorate	26.2	Not analyzed	80-120
L1385599	SP-400-20210803	L1385599-06	EPA 314.0	Total	Perchlorate	27.6	Not analyzed	80-120
L1385599	SP-551-20210803	L1385599-08	EPA 314.0	Total	Perchlorate	26.9	Not analyzed	80-120
L1388446	SP-300-20210809-LAG	L1388446-05	EPA 300.0	Total	Nitrate [as N]	99.2	178	80-120
L1388446	SP-300-20210809-LAG	L1388446-05	EPA 314.0	Total	Perchlorate	89.6	76.4	80-120

Table 8 Sample Preservation Infractions

SDG	Sample ID	Method	Parameter	Item	Outlier	Criteria
L1327057	SP-015-20210309	SM5310B	Total Organic Carbon	Preservation	pH > 2	pH < 2
L1327057	SP-300-20210309-LAG	SM5310B	Total Organic Carbon	Preservation	pH > 2	pH < 2
L1327057	SP-300-20210309-LAG-C1	SM5310B	Total Organic Carbon	Preservation	pH > 2	pH < 2
L1327057	SP-300-20210309-LAG-C2	SM5310B	Total Organic Carbon	Preservation	pH > 2	pH < 2

Table 9 Holding Time Exceedances

SDG	Sample ID	Method	Total or Dissolved	Parameter	Time Limit	Time Elapsed
L1327057	SP-015-20210309	SM5310B	Total	Dissolved Organic Carbon	4 hours	225.7 hours
L1327057	SP-015-20210309	SM5310B	Total	Total Organic Carbon	4 hours	327.9 hours
L1327057	SP-300-20210309-LAG	SM5310B	Total	Dissolved Organic Carbon	4 hours	341.9 hours
L1327057	SP-300-20210309-LAG	SM5310B	Total	Total Organic Carbon	4 hours	350.1 hours
L1327057	SP-300-20210309-LAG-C1	SM5310B	Total	Dissolved Organic Carbon	4 hours	225.4 hours
L1327057	SP-300-20210309-LAG-C1	SM5310B	Total	Total Organic Carbon	4 hours	327.6 hours
L1327057	SP-300-20210309-LAG-C2	SM5310B	Total	Dissolved Organic Carbon	4 hours	227.1 hours
L1327057	SP-300-20210309-LAG-C2	SM5310B	Total	Total Organic Carbon	4 hours	327.8 hours
L1327700	SP-015-20210316	SM2540C	Total	Total Dissolved Solids	7 days	8.3 days
L1327700	SP-400-20210316	SM2540C	Total	Total Dissolved Solids	7 days	8.3 days
L1332405	SP-015-20210330	SM5310B	Total	Dissolved Organic Carbon	4 hours	79.8 hours
L1332405	SP-300-20210330-LAG	SM5310B	Total	Dissolved Organic Carbon	4 hours	79.6 hours
L1332405	SP-300-20210330-LAG-C	SM5310B	Total	Dissolved Organic Carbon	4 hours	81.5 hours
L1349117	SP-015-20210504	EPA 300.0	Total	Nitrate [as N]	48 hours	68.4 hours
L1349117	SP-100-20210504-LEAD	EPA 300.0	Total	Nitrate [as N]	48 hours	68.9 hours
L1349117	SP-200-20210504	EPA 300.0	Total	Nitrate [as N]	48 hours	69.5 hours
L1349117	SP-300-20210504-LAG	EPA 300.0	Total	Nitrate [as N]	48 hours	69.8 hours
L1349117	SP-400-20210504	EPA 300.0	Total	Nitrate [as N]	48 hours	70.8 hours
L1349117	SP-400-20210504-FD	EPA 300.0	Total	Nitrate [as N]	48 hours	71.4 hours

Table 10 Laboratory Blank Detections

SDG	Lab Blank Sample ID	Method	Parameter	Result	Units	Associated Samples with Qualification
L1327057	R3632647-1	SM5310B	Dissolved Organic Carbon	396	ug/L	SP-015-20210309
L1327057	R3634391-1	SM5310B	Dissolved Organic Carbon	463	ug/L	SP-300-20210309-LAG
L1327057	R3633649-1	SM5310B	Total Organic Carbon	880	ug/L	SP-015-20210309, SP-300-20210309-LAG-C1, SP-300-20210309-LAG-C2
L1327700	R3632647-1	SM5310B	Dissolved Organic Carbon	396	ug/L	SP-015-20210316
L1327700	R3634133-1	SM5310B	Total Organic Carbon	378	ug/L	SP-015-20210316
L1329924	R3634874-1	SM5310B	Dissolved Organic Carbon	529	ug/L	SP-015-20210323, SP-300-20210323-LAG, SP-300-20210323-LAG-C
L1329924	R3636165-1	SM5310B	Total Organic Carbon	504	ug/L	SP-015-20210323, SP-300-20210323-LAG
L1332405	R3637780-1	SM5310B	Dissolved Organic Carbon	378	ug/L	SP-015-20210330, SP-300-20210330-LAG
L1332405	R3637781-1	SM5310B	Total Organic Carbon	522	ug/L	SP-300-20210330-LAG-C
L1332405	R3639210-1	SM5310B	Total Organic Carbon	440	ug/L	SP-300-20210330-LAG

Table 11 Equipment Blank Detections

SDG*	Sample ID	Blank Type	Sample Date	Method	Total or Dissolved	Parameter	Result	Units	Associated Samples with Qualification
550-149122-1	FIELD-WK01A-EB	EB	9/15/20	EPA 300.0	Total	Nitrate [as N]	0.21	mg/L	SP-100-WK01A LAG, SP-300-WK01A LEAD
550-149122-1	FIELD-WK01A-EB	EB	9/15/20	EPA 300.1	Total	Chlorate	15	ug/L	SP-100-WK01A LAG, SP-400-WK01A
550-150946-1	FIELDQC-WK05A-EB	EB	10/14/20	EPA 300.0	Total	Nitrate [as N]	0.13	mg/L	SP-200-WK05A, SP-300-WK05A-LEAD
L1385599	FIELDQC-20210803-EB	EB	8/3/21	SW-6010B	Total	Chromium	3.59	ug/L	SP-300-20210803-LAG, SP-300-20210803-LAG-FD, SP-400-20210803, SP-550-20210803, SP-551-20210803

Table 12 Completeness Summary

Method	Total Number of Validated Results	Number of Rejected Results	Percent Completeness
EPA 300.0	226	0	100.00%
EPA 300.1	176	0	100.00%
EPA 314.0	180	0	100.00%
SM2540C	61	0	100.00%
SM2540D	292	0	100.00%
SM5310B	26	0	100.00%
SW-6010B	49	0	100.00%
SW-7199	49	0	100.00%

Appendix 1
Validation Checklists

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-149122-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks	X		Yes	SP-100-WK01A Lag, SP-300-WK01A Lead: Qualify nitrate "J+"; SP-100-WK01A Lag, SP-400-WK01A: Qualify chlorate "J".
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	All: Qualify results detected between the SQL and PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Results qualified as estimated (J or J+) are considered useable for limited purposes. All other results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-WK01A	550-149122-1	9/15/2020	2.6 °C/1.4 °C
SP-100-WK01A Lag	550-149122-2	9/15/2020	2.6 °C/1.4 °C
SP-200-WK01A	550-149122-3	9/15/2020	2.6 °C/1.4 °C
SP-300-WK01A Lead	550-149122-4	9/15/2020	2.6 °C/1.4 °C
SP-400-WK01A	550-149122-5	9/15/2020	2.6 °C/1.4 °C
SP-551-WK01A	550-149122-7	9/15/2020	2.6 °C/1.4 °C
SP-551-WK01A-FD	550-149122-8	9/15/2020	2.6 °C/1.4 °C
FIELD-WK01A-EB	550-149122-9	9/15/2020	2.6 °C/1.4 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Sampler did not sign COC.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
FIELD-WK01A-EB: Chlorate and nitrate were detected. Several results were qualified.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values < RL/PQL.	Yes/Yes/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/01/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-149122-2
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-WK01A	550-149122-1	9/15/2020	2.6 °C
SP-100-WK01A Lag	550-149122-2	9/15/2020	2.6 °C
SP-200-WK01A	550-149122-3	9/15/2020	2.6 °C
SP-300-WK01A Lead	550-149122-4	9/15/2020	2.6 °C
SP-400-WK01A	550-149122-5	9/15/2020	2.6 °C
SP-550-WK01A	550-149122-6	9/15/2020	2.6 °C
SP-551-WK01A	550-149122-7	9/15/2020	2.6 °C
SP-551-WK01A-FD	550-149122-8	9/15/2020	2.6 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Sampler did not sign COC.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	N/A

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values < RL/PQL.	Yes/N/A/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/02/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-149508-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK01B	550-149508-1	9/18/2020	0.9 °C/1.1 °C/3.0 °C
SP-100-WK01B Lag	550-149508-2	9/18/2020	0.9 °C/1.1 °C/3.0 °C
SP-200-WK01B	550-149508-3	9/18/2020	0.9 °C/1.1 °C/3.0 °C
SP-200-WK01B-FD	550-149508-4	9/18/2020	0.9 °C/1.1 °C/3.0 °C
SP-300-WK01B Lead	550-149508-5	9/18/2020	0.9 °C/1.1 °C/3.0 °C
SP-400-WK01B	550-149508-6	9/18/2020	0.9 °C/1.1 °C/3.0 °C
SP-550-WK01B	550-149508-7	9/18/2020	0.9 °C/1.1 °C/3.0 °C
SP-551-WK01B	550-149508-8	9/18/2020	0.9 °C/1.1 °C/3.0 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Sampler did not sign COC.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values < RL/PQL.	Yes/Yes/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 09/24/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 10 with MS/MSD
SDG/Report No.: 550-149511-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK02A	550-149511-1	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-100-WK02A Lag	550-149511-2	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-200-WK02A	550-149511-3	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-200-WK02A-FD	550-149511-4	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-300-WK02A Lead	550-149511-5	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-400-WK02A	550-149511-6	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-550-WK02A	550-149511-7	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-551-WK02A	550-149511-8	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-551-WK02A-MS	550-149511-8 MS	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-551-WK02A-MSD	550-149511-8 MSD	9/21/2020	0.9 °C/1.1 °C/3.0 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Sampler did not sign COC.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values < RL/PQL.	Yes/Yes/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/01/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-149511-2
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK02A	550-149511-1	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-100-WK02A Lag	550-149511-2	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-200-WK02A	550-149511-3	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-200-WK02A-FD	550-149511-4	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-300-WK02A Lead	550-149511-5	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-400-WK02A	550-149511-6	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-550-WK02A	550-149511-7	9/21/2020	0.9 °C/1.1 °C/3.0 °C
SP-551-WK02A	550-149511-8	9/21/2020	0.9 °C/1.1 °C/3.0 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Sampler did not sign COC.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values < RL/PQL.	Yes/Yes/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 09/24/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: 550-149784-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-WK02B	550-149784-1	9/25/2020	1.5 °C/4.2 °C
SP-100-WK02B Lag	550-149784-2	9/25/2020	1.5 °C/4.2 °C
SP-200-WK02B	550-149784-3	9/25/2020	1.5 °C/4.2 °C
SP-300-WK02B Lead	550-149784-4	9/25/2020	1.5 °C/4.2 °C
SP-400-WK02B	550-149784-5	9/25/2020	1.5 °C/4.2 °C
SP-550-WK02B	550-149784-6	9/25/2020	1.5 °C/4.2 °C
SP-551-WK02B	550-149784-7	9/25/2020	1.5 °C/4.2 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values < RL/PQL.	Yes/N/A/Yes
SM2540D: RPD exceeded lab limits for SP-015-WK02B and its lab duplicate. The sample concentration was <5x the PQL, so RPD criteria do not apply. The difference between the two values was ≤ PQL. No qualification is needed.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/01/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: 550-150009-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK03A	550-150009-1	9/30/2020	2.0 °C/1.2 °C
SP-100-WK03A Lag	550-150009-2	9/30/2020	2.0 °C/1.2 °C
SP-200-WK03A	550-150009-3	9/30/2020	2.0 °C/1.2 °C
SP-300-WK03A Lead	550-150009-4	9/30/2020	2.0 °C/1.2 °C
SP-400-WK03A	550-150009-5	9/30/2020	2.0 °C/1.2 °C
SP-550-WK03A	550-150009-6	9/30/2020	2.0 °C/1.2 °C
SP-551-WK03A	550-150009-7	9/30/2020	2.0 °C/1.2 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/20/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-150206-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-WK03B	550-150206-1	10/2/2020	2.0 °C
SP-100-WK03B Lag	550-150206-2	10/2/2020	2.0 °C
SP-200-WK03B	550-150206-3	10/2/2020	2.0 °C
SP-300-WK03B Lead	550-150206-4	10/2/2020	2.0 °C
SP-400-WK03B	550-150206-5	10/2/2020	2.0 °C
SP-400-WK03B-FD	550-150206-6	10/2/2020	2.0 °C
SP-550-WK03B	550-150206-7	10/2/2020	2.0 °C
SP-551-WK03B	550-150206-8	10/2/2020	2.0 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
SM2540D: RPD exceeded lab limits for SP-015-WK03B and its lab duplicate. The sample concentration was <5x the PQL, so RPD criteria do not apply. The difference between the two values was <PQL. For SP-400-WK03B and SP-400-WK03B-FD, the sample concentrations were <5x the PQL, so RPD criteria do not apply. The difference between the two values was = PQL. No qualification is needed	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/15/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-150303-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK04A	550-150303-1	10/6/2020	1.1 °C/3.7 °C
SP-100-WK04A Lag	550-150303-2	10/6/2020	1.1 °C/3.7 °C
SP-200-WK04A	550-150303-3	10/6/2020	1.1 °C/3.7 °C
SP-300-WK04A Lead	550-150303-4	10/6/2020	1.1 °C/3.7 °C
SP-400-WK04A	550-150303-5	10/6/2020	1.1 °C/3.7 °C
SP-550-WK04A	550-150303-6	10/6/2020	1.1 °C/3.7 °C
SP-551-WK04A	550-150303-7	10/6/2020	1.1 °C/3.7 °C
SP-551-WK04A-FD	550-150303-8	10/6/2020	1.1 °C/3.7 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes
Most MS/MSDs were not project samples.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/23/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-150767-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-WK04B	550-150767-1	10/9/2020	1.3 °C
SP-015-WK04B-FD	550-150767-2	10/9/2020	1.3 °C
SP-100-WK04B-Lag	550-150767-3	10/9/2020	1.3 °C
SP-200-WK04B	550-150767-4	10/9/2020	1.3 °C
SP-300-WK04B-Lead	550-150767-5	10/9/2020	1.3 °C
SP-400-WK04B	550-150767-6	10/9/2020	1.3 °C
SP-550-WK04B	550-150767-7	10/9/2020	1.3 °C
SP-551-WK04B	550-150767-8	10/9/2020	1.3 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
SM2540D: RPD exceeded lab limits for SP-015-WK04B and its lab duplicate. The sample concentration was <5x the PQL, so RPD criteria do not apply. The difference between the two values was <PQL. For SP-015-WK04B and SP-015-WK04B-FD, the sample concentrations were <5x the PQL, so RPD criteria do not apply. The difference between the two values was = PQL. No qualification is needed	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/19/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 8
SDG/Report No.: 550-150946-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks	X		Yes	SP-200-WK05A and SP-300-WK05A-LEAD: Qualify nitrate "J+".
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		Yes	SP-015-WK05A: Qualify TSS "J".
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J, J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK05A	550-150946-1	10/14/2020	3.3 °C/2.2 °C
SP-100-WK05A-LAG	550-150946-2	10/14/2020	3.3 °C/2.2 °C
SP-200-WK05A	550-150946-3	10/14/2020	3.3 °C/2.2 °C
SP-300-WK05A-LEAD	550-150946-4	10/14/2020	3.3 °C/2.2 °C
SP-400-WK05A	550-150946-5	10/14/2020	3.3 °C/2.2 °C
SP-550-WK05A	550-150946-6	10/14/2020	3.3 °C/2.2 °C
SP-551-WK05A	550-150946-7	10/14/2020	3.3 °C/2.2 °C
FIELDQC-WK05A-EB	550-150946-8	10/14/2020	3.3 °C/2.2 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/No/Yes
The case narrative reports the temperature at receipt at the Las Vegas service center was 6.1 °C. The samples were delivered soon after sampling and did not have time to cool. Temperatures at receipt at the labs were ≤ 6 °C.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
300.0: Nitrate was detected in FIELDQC-WK05A-EB. The concentrations in 2 samples were <10x the amount in the EB.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/No
SM2540C: RPD exceeded lab limits for SP-015-WK05A and its lab duplicate. The sample concentration was <5x the PQL, so RPD criteria do not apply. The difference between the two values was >PQL.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 11/05/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 3
SDG/Report No.: 550-151054-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20201015-Feed_ET	550-151054-1	10/15/2020	1.8 °C
SP-200-20201015-Mid_ET	550-151054-2	10/15/2020	1.8 °C
SP-300-20201015-Lag_ET	550-151054-3	10/15/2020	1.8 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/No/Yes
The case narrative reports the temperature at receipt at the Las Vegas service center was 16.5 °C. The samples were delivered soon after sampling and did not have time to cool. Temperatures at receipt at the labs were ≤ 6 °C.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/N/A
MS/MSDs were not project samples.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	No/N/A/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 10/20/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: 550-151744-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-300-WK06A-LAG: Qualify perchlorate "J-".
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J-) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK06A	550-151744-1	10/26/2020	1.7 °C/2.6 °C
SP-100-WK06A-LEAD	550-151744-2	10/26/2020	1.7 °C/2.6 °C
SP-200-WK06A	550-151744-3	10/26/2020	1.7 °C/2.6 °C
SP-300-WK06A-LAG	550-151744-4	10/26/2020	1.7 °C/2.6 °C
SP-400-WK06A	550-151744-5	10/26/2020	1.7 °C/2.6 °C
SP-551-WK06A	550-151744-7	10/26/2020	1.7 °C/2.6 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/No/Yes
The case narrative reports the temperature at receipt at the Las Vegas service center was 7.2 °C. The samples were delivered soon after sampling and did not have time to cool. Temperatures at receipt at the labs were ≤ 6 °C.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/No
Perchlorate recovery was low in the MSD of SP-300-WK06A-LAG.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	No/N/A/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 11/05/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 7
SDG/Report No.: 550-151744-2
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK06A	550-151744-1	10/26/2020	1.7 °C
SP-100-WK06A-LEAD	550-151744-2	10/26/2020	1.7 °C
SP-200-WK06A	550-151744-3	10/26/2020	1.7 °C
SP-300-WK06A-LAG	550-151744-4	10/26/2020	1.7 °C
SP-400-WK06A	550-151744-5	10/26/2020	1.7 °C
SP-550-WK06A	550-151744-6	10/26/2020	1.7 °C
SP-551-WK06A	550-151744-7	10/26/2020	1.7 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/No/Yes
The case narrative reports the temperature at receipt for one cooler was 7.2 °C. The samples were delivered soon after sampling and did not have time to cool. Temperature at receipt at the labs were ≤ 6 °C.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/N/A

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/N/A
SM2540D: RPD exceeded lab limits for SP-015-WK06A and its lab duplicate. The sample concentration was <5x the PQL, so RPD criteria do not apply. The difference between the two values was <PQL. No qualification is needed	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 11/17/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 7
SDG/Report No.: 550-152610-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results between the SQL and PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK07A	550-152610-1	11/06/2020	3.5 °C/2.0 °C
SP-100-WK07A-LEAD	550-152610-2	11/06/2020	3.5 °C/2.0 °C
SP-200-WK07A	550-152610-3	11/06/2020	3.5 °C/2.0 °C
SP-300-WK07A-LAG	550-152610-4	11/06/2020	3.5 °C/2.0 °C
SP-400-WK07A	550-152610-5	11/06/2020	3.5 °C/2.0 °C
SP-550-WK07A	550-152610-6	11/06/2020	3.5 °C/2.0 °C
SP-551-WK07A	550-152610-7	11/06/2020	3.5 °C/2.0 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/N/A

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/N/A
SM2540D: RPD exceeded lab limits for SP-015-WK07A and its lab duplicate. The sample concentration was <5x the PQL, so RPD criteria do not apply. The difference between the two values was <PQL. No qualification is needed	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 11/17/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 7
SDG/Report No.: 550-153405-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		Yes	SP-015-WK08A: Qualify TSS "J".
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results between the SQL and PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-WK08A	550-153405-1	11/19/2020	1.3 °C/0.3 °C
SP-100-WK08A-LEAD	550-153405-2	11/19/2020	1.3 °C/0.3 °C
SP-200-WK08A	550-153405-3	11/19/2020	1.3 °C/0.3 °C
SP-300-WK08A-LAG	550-153405-4	11/19/2020	1.3 °C/0.3 °C
SP-400-WK08A	550-153405-5	11/19/2020	1.3 °C/0.3 °C
SP-550-WK08A	550-153405-7	11/19/2020	1.3 °C/0.3 °C
SP-551-WK08A	550-153405-8	11/19/2020	1.3 °C/0.3 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/No
SM2540D: RPD exceeded lab limits for SP-015-WK08A and its lab duplicate. The sample concentration was <5x the PQL, so RPD criteria do not apply. The difference between the two values was >PQL.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 12/07/2020

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 5
SDG/Report No.: 550-156121-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate	X		No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results between the SQL and PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-01122021	550-156121-1	01/12/2021	2.1 °C/0.6 °C
SP-100-01122021-LAG	550-156121-2	01/12/2021	2.1 °C/0.6 °C
SP-200-01122021	550-156121-3	01/12/2021	2.1 °C/0.6 °C
SP-300-01122021-LEAD	550-156121-4	01/12/2021	2.1 °C/0.6 °C
SP-400-01122021	550-156121-5	01/12/2021	2.1 °C/0.6 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/Yes
314.0: The MS/MSD associated with batch 550-230370 was not reported because the parent sample exceeded the calibration range and was reanalyzed. Several samples did not have the MS/MSD in their batch. No qualification.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 01/20/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 4
SDG/Report No.: 550-156472-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	---	---	---	---
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results between the SQL and PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210114-Feed(E)	550-156472-1	01/14/2021	3.7 °C
SP-300-20210114-Lead(E)	550-156472-2	01/14/2021	3.7 °C
SP-200-20210114-Mid(E)	550-156472-3	01/14/2021	3.7 °C
SP-100-20210114-Lag(E)	550-156472-4	01/14/2021	3.7 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	No/N/A/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 02/02/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 5
SDG/Report No.: 550-156702-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	X		Yes	SP-200-20210118: Qualify chlorate "J+".
6. Matrix Spike/Matrix Spike Duplicate	X		No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210118	550-156702-1	01/18/2021	2.4 °C/3.1 °C
SP-100-20210118-LAG	550-156702-2	01/18/2021	2.4 °C/3.1 °C
SP-200-20210118	550-156702-3	01/18/2021	2.4 °C/3.1 °C
SP-300-20210118-LEAD	550-156702-4	01/18/2021	2.4 °C/3.1 °C
SP-400-20210118	550-156702-5	01/18/2021	2.4 °C/3.1 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/No
300.1B: Dichloroacetic acid (surrogate) recovery was high in SP-200-20210118. Chlorate may be biased high.	

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/Yes
314.0: The MS/MSD associated with batch 550-230933 was not reported due to analyst error. No qualification.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 02/02/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 6
SDG/Report No.: 550-157025-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		Yes	SP-015-20210122-FEED: Qualify TSS "J". SP-015-20210122-FEED-FD: Qualify TSS "UJ".
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (UJ, J) are considered useable for limited purposes. All other results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210122-FEED	550-157025-1	1/22/2021	1.5 °C
SP-015-20210122-FEED-FD	550-157025-2	1/22/2021	1.5 °C
SP-100-20210122-LAG	550-157025-3	1/22/2021	1.5 °C
SP-200-20210122-MID	550-157025-4	1/22/2021	1.5 °C
SP-300-20210122-LEAD	550-157025-5	1/22/2021	1.5 °C
SP-400-20210122-POST	550-157025-6	1/22/2021	1.5 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/No
TSS was detected in SP-015-20210122-FEED at <5x the PQL. TSS was not detected in SP-015-20210122-FEED-FD. The difference between the two results was > PQL. Both samples shall be qualified.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 02/02/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 7
SDG/Report No.: 550-157183-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds		X	No	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210126	550-157183-1	01/26/2021	0.6 °C
SP-100-20210126-LAG	550-157183-2	01/26/2021	0.6 °C
SP-200-20210126	550-157183-3	01/26/2021	0.6 °C
SP-300-20210126-LEAD	550-157183-4	01/26/2021	0.6 °C
SP-400-20210126	550-157183-5	01/26/2021	0.6 °C
SP-400-20210126-FD	550-157183-6	01/26/2021	0.6 °C
FIELDQC-20210126-EB	550-157183-7	01/26/2021	0.6 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/Yes

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 02/24/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 5
SDG/Report No.: 550-157268-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210127-FEED	550-157268-1	1/27/2021	0.2 °C
SP-100-20210127-LAG	550-157268-2	1/27/2021	0.2 °C
SP-200-20210127-MID	550-157268-3	1/27/2021	0.2 °C
SP-300-20210127-LEAD	550-157268-4	1/27/2021	0.2 °C
SP-400-20210127-POST	550-157268-5	1/27/2021	0.2 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/N/A
Lab QC only.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/01/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 6
SDG/Report No.: 550-157457-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210129-FEED	550-157457-1	1/29/2021	0.1 °C/1.3 °C
SP-100-20210129-LAG	550-157457-2	1/29/2021	0.1 °C/1.3 °C
SP-100-20210129-LAG-FD	550-157457-3	1/29/2021	0.1 °C/1.3 °C
SP-200-20210129-MID	550-157457-4	1/29/2021	0.1 °C/1.3 °C
SP-300-20210129-LEAD	550-157457-5	1/29/2021	0.1 °C/1.3 °C
SP-400-20210129-POST	550-157457-6	1/29/2021	0.1 °C/1.3 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
One FD pair: SP-100-20210129-LAG and SP-100-20210129-LAG-FD. RPD = 58%; Difference = 4.5, which is < 5 (RL/PQL).	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/01/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 5
SDG/Report No.: 550-157683-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	X		Yes	SP-200-20210202 and SP-400-20210202: Qualify chlorate "J+".
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify detections between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J, J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210202	550-157683-1	02/02/2021	1.7 °C
SP-100-20210202-LAG	550-157683-2	02/02/2021	1.7 °C
SP-200-20210202	550-157683-3	02/02/2021	1.7 °C
SP-300-20210202-LEAD	550-157683-4	02/02/2021	1.7 °C
SP-400-20210202	550-157683-5	02/02/2021	1.7 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	Yes/Yes/No
300.1B: Dichloroacetic acid (surrogate) recoveries were high in SP-200-20210202 and SP-400-20210202. Chlorate may be biased high in the samples.	

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 02/24/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 6
SDG/Report No.: 550-157816-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210203-FEED	550-157816-1	2/03/2021	0.7 °C
SP-100-20210203-LAG-C	550-157816-2	2/03/2021	0.7 °C
SP-100-20210203-LAG-G	550-157816-3	2/03/2021	0.7 °C
SP-200-20210203-MID	550-157816-4	2/03/2021	0.7 °C
SP-300-20210203-LEAD	550-157816-5	2/03/2021	0.7 °C
SP-400-20210203-POST	550-157816-6	2/03/2021	0.7 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
Lab duplicate analyzed.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 02/10/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Study
Task No.: M26
No. of Samples: 7
SDG/Report No.: 550-157970-1
Lab ID: Eurofins TestAmerica
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210205-FEED	550-157970-1	2/05/2021	0.1 °C
SP-100-20210205-LAG-C	550-157970-2	2/05/2021	0.1 °C
SP-100-20210205-LAG-G	550-157970-3	2/05/2021	0.1 °C
SP-200-20210205-MID	550-157970-4	2/05/2021	0.1 °C
SP-300-20210205-LEAD	550-157970-5	2/05/2021	0.1 °C
SP-400-20210205-POST	550-157970-6	2/05/2021	0.1 °C
TANK2-20210205	550-157970-7	2/05/2021	0.1 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/N/A
Lab QC only.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 02/24/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1324982
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-300-20210309-LAG: Qualify perchlorate "J+".
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210309	L1324982-01	3/9/2021	1.4 °C/1.7 °C
SP-100-20210309-LEAD	L1324982-02	3/9/2021	1.4 °C/1.7 °C
SP-200-20210309	L1324982-03	3/9/2021	1.4 °C/1.7 °C
SP-300-20210309-LAG	L1324982-04	3/9/2021	1.4 °C/1.7 °C
SP-400-20210309	L1324982-05	3/9/2021	1.4 °C/1.7 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/No
314.0: Perchlorate recoveries were high in the MSs of SP-300-20210309-LAG and SP-400-20210309. Perchlorate in SP-300-20210309-LAG may be biased high. Perchlorate was ND in SP-400-20210309 so there is no high bias.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/N/A
Lab duplicates	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/16/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: L1327057
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		Yes	SP-015-20210309, SP-300-20210309-LAG-C1, SP-300-20210309-LAG-C2: Qualify TOC "J". SP-300-20210309-LAG: Qualify TOC "J-".
2. Chain-of-Custody	X		No	None
3. Holding Times	X		Yes	SP-015-20210309, SP-300-20210309-LAG: Qualify DOC "J". SP-300-20210309-LAG-C1, SP-300-20210309-LAG-C2: Qualify DOC "J-". SP-015-20210309, SP-300-20210309-LAG-C1, SP-300-20210309-LAG-C2: Qualify TOC "J". SP-300-20210309-LAG: Qualify TOC "J-".
4. Blanks	X		No	SP-015-20210309, SP-300-20210309-LAG: Qualify DOC "J". SP-015-20210309, SP-300-20210309-LAG-C1, SP-300-20210309-LAG-C2: Qualify TOC "J".
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J-, J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.

Data Verification and Validation Summary

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210309	L1327057-01	3/9/2021	1.4 °C/1.7 °C
SP-100-20210309-LEAD	L1327057-02	3/9/2021	1.4 °C/1.7 °C
SP-200-20210309	L1327057-03	3/9/2021	1.4 °C/1.7 °C
SP-300-20210309-LAG	L1327057-04	3/9/2021	1.4 °C/1.7 °C
SP-400-20210309	L1327057-05	3/9/2021	1.4 °C/1.7 °C
SP-300-20210309-LAG-C1	L1327057-06	3/9/2021	1.4 °C/1.7 °C
SP-300-20210309-LAG-C2	L1327057-07	3/9/2021	1.4 °C/1.7 °C

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	No/Yes/Yes
SM5310B: The following TOC samples were not preserved to pH <2: SP-015-20210309, SP-300-20210309-LAG, SP-300-20210309-LAG-C1, and SP-300-20210309-LAG-C2. The analysis was requested after shipment and the samples were preserved by the lab.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/No
The lab analyzed SP-300-20210309-LAG-C1 and SP-300-20210309-LAG-C2 for chlorate, which was not requested. TOC and DOC analyses were not on the COC. They were added after shipment to SP-015-20210309, SP-300-20210309-LAG, SP-300-20210309-LAG-C1, and SP-300-20210309-LAG-C2.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	No
SM5310B: The following TOC samples were not preserved to pH <2 at time of sampling: SP-015-20210309, SP-300-20210309-LAG, SP-300-20210309-LAG-C1, and SP-300-20210309-LAG-C2. The samples were preserved by the lab. The samples were not analyzed within 4 hours as required for unpreserved samples.	

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
SM5310B: DOC was detected in method blanks R3632647-1 (3/18/21) and R3634391-1 (3/23/21). TOC was detected in method blanks R3633649-1 (3/22/21) and R3634133-1 (3/23/21). Associated detections with concentration <10x the MB concentrations were qualified.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/29/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1327680
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	---	---	---	---
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210316	L1327680-01	3/16/2021	0.6 °C
SP-100-20210316-LEAD	L1327680-02	3/16/2021	0.6 °C
SP-200-20210316	L1327680-03	3/16/2021	0.6 °C
SP-300-20210316-LAG	L1327680-04	3/16/2021	0.6 °C
SP-400-20210316	L1327680-05	3/16/2021	0.6 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	No/N/A/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/23/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1327700
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times	X		Yes	SP-015-20210316 and SP-400-20210316: Qualify TDS "J-".
4. Blanks	X		Yes	SP-015-20210316: Qualify DOC and TOC "J+".
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
11. Multiple Results	---	---	Yes	SP-300-20210316-LAG: Qualify 10x chlorate result "R".
Multiple results: SP-300-20210316-LAG was analyzed twice (1X and 10x) for chlorate. Chlorate was not detected in either run. The 1x analysis was used because of the lower PQL.				
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Sample results qualified "R" should not be used. Sample results qualified as estimated (J-, J, J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210316	L1327700-01	3/16/2021	0.6 °C
SP-100-20210316-LEAD	L1327700-02	3/16/2021	0.6 °C
SP-200-20210316	L1327700-03	3/16/2021	0.6 °C
SP-300-20210316-LAG	L1327700-04	3/16/2021	0.6 °C
SP-300-20210316-LAG-C	L1327700-05	3/16/2021	0.6 °C
SP-400-20210316	L1327700-06	3/16/2021	0.6 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	No
SM2540C: SP-015-20210316 and SP-400-20210316 were analyzed past the TDS holding time.	

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
SM5310B: DOC was detected in the method blank in analytical run R3632647-1 (3/18/21). TOC was detected in the method blank in analytical run R3634133-1 (3/23/21). Associated detections with concentration <10x the MB concentrations were qualified.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/26/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1328684
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	---	---	---	---
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210318	L1328684-01	3/18/2021	0.5 °C
SP-100-20210318-LEAD	L1328684-02	3/18/2021	0.5 °C
SP-200-20210318	L1328684-03	3/18/2021	0.5 °C
SP-300-20210318-LAG	L1328684-04	3/18/2021	0.5 °C
SP-300-20210318-LAG-C	L1328684-05	3/18/2021	0.5 °C
SP-400-20210318	L1328684-06	3/18/2021	0.5 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	No/N/A/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/23/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: L1329924
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks	X		Yes	SP-015-20210323, SP-300-20210323-LAG, SP-300-20210323-LAG-C: Qualify DOC "J+". SP-015-20210323, SP-300-20210323-LAG: Qualify TOC "J+".
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
11. Multiple Results	---	---	---	---
Multiple results: N/A				
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Sample results qualified as estimated (J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Data Verification and Validation Summary

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210323	L1329924-01	3/23/2021	1.8 °C
SP-100-20210323-LEAD	L1329924-02	3/23/2021	1.8 °C
SP-200-20210323	L1329924-03	3/23/2021	1.8 °C
SP-200-20210323-FD	L1329924-04	3/23/2021	1.8 °C
SP-300-20210323-LAG	L1329924-05	3/23/2021	1.8 °C
SP-300-20210323-LAG-C	L1329924-06	3/23/2021	1.8 °C
SP-400-20210323	L1329924-07	3/23/2021	1.8 °C

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Sampler did not sign COC.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
SM5310B: DOC was detected in the method blanks R3634875-1 (3/25/21) and R3634874-1 (3/24/21). TOC was detected in the method blank R3636165-1 (3/29/21). Associated detections with concentration <10x the MB concentrations were qualified.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/Yes
MS/MSD not required for all methods.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/30/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1329928
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	Yes	
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	X		No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210323	L1329928-01	3/23/2021	1.8 °C
SP-100-20210323-LEAD	L1329928-02	3/23/2021	1.8 °C
SP-200-20210323	L1329928-03	3/23/2021	1.8 °C
SP-200-20210323-FD	L1329928-04	3/23/2021	1.8 °C
SP-300-20210323-LAG	L1329928-05	3/23/2021	1.8 °C
SP-400-20210323	L1329928-06	3/23/2021	1.8 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/No
314.0: Perchlorate recoveries were outside limits in SP-200-20210323-FD. The concentration in the parent was >4x the amount spiked so recovery criteria do not apply.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A
One field duplicate pair: SP-200-20210323 and SP-200-20210323-FD. RPD was <30%.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 03/26/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: L1331343
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210325	L1331343-01	3/25/2021	0.3 °C
SP-100-20210325-LEAD	L1331343-02	3/25/2021	0.3 °C
SP-200-20210325	L1331343-03	3/25/2021	0.3 °C
SP-300-20210325-LAG	L1331343-04	3/25/2021	0.3 °C
SP-300-20210325-LAG-C	L1331343-05	3/25/2021	0.3 °C
SP-400-20210325	L1331343-06	3/25/2021	0.3 °C
SP-400-20210325-FD	L1331343-07	3/25/2021	0.3 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/N/A
One FD pair: SP-400-20210325 and SP-400-20210325-FD. Both samples were non-detect.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/07/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1332403
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Sample results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210330	L1332403-01	3/30/2021	0.2 °C
SP-100-20210330-LEAD	L1332403-02	3/30/2021	0.2 °C
SP-200-20210330	L1332403-03	3/30/2021	0.2 °C
SP-300-20210330-LAG	L1332403-04	3/30/2021	0.2 °C
SP-400-20210330	L1332403-05	3/30/2021	0.2 °C
FIELDQC-20210330-EB	L1332403-06	3/30/2021	0.2 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/N/A
One lab duplicate ran on FIELDQC-20210330-EB. EB and DUP were ND.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: L1332405
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times	X		Yes	SP-015-20210330, SP-300-20210330-LAG: Qualify DOC "J". SP-300-20210330-LAG-C: Qualify DOC "J-".
4. Blanks	X		Yes	SP-015-20210330, SP-300-20210330-LAG : Qualify DOC "J". SP-300-20210330-LAG, SP-300-20210330-LAG-C: Qualify TOC "J+".
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Sample results qualified as estimated (J-, J, J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210330	L1332405-01	3/30/2021	0.2 °C
SP-100-20210330-LEAD	L1332405-02	3/30/2021	0.2 °C
SP-200-20210330	L1332405-03	3/30/2021	0.2 °C
SP-300-20210330-LAG	L1332405-04	3/30/2021	0.2 °C
SP-300-20210330-LAG-C	L1332405-05	3/30/2021	0.2 °C
SP-400-20210330	L1332405-06	3/30/2021	0.2 °C
FIELDQC-20210330-EB	L1332405-07	3/30/2021	0.2 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	No
SM5310B: DOC was analyzed outside the holding time for SP-015-20210330, SP-300-20210330-LAG, and SP-300-20210330-LAG-C.	

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
SM5310B: DOC was detected in the method blank R3637780-1 (04/02/21). TOC was detected in method blanks R3637781-1 (04/02/21) and R3638909-1 (04/06/21). Associated detections with concentration <10x the MB concentrations were qualified.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A
Lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/13/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1333481
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210401	L1333481-01	4/1/2021	2.9 °C
SP-100-20210401-LEAD	L1333481-02	4/1/2021	2.9 °C
SP-200-20210401	L1333481-03	4/1/2021	2.9 °C
SP-300-20210401-LAG	L1333481-04	4/1/2021	2.9 °C
SP-300-20210401-LAG-C	L1333481-05	4/1/2021	2.9 °C
SP-400-20210401	L1333481-06	4/1/2021	2.9 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/N/A
Unrelated lab duplicates. No qualification.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/13/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1333934
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
11. Multiple Results	---	---	---	---
Multiple results: N/A				
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Sample results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210402	L1333934-01	4/02/2021	1.0 °C
SP-100-20210402-LEAD	L1333934-02	4/02/2021	1.0 °C
SP-200-20210402	L1333934-03	4/02/2021	1.0 °C
SP-300-20210402-LAG	L1333934-04	4/02/2021	1.0 °C
SP-400-20210402	L1333934-05	4/02/2021	1.0 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1333945
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify detections between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J) are considered valid and useable for limited purposes. Unqualified sample results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210402	L1333945-01	4/02/2021	1.0 °C
SP-100-20210402-LEAD	L1333945-02	4/02/2021	1.0 °C
SP-200-20210402	L1333945-03	4/02/2021	1.0 °C
SP-300-20210402-LAG	L1333945-04	4/02/2021	1.0 °C
SP-400-20210402	L1333945-05	4/02/2021	1.0 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A
Lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/13/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1337606
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-400-20210412: Qualify perchlorate "UJ".
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Sample results qualified as estimated (UJ) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210412	L1337606-01	4/12/2021	0.8 °C
SP-100-20210412-LEAD	L1337606-02	4/12/2021	0.8 °C
SP-200-20210412	L1337606-03	4/12/2021	0.8 °C
SP-300-20210412-LAG	L1337606-04	4/12/2021	0.8 °C
SP-400-20210412	L1337606-05	4/12/2021	0.8 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/No
314.0: Perchlorate recoveries were high in the MS/MSD of SP-200-20210412. The concentration in the parent sample was >4x the amount spiked, so recovery criteria do not apply. Perchlorate recovery was low in the MS of SP-400-20210412. No MSD was analyzed.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A
Lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/15/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1337611
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Sample are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210412	L1337611-01	4/12/2021	0.8 °C
SP-100-20210412-LEAD	L1337611-02	4/12/2021	0.8 °C
SP-200-20210412	L1337611-03	4/12/2021	0.8 °C
SP-300-20210412-LAG	L1337611-04	4/12/2021	0.8 °C
SP-300-20210412-LAG-C	L1337611-05	4/12/2021	0.8 °C
SP-400-20210412	L1337611-06	4/12/2021	0.8 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A
Lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/27/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1339737
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210415	L1339737-01	4/15/2021	4.5 °C
SP-100-20210415-LEAD	L1339737-02	4/15/2021	4.5 °C
SP-200-20210415	L1339737-03	4/15/2021	4.5 °C
SP-300-20210415-LAG	L1339737-04	4/15/2021	4.5 °C
SP-300-20210415-LAG-C	L1339737-05	4/15/2021	4.5 °C
SP-400-20210415	L1339737-06	4/15/2021	4.5 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/N/A
Unrelated lab duplicates exceeded RPDs. No qualification.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/N/A

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 04/27/2021

Data Verification and Validation Summary

Project Name:	Hydrogen Membrane Pilot Test	SDG/Report No.:	L1343573
Task No.:	M26	Lab ID:	Pace
No. of Samples:	6	Matrix:	Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Samples are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210423	L1343573-01	4/23/2021	0.3 °C
SP-015-20210423-FD	L1343573-02	4/23/2021	0.3 °C
SP-100-20210423-LEAD	L1343573-03	4/23/2021	0.3 °C
SP-200-20210423	L1343573-04	4/23/2021	0.3 °C
SP-300-20210423-LAG	L1343573-05	4/23/2021	0.3 °C
SP-400-20210423	L1343573-06	4/23/2021	0.3 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A
One FD pair and lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 05/05/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1343579
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	All: Qualify detections between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J) are useable for limited purposes. All other results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210423	L1343579-01	4/23/2021	0.3 °C
SP-015-20210423-FD	L1343579-02	4/23/2021	0.3 °C
SP-100-20210423-LEAD	L1343579-03	4/23/2021	0.3 °C
SP-200-20210423	L1343579-04	4/23/2021	0.3 °C
SP-300-20210423-LAG	L1343579-05	4/23/2021	0.3 °C
SP-400-20210423	L1343579-06	4/23/2021	0.3 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/N/A
One FD pair and lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 05/05/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1344499
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	Yes	All: Qualify results detected between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J) are useable for limited purposes. All other results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210426	L1344499-02	4/26/2021	0.7 °C
SP-100-20210426-LEAD	L1344499-04	4/26/2021	0.7 °C
SP-200-20210426	L1344499-06	4/26/2021	0.7 °C
SP-300-20210426-LAG	L1344499-08	4/26/2021	0.7 °C
SP-400-20210426	L1344499-10	4/26/2021	0.7 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
Lab duplicates. SP-200-20210426: RPD was high for TSS, but the concentration was <5x the PQL. Difference was < PQL. No qualification.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 05/05/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1344581
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Samples are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210426	L1344581-01	4/26/2021	COC not included in Report.
SP-100-20210426-LEAD	L1344581-02	4/26/2021	COC not included in Report.
SP-200-20210426	L1344581-03	4/26/2021	COC not included in Report.
SP-300-20210426-LAG	L1344581-04	4/26/2021	COC not included in Report.
SP-400-20210426	L1344581-05	4/26/2021	COC not included in Report.

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
Lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 05/05/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 5
SDG/Report No.: L1346567
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	All: Qualify results detected between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J) are useable for limited purposes. All other results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210430	L1346567-01	4/30/2021	2.8°C
SP-100-20210430-LEAD	L1346567-02	4/30/2021	2.8°C
SP-200-20210430	L1346567-03	4/30/2021	2.8°C
SP-300-20210430-LAG	L1346567-04	4/30/2021	2.8°C
SP-400-20210430	L1346567-05	4/30/2021	2.8°C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
Lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 05/19/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1349117
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody	X		No	None
3. Holding Times	X		Yes	SP-015-20210504: Qualify nitrate "J-". SP-100-20210504-LEAD, SP-200-20210504, SP-300-20210504-LAG, SP-400-20210504, and SP-400-20210504-FD: Qualify nitrate "UJ".
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-300-20210504-LAG: Qualify perchlorate "J".
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	Yes	All: Qualify results detected between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (UJ, J-, J) are useable for limited purposes. All other results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-015-20210504	L1349117-01	5/4/2021	1.2 °C
SP-100-20210504-LEAD	L1349117-02	5/4/2021	1.2 °C
SP-200-20210504	L1349117-03	5/4/2021	1.2 °C
SP-300-20210504-LAG	L1349117-04	5/4/2021	1.2 °C
SP-400-20210504	L1349117-05	5/4/2021	1.2 °C
SP-400-20210504-FD	L1349117-06	5/4/2021	1.2 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Sampler did not sign COC.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	No
300.0: Nitrate analyses on all samples were after the 48-hour holding time had passed.	

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/No
314.0: Perchlorate recovery was high in the MS of SP-300-20210504-LAG. No MSD was analyzed.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
One FD pair was analyzed. Results agreed SP-300-20210504-LAG: RPD was high for TSS, but the concentration was <5x the PQL. Difference was < PQL. No qualification.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 05/19/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 13
SDG/Report No.: L1354539
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		Yes	SP-100A-202105-PRE, SP-100B-202105-PRE, SP-300B-202105-PRE, SP-300C-202105-PRE: Qualify TOC "J-". SP-100C-202105-PRE, SP-200A-202105-PRE, SP-200B-202105-PRE, SP-200C-202105-PRE, SP-300A-202105-PRE: Qualify TOC "J". SP-300A-202105-PRE: Qualify metals "J-".
2. Chain-of-Custody	X		No	None
3. Holding Times	X		Yes	SP-100A-202105-PRE, SP-100B-202105-PRE, SP-300B-202105-PRE, SP-300C-202105-PRE: Qualify TOC "J-". SP-100C-202105-PRE, SP-200A-202105-PRE, SP-200B-202105-PRE, SP-200C-202105-PRE, SP-300A-202105-PRE: Qualify TOC "J".
4. Blanks	X		No	SP-100C-202105-PRE, SP-200A-202105-PRE, SP-200B-202105-PRE, SP-200C-202105-PRE, SP-300A-202105-PRE: Qualify TOC "J". SP-100-202105-POST: Qualify TOC "J+".
5. Surrogates/Monitoring Compounds	---	---	---	None
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	HOLDINGTANK-202105: Qualify CrVI "R".
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None

Data Verification and Validation Summary

Verification and Validation Label	Stage_2A_Validation_Manual
Verification and Validation Label Code	S2AVM
Overall Assessment: Except where rejected, acceptable as qualified. **Usability:** "R"-qualified results should not be used. Qualified results (J-, J, J+) are useable for limited purposes. All other results are considered valid and useable for all purposes.	

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature (s)
SP-100A-202105-PRE	L1354539-01	5/17/2021	2.0 °C
SP-100B-202105-PRE	L1354539-27	5/17/2021	2.0 °C
SP-100C-202105-PRE	L1354539-28	5/17/2021	2.0 °C
SP-200A-202105-PRE	L1354539-29	5/17/2021	2.0 °C
SP-200B-202105-PRE	L1354539-30	5/17/2021	2.0 °C
SP-200C-202105-PRE	L1354539-31	5/17/2021	2.0 °C
SP-300A-202105-PRE	L1354539-32	5/17/2021	2.0 °C
SP-300B-202105-PRE	L1354539-33	5/17/2021	2.0 °C
SP-300C-202105-PRE	L1354539-34	5/17/2021	2.0 °C
SP-100-202105-POST	L1354539-35	5/17/2021	2.0 °C
SP-200-202105-POST	L1354539-36	5/17/2021	2.0 °C
SP-300-202105-POST	L1354539-37	5/17/2021	2.0 °C
HOLDINGTANK-202105	L1354539-38	5/18/2021	2.0 °C

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	No/Yes/Yes
6010B: SP-300A-202105-PRE was not preserved to pH <2.	
SM5310B: Most samples were not preserved to pH <2.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	No
SM5310B: Most samples were not preserved to pH <2. By the time they were preserved, the holding time for unpreserved samples (4 hours) had expired.	

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
SM5310B: TOC was detected in method blanks R3661466-2 (809 ug/L) from 5/31/21 and R3662038-2 (187 ug/L) from 6/1/21. After dilutions were taken into account, several samples were qualified.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/No
7199: Hexavalent chromium was not recovered in the MS/MSD of HOLDINGTANK-202105. Hexavalent chromium was non-detect in the parent sample.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/N/A/Yes
SP-300-202105-POST: RPD was high for TSS, but the concentration was <5x the PQL. Difference was < PQL. No qualification.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 06/16/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: L1372443
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	None
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-550-20210629: Qualify CrVI "J+".
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results detected between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J, J+) are useable for limited purposes. All other results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210629	L1372443-01	6/29/2021	Not Documented
SP-100-20210629-LEAD	L1372443-02	6/29/2021	Not Documented
SP-200-20210629	L1372443-03	6/29/2021	Not Documented
SP-300-20210629-LAG	L1372443-04	6/29/2021	Not Documented
SP-400-20210629	L1372443-05	6/29/2021	Not Documented
SP-550-20210629	L1372443-06	6/29/2021	Not Documented
SP-551-20210629	L1372443-07	6/29/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Case narrative states cooler temperatures were below 6 °C at time of receipt.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN. Per the case narrative, samples were logged in Las Vegas. COC tracking and temperature recording procedures were not followed in TN.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/No
314.0: Perchlorate recovery was high in the MS of SP-550-20210629. The MSD was not reported.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/Yes
Outliers in unrelated lab duplicates. No qualification	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/06/2021

Data Verification and Validation Summary

Project Name:	Hydrogen Membrane Pilot Test	SDG/Report No.:	L1375849
Task No.:	M26	Lab ID:	Pace
No. of Samples:	7	Matrix:	Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	None
6. Matrix Spike/Matrix Spike Duplicate	X		No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** Results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210708	L1375849-01	7/08/2021	Not documented
SP-300-20210708-LEAD	L1375849-02	7/08/2021	Not documented
SP-200-20210708	L1375849-03	7/08/2021	Not documented
SP-100-20210708-LAG	L1375849-04	7/08/2021	Not documented
SP-400-20210708	L1375849-05	7/08/2021	Not documented
SP-550-20210708	L1375849-06	7/08/2021	Not documented
SP-551-20210708	L1375849-07	7/08/2021	Not documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/N/A/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/No
314.0: Perchlorate recoveries were outside limits in the MS/MSD of SP-100-20210708-LAG. The concentration in the parent sample was >4x the amount spiked. Recovery criteria do not apply.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/Yes
Outliers in unrelated lab duplicates. No qualification	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 9
SDG/Report No.: L1380668
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	None
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		Yes	SP-100-20210720-LEAD and SP-100-20210720-LEAD-FD: Qualify TSS "J".
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J) are useable for limited purposes. All other results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210720	L1380668-01	7/20/2021	Not Documented
SP-100-20210720-LEAD	L1380668-02	7/20/2021	Not Documented
SP-100-20210720-LEAD-FD	L1380668-03	7/20/2021	Not Documented
SP-200-20210720	L1380668-04	7/20/2021	Not Documented
SP-300-20210720-LAG	L1380668-05	7/20/2021	Not Documented
SP-400-20210720	L1380668-06	7/20/2021	Not Documented
SP-550-20210720	L1380668-07	7/20/2021	Not Documented
SP-551-20210720	L1380668-08	7/20/2021	Not Documented
FIELDQC-20210720-EB	L1380668-09	7/20/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Case narrative states cooler temperatures were below 6 °C at time of receipt.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN. Per the case narrative, samples were logged in Las Vegas. COC tracking and temperature recording procedures were not followed.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/No
One FD pair. Outliers in unrelated lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: L1382360
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport		X	No	None
2. Chain-of-Custody		X	No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples	X		Yes	SP-550-20210722, SP-551-20210722: Qualify TSS "J+".
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (J+) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature
SP-015-20210722	L1382360-01	7/22/2021	3.6 °C
SP-100-20210722-LEAD	L1382360-02	7/22/2021	3.6 °C
SP-200-20210722	L1382360-03	7/22/2021	3.6 °C
SP-300-20210722-LAG	L1382360-04	7/22/2021	3.6 °C
SP-400-20210722	L1382360-05	7/22/2021	3.6 °C
SP-550-20210722	L1382360-06	7/22/2021	3.6 °C
SP-551-20210722	L1382360-07	7/22/2021	3.6 °C

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was the LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/No
SM2540D: Recovery was high in the LCS R3685455-2 (07/28/21 15:36) in batch WG1713233 at 116%. Upper limit is 114%. Two samples are affected.	

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For REG/FD results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/N/A
Unrelated lab duplicates. No qualification.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 9
SDG/Report No.: L1383184
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	None
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-550-20210727: Qualify CrVI "UJ".
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results detected between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
11. Other (Serial Dilution)	X		Yes	SP-015-20210727: Qualify Chromium "J".
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (UJ, J) are useable for limited purposes. All other results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210727	L1383184-01	7/27/2021	Not Documented
SP-100-20210727-LEAD	L1383184-02	7/27/2021	Not Documented
SP-200-20210727	L1383184-03	7/27/2021	Not Documented
SP-300-20210727-LAG	L1383184-04	7/27/2021	Not Documented
SP-400-20210727	L1383184-05	7/27/2021	Not Documented
SP-400-20210727-FD	L1383184-06	7/27/2021	Not Documented
SP-550-20210727	L1383184-07	7/27/2021	Not Documented
SP-551-20210727	L1383184-08	7/27/2021	Not Documented
FILEDQC-20210727-EB	L1383184-09	7/27/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Case narrative states cooler temperatures were below 6 °C at time of receipt.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN. Per the case narrative, samples were logged in Las Vegas. COC tracking and temperature recording procedures were not followed.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/No
7199: Hexavalent chromium recoveries low in the MS/MSD of SP-550-20210727.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/No/No
One FD pair. Outliers in unrelated lab duplicates.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

11. Other – Serial Dilution (6010B): Serial Dilution %D was > 10% (10.6%) in SP-015-20210727.

Validated by: Maureen McMyler 08/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 9
SDG/Report No.: L1383980
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates	X		No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210729	L1383980-01	7/29/2021	Not Documented
SP-015-20210729-FD	L1383980-02	7/29/2021	Not Documented
SP-100-20210729-LEAD	L1383980-03	7/29/2021	Not Documented
SP-200-20210729	L1383980-04	7/29/2021	Not Documented
SP-300-20210729-LAG	L1383980-05	7/29/2021	Not Documented
SP-400-20210729	L1383980-06	7/29/2021	Not Documented
SP-550-20210729	L1383980-07	7/29/2021	Not Documented
SP-551-20210729	L1383980-08	7/29/2021	Not Documented
FIELDQC-20210729-EB	L1383980-09	7/29/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Case narrative states cooler temperatures were below 6 °C at time of receipt.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN. Per the case narrative, samples were logged in Las Vegas. COC tracking and temperature recording procedures were not followed.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/Yes
One FD pair. Results were non-detect. RPD was high between SP-551-20210729 and its lab DUP. The sample concentration was <5X RL/PQL, so RPD criteria do not apply. Difference between parent and lab DUP was < RL/PQL.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 7
SDG/Report No.: L1384019
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210729	L1384019-01	7/29/2021	Not documented
SP-015-20210729-FD	L1384019-03	7/29/2021	Not documented
SP-300-20210729-LAG	L1384019-04	7/29/2021	Not documented
SP-400-20210729	L1384019-05	7/29/2021	Not documented
SP-550-20210729	L1384019-06	7/29/2021	Not documented
SP-551-20210729	L1384019-07	7/29/2021	Not documented
FIELDQC-20210729-EB	L1384019-08	7/29/2021	Not documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/Yes/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Case narrative states cooler temperatures were below 6 °C at time of receipt.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN. Per the case narrative, samples were logged in Las Vegas. COC tracking and temperature recording procedures were not followed.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/Yes
One FD pair. Results agreed.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/06/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 9
SDG/Report No.: L1385599
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times	X		Yes	All: Qualify CrVI "J-" for detects and "UJ" for non-detects.
4. Blanks	X		Yes	SP-300-20210803-LAG, SP-300-20210803-LAG-FD, SP-400-20210803, SP-550-20210803, and SP-551-20210803: Qualify chromium "J".
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-300-20210803-LAG, SP-300-20210803-LAG-FD, SP-400-20210803, and SP-551-20210803: Qualify perchlorate "J-".
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results detected between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			

Overall Assessment: Acceptable as qualified.
Usability: Qualified results (UJ, J-, J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210803	L1385599-01	8/03/2021	Not Documented
SP-100-20210803-LEAD	L1385599-02	8/03/2021	Not Documented
SP-200-20210803	L1385599-03	8/03/2021	Not Documented
SP-300-20210803-LAG	L1385599-04	8/03/2021	Not Documented
SP-300-20210803-LAG-FD	L1385599-05	8/03/2021	Not Documented
SP-400-20210803	L1385599-06	8/03/2021	Not Documented
SP-550-20210803	L1385599-07	8/03/2021	Not Documented
SP-551-20210803	L1385599-08	8/03/2021	Not Documented
FIELDQC-20210803-EB	L1385599-09	8/03/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/N/A/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Per the lab project manager, a temperature exceedance at sample receipt would result in notification.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	No
7199: Samples were analyzed outside the 24-hour holding time.	

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/Yes
6010B: Chromium was detected in FIELDQC-20210803-EB. Most samples had similar concentrations.	

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/No
314.0: Perchlorate recoveries were low in the MS and/or MSD of SP-300-20210803-LAG, SP-300-20210803-LAG-FD, SP-400-20210803, and SP-551-20210803.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/Yes

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/19/2021

Data Verification and Validation Summary

Project Name:	Hydrogen Membrane Pilot Test	SDG/Report No.:	L1386879
Task No.:	M26	Lab ID:	Pace
No. of Samples:	8	Matrix:	Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	---	---	---	---
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	No	None
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as reported. **Usability:** All results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210805	L1386879-01	8/05/2021	Not Documented
SP-015-20210805-FD	L1386879-02	8/05/2021	Not Documented
SP-100-20210805-LEAD	L1386879-03	8/05/2021	Not Documented
SP-200-20210805	L1386879-04	8/05/2021	Not Documented
SP-300-20210805-LAG	L1386879-05	8/05/2021	Not Documented
SP-400-20210805	L1386879-06	8/05/2021	Not Documented
SP-550-20210805	L1386879-07	8/05/2021	Not Documented
SP-551-20210805	L1386879-08	8/05/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/N/A/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Per the lab project manager, a temperature exceedance at sample receipt would result in notification.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
COC not provided for transfer between Las Vegas, NV and Mt. Juliet, TN.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/N/A/N/A

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/Yes
One FD pair. Results agreed.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/19/2021

Data Verification and Validation Summary

Project Name: Hydrogen Membrane Pilot Test
Task No.: M26
No. of Samples: 6
SDG/Report No.: L1386900
Lab ID: Pace
Matrix: Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate		X	No	None
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results detected between the MDL/SQL and RL/PQL "J".
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. **Usability:** Qualified results (J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210805	L1386900-01	8/05/2021	Not Documented
SP-015-20210805-FD	L1386900-02	8/05/2021	Not Documented
SP-300-20210805-LAG	L1386900-03	8/05/2021	Not Documented
SP-400-20210805	L1386900-04	8/05/2021	Not Documented
SP-550-20210805	L1386900-05	8/05/2021	Not Documented
SP-551-20210805	L1386900-06	8/05/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/N/A/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Per the lab project manager, a temperature exceedance at sample receipt would result in notification.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	Yes/Yes/Yes

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/Yes
One FD pair. Results agreed.	

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/19/2021

Data Verification and Validation Summary

Project Name:	Hydrogen Membrane Pilot Test	SDG/Report No.:	L1388446
Task No.:	M26	Lab ID:	Pace
No. of Samples:	8	Matrix:	Water

Area Reviewed	Anomalies		Qualification Required	Action Required
	Yes	No	Yes or No	
1. Sample Preservation, Handling, and Transport	X		No	None
2. Chain-of-Custody	X		No	None
3. Holding Times		X	No	None
4. Blanks		X	No	None
5. Surrogates/Monitoring Compounds	---	---	---	---
6. Matrix Spike/Matrix Spike Duplicate	X		Yes	SP-300-20210809-LAG: Qualify nitrate and perchlorate “J”.
7. Laboratory Control Samples		X	No	None
8. Duplicates		X	No	None
9. Compound Quantitation and Reporting Limits		X	Yes	Qualify results detected between the MDL/SQL and RL/PQL “J”.
10. Data Package/EDD comparison (10%)		X	No	None
Verification and Validation Label	Stage_2A_Validation_Manual			
Verification and Validation Label Code	S2AVM			
Overall Assessment: Acceptable as qualified. Usability: Qualified results (UJ, J-, J) are considered valid and useable for limited purposes. Unqualified results are considered valid and useable for all purposes.				

Sample Information:

Field Sample Number	Lab Sample ID	Date Collected	Cooler Temperature(s)
SP-015-20210809	L1388446-01	8/09/2021	Not Documented
SP-015-20210809-FD	L1388446-02	8/09/2021	Not Documented
SP-100-20210809-LEAD	L1388446-03	8/09/2021	Not Documented
SP-200-20210809	L1388446-04	8/09/2021	Not Documented
SP-300-20210809-LAG	L1388446-05	8/09/2021	Not Documented
SP-400-20210809	L1388446-06	8/09/2021	Not Documented
SP-550-20210809	L1388446-07	8/09/2021	Not Documented
SP-551-20210809	L1388446-08	8/09/2021	Not Documented

Data Verification and Validation Summary

The following section is intended to specify areas evaluated and issues encountered. Only applicable methods are listed.

1. Sample Preservation, Handling, and Transport	
Were all samples preserved correctly? Were sample temperatures kept at ≤ 6 °C? Were samples received in proper condition?	Yes/N/A/Yes
Lab report did not indicate temperature at receipt or temperature non-compliance. Per the lab project manager, a temperature exceedance at sample receipt would result in notification.	

2. Chain-of-Custody (COC)	
Were samples recorded on the COCs? Were correct analyses performed on the samples?	Yes/Yes
Lab report did not provide COC for transfer between Las Vegas, NV and Mt. Juliet, TN.	

3. Holding Times	
Were samples analyzed within acceptable holding times?	Yes

4. Blanks	
Does data package include a summary of blank results? Was a method blank extracted and/or analyzed for each batch? Were analytes detected in any blanks?	Yes/Yes/No

5. Surrogates/Monitoring Compounds	
Were samples spiked with the correct surrogate compounds? Were surrogate recoveries reported correctly on data forms? Were recoveries within laboratory limits?	No/N/A/N/A

6. Matrix Spike/Matrix Spike Duplicate	
Was a MS/MSD pair extracted and/or analyzed with each batch? Were recoveries/RPDs reported on data forms? Were recoveries/RPDs of project samples within laboratory established limits?	No/Yes/No
300.0: Nitrate recovery was very high in the MSD of SP-300-20210809-LAG. RPD was very high. Nitrate was not detected in the parent sample, so no high bias or imprecision is possible. Professional judgment: Matrix appears to be causing a problem. Result will be qualified.	
314.0: Perchlorate recovery was low in the MSD of SP-300-20210809-LAG.	

7. Laboratory Control Samples (LCS)	
Was a LCS analyzed with each analytical batch? Were LCS recoveries reported correctly on data forms? Were LCS recoveries within laboratory established limits?	Yes/Yes/Yes

8. Duplicates	
Were any duplicate pairs analyzed in this SDG? For results > 5x the RL/PQL, were RPDs between parent sample and duplicates ≤ lab limits or ≤ 30% (water)/50% (soil) for field duplicates? For results < 5x the RL/PQL, were differences between the two values ≤ RL/PQL.	Yes/Yes/No

9. Compound Quantitation and Reporting Limits	
Were quantitation limits (RLs/PQL) adjusted to reflect dilutions, cleanup, and other factors? If applicable, were reporting limit check recoveries within acceptable limits?	Yes/Yes

10. Data Package/EDD comparison (10%)	
Were 10% of the data package results compared to the electronic data? Did results match?	Yes/Yes

Validated by: Maureen McMyler 08/19/2021

Appendix 2
Laboratory Data Packages

Due to the quantity and size of the file, the laboratory data packages are being sent in a separate file for electronic download.

Appendix 3
DVSR Electronic Data Deliverable

Per the requirements provided by NDEP for Unified Chemical Electronic Data Deliverable Format (July 13, 2018), a database is provided in Microsoft Access format and includes sample, location and analytical data supporting the DVSR and for upload of the Companies' electronic data into the regional database maintained by NDEP.

Appendix C
Performance Sample Results

Table C.1
Test Scenario #1A - Influent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		Field Parameters			Laboratory Parameters					Calculated
					E314.0	E300.1B	E300.0	SM2540C	SM2540D	
		Flow	Temperature	pH	Perchlorate	Chlorate	Nitrate as N	Total Dissolved Solids	Total Suspended Solids	Total Mass Loading
Sample Date	Sample ID	gpm	°C	SU	ppb	ppb	ppm	ppm	ppm	lb/day
9/15/2020	SP-015-WK01A	2.0	28.1	7.67	58,000	97,000	8.4	5,800	17	3.92
9/18/2020	SP-015-WK01B	2.0	28.4	7.66	---	---	---	---	13	---
9/21/2020	SP-015-WK02A	2.0	30.6	7.69	37,000	100,000	8.8	4,800	13	3.50
9/25/2020	SP-015-WK02B	2.0	29.8	7.64	---	---	---	---	17	---
9/30/2020	SP-015-WK03A	2.4	30.2	7.69	60,000	99,000	9.2	5,500	14	4.85
10/2/2020	SP-015-WK03B	2.4	25.5	7.68	---	---	---	---	19	---
10/6/2020	SP-015-WK04A	2.4	27.7	7.6	73,000	120,000	9.9	5,000	<5.0	5.85
10/9/2020	SP-015-WK04B	3.5	24.8	7.62	---	---	---	---	7	---
10/9/2020	SP-015-WK04B-FD	3.5	24.8	7.62	---	---	---	---	12	---
10/14/2020	SP-015-WK05A	3.5	22.3	7.58	50,000	98,000	7.9	5,700	18 J	6.55
10/26/2020	SP-015-WK06A	2.0	17.7	7.66	65,000	120,000	---	5,000	13	4.64[(1)]
11/6/2020	SP-015-WK07A	2.0	22.4	7.65	53,000	94,000	8.3	6,000	6.5	3.73
11/19/2020	SP-015-WK08A	1.6	20.8	7.76	43,000	54,000	8.5	5,100	15 J	2.03

Notes:
1. Mass loading calculation does not include nitrate.
gpm - gallons per minute
°C - Degrees Celcius
SU - Standard Units
ppb - parts per billion
ppm - parts per million
lb/day - pounds per day
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table C.2
Test Scenario #1A - Biological Reactors Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters				Field Parameters			
			E314.0	E300.1B	E300.0	SM2540D				
Sample Date	Sample Location	Sample ID	Perchlorate	Chlorate	Nitrate as N	Total Suspended Solids	Temperature	pH	ORP	Pressure
			ppb	ppb	ppm	ppm	°C	SU	mV	psig
9/15/2020	Lead Reactor	SP-300-WK01A LEAD	34,000	31,000	0.29 J+	12	29.5	7.79	-102	12.8
	Middle Reactor	SP-200-WK01A	340	<100	<0.014	39	30.6	7.78	-397	5.7
	Lag Reactor	SP-100-WK01A LAG	4.2	90 J	0.13 J+	15	30.4	7.65	-406	8.8
9/18/2020	Lead Reactor	SP-300-WK01B LEAD	---	---	---	11	29.9	7.86	-110	---
	Middle Reactor	SP-200-WK01B-FD	---	---	---	34	---	---	---	---
	Middle Reactor	SP-200-WK01B	---	---	---	35	30.5	7.82	-387	---
	Lag Reactor	SP-100-WK01B LAG	---	---	---	15	30.4	7.74	-374	---
9/21/2020	Lead Reactor	SP-300-WK02A LEAD	34,000	33,000	0.33	17	31.2	7.85	-80	13.3
	Middle Reactor	SP-200-WK02A-FD	230	<100	<0.014	24	---	---	---	---
	Middle Reactor	SP-200-WK02A	240	<100	<0.014	19	31.8	7.86	-383	5.8
	Lag Reactor	SP-100-WK02A LAG	6.1	<100	<0.014	9.5	31.5	7.89	-373	8.1
9/25/2020	Lead Reactor	SP-300-WK02B LEAD	---	---	---	12	30.7	7.8	-113	---
	Middle Reactor	SP-200-WK02B	---	---	---	22	31.5	7.78	-397	---
	Lag Reactor	SP-100-WK02B LAG	---	---	---	17	31.5	7.77	-379	---
9/30/2020	Lead Reactor	SP-300-WK03A LEAD	40,000	49,000	1.8	14	29.8	7.83	-162	13.6
	Middle Reactor	SP-200-WK03A	10,000	7,000	0.093	5.5	30.5	7.83	-116	6.7
	Lag Reactor	SP-100-WK03A LAG	54	<10	<0.014	<5.0	30.4	7.49	-327	8.1
10/2/2020	Lead Reactor	SP-300-WK03B LEAD	---	---	---	15	27.8	7.8	-179	---
	Middle Reactor	SP-200-WK03B	---	---	---	9.5	28.5	7.81	-219	---
	Lag Reactor	SP-100-WK03B LAG	---	---	---	5.5	28.4	7.56	-327	---
10/6/2020	Lead Reactor	SP-300-WK04A LEAD	43,000	58,000	2.0	<5.0	28.5	7.8	-93	14.6
	Middle Reactor	SP-200-WK04A	13,000	8,800	0.078	<5.0	29.6	7.81	-119	9.0
	Lag Reactor	SP-100-WK04A LAG	200	<100	<0.014	6.6	29.6	7.44	-163	8.5
10/9/2020	Lead Reactor	SP-300-WK04B-LEAD	---	---	---	16	25.8	7.8	-57	---
	Middle Reactor	SP-200-WK04B	---	---	---	19	27.3	7.8	-328	---
	Lag Reactor	SP-100-WK04B-LAG	---	---	---	11	27.2	7.79	-187	---
10/14/2020	Lead Reactor	SP-300-WK05A-LEAD	62,000	49,000	0.059 J+	7.5	20.9	7.80	-68	18.7
	Middle Reactor	SP-200-WK05A	2,900	2,100	1.3 J+	<5.0	22.2	7.81	-471	13.2
	Lag Reactor	SP-100-WK05A-LAG	52	<10	<0.014	6.0	20.8	7.80	-175	9.3
10/26/2020	Lead Reactor	SP-100-WK06A-LEAD	65,000	15,000	---	5.0	18.8	8.18	-190	17.2
	Middle Reactor	SP-200-WK06A	2,300	250	---	12	19.4	7.80	-394	13.6
	Lag Reactor	SP-300-WK06A-LAG	350 J-	<10	---	12	19.4	7.84	-403	15.6

Table C.2
Test Scenario #1A - Biological Reactors Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters				Field Parameters			
			E314.0	E300.1B	E300.0	SM2540D				
Sample Date	Sample Location	Sample ID	Perchlorate	Chlorate	Nitrate as N	Total Suspended Solids	Temperature	pH	ORP	Pressure
			ppb	ppb	ppm	ppm	°C	SU	mV	psig
11/6/2020	Lead Reactor	SP-100-WK07A-LEAD	9,500	1,300	<0.014	18	25.1	7.24	-383	6.8
	Middle Reactor	SP-200-WK07A	140	<10	<0.014	14	26.3	7.24	-462	5.2
	Lag Reactor	SP-300-WK07A-LAG	17	24 J	<0.014	9.0	26.3	7.24	-368	6.6
11/19/2020	Lead Reactor	SP-100-WK08A-LEAD	4,200	5,000	<0.014	5.0	25.6	7.68	-443	26.6
	Middle Reactor	SP-200-WK08A	98	30 J	<0.014	7.5	27.1	7.82	-194	17.0
	Lag Reactor	SP-300-WK08A-LAG	0.39 J	19 J	<0.014	16	28.9	7.60	-390	21.2

Notes:
ppb - parts per billion
ppm - parts per million
°C - Degrees Celcius
SU - Standard Units
mV - millivolts
psig - pounds per square inch
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J+ - The result is an estimated quantity, but the result may be biased high.
J- - The result is an estimated quantity, but the result may be biased low.

Table C.3
Test Scenario #1A - Effluent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters					Field Parameters		
			E314.0	E300.1B	E300.0	SM2540C	SM2540D			
Sample Location	Sample Date	Sample ID	Perchlorate ppb	Chlorate ppb	Nitrate as N ppm	Total Dissolved Solids ppm	Total Suspended Solids ppm	Temperature °C	pH SU	Turbidty NTU
Post Reactor Tank Effluent	9/15/2020	SP-400-WK01A	4.7	70 J	<0.014	---	13	29.5	7.65	---
	9/18/2020	SP-400-WK01B	---	---	---	---	8.5	30.2	7.80	---
	9/21/2020	SP-400-WK02A	6.4	<100	<0.014	---	16	30.9	7.72	---
	9/25/2020	SP-400-WK02B	---	---	---	---	6.5	30.8	7.79	---
	9/30/2020	SP-400-WK03A	20	<10	<0.014	---	12	28.5	7.76	---
	10/2/2020	SP-400-WK03B-FD	---	---	---	---	9.0	---	---	---
	10/2/2020	SP-400-WK03B	---	---	---	---	14	26.7	7.62	---
	10/6/2020	SP-400-WK04A	89	<100	<0.014	---	6.1	27.7	7.55	---
	10/9/2020	SP-400-WK04B	---	---	---	---	12	28.6	7.7	---
	10/14/2020	SP-400-WK05A	28	<10	<0.014	---	5.0	20.8	8.35	---
	10/26/2020	SP-400-WK06A	190	<10	---	---	16	14.0	8.06	---
	11/6/2020	SP-400-WK07A	10	<10	0.13	---	16	25.5	7.84	---
	11/19/2020	SP-400-WK08A	0.71 J	<10	<0.014	---	20	25.8	8.15	---
Treated Water Holding Tank	9/15/2020	SP-550-WK01A	---	---	---	---	27	30.2	8.38	251
	9/18/2020	SP-550-WK01B	---	---	---	---	13	30.2	8.31	226
	9/21/2020	SP-550-WK02A	---	---	---	---	18	31.1	8.32	286
	9/25/2020	SP-550-WK02B	---	---	---	---	10	30.5	8.29	168
	9/30/2020	SP-550-WK03A	---	---	---	---	9.5	30.0	7.92	37.4
	10/2/2020	SP-550-WK03B	---	---	---	---	5.5	27.5	7.89	79.8
	10/6/2020	SP-550-WK04A	---	---	---	---	12	28.7	7.76	42.1
	10/9/2020	SP-550-WK04B	---	---	---	---	<5.0	27.2	7.98	183
	10/14/2020	SP-550-WK05A	---	---	---	---	14	25.3	8.46	10.2
	10/26/2020	SP-550-WK06A	---	---	---	---	11	17.5	8.38	22.3
	11/6/2020	SP-550-WK07A	---	---	---	---	14	25.7	8.16	309
	11/19/2020	SP-550-WK08A	---	---	---	---	31	26.5	8.29	83.5
Cartridge Filter Effluent	9/15/2020	SP-551-WK01A-FD	2.3	<100	<0.014	5,600	21	---	---	---
	9/15/2020	SP-551-WK01A	2.2	<100	<0.014	5,500	21	30.0	8.40	---
	9/18/2020	SP-551-WK01B	---	---	---	---	8.0	30.4	8.20	---
	9/21/2020	SP-551-WK02A	2.2	<40	<0.014	4,800	9.5	31.2	8.28	---
	9/25/2020	SP-551-WK02B	---	---	---	---	6.0	30.5	8.3	---
	9/30/2020	SP-551-WK03A	130	180	<0.014	5,200	5.0	30.2	7.83	---
	10/2/2020	SP-551-WK03B	---	---	---	---	11	27.7	7.83	---
	10/6/2020	SP-551-WK04A-FD	70	<100	<0.014	4,700	<5.0	---	---	---
	10/6/2020	SP-551-WK04A	73	<100	<0.014	4,700	<5.0	28.9	7.49	---
	10/9/2020	SP-551-WK04B	---	---	---	---	12	27.8	8.22	---
	10/14/2020	SP-551-WK05A	38	<10	<0.014	5,700	15	25.3	8.48	---
	10/26/2020	SP-551-WK06A	170	<10	---	5,200	<5.0	17.8	8.42	---
	11/6/2020	SP-551-WK07A	16	<10	<0.014	5,800	5.5	25.6	8.13	---
	11/19/2020	SP-551-WK08A	0.59 J	<10	<0.014	4,900	26	26.6	8.28	---

Notes:
ppb - parts per billion
ppm - parts per million
SU - Standard Units
°C - Degrees Celcius
NTU - Nephelometric turbidity unit
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table C.4
Test Scenario #1B - Influent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		Field Parameters			Laboratory Parameters						Calculated
					E314.0	E300.1B	E300.0	E300.0	SM2540C	SM2540D	
		Flow	Temperature	pH	Perchlorate	Chlorate	Nitrate as N	Sulfate	Total Dissolved Solids	Total Suspended Solids	Total Mass Loading
Sample Date	Sample ID	gpm	°C	SU	ppb	ppb	ppm	ppm	ppm	ppm	lb/day
1/12/2021	SP-015-01122021	2.0	20.3	7.67	46,000	88,000	6.6	1,500	---	13	3.38
1/18/2021	SP-015-20210118	1.5	22.9	7.62	45,000	110,000	6.3	---	4,800	5.5	2.91
1/22/2021	SP-015-20210122-FEED-FD	1.5	---	---	---	---	---	---	---	<5.0 UJ	---
1/22/2021	SP-015-20210122-FEED	1.5	21.2	7.61	---	---	---	---	---	11 J	---
1/26/2021	SP-015-20210126	1.5	20	7.78	52,000	110,000	6.8	---	4,400	12	3.04
1/27/2021	SP-015-20210127-FEED	1.5	19	7.79	---	---	---	---	---	12	---
1/29/2021	SP-015-20210129-FEED	1.5	22.4	7.8	---	---	---	---	---	11	---
2/2/2021	SP-015-20210202	1.5	22.7	7.79	45,000	100,000	7.7	---	4,900	13	2.75
2/3/2021	SP-015-20210203-FEED	1.5	22.7	7.85	---	---	---	---	---	6	---
2/5/2021	SP-015-20210205-FEED	1.5	23.4	7.88	---	---	---	---	---	13	---

Notes:
gpm - gallons per minute
°C - Degrees Celcius
SU - Standard Units
ppb - parts per billion
ppm - parts per million
lb/day - pounds per day
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
UJ- The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Table C.5
Test Scenario #1B - Biological Reactors Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters					Field Parameters			
			E314.0	E300.1B	E300.0	E300.0	SM2540D				
Sample Date	Sample Location	Sample ID	Perchlorate	Chlorate	Nitrate as N	Sulfate	Total Suspended Solids	pH	Temperature	ORP	Pressure
			ppb	ppb	ppm	ppm	ppm	SU	°C	mV	psig
1/12/2021	Lead Reactor	SP-300-01122021-LEAD	31,000	14,000	0.21	1,500	5.0	8.00	73.2	-365	13.4
	Middle Reactor	SP-200-01122021	620	140	<0.014	1,500	8.0	8.00	72.5	-394	11.2
	Lag Reactor	SP-100-01122021-LAG	25	72 J	<0.014	1,400	8.0	7.85	73	-376	18.8
1/18/2021	Lead Reactor	SP-300-20210118-LEAD	4,800	2,000	<0.014	---	5.0	8.00	78.4	-299	19.6
	Middle Reactor	SP-200-20210118	100	64 J+	<0.014	---	8.5	7.99	77.7	-432	12.1
	Lag Reactor	SP-100-20210118-LAG	2.1	74	<0.014	---	13	7.83	78.6	-470	19.0
1/22/2021	Lead Reactor	SP-300-20210122-LEAD	---	---	---	---	9.5	8.01	75.4	-142	18.6
	Middle Reactor	SP-200-20210122-MID	---	---	---	---	11	8.00	76.6	-404	14.7
	Lag Reactor	SP-100-20210122-LAG	---	---	---	---	14	7.76	78.4	-487	18.9
1/26/2021	Lead Reactor	SP-300-20210126-LEAD	32,000	32,000	0.99	---	8.0	7.99	73	124	20.1
	Middle Reactor	SP-200-20210126	53,000	73,000	10	---	8.5	8.01	73.2	-411	16.2
	Lag Reactor	SP-100-20210126-LAG	14	53	<0.014	---	10	7.73	73.2	-440	18.7
1/27/2021	Lead Reactor	SP-300-20210127-LEAD	---	---	---	---	6.5	8.01	72.5	138	21.0
	Middle Reactor	SP-200-20210127-MID	---	---	---	---	9.0	8.02	72.7	-414	16.2
	Lag Reactor	SP-100-20210127-LAG	---	---	---	---	17	7.69	72.7	-444	18.7
1/29/2021	Lead Reactor	SP-300-20210129-LEAD	---	---	---	---	7.5	8.00	78.7	-472	23.7
	Middle Reactor	SP-200-20210129-MID	---	---	---	---	6.0	8.00	78.1	-421	16.4
	Lag Reactor	SP-100-20210129-LAG-FD	---	---	---	---	5.5	---	---	---	---
	Lag Reactor	SP-100-20210129-LAG	---	---	---	---	10	7.60	78.4	19	18.8
2/2/2021	Lead Reactor	SP-300-20210202-LEAD	33,000	28,000	0.14	---	13	7.99	80.6	6	27.6
	Middle Reactor	SP-200-20210202	680	120 J+	<0.014	---	6.5	8.01	81.5	-422	16.0
	Lag Reactor	SP-100-20210202-LAG	0.62 J	20	<0.014	---	5.5	7.58	82.5	-456	18.6
2/3/2021	Lead Reactor	SP-300-20210203-LEAD	---	---	---	---	9.5	7.99	79.9	60	27.7
	Middle Reactor	SP-200-20210203-MID	---	---	---	---	15	7.98	82.60	-419	15.6
	Lag Reactor	SP-100-20210203-LAG-G	---	---	---	---	5.5	7.62	84.7	-441	17.8
	Lag Reactor	SP-100-20210203-LAG-C	---	---	---	---	12	---	---	---	---
2/5/2021	Lead Reactor	SP-300-20210205-LEAD	---	---	---	---	8.5	8.00	80.2	-5.0	27.9
	Middle Reactor	SP-200-20210205-MID	---	---	---	---	<5.0	7.96	80.2	-418.0	15.8
	Lag Reactor	SP-100-20210205-LAG-C	---	---	---	---	<5.0	---	---	---	---
	Lag Reactor	SP-100-20210205-LAG-G	---	---	---	---	5.5	7.70	80.1	-409	18.1

Notes:
ppb - parts per billion
ppm - parts per million
°C - Degrees Celcius
SU - Standard Units
mV - millivolts
psig - pounds per square inch
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J+ - The result is an estimated quantity, but the result may be biased high.

Table C.6
Test Scenario #1B - Effluent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters					
			E314.0	E300.1B	E300.0	E300.0	SM2540C	SM2540D
Sample Location	Sample Date	Sample ID	Perchlorate	Chlorate	Nitrate as N	Sulfate	Total Dissolved Solids	Total Suspended Solids
			ppb	ppb	ppm	ppm	ppm	ppm
Post Reactor Tank Effluent	1/12/2021	SP-400-01122021	23	69 J	<0.014	1,400	---	9.5
	1/18/2021	SP-400-20210118	2.2	76	<0.014	---	4,800	7.0
	1/22/2021	SP-400-20210122-POST	---	---	---	---	---	7.5
	1/26/2021	SP-400-20210126-FD	8.5	44	<0.014	---	4,400	13
	1/26/2021	SP-400-20210126	8.7	58	<0.014	---	4,200	15
	1/27/2021	SP-400-20210127-POST	---	---	---	---	---	13
	1/29/2021	SP-400-20210129-POST	---	---	---	---	---	7.0
	2/2/2021	SP-400-20210202	0.85 J	45 J+	<0.014	---	5,000	13
	2/3/2021	SP-400-20210203-POST	---	---	---	---	---	9.5
	2/5/2021	SP-400-20210205-POST	---	---	---	---	---	11

Notes:
ppb - parts per billion
ppm - parts per million
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J+ - The result is an estimated quantity, but the result may be biased high.

Table C.7
Test Scenario #2 - Influent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		Field Parameters			Laboratory Parameters								Calculated
					E314.0	E300.1B	E300.0	E300.0	SM5310B	SM5310B	SM2540C	SM2540D	
Sample Date	Sample ID	Flow	Temperature	pH	Perchlorate	Chlorate	Nitrate as N	Sulfate	Total Organic Carbon	Dissolved Organic Carbon	Total Dissolved Solids	Total Suspended Solids	Total Mass Loading
		gpm	°C	SU	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	lb/day
3/9/2021	SP-015-20210309	0.75	20.5	7.72	79,400	173,000	10,000	1,930,000	2,230 J	3,060 J	7,180,000	<2,500	2.36
3/16/2021	SP-015-20210316	0.75	20.7	7.51	88,100	163,000	9,360 J	1,860,000	2,220 J+	2,960 J+	7,200,000 J-	<2,500	2.35
3/18/2021	SP-015-20210318	0.75	25.6	7.72	---	---	---	---	---	---	---	<2,500	---
3/23/2021	SP-015-20210323	0.75	20.3	7.92	85,600	178,000	9,430	1,800,000	2,540 J+	2,170 J+	7,600,000	<2,780	2.46
3/25/2021	SP-015-20210325	0.75	21	7.86	---	---	---	---	---	---	---	<2,500	---
3/30/2021	SP-015-20210330	0.75	21.3	7.45	90,400	179,000	9,000	1,880,000	3,210	2,380 J	7,140,000	<2,500	2.51
4/1/2021	SP-015-20210401	0.75	18.7	7.35	---	---	---	---	---	---	---	<2,500	---
4/2/2021	SP-015-20210402	0.75	22.8	7.39	95,700	191,000	9,300	1,840,000	---	---	---	---	2.67
4/12/2021	SP-015-20210412	0.75	23.3	7.85	83,900	181,000	10,300	2,160,000	---	---	6,820,000	<2,500	2.48
4/15/2021	SP-015-20210415	0.75	20.8	7.51	---	---	---	---	---	---	---	<2,530	---
4/23/2021	SP-015-20210423-FD	2.5	22.2	7.47	112,000	204,000	11,900	1,950,000	---	---	7,200,000	4,000	9.84
4/23/2021	SP-015-20210423	2.5	22.2	7.47	105,000	197,000	11,900	1,960,000	---	---	7,320,000	3,900	9.42
4/26/2021	SP-015-20210426	1.25	21.9	7.35	158,000	373,000	15,100	1,890,000	---	---	6,800,000	<2,500	8.20
4/30/2021	SP-015-20210430	1.25	22.5	7.79	173,000	411,000	17,000	1,870,000	---	---	6,820,000	3,000	9.02
5/4/2021	SP-015-20210504	1.25	24.8	7.25	165,000	372,000	13,500 J-	1,910,000	---	---	7,220,000	7,900	8.26

Notes:
gpm - gallons per minute
°C - Degrees Celcius
SU - Standard Units
ppb - parts per billion
lb/day - pounds per day
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J+ - The result is an estimated quantity, but the result may be biased high.
J- - The result is an estimated quantity, but the result may be biased low.

Table C.8
Test Scenario #2 - Biological Reactors Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters								Field Parameters			
			E314.0	E300.1B	E300.0	E300.0	SM5310B	SM5310B	SM2540C	SM2540D				
Sample Date	Sample Location	Sample ID	Perchlorate	Chlorate	Nitrate as N	Sulfate	Total Organic Carbon	Dissolved Organic Carbon	Total Dissolved Solids	Total Suspended Solids	pH	Temperature	ORP	Pressure
			ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	SU	°C	mV	psig
3/9/2021	Lead Reactor	SP-100-20210309-LEAD	79,200	59,500	<240	1,950,000	---	---	---	<2,500	7.45	73.6	11	10.6
	Middle Reactor	SP-200-20210309	1,750	816	<240	1,930,000	---	---	---	<2,500	7.53	75.9	-252	5.3
	Lag Reactor	SP-300-20210309-LAG	19.6 J+	<24.0	<240	1,920,000	4,780 J-	4,450 J	---	<2,500	7.45	78.0	-441	9.2
	Lag-C Reactor	SP-300-20210309-LAG-C2	---	---	---	---	5,440 J	6,080 J-	---	7,010	---	---	---	---
	Lag-C Reactor	SP-300-20210309-LAG-C1	---	---	---	---	5,210 J	5,500 J-	---	6,130	---	---	---	---
3/16/2021	Lead Reactor	SP-100-20210316-LEAD	73,800	50,100	790	1,900,000	---	---	---	<2,500	7.19	71.8	265	9.9
	Middle Reactor	SP-200-20210316	885	164	<240	1,820,000	---	---	---	3,100	7.25	72.3	-233	6.8
	Lag Reactor	SP-300-20210316-LAG	9.51	<24.0	<240	1,750,000	4,330	4,910	---	6,300	7.33	74.1	-391	10.2
	Lag-C Reactor	SP-300-20210316-LAG-C	---	---	---	---	4,770	5,030	---	3,700	---	---	---	---
3/18/2021	Lead Reactor	SP-100-20210318-LEAD	---	---	---	---	---	---	---	<2,500	7.21	80.8	-39	9.5
	Middle Reactor	SP-200-20210318	---	---	---	---	---	---	---	<2,550	7.31	81.5	-343	7.1
	Lag Reactor	SP-300-20210318-LAG	---	---	---	---	---	---	---	6,370	7.3	82.9	-351	10
	Lag-C Reactor	SP-300-20210318-LAG-C	---	---	---	---	---	---	---	3,900	---	---	---	---
3/23/2021	Lead Reactor	SP-100-20210323-LEAD	80,800	51,900	<480	1,880,000	---	---	---	<2,800	7.37	74.1	54	9.5
	Middle Reactor	SP-200-20210323-FD	532	<24.0	<480	1,500,000	---	---	---	3,390	---	---	---	---
	Middle Reactor	SP-200-20210323	661	<24.0	<480	1,500,000	---	---	---	4,040	7.31	78.2	-324	7.1
	Lag Reactor	SP-300-20210323-LAG	16.9	<24.0	<480	1,480,000	4,210 J+	3,790 J+	7,480,000	7,600	7.39	81.3	-358	10.2
	Lag-C Reactor	SP-300-20210323-LAG-C	---	---	---	---	5,440	3,910 J+	---	3,800	---	---	---	---
3/25/2021	Lead Reactor	SP-100-20210325-LEAD	---	---	---	---	---	---	---	<2,500	7.22	73.6	-338	9.5
	Middle Reactor	SP-200-20210325	---	---	---	---	---	---	---	3,300	7.26	76.6	-342	7.8
	Lag Reactor	SP-300-20210325-LAG	---	---	---	---	---	---	---	<2,500	7.31	78.4	-351	10.5
	Lag-C Reactor	SP-300-20210325-LAG-C	---	---	---	---	---	---	---	<2,500	---	---	---	---
3/30/2021	Lead Reactor	SP-100-20210330-LEAD	96,800	78,700	1,210	1,780,000	---	---	---	2,860	7.21	79.3	388	9.6
	Middle Reactor	SP-200-20210330	1,630	581	<480	1,870,000	---	---	---	2,630	6.83	83.8	-327	8.3
	Lag Reactor	SP-300-20210330-LAG	22.6	<24.0	<4,800	1,750,000	4,090 J+	3,720 J	---	4,900	7.35	84.9	-358	9.9
	Lag-C Reactor	SP-300-20210330-LAG-C	---	---	---	---	4,620 J+	3,910 J-	---	3,600	---	---	---	---
4/1/2021	Lead Reactor	SP-100-20210401-LEAD	---	---	---	---	---	---	---	<2,500	7.23	72.7	400	10
	Middle Reactor	SP-200-20210401	---	---	---	---	---	---	---	10,600	6.67	78.1	-326	9.6
	Lag Reactor	SP-300-20210401-LAG	---	---	---	---	---	---	---	<2,500	7.35	79.5	-359	10.4
	Lag-C Reactor	SP-300-20210401-LAG-C	---	---	---	---	---	---	---	5,300	---	---	---	---
4/2/2021	Lead Reactor	SP-100-20210402-LEAD	83,200	91,700	696 J	1,850,000	---	---	---	---	7.25	75.6	378	10.1
	Middle Reactor	SP-200-20210402	553	<24.0	<480	1,910,000	---	---	---	---	6.73	81.3	-333	10
	Lag Reactor	SP-300-20210402-LAG	11.9	<24.0	<480	1,840,000	---	---	---	---	7.33	83.1	-378	10.3
4/12/2021	Lead Reactor	SP-100-20210412-LEAD	89,900	83,200	1,220	2,170,000	---	---	---	<2,500	7.19	83.5	438	10.7
	Middle Reactor	SP-200-20210412	1,430	495	<48.0	2,190,000	---	---	---	8,130	6.77	87.1	-360	13
	Lag Reactor	SP-300-20210412-LAG	14.7	<24.0	<48.0	2,130,000	---	---	---	8,000	7.33	87.6	-350	9.6
	Lag-C Reactor	SP-300-20210412-LAG-C	---	---	---	---	---	---	---	4,100	---	---	---	---
4/15/2021	Lead Reactor	SP-100-20210415-LEAD	---	---	---	---	---	---	---	<2,500	7.23	74.3	405	11
	Middle Reactor	SP-200-20210415	---	---	---	---	---	---	---	11,800	7.19	78.1	-347	11.5
	Lag Reactor	SP-300-20210415-LAG	---	---	---	---	---	---	---	24,500	7.37	69.44	-365	9.5
	Lag-C Reactor	SP-300-20210415-LAG-C	---	---	---	---	---	---	---	5,100	---	---	---	---
4/23/2021	Lead Reactor	SP-100-20210423-LEAD	92,100	96,600	807 J	2,010,000	---	---	---	4,100	7.28	76.3	336	14
	Middle Reactor	SP-200-20210423	30,700	16,700	<480	2,060,000	---	---	---	7,200	7.18	79.2	-233	25
	Lag Reactor	SP-300-20210423-LAG	1,990	255	<480	1,930,000	---	---	---	<2,500	7.33	79.7	-376	11.5
4/26/2021	Lead Reactor	SP-100-20210426-LEAD	158,000	160,000	670 J	1,920,000	---	---	---	<2,780	7.30	74.1	277	15.5
	Middle Reactor	SP-200-20210426	30,200	12,400	<480	1,960,000	---	---	---	16,000	7.27	76.6	-261	24.4
	Lag Reactor	SP-300-20210426-LAG	754	<24.0	<480	1,890,000	---	---	---	3,660	7.38	76.6	-371	13.5
4/30/2021	Lead Reactor	SP-100-20210430-LEAD	139,000	134,000	983 J	1,980,000	---	---	---	4,600	7.29	79.2	-73	17.5
	Middle Reactor	SP-200-20210430	20,600	5,940	<480	1,770,000	---	---	---	6,000	7.28	83.1	-325	24.7
	Lag Reactor	SP-300-20210430-LAG	<6.00	<24.0	<480	1,580,000	---	---	---	4,000	7.3	85.3	-399	12.9

Table C.8
Test Scenario #2 - Biological Reactors Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters								Field Parameters			
			E314.0	E300.1B	E300.0	E300.0	SM5310B	SM5310B	SM2540C	SM2540D				
Sample Date	Sample Location	Sample ID	Perchlorate	Chlorate	Nitrate as N	Sulfate	Total Organic Carbon	Dissolved Organic Carbon	Total Dissolved Solids	Total Suspended Solids	pH	Temperature	ORP	Pressure
			ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	SU	°C	mV	psig
5/4/2021	Lead Reactor	SP-100-20210504-LEAD	112,000	54,800	<480 UJ	1,930,000	---	---	---	17,800	7.17	79.9	-266	20.7
	Middle Reactor	SP-200-20210504	6,910	<24.0	<480 UJ	1,620,000	---	---	---	39,500	7.31	81.5	-363	17.0
	Lag Reactor	SP-300-20210504-LAG	1.62 J	<24.0	<480 UJ	1,430,000	---	---	---	43,000	7.41	82.2	-377	12.9

Notes:
ppb - parts per billion
°C - Degrees Celcius
SU - Standard Units
mV - millivolts
psig - pounds per square inch
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J+ - The result is an estimated quantity, but the result may be biased high.
J- - The result is an estimated quantity, but the result may be biased low.

Table C.9
Test Scenario #2 - Effluent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters						Field Parameters	
			E314.0	E300.1B	E300.0	E300.0	SM2540C	SM2540D		
Sample Location	Sample Date	Sample ID	Perchlorate	Chlorate	Nitrate as N	Sulfate	Total Dissolved Solids	Total Suspended Solids	Temperature	pH
			ppb	ppb	ppb	ppb	ppb	ppb	°C	SU
Post Reactor Tank Effluent	3/9/2021	SP-400-20210309	<0.300	<240	<48.0	1,910,000	7,340,000	<2,500	22.6	7.53
	3/16/2021	SP-400-20210316	<0.300	<24.0	<48.0	1,810,000	7,080,000 J-	6,500	20.1	7.38
	3/18/2021	SP-400-20210318	---	---	---	---	---	4,700	25.1	7.42
	3/23/2021	SP-400-20210323	1.39 J	<24.0	<480	1,760,000	7,370,000	4,490	24	7.56
	3/25/2021	SP-400-20210325-FD	---	---	---	---	---	<2,500	---	---
	3/25/2021	SP-400-20210325	---	---	---	---	---	<2,500	23.1	7.5
	3/30/2021	SP-400-20210330	<0.300	<24.0	<480	1,810,000	7,080,000	<2,500	25.1	7.31
	4/1/2021	SP-400-20210401	---	---	---	---	---	<2,500	22.2	7.31
	4/2/2021	SP-400-20210402	<0.300	<24.0	<480	1,850,000	---	---	25.6	7.3
	4/12/2021	SP-400-20210412	<0.300 UJ	<24.0	<48.0	2,180,000	---	3,100	29.6	7.33
	4/15/2021	SP-400-20210415	---	---	---	---	---	2,500	22.7	7.31
	4/23/2021	SP-400-20210423	346	<24.0	<480	1,940,000	7,340,000	<2,530	25.5	7.40
	4/26/2021	SP-400-20210426	103	<24.0	<480	1,780,000	6,800,000	<2,500	24.7	7.44
	4/30/2021	SP-400-20210430	<6.00	<24.0	<480	1,540,000	6,340,000	<2,500	26.1	7.36
	5/4/2021	SP-400-20210504-FD	1.12 J	<24.0	<480 UJ	1,480,000	6,440,000	39,200	---	---
	5/4/2021	SP-400-20210504	<0.300	<24.0	<480 UJ	1,440,000	6,400,000	46,000	25.9	7.52

Notes:
ppb - parts per billion
°C - Degrees Celcius
SU - Standard Units
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J- - The result is an estimated quantity, but the result may be biased low.
UJ- The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Table C.10
Test Scenario #3 - Influent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		Field Parameters			Laboratory Parameters							Calculated
					E314.0	E300.1B	E300.0	SW6010B	SW7199	SM2540C	SM2540D	
Sample Date	Sample ID	Flow	Temperature	pH	Perchlorate	Chlorate	Nitrate as N	Chromium	Chromium, Hexavalent	Total Dissolved Solids	Total Suspended Solids	Total Mass Loading
		gpm	°F	SU	ppb	ppb	ppb	ppb	ppb	ppb	ppb	lb/day
6/29/2021	SP-015-20210629	0.75	89.8	7.35	97,700	193,000	13,300	436	425	7,180,000	<2,500	2.74
7/8/2021	SP-015-20210708	0.75	95.9	7.35	95,800	180,000	12,200	493	514	8,140,000	<2,500	2.59
7/20/2021	SP-015-20210720	0.75	93	7.75	94,900	210,000	12,900	452	450	7,660,000	<2,500	2.86
7/22/2021	SP-015-20210722	0.75	89.3	7.75	---	---	---	---	---	---	<2,500	---
7/27/2021	SP-015-20210727	0.75	86	7.79	94,500	210,000	11,600	431 J	344	7,440,000	<2,500	2.85
7/29/2021	SP-015-20210729-FD	---	---	---	---	---	---	424	351	---	<2,500	---
7/29/2021	SP-015-20210729	0.75	84	7.9	---	---	---	428	353	---	<2,530	---
8/3/2021	SP-015-20210803	0.75	80.1	8.04	80,600	215,000	13,200	381	351	7,660,000	<2,500	2.78
8/5/2021	SP-015-20210805-FD	---	---	---	---	---	---	450	325	---	2,700	---
8/5/2021	SP-015-20210805	0.75	72.1	7.82	---	---	---	453	320	---	2,600	---
8/9/2021	SP-015-20210809-FD	---	---	---	93,800	202,000	13,800	400	276	8,060,000	5,600 J	---
8/9/2021	SP-015-20210809	0.75	80.4	7.33	94,500	204,000	13,600	394	273	7,800,000	8,600 J	2.81

Notes:
gpm - gallons per minute
°F - Degrees Fahrenheit
SU - Standard Units
ppb - parts per billion
lb/day - pounds per day
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J+ - The result is an estimated quantity, but the result may be biased high.
J- - The result is an estimated quantity, but the result may be biased low.

Table C.11
TestScenario #3 - Biological Reactors Performane Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters						Field Parameters			
			E314.0	E300.1B	E300.0	SW6010B	SW7199	SM2540D				
Sample Date	Sample Location	Sample ID	Perchlorate	Chlorate	Nitrate as N	Chromium	Chromium, Hexavalent	Total Suspended Solids	pH	Temperature	ORP	Pressure
			ppb	ppb	ppb	ppb	ppb	ppb	SU	°F	mV	psig
6/29/2021	Lead Reactor	SP-100-20210629-LEAD	43,200	22,100	<480	---	---	<2,500	7.35	92.8	-71	8.4
	Middle Reactor	SP-200-20210629	1,370	<24.0	<4,800	---	---	<2,500	7.29	95.2	-388	5.1
	Lag Reactor	SP-300-20210629-LAG	<0.300	<24.0	<480	18.6	<0.150	<2,500	7.4	97.9	-403	5.4
7/8/2021	Lead Reactor	SP-300-20210708-LEAD	45,700	12,000	<48.0	---	---	<2,500	7.4	99.9	-120	7.0
	Middle Reactor	SP-200-20210708	1,290	<24.0	<48.0	---	---	<2,500	7.3	100.2	-392	5.1
	Lag Reactor	SP-100-20210708-LAG	43.2	<24.0	<48.0	15.9	<0.150	<2,500	7.3	100.2	-405	7.8
7/20/2021	Lead Reactor	SP-100-20210720-LEAD-FD	43,500	16,500	<480	---	---	2,700 J	---	---	---	---
	Lead Reactor	SP-100-20210720-LEAD	42,800	16,100	<480	---	---	6,700 J	7.31	96.8	18	8.6
	Middle Reactor	SP-200-20210720	<0.300	<24.0	<480	---	---	2,900	7.29	97.9	-365	5.2
	Lag Reactor	SP-300-20210720-LAG	<0.300	<24.0	<480	11.7	<0.150	<2,500	7.4	95.7	-398	7.8
7/22/2021	Lead Reactor	SP-100-20210722-LEAD	---	---	---	---	---	6,900	7.31	94.5	87	9.6
	Middle Reactor	SP-200-20210722	---	---	---	---	---	4,500	7.3	96.6	-364	5.4
	Lag Reactor	SP-300-20210722-LAG	---	---	---	---	---	3,400	7.39	95.2	-394	8.1
7/27/2021	Lead Reactor	SP-100-20210727-LEAD	38,700	27,100	<480	---	---	7,700	7.30	89.6	91	12.0
	Middle Reactor	SP-200-20210727	823	<24.0	<480	---	---	2,900	7.28	90.9	-361	5.5
	Lag Reactor	SP-300-20210727-LAG	0.612 J	<24.0	<480	12.2	<0.150	<5,000	7.4	93.7	-397	8.2
7/29/2021	Lead Reactor	SP-100-20210729-LEAD	---	---	---	---	---	<2,500	7.30	89.4	129	12.8
	Middle Reactor	SP-200-20210729	---	---	---	---	---	<2,500	7.31	93.4	-323	5.7
	Lag Reactor	SP-300-20210729-LAG	---	---	---	12.0	<0.150	3,100	7.41	93.2	-418	8.3
8/3/2021	Lead Reactor	SP-100-20210803-LEAD	31,400	26,600	760 J	---	---	<2,500	7.29	90.1	25	15.0
	Middle Reactor	SP-200-20210803	9,350	1,310	<480	---	---	<2,500	7.3	94.3	-169	5.5
	Lag Reactor	SP-300-20210803-LAG	2.07 J-	<24.0	<480	7.16 J	<0.150	<2,500	7.42	93.6	-378	8.8
	Lag Reactor	SP-300-20210803-LAG-FD	2.11 J-	<24.0	<480	6.85 J	<0.150	<2,500	---	---	---	---
8/5/2021	Lead Reactor	SP-100-20210805-LEAD	---	---	---	---	---	<2,500	7.30	85.8	45	17.0
	Middle Reactor	SP-200-20210805	---	---	---	---	---	<2,500	7.3	91.9	-155	5.7
	Lag Reactor	SP-300-20210805-LAG	---	---	---	6.10 J	<0.150	<2,500	7.4	93.4	---	8.6
8/9/2021	Lead Reactor	SP-100-20210809-LEAD	34,100	21,700	<480	---	---	3,200	7.30	91.8	52	20.4
	Middle Reactor	SP-200-20210809	11,300	1,670	<480	---	---	4,100	7.31	94.5	-162	5.6
	Lag Reactor	SP-300-20210809-LAG	1.85 J	<24.0	<480 UJ	5.19 J	<0.150	3,800	7.4	94.8	-403	8.8

Notes:
ppb - parts per billion
°F - Degrees Fahrenheit
SU - Standard Units
mV - millivolts
psig - pounds per square inch
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
J+ - The result is an estimated quantity, but the result may be biased high.
J- - The result is an estimated quantity, but the result may be biased low.

Table C.12
Test Scenario #3 - Effluent Performance Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

			Laboratory Parameters							Field Parameters	
			E314.0	E300.1B	E300.0	SW6010B	SW7199	SM2540C	SM2540D		
			Perchlorate	Chlorate	Nitrate as N	Chromium	Chromium, Hexavalent	Total Dissolved Solids	Total Suspended Solids	Temperature	pH
Sample Location	Sample Date	Sample ID	ppb	ppb	ppb	ppb	ppb	ppb	ppb	°F	SU
Post Reactor Tank Effluent	6/29/2021	SP-400-20210629	<0.300	<24.0	<480	18.5	<0.150	---	<2,500	---	---
	7/8/2021	SP-400-20210708	54.9	<24.0	<48.0	14.9	<0.150	---	2,700	---	---
	7/20/2021	SP-400-20210720	<0.300	<24.0	<480	10.0	<0.150	---	<2,500	93.4	7.63
	7/22/2021	SP-400-20210722	---	---	---	---	---	---	3,400	---	---
	7/27/2021	SP-400-20210727-FD	1.33 J	<24.0	<480	12.3	<0.150	---	<5,000	---	---
	7/27/2021	SP-400-20210727	1.59 J	<24.0	<480	11.8	<0.150	---	3,500	89.1	7.60
	7/29/2021	SP-400-20210729	---	---	---	11.6	<0.150	---	<2,500	89.2	7.65
	8/3/2021	SP-400-20210803	0.535 J-	<24.0	<480	6.72 J	<0.150	---	<2,500	86.5	7.84
	8/5/2021	SP-400-20210805	---	---	---	4.88 J	<0.150	---	<2,500	89.1	7.50
	8/9/2021	SP-400-20210809	<0.300	<24.0	<480	5.35 J	<0.150	---	5,300	---	---
Treated Water Holding Tank	6/29/2021	SP-550-20210629	35.6 J+	<24.0	<480	19.4	0.358 J	---	4,000	---	---
	7/8/2021	SP-550-20210708	---	---	---	15.9	<0.150	---	7,300	---	---
	7/20/2021	SP-550-20210720	---	---	---	10.2	<0.150	---	4,300	91.6	7.42
	7/22/2021	SP-550-20210722	---	---	---	---	---	---	4,200 J+	---	---
	7/27/2021	SP-550-20210727	---	---	---	12.3	<0.150 UJ	---	5,700	86.0	7.39
	7/29/2021	SP-550-20210729	---	---	---	11.7	<0.150	---	<2,500	86.7	7.96
	8/3/2021	SP-550-20210803	---	---	---	8.16 J	<0.150	---	3,500	86.0	8.03
	8/5/2021	SP-550-20210805	---	---	---	5.26 J	<0.150	---	<2,500	86.4	8.11
	8/9/2021	SP-550-20210809	---	---	---	6.31 J	0.334 J	---	4,300	---	---
Cartridge Filter Effluent	6/29/2021	SP-551-20210629	39.2	<24.0	<480	18.5	0.185 J	7,340,000	4,300	---	---
	7/8/2021	SP-551-20210708	11.4	<24.0	<48.0	20.9	<0.150	8,320,000	3,700	---	---
	7/20/2021	SP-551-20210720	<0.300	<24.0	<480	10.5	<0.150	7,440,000	8,670	92.5	7.41
	7/22/2021	SP-551-20210722	---	---	---	---	---	---	7,730 J+	---	---
	7/27/2021	SP-551-20210727	0.336 J	<24.0	<480	12.8	<0.150	7,600,000	8,600	86.9	7.41
	7/29/2021	SP-551-20210729	---	---	---	10.6	<0.150	---	2,700	86.4	8.03
	8/3/2021	SP-551-20210803	0.541 J-	<24.0	<480	7.87 J	<0.150	7,760,000	<2,500	86.7	8.01
	8/5/2021	SP-551-20210805	---	---	---	4.60 J	<0.150	---	<2,500	86.9	8.03
	8/9/2021	SP-551-20210809	<0.300	<24.0	<480	6.14 J	0.381 J	7,580,000	14,800	---	---

Notes:
ppb - parts per billion
°F - Degrees Fahrenheit
SU - Standard Units
--- Not analyzed
J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value
J+ - The result is an estimated quantity, but the result may be biased high
J- - The result is an estimated quantity, but the result may be biased low
UJ- The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Appendix D
Operational Sample Results

Table D.1
System Start-Up - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.0	A4500-P-E
Sample Date	Sample ID	Perchlorate µg/L	Chlorate µg/L	Nitrate as N mg/L	Phosphorus, Total as P mg/L
7/8/2020	EQ101-20200708	49100	71000	7.58	---
7/8/2020	Preserved	47600	---	---	---
7/24/2020	SP-015-20200724	46600	<100,000 S	1.45	---
7/24/2020	SP-100-20200724	47600	<100,000 S	<0.100	---
7/24/2020	SP-200-20200724	48200	<100,000 S	<0.100	---
7/24/2020	SP-300-20200724	46200	<100,000 S	<0.100	---
7/29/2020	SP-015-20200729 - (Feed)	60100	---	---	---
7/29/2020	SP-100-20200729 - (Lag)	56500	---	---	---
7/31/2020	SP-015-20200731-(Feed)	54500	---	---	---
7/31/2020	SP-300-20200731-(Lag)	10600	---	---	---
8/4/2020	SP-015-20200804-Feed	50800	---	---	---
8/4/2020	SP-100-20200804-Lead	49300	---	---	---
8/4/2020	SP-300-20200804-Lag	3780	---	---	---
8/6/2020	SP-100-20200806-Lead	47100	---	---	---
8/6/2020	SP-200-20200806-Middle	25100	---	---	---
8/6/2020	SP-300-20200806-Lag	2140	---	---	---
8/10/2020	SP-015-20200810-Feed	50900	---	---	---
8/10/2020	SP-300-20200810-Lead	48000	---	---	---
8/10/2020	SP-200-20200810-Mid	16200	---	---	---
8/10/2020	SP-100-20200810-Lag	1100	---	---	---
8/12/2020	SP-015-20200812-Feed	42600	81,100 S	---	---
8/12/2020	SP-100-20200812-Lag	444	<20.0 S	---	---
8/12/2020	SP-200-20200812-Mid	9800	124 S	---	---
8/12/2020	SP-300-20200812-Lead	46100	15,100 S	---	---
8/12/2020	SP-400-20200812-Post	390	---	---	---
8/14/2020	SP-300-20200814-Lag	510 S	---	---	---
8/17/2020	SP-015-20200817-Feed	52000	---	---	---
8/17/2020	SP-100-20200817-Lead	32000	---	---	---
8/17/2020	SP-200-20200817-Mid	9370	---	---	---
8/17/2020	SP-300-20200817-Lag	178	---	---	---
8/17/2020	SP-400-20200817-Post	156	---	---	---
8/18/2020	SP-100-20200818-Lag	10100	---	---	---
8/18/2020	SP-200-20200818-Mid	41200	---	---	---
8/18/2020	SP-300-20200818-Lead	53400	---	---	---
8/18/2020	SP-400-20200818-Post	9630	---	---	---
8/19/2020	SP-015-20200819-Feed	52000	---	---	---
8/19/2020	SP-100-20200819-Lag	9840	---	---	---
8/19/2020	SP-200-20200819-Mid	38900	---	---	---
8/19/2020	SP-300-20200819-Lead	53300	---	---	---
8/19/2020	SP-400-20200819-Post	10100	---	---	---
8/20/2020	SP-100-20200820-Lag	2660	---	---	---
8/20/2020	SP-200-20200820-Mid	31300	---	---	---

Table D.1
System Start-Up - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.0	A4500-P-E
		Perchlorate	Chlorate	Nitrate as N	Phosphorus, Total as P
Sample Date	Sample ID	µg/L	µg/L	mg/L	mg/L
8/20/2020	SP-300-20200820-Lead	53800	---	---	---
8/20/2020	SP-400-20200820-Post	2590	---	---	---
8/21/2020	SP-100-20200821-Lag	1750	---	---	---
8/21/2020	SP-200-20200821-Mid	24100	---	---	---
8/21/2020	SP-300-20200821-Lead	53500	---	---	---
8/21/2020	SP-400-20200821-Post	1750	---	---	---
8/24/2020	SP-015-20200824-Feed	42300	---	---	---
8/24/2020	SP-100-20200824-Lead	37500	---	---	---
8/24/2020	SP-200-20200824-Mid	10200	---	---	---
8/24/2020	SP-300-20200824-Lag	355	---	---	---
8/24/2020	SP-400-20200824-Post	<12.5	---	---	---
8/25/2020	SP-100-20200825-Lead	37700	---	---	---
8/25/2020	SP-200-20200825-Mid	16800	---	---	---
8/25/2020	SP-300-20200825-Lag	109	---	---	---
8/25/2020	SP-400-20200825-Post	<12.5	---	---	---
8/26/2020	SP-100-20200826-Lag	4560	---	---	---
8/26/2020	SP-200-20200826-Mid	27300	---	---	---
8/26/2020	SP-300-20200826-Lead	46200	---	---	---
8/26/2020	SP-400-20200826-Post	1500	---	---	---
8/27/2020	SP-015-20200827-Feed	50500	---	---	1.28 S
8/27/2020	SP-0400-20200827-Post	---	---	---	1.06 S
8/27/2020	SP-100-20200827-Lag	1680	---	---	---
8/27/2020	SP-200-20200827-Mid	30200	---	---	---
8/27/2020	SP-300-20200827-Lead	48100	---	---	---
8/27/2020	SP-400-20200827-Post	1310	---	---	---
8/28/2020	SP-100-20200828-Lag (F)	767	---	---	---
8/28/2020	SP-100-20200828-Lag (NF)	685	---	---	---
8/28/2020	SP-200-20200828-Mid (F)	29300	---	---	---
8/28/2020	SP-300-20200828-Lead (F)	54000	---	---	---
8/28/2020	SP-400-20200828-Post (F)	1190	---	---	---

Notes:

µg/L - micrograms per liter

mg/L - milligrams per liter

S - Associated matrix spike and duplicate outside of acceptable range.

J - Estimated value

L - Reported value was higher than the matrix spike.

1. Analysis of operational samples was performed at Silver State (an off-site laboratory) under quick turn-around time for immediate use in system operational inputs and were not validated in accordance with the NDEP-approved Work Plan and System Operation Manual.

Table D.2
Test Scenario #1A - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	E300.0 Chloride mg/L	E300.0 Fluoride mg/L	E200.7 Calcium mg/L	E200.7 Magnesium mg/L	E200.7 Potassium mg/L	E200.7 Sodium mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L	A4500-CN-E Cyanide, Total mg/L	A2320 Alkalinity, Carbonate (As CaCO3) mg/L
8/31/2020	SP-015-20200831-Feed	54300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/31/2020	SP-100-20200831-Lag	<25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/31/2020	SP-200-20200831-Mid	9490	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/31/2020	SP-300-20200831-Lead	50100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/31/2020	SP-400-20200831-Post	<25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/1/2020	SP-100-20200901-Lag	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/1/2020	SP-200-20200901-Mid	4730	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/1/2020	SP-300-20200901-Lead	50400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/1/2020	SP-400-20200901-Post	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/2/2020	SP-100-20200902-Lag	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/2/2020	SP-200-20200902-Mid	2110	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/2/2020	SP-300-20200902-Lead	49500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/2/2020	SP-400-20200902-Post	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/3/2020	SP-015-20200903-Feed	56100	47,500 S	---	---	1,750 S	---	---	---	---	---	---	---	---	---	---	---
9/3/2020	SP-100-20200903-Lag	<12.5	<20 S	---	---	1,670 S	---	---	---	---	---	---	---	---	---	---	---
9/3/2020	SP-200-20200903-Mid	3330	<1,000 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/3/2020	SP-300-20200903-Lead	48500	66,900 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/3/2020	SP-400-20200903-Post	<12.5	<20 S	---	---	1,660 S	---	---	---	---	---	---	---	---	---	---	---
9/4/2020	SP-100-20200904-Lag	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/4/2020	SP-200-20200904-Mid	1840	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/4/2020	SP-300-20200904-Lead	46000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/4/2020	SP-400-20200904-Post	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/8/2020	SP-015-20200908-Feed	51800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/8/2020	SP-100-20200908-Lag	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/8/2020	SP-200-20200908-Mid	1910	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/8/2020	SP-300-20200908-Lead	37300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/8/2020	SP-400-20200908-Post	<12.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/10/2020	SP-300-20200910-Lead	38000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/10/2020	SP-200-20200910-Mid	1710	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/10/2020	SP-100-20200910-Lag	<5.00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/10/2020	SP-400-20200910-Post	<5.00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/10/2020	SP-100-20200910-Lag	---	---	---	---	---	---	---	---	---	---	---	---	---	<5.00	---	---
9/10/2020	SP-450-20200910-Surge	---	---	---	---	---	---	---	---	---	---	---	---	---	<5.00	---	---
9/10/2020	SP-551-20200910-Effluent	---	---	---	---	---	---	---	---	---	---	---	---	---	<5.00	---	---
9/11/2020	SP-015-20200911-Feed	43100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/11/2020	SP-100-20200911-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/11/2020	SP-200-20200911-Mid	1280	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/11/2020	SP-300-20200911-Lead	34300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/11/2020	SP-400-20200911-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/14/2020	SP-015-20200914-Feed	36500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/14/2020	SP-100-20200914-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/14/2020	SP-200-20200914-Mid	369	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/14/2020	SP-300-20200914-Lead	23900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/14/2020	SP-400-20200914-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/17/2020	SP-015-20200917-Feed	36800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/17/2020	SP-100-20200917-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/17/2020	SP-200-20200917-Mid	510	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/17/2020	SP-300-20200917-Lead	24000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/17/2020	SP-400-20200917-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/22/2020	SP-015-20200922-Feed	35400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.2
Test Scenario #1A - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	E300.0 Chloride mg/L	E300.0 Fluoride mg/L	E200.7 Calcium mg/L	E200.7 Magnesium mg/L	E200.7 Potassium mg/L	E200.7 Sodium mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L	A4500-CN-E Cyanide, Total mg/L	A2320 Alkalinity, Carbonate (As CaCO3) mg/L
9/22/2020	SP-100-20200922-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/22/2020	SP-200-20200922-Mid	573	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/22/2020	SP-300-20200922-Lead	23800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/22/2020	SP-400-20200922-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/24/2020	SP-015-20200924-Feed	---	---	---	5.63 S	1,700 S	1970	1.66 S	262 L	170 L	61.3	2,240 L	---	---	---	0.092 S	<5
9/24/2020	SP-100-20200924-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/24/2020	SP-200-20200924-Mid	482	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/24/2020	SP-300-20200924-Lead	24000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/24/2020	SP-400-20200924-Post	<5	---	---	<0.2 S	1,580 S	1980	1.52 S	254 L	169 L	65	2,500 L	---	---	---	0.093 S	<5
9/24/2020	SP-550-20200924-HT	---	---	---	<0.2 S	1,630 S	1990	1.47 S	269 L	173 L	69.5	2,730 L	---	---	---	<0.05 S	<5
9/29/2020	SP-015-20200929-Feed	37100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/29/2020	SP-100-20200929-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/29/2020	SP-200-20200929-Mid	6300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/29/2020	SP-300-20200929-Lead	38300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/29/2020	SP-400-20200929-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/2/2020	SP-015-20201002-Feed	34800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/2/2020	SP-100-20201002-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/2/2020	SP-200-20201002-Mid	3200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/2/2020	SP-300-20201002-Lead	26200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/2/2020	SP-400-20201002-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/7/2020	AWF-20201007-Wet Well	39400	---	66.7 S	3.35 S	---	---	---	---	---	---	---	---	---	---	---	---
10/7/2020	SP-015-20201007-Feed	40400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/7/2020	SP-100-20201007-Lag	1830	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/7/2020	SP-200-20201007-Mid	16200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/7/2020	SP-300-20201007-Lead	32000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/7/2020	SP-400-20201007-Post	2090	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/8/2020	SP-100-20201008-Lag	2,910 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/8/2020	SP-200-20201008-Mid	16,100 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/8/2020	SP-300-20201008-Lead	32,600 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/8/2020	SP-400-20201008-Post	2,800 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/9/2020	SP-015-20201009-Feed	36300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/9/2020	SP-100-20201009-Lag	98.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/9/2020	SP-200-20201009-Mid	4350	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/9/2020	SP-300-20201009-Lead	31800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/9/2020	SP-400-20201009-Post	117	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/12/2020	SP-015-20201012-Feed	35800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/12/2020	SP-100-20201012-Lag	36.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/12/2020	SP-200-20201012-Mid	3100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/12/2020	SP-300-20201012-Lead	29100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/12/2020	SP-400-20201012-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/13/2020	SP-100-20201013-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/13/2020	SP-200-20201013-Mid	1820	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/13/2020	SP-300-20201013-Lead	28800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/13/2020	SP-400-20201013-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/14/2020	SP-015-20201014-Feed	31400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/14/2020	SP-100-20201014-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/14/2020	SP-200-20201014-Mid	2020	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/14/2020	SP-300-20201014-Lead	25500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/14/2020	SP-400-20201014-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/15/2020	SP-015-20201015-Feed	32,100 S	---	204 S	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.2
Test Scenario #1A - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	E300.0 Chloride mg/L	E300.0 Fluoride mg/L	E200.7 Calcium mg/L	E200.7 Magnesium mg/L	E200.7 Potassium mg/L	E200.7 Sodium mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L	A4500-CN-E Cyanide, Total mg/L	A2320 Alkalinity, Carbonate (As CaCO3) mg/L
10/15/2020	SP-200-20201015-Mid	1,280 S	---	1.23 S	---	---	---	---	---	---	---	---	---	---	---	---	---
10/15/2020	SP-300-20201015-Lag	222 S	---	<0.04 S	---	---	---	---	---	---	---	---	---	---	---	---	---
10/19/2020	SP-300-20201019-Lag	---	---	---	---	---	---	---	---	---	---	---	1.63	---	---	---	---
10/20/2020	SP-015-20201020-Feed	49400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/20/2020	SP-100-20201020-Lead	41400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/20/2020	SP-200-20201020-Mid	1150	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/20/2020	SP-300-20201020-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/20/2020	SP-400-20201020-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/21/2020	SP-015-20201021-Feed	48300	---	---	---	1560	---	---	---	---	---	---	---	---	---	---	---
10/21/2020	SP-100-20201021-Lead	45000	---	---	---	1520	---	---	---	---	---	---	---	---	---	---	---
10/21/2020	SP-200-20201021-Mid	4560	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/21/2020	SP-300-20201021-Lag	137	---	---	---	1430	---	---	---	---	---	---	---	---	---	---	---
10/21/2020	SP-400-20201021-Post	79.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/26/2020	SP-015-20201026-Feed	47,800 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/26/2020	SP-100-20201026-Lead	36,800 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/26/2020	SP-200-20201026-Mid	1,830 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/26/2020	SP-300-20201026-Lag	209 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/26/2020	SP-400-20201026-Post	178 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/27/2020	SP-100-20201027-Lead	37200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/27/2020	SP-200-20201027-Mid	1110	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/27/2020	SP-300-20201027-Lag	257	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/27/2020	SP-400-20201027-Post	200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/28/2020	SP-015-20201028-Feed	---	---	---	---	1420	---	---	---	---	---	---	---	---	---	---	---
10/28/2020	SP-100-20201028-Lead	37100	---	---	---	1420	---	---	---	---	---	---	---	---	---	---	---
10/28/2020	SP-200-20201028-Mid	2760	---	---	---	1400	---	---	---	---	---	---	---	---	---	---	---
10/28/2020	SP-300-20201028-Lag	334	---	---	---	1240	---	---	---	---	---	---	---	---	---	---	---
10/28/2020	SP-400-20201028-Post	257	---	---	---	1250	---	---	---	---	---	---	---	---	---	---	---
10/29/2020	SP-100-20201029-Lead	35500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/29/2020	SP-200-20201029-Mid	2500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/29/2020	SP-300-20201029-Lag	266	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/29/2020	SP-400-20201029-Post	157	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/30/2020	SP-015-20201030-Feed	38100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/30/2020	SP-100-20201030-Lead	12800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/30/2020	SP-200-20201030-Mid	466	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/30/2020	SP-300-20201030-Lag	33.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/30/2020	SP-400-20201030-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/2/2020	SP-100-20201102-Lead	8300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/2/2020	SP-200-20201102-Mid	342	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/2/2020	SP-300-20201102-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/2/2020	SP-400-20201102-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/4/2020	SP-015-20201104-Feed	38000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/4/2020	SP-100-20201104-Lead	11400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/4/2020	SP-200-20201104-Mid	392	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/4/2020	SP-300-20201104-Lag	56.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/4/2020	SP-400-20201104-Post	38.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
11/5/2020	SP-100-20201105-Lead	13000	---	---	---	1,670 S	---	---	---	---	---	---	---	---	---	---	---
11/5/2020	SP-200-20201105-Mid	584	---	---	---	1,570 S	---	---	---	---	---	---	---	---	---	---	---
11/5/2020	SP-300-20201105-Lag	<5	---	---	---	1,630 S	---	---	---	---	---	---	---	---	---	---	---
11/5/2020	SP-400-20201105-Post	<5	---	---	---	1,610 S	---	---	---	---	---	---	---	---	---	---	---
11/9/2020	SP-015-20201109-Feed	43,500 S	---	---	---	1,490 S	---	---	---	---	---	---	---	---	---	---	---

Table D.2
Test Scenario #1A - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	E300.0 Chloride mg/L	E300.0 Fluoride mg/L	E200.7 Calcium mg/L	E200.7 Magnesium mg/L	E200.7 Potassium mg/L	E200.7 Sodium mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L	A4500-CN-E Cyanide, Total mg/L	A2320 Alkalinity, Carbonate (As CaCO3) mg/L
11/9/2020	SP-100-20201109-Lead	29,400 S	---	---	---	1,360 S	---	---	---	---	---	---	---	---	---	---	---
11/9/2020	SP-200-20201109-Mid	3,040 S	---	---	---	1,310 S	---	---	---	---	---	---	---	---	---	---	---
11/9/2020	SP-300-20201109-Lag	385 S	---	---	---	1,260 S	---	---	---	---	---	---	---	---	---	---	---
11/9/2020	SP-400-20201109-Post	350 S	---	---	---	1,250 S	---	---	---	---	---	---	---	---	---	---	---
11/10/2020	SP-015-20201110-Feed	44,600 S	---	---	---	1470	---	---	---	---	---	---	---	6.68	---	---	---
11/10/2020	SP-100-20201110-Lead	27,000 S	---	---	---	1500	---	---	---	---	---	---	---	---	---	---	---
11/10/2020	SP-200-20201110-Mid	3,100 S	---	---	---	1400	---	---	---	---	---	---	---	---	---	---	---
11/10/2020	SP-300-20201110-Lag	402 S	---	---	---	1370	---	---	---	---	---	---	---	---	---	---	---
11/10/2020	SP-400-20201110-Post	386 S	---	---	---	1370	---	---	---	---	---	---	---	---	---	---	---
11/11/2020	SP-100-20201111-Lead	26000	---	---	---	1430	---	---	---	---	---	---	---	---	---	---	---
11/11/2020	SP-200-20201111-Mid	3110	---	---	---	1350	---	---	---	---	---	---	---	---	---	---	---
11/11/2020	SP-300-20201111-Lag	492	---	---	---	1400	---	---	---	---	---	---	---	---	---	---	---
11/11/2020	SP-400-20201111-Post	494	---	---	---	1350	---	---	---	---	---	---	---	---	---	---	---
11/12/2020	SP-100-20201112-Lead	25,500 S	---	---	---	1470	---	---	---	---	---	---	---	---	---	---	---
11/12/2020	SP-200-20201112-Mid	29,90 S	---	---	---	1350	---	---	---	---	---	---	---	---	---	---	---
11/12/2020	SP-300-20201112-Lag	489 S	---	---	---	1390	---	---	---	---	---	---	---	---	---	---	---
11/12/2020	SP-400-20201112-Post	414 S	---	---	---	1400	---	---	---	---	---	---	---	---	---	---	---
11/13/2020	SP-015-20201113-Feed	41,700 S	---	---	---	1,470 S	---	---	---	---	---	---	---	---	---	---	---
11/13/2020	SP-100-20201113-Lead	26,200 S	---	---	---	1,450 S	---	---	---	---	---	---	---	---	---	---	---
11/13/2020	SP-200-20201113-Mid	3,330 S	---	---	---	1,360 S	---	---	---	---	---	---	---	---	---	---	---
11/13/2020	SP-300-20201113-Lag	666 S	---	---	---	1,360 S	---	---	---	---	---	---	---	---	---	---	---
11/13/2020	SP-400-20201113-Post	610 S	---	---	---	1,360 S	---	---	---	---	---	---	---	---	---	---	---
11/16/2020	SP-100-20201116-Lead	27,300 S	---	---	---	1,450 S	---	---	---	---	---	---	---	---	---	---	---
11/16/2020	SP-200-20201116-Mid	3,570 S	---	---	---	1,350 S	---	---	---	---	---	---	---	---	---	---	---
11/16/2020	SP-300-20201116-Lag	632 S	---	---	---	1,380 S	---	---	---	---	---	---	---	---	---	---	---
11/16/2020	SP-400-20201116-Post	586 S	---	---	---	1,360 S	---	---	---	---	---	---	---	---	---	---	---
11/17/2020	SP-015-20201117-Feed	41000	---	---	---	1470	---	---	---	---	---	---	---	---	---	---	---
11/17/2020	SP-100-20201117-Lead	6380	---	---	---	1460	---	---	---	---	---	---	---	---	---	---	---
11/17/2020	SP-200-20201117-Mid	183	---	---	---	1310	---	---	---	---	---	---	---	---	---	---	---
11/17/2020	SP-300-20201117-Lag	30.2	---	---	---	1300	---	---	---	---	---	---	---	---	---	---	---
11/17/2020	SP-400-20201117-Post	29.7	---	---	---	1260	---	---	---	---	---	---	---	---	---	---	---
11/18/2020	SP-100-20201118-Lead	5,110 S	---	---	---	1470	---	---	---	---	---	---	---	---	---	---	---
11/18/2020	SP-200-20201118-Mid	144 S	---	---	---	1290	---	---	---	---	---	---	---	---	---	---	---
11/18/2020	SP-300-20201118-Lag	<5 S	---	---	---	1260	---	---	---	---	---	---	---	---	---	---	---
11/18/2020	SP-400-20201118-Post	<5 S	---	---	---	1260	---	---	---	---	---	---	---	---	---	---	---
11/19/2020	SP-100-20201119-Lead	3950	---	---	---	1430	---	---	---	---	---	---	---	---	---	---	---
11/19/2020	SP-200-20201119-Mid	103	---	---	---	1290	---	---	---	---	---	---	---	---	---	---	---
11/19/2020	SP-300-20201119-Lag	<5	---	---	---	1240	---	---	---	---	---	---	---	---	---	---	---
11/19/2020	SP-400-20201119-Post	<5	---	---	---	1250	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L - micrograms per liter
mg/L - milligrams per liter
S - Associated matrix spike and duplicate outside of acceptable range.
J - Estimated value
L - Reported value was higher than the matrix spike.
1. Analysis of operational samples was performed at Silver State (an off-site laboratory) under quick turn-around time for immediate use in system operational inputs and were not validated in accordance with the NDEP-approved Work Plan and System Operation Manual.

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.1	E300.0	E300.0	A4500-P-E	A5310B	A2540D
		Perchlorate	Chlorate	Chlorate	Nitrate as N	Sulfate	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids
Sample Date	Sample ID	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
12/1/2020	SP-015-20201201-Feed	41500	89400	---	6.52	1,590 S	---	---	---
12/1/2020	SP-100-20201201-Lead	34000	16000	---	<0.1	1,550 S	---	---	---
12/1/2020	SP-200-20201201-Mid	1530	<20	---	<0.1	1,570 S	---	---	---
12/1/2020	SP-300-20201201-Lag	<5	<20	---	<0.1	1,540 S	---	---	---
12/1/2020	SP-400-20201201-Post	<5	<20	---	<0.1	1,560 S	---	---	---
12/2/2020	SP-100-20201202-Lead	29000	---	---	---	---	---	---	---
12/2/2020	SP-200-20201202-Mid	150	---	---	---	---	---	---	---
12/2/2020	SP-300-20201202-Lag	<5	---	---	---	---	---	---	---
12/2/2020	SP-400-20201202-Post	<5	---	---	---	---	---	---	---
12/3/2020	SP-100-20201203-Lead	40800	---	---	---	---	---	---	---
12/3/2020	SP-200-20201203-Mid	16600	---	---	---	---	---	---	---
12/3/2020	SP-300-20201203-Lag	373	---	---	---	---	---	---	---
12/3/2020	SP-400-20201203-Post	201	---	---	---	---	---	---	---
12/4/2020	SP-100-20201204-Lead	40,400 S	---	---	---	---	---	---	---
12/4/2020	SP-200-20201204-Mid	24,800 S	---	---	---	---	---	---	---
12/4/2020	SP-300-20201204-Lag	2,850 S	---	---	---	---	---	---	---
12/4/2020	SP-400-20201204-Post	2,700 S	---	---	---	---	---	---	---
12/7/2020	SP-015-20201207-Feed	43,900 S	114000	---	7.72	14,10 S	---	---	---
12/7/2020	SP-100-20201207-Lead	46,800 S	76400	---	0.41	1,410 S	---	---	---
12/7/2020	SP-200-20201207-Mid	43,200 S	19900	---	<0.2	1,390 S	---	---	---
12/7/2020	SP-300-20201207-Lag	39,100 S	5170	---	<0.2	1,390 S	---	---	---
12/7/2020	SP-400-20201207-Post	39,200 S	5210	---	<0.2	1,400 S	---	---	---
12/7/2020	Tank 1 - 20201207	68,000 S	115000	---	7.36 S	1480	---	---	---
12/8/2020	SP-100-20201208-Lead	48800	---	---	---	---	---	---	---
12/8/2020	SP-200-20201208-Mid	41100	---	---	---	---	---	---	---
12/8/2020	SP-300-20201208-Lag	24000	---	---	---	---	---	---	---
12/10/2020	SP-100-20201210-Lead	40300	---	---	---	---	---	---	---
12/10/2020	SP-200-20201210-Mid	3940	---	---	---	---	---	---	---
12/10/2020	SP-300-20201210-Lag	213	---	---	---	---	---	---	---
12/11/2020	SP-100-20201211-Lead	39900	---	---	---	---	---	---	---

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L
12/11/2020	SP-200-20201211-Mid	2220	---	---	---	---	---	---	---
12/11/2020	SP-300-20201211-Lag	<5	---	---	---	---	---	---	---
12/14/2020	SP-100-20201214-Lead	41000	---	---	---	---	---	---	---
12/14/2020	SP-200-20201214-Mid	1100	---	---	---	---	---	---	---
12/14/2020	SP-300-20201214-Lag	<5	---	---	---	---	---	---	---
12/15/2020	SP-100-20201215-Lead	42600	---	---	---	---	---	---	---
12/15/2020	SP-200-20201215-Mid	7040	---	---	---	---	---	---	---
12/15/2020	SP-300-20201215-Lag	585	---	---	---	---	---	---	---
12/16/2020	SP-015-20201216-Feed	40600	99800	---	7.1	1,450 S	---	---	---
12/16/2020	SP-100-20201216-Lead	43200	52000	---	1.24	1,500 S	---	---	---
12/16/2020	SP-200-20201216-Mid	14400	3650	---	<0.2	1,670 S	---	---	---
12/16/2020	SP-300-20201216-Lag	3930	731	---	<0.2	1,440 S	---	---	---
12/17/2020	SP-100-20201217-Lead	42300	---	---	---	---	---	---	---
12/17/2020	SP-200-20201217-Mid	12400	---	---	---	---	---	---	---
12/17/2020	SP-300-20201217-Lag	3540	---	---	---	---	---	---	---
12/18/2020	SP-100-20201218-Lead	42300	41900	---	0.626	1460	---	---	---
12/18/2020	SP-200-20201218-Mid	7210	1540	---	<0.1	1450	---	---	---
12/18/2020	SP-300-20201218-Lag	646	1670	---	<0.1	1440	---	---	---
12/18/2020	Tank1-20201218	46100	119000	---	7.87	1380	---	---	---
12/21/2020	SP-100-20201221-Lead	37200	29600	---	0.417	1,500 S	---	---	---
12/21/2020	SP-200-20201221-Mid	1050	<400	---	<0.2	1,460 S	---	---	---
12/21/2020	SP-300-20201221-Lag	<5	<40	---	<0.2	1,440 S	---	---	---
12/22/2020	SP-100-20201222-Lead	38800	---	---	---	---	---	---	---
12/22/2020	SP-200-20201222-Mid	1210	---	---	---	---	---	---	---
12/22/2020	SP-300-20201222-Lag	35.4	---	---	---	---	---	---	---
12/22/2020	Tank 2-20201222	42800	---	118	7.97	1,310 S	---	---	---
12/23/2020	SP-100-20201223-Lead	48000	---	---	---	---	---	---	---
12/23/2020	SP-200-20201223-Mid	1860	---	---	---	---	---	---	---
12/23/2020	SP-300-20201223-Lag	49.4	---	---	---	---	---	---	---
12/24/2020	SP-100-20201224	50200	47200	---	0.396 S	1,350 S	---	---	---

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L
12/24/2020	SP-200-20201224	11800	2490	---	<0.2 S	1,380 S	---	---	---
12/24/2020	SP-300-20201224	879	49.5	---	<0.2 S	1,410 S	---	---	---
12/24/2020	Tank 1-20201224	56300	112000	---	7.93 S	1,380 S	---	---	---
12/26/2020	SP-100-20201226-Lead	50300	---	---	---	---	---	---	---
12/26/2020	SP-200-20201226-Mid	4800	---	---	---	---	---	---	---
12/26/2020	SP-300-20201226-Lag	192	---	---	---	---	---	---	---
12/28/2020	SP-100-20201228-Lead	48800	35300	---	0.32	1300	---	---	---
12/28/2020	SP-200-20201228-Mid	3330	455	---	<0.2	1280	---	---	---
12/28/2020	SP-300-20201228-Lag	151	<40	---	<0.2	1280	---	---	---
12/29/2020	SP-100-20201229-Lead	51800	---	---	---	---	---	---	---
12/29/2020	SP-200-20201229-Mid	5680	---	---	---	---	---	---	---
12/29/2020	SP-300-20201229-Lag	360	---	---	---	---	---	---	---
12/29/2020	Tank 2-20201229	50800	106000	---	6.84	1,490 S	---	---	---
12/30/2020	SP-015-20201230-Feed	55500	---	---	---	1330	---	---	---
12/30/2020	SP-100-20201230-Lead	50100	---	---	---	1350	---	---	---
12/30/2020	SP-200-20201230-Mid	3280	---	---	---	1300	---	---	---
12/30/2020	SP-300-20201230-Lag	197	---	---	---	1290	---	---	---
12/31/2020	SP-015-20201231-Feed	50000	106000	---	---	---	---	---	---
12/31/2020	SP-100-20201231-Lead	47700	16900	---	---	---	---	---	---
12/31/2020	SP-200-20201231-Mid	1510	952	---	---	---	---	---	---
12/31/2020	SP-300-20201231-Lag	103	960	---	---	---	---	---	---
1/1/2021	SP-015-20210101-Feed	47900	---	---	---	---	---	---	---
1/1/2021	SP-100-20210101-Lead	38800	---	---	---	---	---	---	---
1/1/2021	SP-200-20210101-Mid	826	---	---	---	---	---	---	---
1/1/2021	SP-300-20210101-Lag	32.5	---	---	---	---	---	---	---
1/4/2021	SP-015-20210104-Feed	44800	96100	---	7.45	1500	---	---	<5
1/4/2021	SP-100-20210104-Lead	29200	11600	---	<0.2	1510	---	---	---
1/4/2021	SP-200-20210104-Mid	713	<200	---	<0.2	1400	---	---	---
1/4/2021	SP-300-20210104-Lag	28	<40	---	<0.2	1400	---	---	---
1/4/2021	SP-400-20210104-Post	---	---	---	---	---	0.433	---	---

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.1	E300.0	E300.0	A4500-P-E	A5310B	A2540D
		Perchlorate	Chlorate	Chlorate	Nitrate as N	Sulfate	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids
Sample Date	Sample ID	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1/4/2021	Tank 1-20210104	53200	110000	---	7.79	1460	---	---	---
1/4/2021	Tank 2-20210104	---	---	---	---	---	---	---	10
1/5/2021	SP-015-20210105-Feed	50400	---	---	---	---	---	---	---
1/5/2021	SP-100-20210105-Lead	32700	---	---	---	---	---	---	---
1/5/2021	SP-200-20210105-Mid	895	---	---	---	---	---	---	---
1/5/2021	SP-300-20210105-Lag	38	---	---	---	---	---	---	---
1/5/2021	SP-400-20210105-Post	36.5	---	---	---	---	---	---	---
1/6/2021	SP-015-20210106-Feed	48800	---	---	---	1480	---	---	---
1/6/2021	SP-100-20210106-Lead	31700	---	---	---	1470	---	---	---
1/6/2021	SP-200-20210106-Mid	1050	---	---	---	1390	---	---	---
1/6/2021	SP-300-20210106-Lag	51.4	---	---	---	1350	---	---	---
1/6/2021	SP-400-20210106-Post	23.7	---	---	---	1360	---	---	---
1/7/2021	SP-015-20210107-Feed	49000	---	---	---	---	1.24	---	---
1/7/2021	SP-100-20210107-Lead	32100	---	---	---	---	0.955	---	---
1/7/2021	SP-200-20210107-Mid	1260	---	---	---	---	0.9	---	---
1/7/2021	SP-300-20210107-Lag	87.3	---	---	---	---	1.03	---	---
1/8/2021	SP-015-20210108-Feed	46500	---	---	---	1420	---	---	---
1/8/2021	SP-100-20210108-Lead	32800	---	---	---	1430	---	---	---
1/8/2021	SP-200-20210108-Mid	899	---	---	---	1360	---	---	---
1/8/2021	SP-300-20210108-Lag	74.7	---	---	---	1340	---	---	---
1/11/2021	SP-015-20210111-Feed	54200	96300	---	---	1,440 S	---	---	---
1/11/2021	SP-100-20210111-Lag	10.4	<40	---	---	1,350 S	---	---	---
1/11/2021	SP-200-20210111-Mid	576	<200	---	---	1,400 S	---	---	---
1/11/2021	SP-300-20210111-Lead	29800	9650	---	---	1,440 S	---	---	---
1/12/2021	SP-015-20210112-Feed	44900	103000	---	6.8	1410	---	---	6
1/12/2021	SP-100-20210112-Lag	25.7	<40	---	<0.2	1310	---	---	<5
1/12/2021	SP-200-20210112-Mid	671	<200	---	<0.2	1350	---	---	<5
1/12/2021	SP-300-20210112-Lead	31000	15700	---	<2.5	1410	---	---	<5
1/12/2021	SP-400-20210112-Post	22.3	<40	---	<0.2	1310	---	---	<5
1/12/2021	Tank 1-20210112	49200	126000	---	8.05	1410	---	---	<5

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L
1/13/2021	SP-015-20210113-Feed	45600	---	---	---	---	---	---	---
1/13/2021	SP-100-20210113-Lag	27	---	---	---	---	---	---	---
1/13/2021	SP-200-20210113-Mid	884	---	---	---	---	---	---	---
1/13/2021	SP-300-20210113-Lead	30500	---	---	---	---	---	---	---
1/14/2021	SP-015-20210114-Feed	45400	---	---	---	1480	---	---	---
1/14/2021	SP-100-20210114-Lag	44.6	---	---	---	1370	---	---	---
1/14/2021	SP-200-20210114-Mid	729	---	---	---	1410	---	---	---
1/14/2021	SP-300-20210114-Lead	30500	---	---	---	1480	---	---	---
1/15/2021	SP-015-20210115-Feed	40600	97900	---	8.87	1480	---	---	---
1/15/2021	SP-100-20210115-Lag	23.8	<100	---	<0.2	1390	---	---	---
1/15/2021	SP-200-20210115-Mid	739	<200	---	<0.2	1430	---	---	---
1/15/2021	SP-300-20210115-Lead	28900	60200	---	<2.5	1500	---	---	---
1/15/2021	Tank 2-20210115	48300	116000	---	9.16	1490	---	---	---
1/16/2021		<5 S	---	---	---	---	---	---	---
1/16/2021	SP-015-20210116-Feed	38,000 S	---	---	---	---	---	---	---
1/16/2021	SP-200-20210116-Mid	63 S	---	---	---	---	---	---	---
1/16/2021	SP-300-20210116-Lead	5,460 S	---	---	---	---	---	---	---
1/18/2021	SP-015-20210118-Feed	36900	---	---	---	---	---	---	---
1/18/2021	SP-100-20210118-Lag	<5	---	---	---	---	---	---	---
1/18/2021	SP-200-20210118-Mid	110	---	---	---	---	---	---	---
1/18/2021	SP-300-20210118-Lead	3830	---	---	---	---	---	---	---
1/18/2021	Tank 1-20210118	53400	119000	---	7.98	1490	---	---	---
1/19/2021	SP-015-20210119-Feed	41100	101000	---	7.35	1540	---	---	---
1/19/2021	SP-100-20210119-Lag	<5	<100	---	<0.5	1430	---	---	---
1/19/2021	SP-200-20210119--Mid	188	<200	---	<0.5	1490	---	---	---
1/19/2021	SP-300-20210119-Lead	17800	16600	---	0.747	1580	---	---	---
1/20/2021	SP-015-2021020-Feed	43900	---	---	---	---	---	---	---
1/20/2021	SP-100-20210120-Lag	<5	---	---	---	---	---	---	---
1/20/2021	SP-200-20210120-Mid	443	---	---	---	---	---	---	---
1/20/2021	SP-300-20210120-Lead	27000	---	---	---	---	---	---	---

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.1	E300.0	E300.0	A4500-P-E	A5310B	A2540D
		Perchlorate	Chlorate	Chlorate	Nitrate as N	Sulfate	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids
Sample Date	Sample ID	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1/21/2021	SP-015-20210121-Feed	43400	---	---	---	1380	---	---	---
1/21/2021	SP-100-20210121-Lag	<5	---	---	---	1300	---	---	---
1/21/2021	SP-200-20210121-Mid	437	---	---	---	1350	---	---	---
1/21/2021	SP-300-20210121-Lead	29200	---	---	---	1390	---	---	---
1/22/2021	SP-015-20210122-Feed	39100	92300	---	8.83 S	1440	---	---	---
1/22/2021	SP-100-20210122-Lag	<5	<100	---	<0.5 S	1370	---	---	---
1/22/2021	SP-200-20210122-Mid	389	<100	---	<0.5 S	1400	---	---	---
1/22/2021	SP-300-20210122-Lead	28100	32800	---	1.07 S	1440	---	---	---
1/22/2021	Tank 2-20210122	50300	115000	---	9.88 S	1400	---	---	---
1/25/2021	SP-015-20210125-Feed	40300	---	---	---	1350	---	---	---
1/25/2021	SP-100-20210125-Lag	<5	---	---	---	1240	---	---	---
1/25/2021	SP-200-20210125-Mid	451	---	---	---	1310	---	---	---
1/25/2021	SP-300-20210125-Lead	26700	---	---	---	1360	---	---	---
1/26/2021	SP-015-20210126-Feed	45100	112000	---	7.14	1350	---	---	---
1/26/2021	SP-100-20210126-Lag	<5	<100	---	<0.5	1260	---	---	---
1/26/2021	SP-200-20210126-Mid	514	<200	---	<0.5	1330	---	---	---
1/26/2021	SP-300-20210126-Lead	28600	36800	---	1.37	1350	---	---	---
1/26/2021	Tank 1-20210126	47800	131000	---	8.22	1410	---	---	---
1/27/2021	SP-015-20210127-Feed	48900	---	---	---	1370	---	---	---
1/27/2021	SP-100-20210127-Lag	<5	---	---	---	1280	---	---	---
1/27/2021	SP-200-20210127-Mid	433	---	---	---	1320	---	---	---
1/27/2021	SP-300-20210127-Lead	30300	---	---	---	1380	---	---	---
1/28/2021	SP-015-20210128-Feed	49500	---	---	---	1340	---	---	---
1/28/2021	SP-100-20210128-Lag	<5	---	---	---	1290	---	---	---
1/28/2021	SP-200-20210128-Mid	459	---	---	---	1310	---	---	---
1/28/2021	SP-300-20210128-Lead	31100	---	---	---	1340	---	---	---
1/29/2021	SP-015-20210129-Feed	48000	97600	---	7.77	1460	---	---	---
1/29/2021	SP-100-20210129-Lag	<5	<100	---	<0.5	1410	---	---	---
1/29/2021	SP-200-20210129-Mid	528	<200	---	<0.5	1420	---	---	---
1/29/2021	SP-300-20210129-Lead	35900	36100	---	0.596	1470	---	---	---

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.1	E300.0	E300.0	A4500-P-E	A5310B	A2540D
		Perchlorate	Chlorate	Chlorate	Nitrate as N	Sulfate	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids
Sample Date	Sample ID	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2/1/2021	SP-015-20210201-Feed	52800	104000	---	<5	1400	---	---	---
2/1/2021	SP-100-20210201-Lag	<5	<100	---	<5	1430	---	---	---
2/1/2021	SP-200-20210201-Mid	486	<200	---	<5	1380	---	---	---
2/1/2021	SP-300-20210201-Lead	35700	14900	---	<5	1450	---	---	---
2/2/2021	SP-015-20210202-Feed	54000	105000	---	8.07	1480	---	5	---
2/2/2021	SP-100-20210202-Lag	<5	<100	---	<0.5	1450	---	---	---
2/2/2021	SP-200-20210202-Mid	447	<200	---	<0.5	1460	---	---	---
2/2/2021	SP-300-20210202-Lead	36300	35700	---	0.565	1490	---	---	---
2/2/2021	Tank 1-20210202	---	---	---	---	---	---	5.41	---
2/2/2021	Tank 2-20210202	54700	109000	---	7.92	1510	---	6.77	---
2/3/2021	SP-015-20210203-Feed	52400	---	---	---	1490	---	---	---
2/3/2021	SP-100-20210203-Lag C	---	---	---	---	1460	---	---	---
2/3/2021	SP-100-20210203-Lag G	<5	---	---	---	1410	---	---	---
2/3/2021	SP-200-20210203-Mid	983	---	---	---	1450	---	---	---
2/3/2021	SP-300-20210203-Lead	36900	---	---	---	1500	---	---	---
2/4/2021	AWF-20210204	54800	77500	---	8.18	1920	---	2.56	6
2/4/2021	IWF-20210204	530000	1410000	---	37.6	1490	---	2.49	<5
2/4/2021	SP-015-20200204-Feed	51500	---	---	---	---	---	---	---
2/4/2021	SP-100-20200204-Lag	<5	---	---	---	---	---	---	---
2/4/2021	SP-200-20200204-Mid	737	---	---	---	---	---	---	---
2/4/2021	SP-300-20200204-Lead	35100	---	---	---	---	---	---	---
2/5/2021	SP-015-20210205-Feed	53000	---	---	---	---	---	---	---
2/5/2021	SP-100-20210205-Lag	54	---	---	---	---	---	---	---
2/5/2021	SP-200-20210205-Mid	637	---	---	---	---	---	---	---
2/5/2021	SP-300-20210205-Lead	37900	---	---	---	---	---	---	---
2/8/2021	SP-015-20210208-Feed	53000	---	---	---	---	---	---	---
2/8/2021	SP-100-20210208-Lag	<5	---	---	---	---	---	---	---
2/8/2021	SP-200-20210208-Mid	651	---	---	---	---	---	---	---
2/8/2021	SP-300-20210208-Lead	36900	---	---	---	---	---	---	---
2/9/2021	SP-015-20210209-Feed	53900	---	---	---	1400	---	---	---

Table D.3
Test Scenario #1B - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314 Perchlorate µg/L	E300.1 Chlorate µg/L	E300.1 Chlorate mg/L	E300.0 Nitrate as N mg/L	E300.0 Sulfate mg/L	A4500-P-E Phosphorus, Total as P mg/L	A5310B Total Organic Carbon mg/L	A2540D Total Suspended Solids mg/L
2/9/2021	SP-100-20210209-Lag	20.8	---	---	---	1340	---	---	---
2/9/2021	SP-200-20210209-Mid	783	---	---	---	1380	---	---	---
2/9/2021	SP-300-20210209-Lead	38300	---	---	---	1390	---	---	---
2/9/2021	SP-400-20210209-Post	<5	---	---	---	1350	---	---	---
2/10/2021	SP-015-20210210-Feed	49100	---	---	---	---	---	---	---
2/10/2021	SP-100-20210210-Lag	<5	---	---	---	---	---	---	---
2/10/2021	SP-200-20210210-Mid	583	---	---	---	---	---	---	---
2/10/2021	SP-300-20210210-Lead	37000	---	---	---	---	---	---	---
2/10/2021	SP-400-20210210-Post	<5	---	---	---	---	---	---	---

Notes:

µg/L - micrograms per liter

mg/L - milligrams per liter

S - Associated matrix spike and duplicate outside of acceptable range.

J - Estimated value

L - Reported value was higher than the matrix spike.

1. Analysis of operational samples was performed at Silver State (an off-site laboratory) under quick turn-around time for immediate use in system operational inputs and were not validated in accordance with the NDEP-approved Work Plan and System Operation Manual.

Table D.4
Test Scenario #2 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.7	E200.7	E200.7	E200.7	A2540C	A4500-P-E	A5310B	A2540D	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Calcium	Magnesium	Manganese	Iron	Total Dissolved Solids	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/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
2/17/2021	Tank 2 - 20210217	101000	191000	11.8	2000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/18/2021	SP-015-20210218-Feed	101000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/18/2021	SP-100-20210218-Lag	54400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/18/2021	SP-200-20210218-Mid	70000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/18/2021	SP-300-20210218-Lead	85900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/19/2021	SP-015-20210219-Feed	98800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/19/2021	SP-100-20210219-Lag	67700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/19/2021	SP-200-20210219-Mid	83700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/19/2021	SP-300-20210219-Lead	96500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/22/2021	SP-015-20210222-Feed	91000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/22/2021	SP-100-20210222-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/22/2021	SP-200-20210222-Mid	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/22/2021	SP-300-20210222-Lead	7100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/23/2021	SP-015-20210223-Feed	79400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/23/2021	SP-100-20210223-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/23/2021	SP-200-20210223-Mid	1080	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/23/2021	SP-300-20210223-Lead	43800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/23/2021	Tank 1-20210223-	102000	208000	11.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/24/2021	SP-015-20210224-Feed	96000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/24/2021	SP-100-20210224-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/24/2021	SP-200-20210224-Mid	1320	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/24/2021	SP-300-20210224-Lead	60500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/25/2021	SP-015-20210225-Feed	88300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/25/2021	SP-100-20210225-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/25/2021	SP-200-20210225-Mid	19300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/25/2021	SP-300-20210225-Lead	75400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/25/2021	Tank 1-20210225	101000	209000	11.9	1830	407 L	184 L	0.673	0.954	7760	---	---	---	---	164	<5	<5	164	1770	1020	758
2/26/2021	SP-015-20210226-Feed	71000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/26/2021	SP-100-20210226-Lead	71700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/26/2021	SP-200-20210226-Mid	19300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/26/2021	SP-300-20210226-Lag	224	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/26/2021	SP-400-20210226-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/1/2021	SP-015-20210301-Feed	89000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/1/2021	SP-100-20210301-Lead	76800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/1/2021	SP-200-20210301-Mid	33100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/1/2021	SP-300-20210301-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/2/2021	SP-015-20210302-Feed	90400	158000	9.72	2040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/2/2021	SP-100-20210302-Lead	78400	51900	0.653	2060	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/2/2021	SP-200-20210302-Mid	38700	3350	<0.5	2050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/2/2021	SP-300-20210302-Lag	785	3480	<0.5	1990	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/3/2021	SP-015-20210303-Feed	89800	---	---	---	---	---	---	---	---	---	---	<5	---	---	---	---	---	---	---	---
3/3/2021	SP-100-20210303-Lead	79400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/3/2021	SP-200-20210303-Mid	49500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/3/2021	SP-300-20210303-Lag	657	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/3/2021	Tank 2 - 20210303	92900	---	---	---	---	---	---	---	---	---	---	20	---	---	---	---	---	---	---	---
3/4/2021	SP-015-20210304-Feed	80000	157000	10.5	2010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/4/2021	SP-100-20210304-Lead	85700	58000	0.607	2050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/4/2021	SP-200-20210304-Mid	5040	568	<0.5	2010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/4/2021	SP-300-20210304-Lag	<5	<100	<0.5	1980	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/5/2021	SP-015-20210305-Feed	79200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/5/2021	SP-100-20210305-Lead	82300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/5/2021	SP-200-20210305-Mid	1520	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/5/2021	SP-300-20210305-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/8/2021	SP-015-20210308	88700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/8/2021	SP-100-20210308	82100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/8/2021	SP-200-20210308	822	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/8/2021	SP-300-20210308	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/8/2021	Tank 1-20210308	108000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.4
Test Scenario #2 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.7	E200.7	E200.7	E200.7	A2540C	A4500-P-E	A5310B	A2540D	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Calcium	Magnesium	Manganese	Iron	Total Dissolved Solids	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/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
3/8/2021	Tank 2-20210308	101000	196000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	AWF-20210309	62800	82700	8.53	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	IWF-20210309	504000	1370000	36	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	SP-015-20210309-Feed	87800	181000	11.1	1,890 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	SP-100-20210309-Lead	85100	63800	0.537	1,890 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	SP-200-20210309-Mid	1820	902	<0.5	1,830 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	SP-300-20210309-Lag	<5	<100	<0.5	1,800 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	SP-400-20210309-Post	<5	<100	<0.5	1,780 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/2021	Tank 1-20210309	111000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/11/2021	SP-015-20210311-Feed	93700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/11/2021	SP-100-20210311-Lead	86300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/11/2021	SP-200-20210311-Mid	458	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/11/2021	SP-300-20210311-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/12/2021	SP-015-20210312-Feed	98200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/12/2021	SP-100-20210312-Lead	90500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/12/2021	SP-200-20210312-Mid	136	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/12/2021	SP-300-20210312-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/12/2021	Tank 2-20210312	112000	227000	12.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/15/2021	SP-015-20210315-Feed	88300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/15/2021	SP-100-20210315-Lead	74500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/15/2021	SP-200-20210315-Mid	529	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/15/2021	SP-300-20210315-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/16/2021	SP-015-20210316-Feed	86900	175000	10.9	1880	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/16/2021	SP-100-20210316-Lead	80500	49500	0.624	1900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/16/2021	SP-200-20210316-Mid	970	242	<0.5	1800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/16/2021	SP-300-20210316-Lag	<5	<100	<0.5	1760	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/16/2021	Tank 1-20210316	109000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/16/2021	Tank 2-20210316	107000	213000	13.2	1910	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/17/2021	SP-015-20210317-Feed	100000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/17/2021	SP-100-20210317-Lead	76500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/17/2021	SP-200-20210317-Mid	727	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/17/2021	SP-300-20210317-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/18/2021	SP-015-20210318-Feed	97800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/18/2021	SP-100-20210318-Lead	69300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/18/2021	SP-200-20210318-Mid	96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/18/2021	SP-300-20210318-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/19/2021	SP-015-20210319-Feed	89100	---	---	---	---	---	---	---	---	---	2.14	---	---	---	---	---	---	---	---	---
3/19/2021	SP-100-20210319-Lead	70700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/19/2021	SP-200-20210319-Mid	1430	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/19/2021	SP-300-20210319-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/19/2021	SP-400-20210319-Post	---	---	---	---	---	---	---	---	---	0.551 S	---	---	---	---	---	---	---	---	---	---
3/19/2021	Tank 2-20210319	---	---	---	---	---	---	---	---	---	---	6	---	---	---	---	---	---	---	---	---
3/22/2021	SP-015-20210322-Feed	102000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/22/2021	SP-100-20210322-Lead	82700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/22/2021	SP-200-20210322-Mid	1950	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/22/2021	SP-300-20210322-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/22/2021	Tank 1-20210322	124000	249000	15.1	1990	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/23/2021	SP-015-20210323-Feed	92800	161000	11.7	2010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/23/2021	SP-100-20210323-Lead	80700	46200	0.698	2020	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/23/2021	SP-200-20210323-Mid	524	<200	<0.5	1960	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/23/2021	SP-300-20210323-Lag	<5	<100	<0.5	1970	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/24/2021	SP-015-20210324-Feed	102000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/24/2021	SP-100-20210324-Lead	83600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/24/2021	SP-200-20210324-Mid	341	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/24/2021	SP-300-20210324-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/25/2021	SP-015-20210325-Feed	101000	174000	11.7	2,020 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/25/2021	SP-100-20210325-Lead	86500	62900	0.538	2,030 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/25/2021	SP-200-20210325-Mid	1210	<100	<0.5	1,960 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.4
Test Scenario #2 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.7	E200.7	E200.7	E200.7	A2540C	A4500-P-E	A5310B	A2540D	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Calcium	Magnesium	Manganese	Iron	Total Dissolved Solids	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/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
3/25/2021	SP-300-20210325-Lag	<5	<100	<0.5	1,970 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/26/2021	SP-015-20210326-Feed	92800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/26/2021	SP-100-20210326-Lead	85500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/26/2021	SP-200-20210326-Mid	581	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/26/2021	SP-300-20210326-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/26/2021	Tank 2-20210326	103000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/30/2021	SP-015-20210330-Feed	88000	187000	11.4	2040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/30/2021	SP-100-20210330-Lead	93500	79700	1.55	2020	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/30/2021	SP-200-20210330-Mid	1640	653	<0.5	2030	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/30/2021	SP-300-20210330-Lag	<5	<100	<0.5	1950	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/31/2021	SP-015-20210331-Feed	82200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/31/2021	SP-100-20210331-Lead	94100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/31/2021	SP-200-20210331-Mid	1020	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/31/2021	SP-300-20210331-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/31/2021	Tank 2-20210331-	103000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/1/2021	SP-015-20210401	83200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/1/2021	SP-100-20210401	93800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/1/2021	SP-200-20210401	629	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/1/2021	SP-300-20210401	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/2/2021	SP-015-20210402-Feed	91900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/2/2021	SP-100-20210402-Lead	92400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/2/2021	SP-200-20210402-Mid	520	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/2/2021	SP-300-20210402-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/5/2021	SP-015-20210405-Feed	89700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/5/2021	SP-100-20210405-Lead	89800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/5/2021	SP-200-20210405-Mid	1030	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/5/2021	SP-300-20210405-Lag	21.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/5/2021	Tank 2-20210405	94000	194000	12.4	1920	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/6/2021	SP-015-20210406-Feed	107000	---	---	1990	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/6/2021	SP-100-20210406-Lead	91200	---	---	1960	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/6/2021	SP-200-20210406-Mid	1410	---	---	1980	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/6/2021	SP-300-20210406-Lag	<5	---	---	1950	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/7/2021	SP-015-20210407-Feed	109000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/7/2021	SP-100-20210407-Lead	87700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/7/2021	SP-200-20210407-Mid	1500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/7/2021	SP-300-20210407-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/8/2021	SP-015-20210408-Feed	90900	---	---	1970	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/8/2021	SP-100-20210408-Lead	87400	---	---	1980	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/8/2021	SP-200-20210408-Mid	1370	---	---	1990	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/8/2021	SP-300-20210408-Lag	<5	---	---	1960	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/9/2021	SP-015-20210409-Feed	107000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/9/2021	SP-100-20210409-Lead	87400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/9/2021	SP-200-20210409-Mid	1460	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/9/2021	SP-300-20210409-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/12/2021	SP-015-20210412-Feed	76400	180000	10.6	1,950 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/12/2021	SP-100-20210412-Lead	84800	84800	1.25	1,920 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/12/2021	SP-200-20210412-Mid	1440	647	<0.5	1,940 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/12/2021	SP-300-20210412-Lag	<5	<100	<0.5	1,890 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/13/2021	SP-015-20210413-Feed	67100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/13/2021	SP-100-20210413-Lead	62300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/13/2021	SP-200-20210413-Mid	303	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/13/2021	SP-300-20210413-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/14/2021	AWF-20210414	62100	91500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/14/2021	IWF-20210414	481000	1380000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/14/2021	SP-015-20210414-Feed	84700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/14/2021	SP-100-20210414-Lead	72000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/14/2021	SP-200-20210414-Mid	689	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/14/2021	SP-300-20210414-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.4
Test Scenario #2 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.7	E200.7	E200.7	E200.7	A2540C	A4500-P-E	A5310B	A2540D	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Calcium	Magnesium	Manganese	Iron	Total Dissolved Solids	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/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
4/14/2021	Tank 2-20210414	103000	213000	13.5	1920	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/15/2021	SP-015-20210415-Feed	100000	---	---	1930	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/15/2021	SP-100-20210415-Lead	76300	---	---	1910	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/15/2021	SP-200-20210415-Mid	898	---	---	1920	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/15/2021	SP-300-20210415-Lag	<5	---	---	1870	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/15/2021	Tank 1-20210415	110000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/16/2021	SP-015-20210416-Feed	97600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/16/2021	SP-100-20210416-Lead	93800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/16/2021	SP-200-20210416-Mid	12200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/16/2021	SP-300-20210416-Lag	465	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/16/2021	Tank 2-20210416	106000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/19/2021	SP-015-20210419-Feed	90000	210000	---	1,930 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/19/2021	SP-100-20210419-Lead	90200	108000	---	1,910 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/19/2021	SP-200-20210419-Mid	17800	8,390 J	---	1,920 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/19/2021	SP-300-20210419-Lag	563	<100	---	1,910 S	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/19/2021	SP-400-20210419-Post	---	---	---	1950	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/20/2021	SP-015-20210420-Feed	88800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/20/2021	SP-100-20210420-Lead	89800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/20/2021	SP-200-20210420-Mid	15900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/20/2021	SP-300-20210420-Lag	281	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/20/2021	SP-400-20210420-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/21/2021	SP-015-20210421-Feed	103000	238000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/21/2021	SP-100-20210421-Lead	90800	112000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/21/2021	SP-200-20210421-Mid	44900	22800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/21/2021	SP-300-20210421-Lag	14300	1860	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/21/2021	SP-400-20210421-Post	13000	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/22/2021	SP-015-20210422-Feed	102000	227000	12	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/22/2021	SP-100-20210422-Lead	90600	108000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/22/2021	SP-200-20210422-Mid	47700	29400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/22/2021	SP-300-20210422-Lag	7610	1800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/22/2021	SP-400-20210422-Post	5820	366	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/23/2021	SP-015-20210423-Feed	100000	225000	12.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/23/2021	SP-100-20210423-Lead	88300	102000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/23/2021	SP-200-20210423-Mid	28600	17000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/23/2021	SP-300-20210423-Lag	1520	388	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/23/2021	SP-400-20210423-Post	337	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/23/2021	Tank 2-20210423	179000	496000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/26/2021	SP-015-20210426-Feed	140000	387000	12.4	1910	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/26/2021	SP-100-20210426-Lead	139000	148000	---	1800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/26/2021	SP-200-20210426-Mid	13200	11700	---	1880	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/26/2021	SP-300-20210426-Lag	1330	<100	---	1700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/26/2021	SP-400-20210426-Post	1530	<100	---	1700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/27/2021	SP-015-20210427-Feed	171000	431000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/27/2021	SP-100-20210427-Lead	152000	170000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/27/2021	SP-200-20210427-Mid	41200	20600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/27/2021	SP-300-20210427-Lag	2530	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/27/2021	SP-400-20210427-Post	179	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/28/2021	SP-015-20210428-Feed	168000	430000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/28/2021	SP-100-20210428-Lead	152000	185000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/28/2021	SP-200-20210428-Mid	49500	26100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/28/2021	SP-300-20210428-Lag	1750	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/28/2021	SP-400-20210428-Post	319	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/29/2021	SP-015-20210429-Feed	134000	161000	---	1900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/29/2021	SP-100-20210429-Lead	139000	7550	---	1900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/29/2021	SP-200-20210429-Mid	36800	769	---	1870	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/29/2021	SP-300-20210429-Lag	800	<100	---	1710	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/29/2021	SP-400-20210429-Post	208	<100	---	1720	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/29/2021	Tank 1-20210429	164000	428000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.4
Test Scenario #2 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.7	E200.7	E200.7	E200.7	A2540C	A4500-P-E	A5310B	A2540D	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Calcium	Magnesium	Manganese	Iron	Total Dissolved Solids	Phosphorus, Total as P	Total Organic Carbon	Total Suspended Solids	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/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
4/30/2021	SP-015-20210430-Feed	165000	390000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/30/2021	SP-100-20210430-Lead	133000	122000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/30/2021	SP-200-20210430-Mid	19400	5510	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/30/2021	SP-300-20210430-Lag	179	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/30/2021	SP-400-20210430-Post	65.3	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/3/2021	SP-015-20210503-Feed	143000	341000	14.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/3/2021	SP-100-20210503-Lead	115000	54200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/3/2021	SP-200-20210503-Mid	21700	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/3/2021	SP-300-20210503-Lag	335	<100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/3/2021	SP-400-20210503-Post	116	<100	---	---	---	---	---	---	---	0.367 S	---	---	---	---	---	---	---	---	---	---
5/4/2021	SP-015-20210504-Feed	152000	338000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/4/2021	SP-100-20210504-Lead	99500	47700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/4/2021	SP-200-20210504-Mid	12400	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/4/2021	SP-300-20210504-Lag	<5	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/4/2021	SP-400-20210504-Post	<5	<200	---	---	---	---	---	---	---	0.552 S	---	---	---	---	---	---	---	---	---	---
5/5/2021	SP-015-20210505-Feed	150000	328000	13.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/5/2021	SP-100-20210505-Lead	99100	51700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/5/2021	SP-200-20210505-Mid	10000	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/5/2021	SP-300-20210505-Lag	96.4	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/5/2021	SP-400-20210505-Post	<5	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/6/2021	SP-015-20210506-Feed	154000	348000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/6/2021	SP-100-20210506-Lead	126000	106000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/6/2021	SP-200-20210506-Mid	53300	7030	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/6/2021	SP-300-20210506-Lag	1690	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/6/2021	SP-400-20210506-Post	139	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/7/2021	SP-015-20210507-Feed	154000	362000	---	---	---	---	---	---	---	---	---	---	<0.1	---	---	---	---	---	---	---
5/7/2021	SP-100-20210507-Lead	123000	75700	---	---	---	---	---	---	---	---	---	---	<0.1	---	---	---	---	---	---	---
5/7/2021	SP-200-20210507-Mid	39800	6010	---	---	---	---	---	---	---	---	---	---	<0.1	---	---	---	---	---	---	---
5/7/2021	SP-300-20210507-Lag	2670	<200	---	---	---	---	---	---	---	---	---	---	<0.1	---	---	---	---	---	---	---
5/7/2021	SP-400-20210507-Post	609	<200	---	---	---	---	---	---	---	---	---	---	0.145	---	---	---	---	---	---	---
5/10/2021	SP-015-20210510-Feed	168000	426000	17.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/10/2021	SP-100-20210510-Lead	145000	126000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/10/2021	SP-200-20210510-Mid	182000	25800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/10/2021	SP-300-20210510-Lag	33600	1740	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/10/2021	SP-400-20210510-Post	22600	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/11/2021	SP-015-20210511-Feed	173000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/11/2021	SP-100-20210511-Lead	150000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/11/2021	SP-200-20210511-Mid	98900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/11/2021	SP-300-20210511-Lag	50600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/11/2021	SP-400-20210511-Post	37600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/12/2021	SP-015-20210512-Feed	177000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/12/2021	SP-100-20210512-Lead	147000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/12/2021	SP-200-20210512-Mid	109000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/12/2021	SP-300-20210512-Lag	63100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/12/2021	SP-400-20210512-Post	47800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L - micrograms per liter
mg/L - milligrams per liter
S - Associated matrix spike and duplicate outside of acceptable range.
J - Estimated value
L - Reported value was higher than the matrix spike.
1. Analysis of operational samples was performed at Silver State (an off-site laboratory) under quick turn-around time for immediate use in system operational inputs and were not validated in accordance with the NDEP-approved Work Plan and System Operation Manual.

Table D.5
Test Scenario #3 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.8	A3500-Cr B	E200.7	E200.7	A2540C	A4500-P-E	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Chromium	Chromium, Hexavalent	Calcium	Magnesium	Total Dissolved Solids	Phosphorus, Total as P	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/L	mg/L	mg/L	µg/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
5/20/2021	SP-015-20210520-Feed	105000	---	---	---	350 L	---	---	---	---	---	---	---	---	---	---	---	---	---
5/20/2021	SP-100-20210520-Lead	172000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/20/2021	SP-200-20210520-Mid	28400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/20/2021	SP-300-20210520-Post	16600	---	---	---	35 L	---	---	---	---	---	---	---	---	---	---	---	---	---
5/20/2021	Tank 2-20210520	106000	244000	13.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/21/2021	SP-015-20210521-Feed	106000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/21/2021	SP-100-20210521-Lead	104000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/21/2021	SP-200-20210521-Mid	68600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/21/2021	SP-300-20210521-Lag	20500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/24/2021	IWF-CP-20210524	---	---	---	---	4,000 L	---	---	---	---	---	---	---	---	---	---	---	---	---
5/24/2021	SP-015-20210524-Feed	105000	---	---	---	410 L	---	---	---	---	---	---	---	---	---	---	---	---	---
5/24/2021	SP-100-20210524-Lead	100000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/24/2021	SP-200-20210524-Mid	38500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/24/2021	SP-300-20210524-Lag	1360	---	---	---	27 L	---	---	---	---	---	---	---	---	---	---	---	---	---
5/24/2021	Tank 2-20210524	104000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/25/2021	SP-015-20210525	104000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/25/2021	SP-100-20210525	104000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/25/2021	SP-200-20210525	38200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/25/2021	SP-300-20210525	1110	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/26/2021	SP-015-20210526-Feed	100000	226000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/26/2021	SP-100-20210526-Lead	101000	114000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/26/2021	SP-200-20210526-Mid	37800	3800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/26/2021	SP-300-20210526-Lag	1190	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/27/2021	SP-015-20210527	103000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/27/2021	SP-100-20210527	101000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/27/2021	SP-200-20210527	35100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/27/2021	SP-300-20210527	1240	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/28/2021	SP-015-20210528-Feed	97600	---	---	---	450	---	---	---	---	---	---	---	---	---	---	---	---	---
5/28/2021	SP-100-20210528-Lead	89700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/28/2021	SP-200-20210528-Mid	33900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/28/2021	SP-300-20210528-Lag	1100	---	---	---	29	---	---	---	---	---	---	---	---	---	---	---	---	---
5/28/2021	SP-400-20210528-Post	629	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/28/2021	T-550-20210528-F	---	---	---	---	24	---	---	---	---	---	---	---	---	---	---	---	---	---
6/2/2021	SP-015-20210602-Feed	90800	---	---	---	440	---	---	---	---	---	---	---	---	---	---	---	---	---
6/2/2021	SP-100-20210602-Lead	82400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/2/2021	SP-200-20210602-Mid	36700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/2/2021	SP-300-20210602-Lag	3210	---	---	---	88	---	---	---	---	---	---	---	---	---	---	---	---	---
6/2/2021	T-550-20210602	---	---	---	---	14	---	---	---	---	---	---	---	---	---	---	---	---	---
6/2/2021	T-550-20210602-F	---	---	---	---	<10	---	---	---	---	---	---	---	---	---	---	---	---	---
6/2/2021	Tank 2-20210602	89400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/3/2021	SP-015-20210603-Feed	93200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/3/2021	SP-100-20210603-Lead	79900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/3/2021	SP-200-20210603-Mid	34900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/3/2021	SP-300-20210603-Lag	2220	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/3/2021	SP-400-20210603-Post	1570	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/4/2021	SP-015-20210604-Feed	86200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/4/2021	SP-100-20210604-Lead	70100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/4/2021	SP-200-20210604-Mid	19700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/4/2021	SP-300-20210604-Lag	406	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/4/2021	SP-400-20210604-Post	210	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.5
Test Scenario #3 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.8	A3500-Cr B	E200.7	E200.7	A2540C	A4500-P-E	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Chromium	Chromium, Hexavalent	Calcium	Magnesium	Total Dissolved Solids	Phosphorus, Total as P	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/L	mg/L	mg/L	µg/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
6/7/2021	SP-015-20210607-Feed	88400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/7/2021	SP-100-20210607-Lead	62400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/7/2021	SP-200-20210607-Mid	22800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/7/2021	SP-300-20210607-Lag	336	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/7/2021	SP-400-20210607-Post	155	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/8/2021	SP-015-20210608-Feed	90200	195000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/8/2021	SP-100-20210608-Lead	66400	34900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/8/2021	SP-200-20210608-Mid	5950	368	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/8/2021	SP-300-20210608-Lag	74.4	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/8/2021	SP-400-20210608-Post	64.4	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/8/2021	T-550-20210608-Treated	<5	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/9/2021	SP-015-20210609-Feed	92100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/9/2021	SP-100-20210609-Lead	68200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/9/2021	SP-200-20210609-Mid	21400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/9/2021	SP-300-20210609-Lag	823	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/9/2021	SP-400-20210609-Post	411	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/9/2021	T-550-20210609-Treated	200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/10/2021	SP-015-20210610-Feed	88200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/10/2021	SP-100-20210610-Lead	70000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/10/2021	SP-200-20210610-Mid	10700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/10/2021	SP-300-20210610-Lag	211	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/10/2021	SP-400-20210610-Post	120	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/11/2021	SP-015-20210611-Feed	86700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/11/2021	SP-100-20210611-Lead	73400	---	---	---	---	---	---	---	---	---	0.182	---	---	---	---	---	---	---
6/11/2021	SP-200-20210611-Mid	11000	---	---	---	---	---	---	---	---	---	<0.1	---	---	---	---	---	---	---
6/11/2021	SP-300-20210611-Lag	159	---	---	---	---	---	---	---	---	---	<0.1	---	---	---	---	---	---	---
6/11/2021	SP-400-20210611-Post	41.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/14/2021	SP-015-20210614-Feed	85600	---	---	---	---	---	407	192	8120	---	---	144	<5	<5	144	1810	1020	791
6/14/2021	SP-100-20210614-Lead	69600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/14/2021	SP-200-20210614-Mid	463	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/14/2021	SP-300-20210614-Lag	<5	---	---	---	---	---	423	199	7670	---	---	292	<5	<5	292	1880	1060	819
6/14/2021	SP-400-20210614-Post	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/15/2021	SP-015-20210615-Feed	88900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/15/2021	SP-100-20210615-Lead	50700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/15/2021	SP-200-20210615-Mid	774	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/15/2021	SP-300-20210615-Lag	44.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/15/2021	SP-400-20210615-Post	22.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/16/2021	SP-015-20210616-Feed	86300	---	---	---	---	---	---	---	---	---	1.44	---	---	---	---	---	---	---
6/16/2021	SP-100-20210616-Lead	54800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/16/2021	SP-200-20210616-Mid	2020	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/16/2021	SP-300-20210616-Lag	167	---	---	---	---	---	---	---	---	---	0.586	---	---	---	---	---	---	---
6/16/2021	SP-400-20210616-Post	102	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/17/2021	SP-015-20210617-Feed	88300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/17/2021	SP-100-20210617-Lead	54500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/17/2021	SP-200-20210617-Mid	4230	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/17/2021	SP-300-20210617-Lag	274	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/17/2021	SP-400-20210617-Post	153	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/18/2021	SP-300-20210618-Lag	1850	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/22/2021	SP-015-20210622-Feed	82900	200000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/22/2021	SP-100-20210622-Lead	58000	41200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.5
Test Scenario #3 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Sample ID	E314	E300.1	E300.0	E300.0	E200.8	A3500-Cr B	E200.7	E200.7	A2540C	A4500-P-E	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
		Perchlorate	Chlorate	Nitrate as N	Sulfate	Chromium	Chromium, Hexavalent	Calcium	Magnesium	Total Dissolved Solids	Phosphorus, Total as P	Ammonia, as N	Alkalinity, Bicarbonate (As CaCO3)	Alkalinity, Carbonate (As CaCO3)	Alkalinity, Hydroxide (As CaCO3)	Alkalinity, Total (As CaCO3)	Hardness (As CaCO3)	Hardness, Calcium (As CaCO3)	Hardness, Magnesium (As CaCO3)
		µg/L	µg/L	mg/L	mg/L	µg/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
6/22/2021	SP-200-20210622-Mid	5360	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/22/2021	SP-300-20210622-Lag	418	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/22/2021	SP-400-20210622-Post	213	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/23/2021	SP-015-20210623-Feed	101000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/23/2021	SP-100-20210623-Lead	74500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/23/2021	SP-200-20210623-Mid	4610	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/23/2021	SP-300-20210623-Lag	314	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/23/2021	SP-400-20210623-Post	249	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/24/2021	SP-015-20210624-Feed	98700	---	---	---	---	---	---	---	---	1.72 S	---	---	---	---	---	---	---	---
6/24/2021	SP-100-20210624-Lead	73900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/24/2021	SP-200-20210624-Mid	5240	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/24/2021	SP-300-20210624-Lag	219	---	---	---	---	---	---	---	---	0.94 S	---	---	---	---	---	---	---	---
6/24/2021	Tank 1-20210624	92000	195000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/25/2021	SP-015-20210625-Feed	91600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/25/2021	SP-100-20210625-Lead	47200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/25/2021	SP-200-20210625-Mid	3130	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/25/2021	SP-300-20210625-Lag	102	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/25/2021	SP-400-20210625-Post	75.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/28/2021	SP-015-20210628-Feed	95100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/28/2021	SP-100-20210628-Lead	40700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/28/2021	SP-200-20210628-Mid	1610	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/28/2021	SP-300-20210628-Lag	88.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/28/2021	SP-400-20210628-Post	79.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/29/2021	SP-015-20210629-Feed	95500	---	---	2100	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/29/2021	SP-100-20210629-Lead	43300	---	---	2130	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/29/2021	SP-200-20210629-Mid	<5	---	---	1920	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/29/2021	SP-300-20210629-Lag	45.3	---	---	1870	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/29/2021	SP-400-20210629-Post	35.1	---	---	1900	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/30/2021	SP-015-20210630-Feed	96900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/30/2021	SP-100-20210630-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/30/2021	SP-200-20210630-Mid	9650	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/30/2021	SP-300-20210630-Lead	87700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/1/2021	SP-015-20210701-Feed	96900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/1/2021	SP-100-20210701-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/1/2021	SP-200-20210701-Mid	547	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/1/2021	SP-300-20210701-Lead	82400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/2/2021	SP-015-20210702-Feed	93200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/2/2021	SP-100-20210702-Lag	31.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/2/2021	SP-200-20210702-Mid	1380	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/2/2021	SP-300-20210702-Lead	66400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/7/2021	SP-015-20210707-Feed	101000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/7/2021	SP-100-20210707-Lag	91.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/7/2021	SP-200-20210707-Mid	1510	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/7/2021	SP-300-20210707-Lead	74800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/7/2021	SP-400-20210707-Post	62.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/8/2021	SP-015-20210708-Feed	98000	---	---	---	370	0.501	---	---	---	---	---	---	---	---	---	---	---	---
7/8/2021	SP-100-20210708-Lag	98.4	---	---	---	<10	0.06	---	---	---	---	---	---	---	---	---	---	---	---
7/8/2021	SP-200-20210708-Mid	1500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/8/2021	SP-300-20210708-Lead	44300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/8/2021	SP-400-20210708-Post	---	---	---	---	<10	0.068	---	---	---	---	---	---	---	---	---	---	---	---

Table D.5
Test Scenario #3 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.0	E300.0	E200.8	A3500-Cr B	E200.7	E200.7	A2540C	A4500-P-E	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
Sample Date	Sample ID	Perchlorate µg/L	Chlorate µg/L	Nitrate as N mg/L	Sulfate mg/L	Chromium µg/L	Chromium, Hexavalent mg/L	Calcium mg/L	Magnesium mg/L	Total Dissolved Solids mg/L	Phosphorus, Total as P mg/L	Ammonia, as N mg/L	Alkalinity, Bicarbonate (As CaCO3) mg/L	Alkalinity, Carbonate (As CaCO3) mg/L	Alkalinity, Hydroxide (As CaCO3) mg/L	Alkalinity, Total (As CaCO3) mg/L	Hardness (As CaCO3) mg/L	Hardness, Calcium (As CaCO3) mg/L	Hardness, Magnesium (As CaCO3) mg/L
7/8/2021	SP-550-20210708	---	---	---	---	<10	0.044	---	---	---	---	---	---	---	---	---	---	---	---
7/8/2021	SP-551-20210708	---	---	---	---	<10	0.024	---	---	---	---	---	---	---	---	---	---	---	---
7/9/2021	SP-015-20210709-Feed	98900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/9/2021	SP-100-20210709-Lag	135	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/9/2021	SP-200-20210709-Mid	1730	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/9/2021	SP-300-20210709-Lead	37400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/12/2021	SP-015-20210712-Feed	95300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/12/2021	SP-100-20210712-Lag	1970	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/12/2021	SP-200-20210712-Mid	8380	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/12/2021	SP-300-0210712-Lead	36000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	SP-015-20210715-Feed	93100	---	---	---	460	0.497	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	SP-100-20210715-Lag	107	---	---	---	<20	0.027	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	SP-200-20210715-Mid	2000	---	---	---	<20	0.026	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	SP-300-20210715-Lead	37300	---	---	---	36	0.044	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	SP-400-20210715-Post	---	---	---	---	<20	0.039	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	SP-550-20210715	---	---	---	---	<20	0.027	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	SP-551-20210715	---	---	---	---	<10	0.02	---	---	---	---	---	---	---	---	---	---	---	---
7/15/2021	Tank 1 - 20210715	90900	184000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/19/2021	SP-015-20210719-FEED	90800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/19/2021	SP-100-20210719-LEAD	51700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/19/2021	SP-200-20210719-MID	60	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/19/2021	SP-300-20210719-LAG	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/20/2021	SP-015-20210720	---	---	---	---	440 L	0.478 S	---	---	---	---	---	---	---	---	---	---	---	---
7/20/2021	SP-100-20210720-Lead	41000	---	---	---	24 L	<0.01 S	---	---	---	---	---	---	---	---	---	---	---	---
7/20/2021	SP-200-20210720	265	---	---	---	<20 L	<0.01 S	---	---	---	---	---	---	---	---	---	---	---	---
7/20/2021	SP-300-20210720-Lag	<5	---	---	---	<20 L	0.035 S	---	---	---	---	---	---	---	---	---	---	---	---
7/20/2021	SP-400-20210720	---	---	---	---	<20 L	0.075 S	---	---	---	---	---	---	---	---	---	---	---	---
7/20/2021	SP-550-20210720	---	---	---	---	<20 L	0.015 S	---	---	---	---	---	---	---	---	---	---	---	---
7/20/2021	SP-551-20210720	---	---	---	---	<20 L	0.012 S	---	---	---	---	---	---	---	---	---	---	---	---
7/21/2021	SP-015-20210721-Feed	93200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/21/2021	SP-100-20210721-Lead	38500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/21/2021	SP-200-20210721-Mid	443	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/21/2021	SP-300-20210721-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/22/2021	SP-015-20210722-Feed	95500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/22/2021	SP-100-20210722-Lead	36200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/22/2021	SP-200-20210722-Mid	552	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/22/2021	SP-300-20210722-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/23/2021	SP-015-20210723-Feed	90400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/23/2021	SP-100-20210723-Lead	45600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/23/2021	SP-200-20210723-Mid	908	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/23/2021	SP-300-20210723-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/23/2021	Tank 2-20210723	95300	211000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/26/2021	SP-015-20210726-Feed	91800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/26/2021	SP-100-20210726-Lead	40300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/26/2021	SP-200-20210726-Mid	991	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/26/2021	SP-300-20210726-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/27/2021	SP-015-20210727-FEED	86500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/27/2021	SP-100-20210727-LEAD	37200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/27/2021	SP-200-20210727-MID	748	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/27/2021	SP-300-20210727-LAG	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table D.5
Test Scenario #3 - Operational Sample Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

		E314	E300.1	E300.0	E300.0	E200.8	A3500-Cr B	E200.7	E200.7	A2540C	A4500-P-E	A4500-NH3-D	A2320	A2320	A2320	A2320	A2340B	A2340B	A2340B
Sample Date	Sample ID	Perchlorate µg/L	Chlorate µg/L	Nitrate as N mg/L	Sulfate mg/L	Chromium µg/L	Chromium, Hexavalent mg/L	Calcium mg/L	Magnesium mg/L	Total Dissolved Solids mg/L	Phosphorus, Total as P mg/L	Ammonia, as N mg/L	Alkalinity, Bicarbonate (As CaCO3) mg/L	Alkalinity, Carbonate (As CaCO3) mg/L	Alkalinity, Hydroxide (As CaCO3) mg/L	Alkalinity, Total (As CaCO3) mg/L	Hardness (As CaCO3) mg/L	Hardness, Calcium (As CaCO3) mg/L	Hardness, Magnesium (As CaCO3) mg/L
7/28/2021	SP-015-20210728-Feed	89100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/28/2021	SP-100-20210728-Lead	37500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/28/2021	SP-200-20210728-Mid	538	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/28/2021	SP-300-20210728-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/29/2021	SP-015-20210729-Feed	90700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/29/2021	SP-100-20210729-Lead	37900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/29/2021	SP-200-20210729-Mid	217	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/29/2021	SP-300-20210729-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/30/2021	SP-015-20210730-FEED	82400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/30/2021	SP-100-20210730-LEAD	37500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/30/2021	SP-200-20210730-MID	2970	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7/30/2021	SP-300-20210730-LAG	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/2/2021	SP-015-20210802-FEED	98100	241000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/2/2021	SP-100-20210802-LEAD	42900	24900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/2/2021	SP-200-20210802-MID	14500	1600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/2/2021	SP-300-20210802-LAG	<5	<200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/3/2021	SP-015-20210803-FEED	104000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/3/2021	SP-100-20210803-LEAD	38900	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/3/2021	SP-200-20210803-MID	12000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/3/2021	SP-300-20210803-LAG	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/4/2021	SP-015-20210804-FEED	99800	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/4/2021	SP-100-20210804-LEAD	41600	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/4/2021	SP-200-20210804-MID	22300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/4/2021	SP-300-20210804-LAG	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/5/2021	SP-015-20210805-Feed	101000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/5/2021	SP-100-20210805-Lead	36300	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/5/2021	SP-200-20210805-Mid	18000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/5/2021	SP-300-20210805-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/6/2021	SP-015-20210806-Feed	94200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/6/2021	SP-100-20210806-Lead	44700	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/6/2021	SP-200-20210806-Mid	28400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/6/2021	SP-300-20210806-Lag	797	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/9/2021	SP-015-20210809-Feed	96100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/9/2021	SP-100-20210809-Lead	32500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/9/2021	SP-200-20210809-Mid	11500	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8/9/2021	SP-300-20210809-Lag	<5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L - micrograms per liter
mg/L - milligrams per liter
S - Associated matrix spike and duplicate outside of acceptable range.
J - Estimated value
L - Reported value was higher than the matrix spike.
1. Analysis of operational samples was performed at Silver State (an off-site laboratory) under quick turn-around time for immediate use in system operational inputs and were not validated in accordance with the NDEP-approved Work Plan and System Operation Manual.

Appendix E
Hydrogen, Carbon Dioxide, and Nitrogen Consumption

Table E.1
Hydrogen, Carbon Dioxide, and Nitrogen Consumption
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Sample Date	Feed Flow Rate	Influent Concentration			Influent Mass Loading				Hydrogen							Carbon Dioxide			Nitrogen						Air		
		E314.0	E300.1B	E300.0					Theoretical Hydrogen Requirement			Hydrogen Consumption			Excess Hydrogen Consumed	CO_2 Consumption			Daily Sparge Frequency	Sparge Duration[1]			N_2 Consumption		Air Consumption		
		Perchlorate	Chlorate	Nitrate as N	Perchlorate	Chlorate	Nitrate as N	Total Contaminant Mass Loading								Total		Per Pound of Contaminant		Lead	Middle	Lag	Total	Per Pound of Contaminant	Total		Per Pound of Contaminant
	gpm	ppb	ppb	ppb	lb/day	lb/day	lb/day	lb/day	sccm	mg/L	lb/day	sccm	mg/L	lb/day	%	sccm	ft³/day	ft³/lb		sec	sec	sec	ft³/day	ft³/lb	sccm	ft³/day	ft³/lb
Test Scenario #1A																											
9/15/2020	2.0	58,000	97,000	8,400	1.4	2.3	0.2	3.92	1,644	19	0.47	2370	28	0.67	44%	363	18.5	4.7	2	60	30	90	168	43	1800	91.5	23.3
9/21/2020	2.0	37,000	100,000	8,800	0.9	2.4	0.2	3.50	1,486	17	0.42	2381	28	0.67	60%	348	17.7	5.1	2	60	30	90	168	48	1800	91.5	26.1
11/6/2020	2.0	53,000	94,000	8,300	1.3	2.3	0.2	3.73	1,569	18	0.44	3577	42	1.01	128%	290	14.7	4.0	4	60	30	90	336	90	926	47.1	12.6
11/19/2020	1.6	43,000	54,000	8,500	0.8	1.0	0.2	2.03	919	14	0.26	3579	53	1.01	290%	394	20.0	9.9	4	60	30	90	336	166	222	11.3	5.6
Average	**1.9**	**47,750**	**86,250**	**8,500**	**1.1**	**2.0**	**0.2**	**3.30**	**1,404**	**17**	**0.40**	**2977**	**38**	**0.84**	**130%**	**349**	**17.7**	**5.9**	**3**	**60**	**30**	**90**	**252**	**87**	**1187**	**60.4**	**16.9**
Test Scenario #1B																											
1/18/2021	1.5	45,000	110,000	6,300	0.8	2.0	0.1	2.91	1,168	18	0.33	2679	42	0.76	129%	405	20.6	7.1	4	90	30	90	392	135	75	3.8	1.3
1/26/2021	1.5	52,000	110,000	6,800	0.9	2.0	0.1	3.04	1,231	19	0.35	1925	30	0.54	56%	312	15.8	5.2	4	90	30	90	392	129	112	5.7	1.9
2/2/2021	1.5	45,000	100,000	7,700	0.8	1.8	0.1	2.75	1,142	18	0.32	1587	25	0.45	39%	243	12.3	4.5	4	90	30	90	392	143	112	5.7	2.1
Average	**1.5**	**47,333**	**106,667**	**6,933**	**0.9**	**1.9**	**0.1**	**2.90**	**1,180**	**19**	**0.33**	**2064**	**32**	**0.58**	**75%**	**320**	**16.3**	**5.6**	**4**	**90**	**30**	**90**	**392**	**135**	**100**	**5.1**	**1.8**
Test Scenario #2																											
3/16/2021	0.75	88,100	163,000	9,360	0.8	1.5	0.1	2.35	941	30	0.27	1602	50	0.45	70%	414	21.0	9.0	4	60	30	90	336	143	150	7.6	3.3
3/23/2021	0.75	85,600	178,000	9,430	0.8	1.6	0.1	2.46	980	31	0.28	1503	47	0.43	53%	294	15.0	6.1	4	60	30	90	336	137	150	7.6	3.1
4/2/2021	0.75	95,700	191,000	9,300	0.9	1.7	0.1	2.67	1,055	33	0.30	1600	50	0.45	52%	216	11.0	4.1	4	60	30	90	336	126	100	5.1	1.9
4/12/2021	0.75	83,900	181,000	10,300	0.8	1.6	0.1	2.48	995	31	0.28	1603	50	0.45	61%	241	12.2	4.9	4	60	60	90	392	158	150	7.6	3.1
Average	**0.75**	**88,325**	**178,250**	**9,598**	**0.8**	**1.6**	**0.1**	**2.49**	**993**	**31**	**0.28**	**1577**	**49**	**0.45**	**59%**	**291**	**14.8**	**6.0**	**4**	**60**	**38**	**90**	**350**	**141**	**138**	**7.0**	**2.8**
Test Scenario #2 Additional Testing																											
4/30/2021	1.25	173,000	411,000	17,000	2.6	6.2	0.3	9.02	3,525	66	1.00	5600	105	1.58	59%	926	47.1	5.2	4	60	30	90	336	37	0	0.0	0.0
5/4/2021	1.25	165,000	372,000	13,500	2.5	5.6	0.2	8.26	3,199	60	0.90	4423	83	1.25	38%	837	42.6	5.2	4	60	30	90	336	41	0	0.0	0.0
Average	**1.3**	**169,000**	**391,500**	**15,250**	**2.5**	**5.9**	**0.2**	**8.64**	**3,362**	**63**	**0.95**	**5012**	**94**	**1.42**	**49%**	**882**	**44.8**	**5.2**	**4**	**60**	**30**	**90**	**336**	**39**	**0**	**0.0**	**0.0**
Test Scenario #3																											
6/29/2021	0.75	97,700	193,000	13,300	0.9	1.7	0.1	2.74	1,120	35	0.32	1993	62	0.56	78%	342	17.4	6.4	0	0	0	0	0	0	0	0.0	0.0
7/20/2021	0.75	94,900	210,000	12,900	0.9	1.9	0.1	2.86	1,158	36	0.33	1996	63	0.56	72%	300	15.3	5.3	0	0	0	0	0	0	0	0.0	0.0
7/27/2021	0.75	94,500	210,000	11,600	0.9	1.9	0.1	2.85	1,140	36	0.32	1993	62	0.56	75%	262	13.3	4.7	0	0	0	0	0	0	0	0.0	0.0
8/3/2021	0.75	80,600	215,000	13,200	0.7	1.9	0.1	2.78	1,127	35	0.32	1642	51	0.46	46%	185	9.4	3.4	0	0	0	0	0	0	0	0.0	0.0
8/9/2021	0.75	94,500	204,000	13,600	0.9	1.8	0.1	2.81	1,147	36	0.32	1542	48	0.44	34%	150	7.6	2.7	0	0	0	0	0	0	0	0.0	0.0
Average	**0.75**	**92,440**	**206,400**	**12,920**	**0.8**	**1.9**	**0.1**	**2.81**	**1,139**	**36**	**0.32**	**1833**	**57**	**0.52**	**61%**	**248**	**12.6**	**4.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0**	**0.0**

Notes
1. During air sparging operations, each reactor received nitrogen at a rate of 28 ft^3/min.
gpm - gallons per minute
ppb - parts per billion
lb/day - pounds per day
mg/L - milligram per liter
sccm - standard cubic centimeter per minute
% - percent
ft^3/day - cubic feet per day
ft^3/lb- cubic feet per pound
sec - seconds
ft^3/min- cubic feet per minute

Conversion Factors and Numerical Inputs

g to lb	453		Perchlorate Molecular Weight (Cl	99.5	g/mol
lb to gal	8.34		Chlorate Molecular Weight (ClO3-	83.5	g/mol
Minute per day	1440		Nitrate-N Molecular Weight	14	g/mol
Liter/gal to cm3	1000		gal to ft3	7.48	
cm3 to ft3	0.00003531		Liter to gal	3.785	
Density of hydrogen	0.089	g/L	cc to ft3	0.0000353	
Density of CO2	1.977	g/L			
Density of N2	1.25	g/L			

Appendix F
Biomass Data

Table F-1.
Solids Captured in Cartridge Filter
Hydrogen-Gas Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Date Installed	Date Removed	Solids in Filter (g)	Approximate Flux (gal)	Solids in Filter (mg/L)
Scenario #1A				
9/30/2021	10/4/2021	111.25	13,248	2.2
10/4/2021	10/4/2021	66.65	12,216	1.4
10/23/2021	10/27/2021	83.40	10,600	2.1
11/2/2021	11/5/2021	82.70	7,495	2.9
11/5/2021	11/7/2021	117.80	3,685	8.4
11/7/2021	11/9/2021	85.50	4,368	5.2
Average				3.7
Scenario #3				
5/19/2021	5/21/2021	109.35	1,440	20.1
6/16/2021	6/30/2021	55.90	16,416	0.9
6/30/2021	7/6/2021	111.55	6,480	4.5
7/6/2021	7/16/2021	39.45	10,800	1.0
7/16/2021	8/10/2021	27.30	20,000	0.4
Average				5.4

Note: The cartridge filter was not used for Test Scenario #1B and #2.

Table F.2
Cleaning Results
Hydrogen-Gas Based Permeable Membrane Pilot Study Report
Nevada Environmental Response Trust

Test Scenario	Sample Location	Sample Type	Sample Date	Sample ID	SM5310B	SM5310B	SM2540D	SW6010B	SW7199	SW6010B	SW6010B	SW6010B	SW6010B
					Total Organic Carbon	Dissolved Organic Carbon	Total Suspended Solids	Chromium	Chromium, Hexavalent	Calcium	Magnesium	Iron	Manganese
					mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Scenario #1A	SP-100	Pre pH Adjustment	11/24/2020	SP-100-20201124-PRE	1,100 P2	---	38	---	---	---	---	---	---
	SP-100	Post pH Adjustment	11/24/2020	SP-100-20201124-POST	1,000 P2	---	---	---	---	---	---	---	---
	SP-200	Pre pH Adjustment	11/24/2020	SP-200-20201124-PRE	560 P2	---	58 D	---	---	---	---	---	---
	SP-200	Post pH Adjustment	11/24/2020	SP-200-20201124-POST	550 P2	---	---	---	---	---	---	---	---
	SP-300	Pre pH Adjustment	11/24/2020	SP-300-20201124-PRE	720 P2	---	49	---	---	---	---	---	---
	SP-300	Post pH Adjustment	11/24/2020	SP-300-20201124-POST	700 P2	---	---	---	---	---	---	---	---
	Holding Tank	Post pH Adjustment	11/24/2020	HOLDING TANK-20201124	740 P2	---	1,300 D	---	---	---	---	---	---
Scenario #1B	SP-100	Pre pH Adjustment #1	2/16/2021	SP-100A-20210216-PRE	190	180	71 D	---	---	28	3.2	1.3	0.013 J
	SP-100	Pre pH Adjustment #2	2/16/2021	SP-100B-20210216-PRE	170	---	64 D	---	---	---	---	---	---
	SP-100	Pre pH Adjustment #3	2/16/2021	SP-100C-20210216-PRE	160	---	72 D	---	---	---	---	---	---
	SP-100	Post pH Adjustment	2/16/2021	SP-100-20210216-POST	160	160	83 D	---	---	62	6.9	2.1	0.022
	SP-200	Pre pH Adjustment #1	2/16/2021	SP-200A-20210216-PRE	240	230	81 D	---	---	47	7.7	1.8	0.034
	SP-200	Pre pH Adjustment #2	2/16/2021	SP-200B-20210216-PRE	240	---	130 D	---	---	---	---	---	---
	SP-200	Pre pH Adjustment #3	2/16/2021	SP-200C-20210216-PRE	240	---	190 D	---	---	---	---	---	---
	SP-200	Post pH Adjustment	2/16/2021	SP-200-20210216-POST	230	220	87 D	---	---	73	12	1.7	0.027
	SP-300	Pre pH Adjustment #1	2/16/2021	SP-300A-20210216-PRE	450	430	130 D	---	---	22	5.1	2.5	0.037
	SP-300	Pre pH Adjustment #2	2/16/2021	SP-300B-20210216-PRE	430	---	150 D	---	---	---	---	---	---
	SP-300	Pre pH Adjustment #3	2/16/2021	SP-300C-20210216-PRE	510	---	120 D	---	---	---	---	---	---
	SP-300	Post pH Adjustment	2/16/2021	SP-300-20210216-POST	420	410	54 D	---	---	85	25	1.1	0.018 J
	Holding Tank	Post pH Adjustment	2/17/2021	HOLDING TANK-20210217	160	160	340 D	---	---	---	---	---	---
Scenario #2	SP-100	Pre pH Adjustment #1	5/17/2021	SP-100A-202105-PRE	901	---	1,710	---	---	86.5	21.6	5.19	0.0746
	SP-100	Pre pH Adjustment #2	5/17/2021	SP-100B-202105-PRE	907	---	720	---	---	---	---	---	---
	SP-100	Pre pH Adjustment #3	5/17/2021	SP-100C-202105-PRE	774 B	---	1,300	---	---	---	---	---	---
	SP-100	Post pH Adjustment	5/17/2021	SP-100-202105-POST	112 B	---	140	---	---	195	89.8	3.38	0.159
	SP-200	Pre pH Adjustment #1	5/17/2021	SP-200A-202105-PRE	479 B	---	1,210	---	---	157	69.1	10.3	0.295
	SP-200	Pre pH Adjustment #2	5/17/2021	SP-200B-202105-PRE	515 B	---	1,220	---	---	---	---	---	---
	SP-200	Pre pH Adjustment #3	5/17/2021	SP-200C-202105-PRE	528 B	---	1,180	---	---	---	---	---	---
	SP-200	Post pH Adjustment	5/17/2021	SP-200-202105-POST	63.8	---	86	---	---	327	98.4	1.96	0.707
	SP-300	Pre pH Adjustment #1	5/17/2021	SP-300A-202105-PRE	316 B	---	987	---	---	87.4	34.3	7.58	0.169
	SP-300	Pre pH Adjustment #2	5/17/2021	SP-300B-202105-PRE	311	---	920	---	---	---	---	---	---
	SP-300	Pre pH Adjustment #3	5/17/2021	SP-300C-202105-PRE	228	---	960	---	---	---	---	---	---
	SP-300	Post pH Adjustment	5/17/2021	SP-300-202105-POST	46.3	---	58 P1	---	---	277	92.9	5.56	0.566
	Holding Tank	Post pH Adjustment	5/18/2021	HOLDINGTANK-202105	288	---	420	1.3	<0.00015 U J6	---	---	---	---
Scenario #3	SP-100	Pre pH Adjustment #3	8/24/2021	SP-100C-20210824-PRE	771	---	717	---	---	---	---	---	---
	SP-100	Pre pH Adjustment #2	8/24/2021	SP-100B-20210824-PRE	765	---	1,670	---	---	---	---	---	---
	SP-100	Pre pH Adjustment #1	8/24/2021	SP-100A-20210824-PRE	642	---	3,410	---	---	---	---	---	---
	SP-100	Post pH Adjustment	8/25/2021	SP-100-20210825-POST	167	---	7.7	---	---	---	---	---	---
	SP-200	Pre pH Adjustment #3	8/24/2021	SP-200C-20210824-PRE	183	---	1,460	---	---	---	---	---	---
	SP-200	Pre pH Adjustment #2	8/24/2021	SP-200B-20210824-PRE	187	---	936 J3	---	---	---	---	---	---
	SP-200	Pre pH Adjustment #1	8/24/2021	SP-200A-20210824-PRE	187	---	1,790	---	---	---	---	---	---
	SP-200	Post pH Adjustment	8/25/2021	SP-200-20210825-POST	647	---	7.47	---	---	---	---	---	---
	SP-300	Pre pH Adjustment #3	8/24/2021	SP-300C-20210824-PRE	226	---	1,140	---	---	---	---	---	---
Scenario #3 (continued)	SP-300	Pre pH Adjustment #2	8/24/2021	SP-300B-20210824-PRE	224	---	585	---	---	---	---	---	---
	SP-300	Pre pH Adjustment #1	8/24/2021	SP-300A-20210824-PRE	206	---	1,650	---	---	---	---	---	---
	SP-300	Post pH Adjustment	8/25/2021	SP-300-20210825-POST	206	---	533	---	---	---	---	---	---

Notes

mg/L - milligram per liter

B - The same analyte is found in the associated blank.

D - Sample results are obtained from a dilution; the surrogate or matrix spike recoveries reported are calculated from diluted samples.

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

J3 - The associated batch QC was outside the established quality control range for precision.

J6 - The sample matrix interfered with the ability to make any accurate determination; spike value is low.

P1 - RPD value not applicable for sample concentrations less than 5 times the reporting limit.

P2 - The sample was received with pH>2.

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

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

Total Organic Carbon and Total Suspended Solids analysis was performed for biomass quantification. Dissolved organic carbon analysis was performed to verify Total Organic Carbon Analysis. Metals analysis was performed to evaluate if metals were contributing membrane fouling. Based on the metals results, APT does not think metals are contributing to module fouling.

Table F.3
Biomass Data From FBR
Hydrogen-Gas Based Permeable Membrane Pilot Study Program
Nevada Environmental Response Trust

	Bio-solids at DAF (ppm)	Ferric Cl- at DAF (ppm)	Polymer at DAF (ppm)	Ton Pressed Solids/ Month
5/1/2022	16.39	5.42	11.12	31
6/1/2020	15.68	5.79	11.79	34.2
7/1/2020	13.17	5.68	10.61	27
8/1/2020	14.18	4.94	10.07	25.7
9/1/2020	13.29	5.24	11.27	30.3
10/1/2020	13.12	5.43	11.22	25.6
11/1/2020	14.22	4.94	10.61	25.7
12/1/2020	20.15	5.16	10.97	44.6
1/1/2021	18.4	5.27	12.37	40.5
2/1/2021	17.97	7.65	11.64	37.9
3/1/2021	17.48	7.13	11.64	34.4
4/1/2021	17.01	6.42	11.71	33.1
5/1/2021	12.5	6.52	11.23	23.2
6/1/2021	16.55	6.67	9.19	31.7
7/1/2021	14.46	5.27	12.37	28.8

Appendix G
Hypothetical Full-Scale Design Cost Tables

Appendix G Hypothetical Equipment and Instrumentation List

Equipment	Capacity	Construction Material	Qty	Unit Cost	Total Cost
Tanks					
Equalization Tank	1.5 MM gal	Lined Carbon steel	1	$1,788,500	$1,788,500
Reactors Holding Modules	120,000 gal	30 x 64 x 8 ft	3	$1,070,000	$3,210,000
Caustic Holding Tank	5,000 gal	Cylindrical FRP or Carbon Steel	1	$32,000	$32,000
Spent Caustic Holding Tank	35,000 gal	Cylindrical Carbon Steel	1	$300,500	$300,500
Backwash Holding Tank	40,000 gal	Cylindrical Carbon Steel with Cone Bottom	1	$428,000	$428,000
Carbon dioxide tank	2,000 gal	Carbon Steel	1	$16,000	$16,000
Subtotal					*$5,775,000*
Other Equipment					
Nitrogen Separator/Nitrogen Tanks	---/2,200 gal	Proprietary from Generon	1	$1,070,000	$1,070,000
Centrifuge		Western States Q520 centrifuge	1	$535,000	$535,000
Membrane Modules			4,051	$2,140	$8,669,200
Air compressor	75 HP	Carbon steel	1	$187,300	$187,300
Polymer Addition System			1	$21,000	$21,000
Media filter	8 ft diameter	FRP	1	$193,000	$193,000
Subtotal					*$10,676,000*
Pumps					
Influent Pump	1,200 gpm	316 Stainless Steel, 50 HP	2	$25,000	$50,000
Reactor Recirculation Pump	12,500 gpm	316 Stainless Steel, 200 HP	6	$154,500	$927,000
Cleaning Solution Recirculation Pump	100 gpm	316 Stainless Steel, 5 HP	6	$3,000	$18,000
Raw Caustic Transfer Pump	50 gpm	316 Stainless Steel , 3 HP	4	$2,500	$10,000
Spent Caustic Pump	100 gpm	316 Stainless Steel , 5 HP	6	$3,100	$18,600
Backwash Pump	1,500 gpm	316 Stainless Steel, 60 HP	2	$26,750	$53,500
Decant Pump	100 gpm	316 Stainless Steel, 5 HP	2	$3,000	$6,000
Centrate Pump	50 gpm	316 Stainless Steel, 3 HP	2	$2,500	$5,000
Nutrient Metering Pump	0.5 gph		2	$2,500	$5,000
Subtotal					*$1,094,000*
Instruments					
Flow Control Valve		Modulating	2	$8,000	$16,000
Control valve for different sections		Open and Close	36	$4,300	$154,800
Control Valve for caustic flow to each section		Open and Close	36	$4,300	$154,800
Control Valve for spent caustic flow from each section		Open and Close	36	$4,300	$154,800
Feed flowmeter	1200 gpm	316 Stainless Steel or PTFE	1	$8,000	$8,000
Module recirculation pressure transmitter		316 Stainless Steel	3	$2,150	$6,500
Nitrate Analyzer			3	$2,150	$6,500
pH meter		PPS and lead-free membrane glass	3	$1,600	$4,800
ORP meter		PPS and lead-free membrane glass	3	$1,600	$4,800
Pulse manifold	12 in by 10 ft	PVC	36	$2,150	$77,400
Temperature transmitter		316 Stainless Steel	4	$1,600	$6,400
Level transmitter		PTFE	6	$1,600	$9,600
Hydrogen mass flow controller		316 Stainless Steel	3	$3,200	$9,600
Subtotal					*$614,000*
			Total		**$18,159,000**

Notes:
gal – gallon
gpm – gallons per minute
ft – feet
hp – horsepower
lb/day – pounds per day
FRP – Fiberglass Reinforced Plastic
PPS – Polyphenylene Sulfide
PTFE - Poly Tetrafluoroethylene
ORP – Oxidation-Reduction Potential