

# TECHNICAL MEMORANDUM

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**To:** Nevada Environmental Response Trust

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**Cc:** Nevada Division of Environmental Protection  
United States Environmental Protection Agency

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**From:** Arul Ayyaswami and Dan Pastor

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**Date:** June 8, 2018

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**Subject:** Unit 4 Source Area In-Situ Bioremediation Treatability Study Monthly Progress Report

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At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this memorandum that summarizes Tetra Tech's progress made during April 2018 toward successfully implementing the Unit 4 Source Area In-Situ Bioremediation Treatability Study. The location of the treatability study is depicted on Figure 1 and the location of proposed borings and monitoring wells are depicted on Figure 2.

## Task Progress Update: April 2018

### Task M21 – Unit 4 Source Area In-situ Bioremediation Treatability Study

- Task Leader – Arul Ayyaswami
- Current Status

#### Bench-Scale Studies

- The University of Nevada – Las Vegas (UNLV) continues microcosm testing with a combination of carbon substrates, mixed microbial cultures, and soil and groundwater collected from boring locations in the vicinity of the Unit 4 Building. Evaluation of the microcosm results indicates:
  - Hexavalent chromium completely reduced within 14 days and nitrate completely degraded within 83 days in microcosms containing molasses, soil, a mixed bacterial culture, and groundwater collected from monitoring well M-251-100 that has been diluted at a 1:1 ratio.
  - Hexavalent chromium completely reduced within 77 days in microcosms containing molasses, soil, a mixed bacterial culture, and undiluted groundwater. Nitrate, chlorate, and perchlorate have not yet degraded in these microcosms.
  - Chlorate concentrations reduced from approximately 13,000 mg/L to 3,600 mg/L and perchlorate concentrations reduced from approximately 1,800 mg/L to 570 mg/L after 63 days in microcosms containing molasses, groundwater diluted at a 1:1 ratio, and a mixed bacterial culture. Due to the extended duration of testing and number of samples collected, there was insufficient water present in these microcosms to collect additional

samples for analysis. Therefore, a separate set of microcosms containing molasses, groundwater diluted at a 1:1 ratio, and a mixed bacterial culture is currently being sampled to evaluate chlorate and perchlorate reduction. Chlorate and perchlorate have not yet started to degrade in the new set of microcosms.

- Microcosms containing emulsified vegetable oil, soil, and a mixed bacterial culture did not promote significant biodegradation with undiluted groundwater or groundwater diluted at a 1:1 ratio from M-251-100. This is due to the soil absorbing a significant amount of oil, leaving very little remaining for immediate use by bacteria. A more soluble substrate appears to be better suited for these conditions.
- The potential toxicity of hexavalent chromium to bacteria was evaluated with microcosms containing various ratios of diluted groundwater and groundwater treated with an ion-exchange resin to remove hexavalent chromium. Hexavalent chromium does not appear to be toxic to the bacteria at the concentration present in the undiluted groundwater collected from monitoring well M-251-100 (110 milligrams per liter).
- The slow chlorate and perchlorate degradation being observed is attributed to high salt content. Additional testing will be performed to determine the concentration ratios for optimal perchlorate degradation and hexavalent chromium reduction for use in field testing.

#### **Pre-Field Activities**

- On April 12, 2018, the Underground Injection Control permit application was approved by the Nevada Department of Environmental Protection Bureau of Water Pollution Control.
- Tronox ground breaking permit applications were submitted for the additional drilling and excavation activities within the basement of the former Unit 4 cell building and to the east of the former Unit 4 cell building.
- **Schedule and Progress Updates**
  - UNLV microcosm testing will continue in May 2018 in accordance with the Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Work Plan. The Trust is planning to submit a Treatability Study Modification Request in June 2018 for the Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale study. This modification proposes additional work to evaluate the use of citric acid and nano-scale zero valent iron to biodegrade chemicals of concern and to determine the degradation rate for chloroform.
  - Following receipt of the Tronox ground breaking permit for the basement area, the following injection/extraction wells and groundwater monitoring wells are planned for installation in May 2018:
    - U4-E-01I and U4-E-01D
    - U4-E-02I and U4-E-02D
    - U4-E-04I and U4-E-04D
    - U4-E-05I and U4-E-05D
    - U4IS-MW-02I and U4IS-MW-02D

Proposed well locations are shown on the attached Figure 2. The attached Table 1 provides the proposed well construction details, Table 2 provides the proposed soil sampling parameters, and Table 3 provides the proposed groundwater monitoring parameters. These wells are associated with the pre-implementation Part 1 activities, which are necessary to obtain information for the design and installation of the remaining wells as part of the pre-implementation Part 2 activities. The findings from the pre-implementation Part 2 activities and the design for the remaining wells are anticipated to be presented in a fourth quarter 2018 Stakeholder's Roundtable meeting,

- followed by an independent third-party cost review and submittal of the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum.
- Geotechnical borings G-1 through G-6 (see the attached Figure 2) associated with geotechnical and structural evaluation are planned to be drilled starting on May 15, 2018 to a depth of up to 60 feet below ground surface. Soil samples will be collected from depths selected by a geotechnical engineer and analyzed by a geotechnical laboratory for one or more of the following physical properties:
    - Moisture content by ASTM D2216
    - Gradation with Hydrometer by ASTM D422
    - Liquid and Plastic Limits by ASTM D4318
    - Direct Shear by AASHTO T236
    - Swell/Collapse of Soils (Method B) by ASTM D4546
  - Health and Safety
    - There were no health and safety incidents related to Task M21 during April 2018.

## CERTIFICATION

### Unit 4 Source Area Bioremediation Treatability Study Monthly Progress 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:** , not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

*not individually, but solely as  
Pres. Trust*

**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:** 6/18/18

## CERTIFICATION

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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:** Unit 4 Source Area Bioremediation Treatability Study Monthly Progress Report, Nevada Environmental Response Trust Site, Henderson, Nevada



June 8, 2018

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**Kyle Hansen, CEM**  
Field Operations Manager/Geologist  
Tetra Tech, Inc.

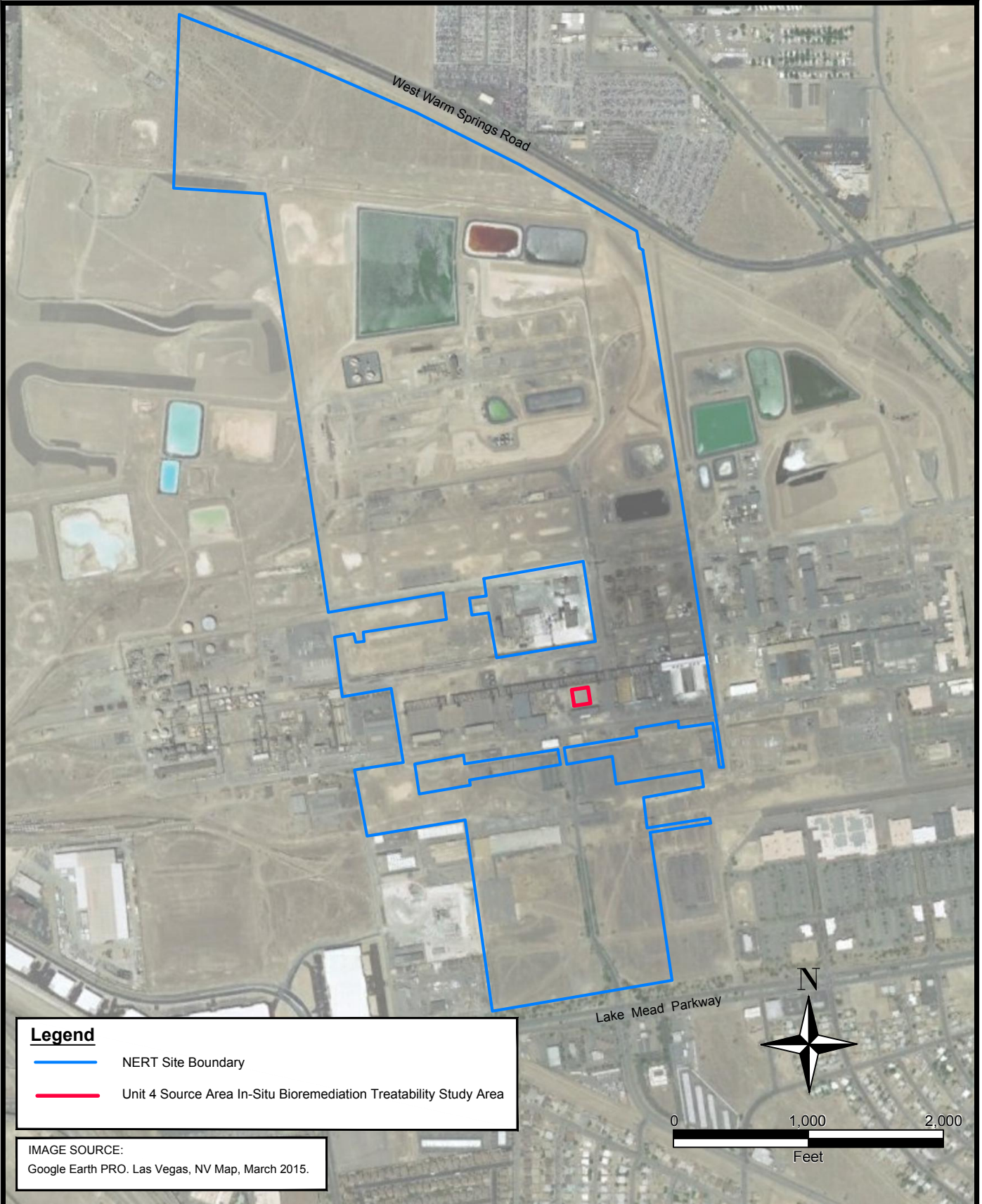
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Date

Nevada CEM Certificate Number: 2167  
Nevada CEM Expiration Date: September 18, 2018

# Figures

tts148fs1.tt.local\P: Figure 1 - Proposed Unit 4 Treatability Study Location 87600016.dwg



**Legend**

- NERT Site Boundary
- Unit 4 Source Area In-Situ Bioremediation Treatability Study Area

IMAGE SOURCE:  
Google Earth PRO. Las Vegas, NV Map, March 2015.

 <p>www.tetratech.com 150 S. 4th Street, Unit A Henderson, Nevada 89015 PHONE: (702) 854-2293</p>	<p>NEVADA ENVIRONMENTAL RESPONSE TRUST SITE</p> <p>UNIT 4 SOURCE AREA IN-SITU BIOREMEDIATION TREATABILITY STUDY WORK PLAN</p> <p><b>SITE LOCATION MAP</b></p>	<p>Project No: 87600016</p> <p>Date: OCTOBER 27, 2017</p> <p>Designed By: PK</p>
	<p>Figure No.</p> <p><b>1</b></p>	

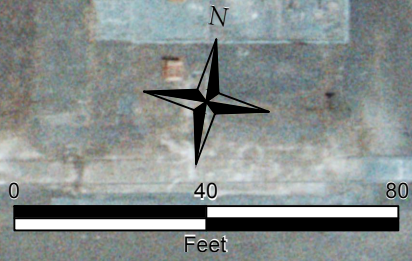


**Legend**

- Geotechnical Soil Boring Location
- ⊙ Existing Third Mobilization Monitoring Well
- Proposed Qal Monitoring Well
- ⊙ Proposed Vadose Zone Injection Well
- ⊙ Proposed Nested Monitoring Well
- ⊙ Proposed UMCf Injection/Extraction Well Cluster (2 Screen Intervals)
- In-Situ Bioremediation Area
- Soil Flushing Area
- Unit 4 Treatability Study Area
- Department of Homeland Security Restricted Area
- Existing Unit 4 Building

**Notes:**

1. All locations are approximate.
2. Imagery Source: Aerotech Mapping, August 2016.
3. Well location source: Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan, Tetra Tech, 2017.




**TETRA TECH**

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NEVADA ENVIRONMENTAL RESPONSE TRUST SITE  
 UNIT 4 SOURCE AREA IN-SITU BIOREMEDIATION TREATABILITY STUDY

**BORING AND WELL LOCATIONS**

Project No:	117-7502018
Date:	JUNE 4, 2018
Designed By:	CL
Figure No.	<b>2</b>



# Tables

**Table 1 - Well Construction Details**  
Unit 4 Bioremediation Treatability Study

Well ID	Borehole Size (inches)	Well Diameter (inches)	Well Material (blank casing)	Well Vault	Filter Pack Material	Screen Material	Screen Interval (feet bgs)	Screen Top (feet bgs)	Screen Bottom (feet bgs)	Screen Length (feet)	Total Depth of Borehole (feet bgs)	Total Depth of Well (feet bgs)
U4-E-01I	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	75-90	75	90	15	92	90.5
U4-E-01D	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	95-110	95	110	15	115	110.5
U4-E-02I	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	75-90	75	90	15	92	90.5
U4-E-02D	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	95-110	95	110	15	115	110.5
U4-E-04I	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	75-90	75	90	15	92	90.5
U4-E-04D	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	95-110	95	110	15	115	110.5
U4-E-05I	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	75-90	75	90	15	92	90.5
U4-E-05D	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	95-110	95	110	15	115	110.5
U4IS-MW-02I	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	75-90	75	90	15	92	90.5
U4IS-MW-02D	8.63	4	Sch. 80 PVC	18-in. Diameter Round	#2/16 Sand	4-in SS 0.010"	95-110	95	110	15	115	110.5

**Notes:**

- amsl Above mean sea level
- bgs Below ground surface
- btoc Below top of casing
- GW Groundwater
- in Inches
- PVC Polyvinyl Chloride
- Sch. Schedule
- TOC Top of Casing
- SS Stainless Steel

**Table 2 - Soil Sample Analytical Program**  
Unit 4 Source Area Bioremediation Treatability Study

Baseline Monitoring Parameters		Monitoring Wells									
Parameter	Analytical Method	U4-E-01I	U4-E-01D	U4-E-02I	U4-E-02D	U4-E-04I	U4-E-04D	U4-E-05I	U4-E-05D	U4IS-MW-02I	U4IS-MW-02D
<b>Soil Analytical Parameters</b>											
Perchlorate	E314.0		X		X		X		X		
Chlorate/Chlorite	E300.1		X		X		X		X		
Chloroform	SW8260		X		X		X		X		
Hexavalent Chromium	SW7199		X		X		X		X		
Total Chromium	SW6010B		X		X		X		X		
Total Organic Carbon	SM5130B		X		X		X		X		
pH	SW846 9045C		X		X		X		X		
Soluble Cations and Anions	SW6010B/300.1/E300.1/SM2320B		X		X		X		X		
Total Dissolved Solids	SM2540C		X		X		X		X		
Metals	SW 846 6010/6020		X		X		X		X		

No samples sent to lab

**Notes:**

MS/MSD not applicable to TDS, alkalinity, hardness, methane.

Field Blank

Equipment Blank

**\*below ground surface of basement floor in Unit 4**

\*Samples will be collected from the deep boring only at depths of 70, 75, 80, 85, 90, 95, 100, 105, 110, and 115 feet bgs.

**Table 3 - Groundwater Monitoring Parameters**  
Unit 4 Source Area Bioremediation Treatability Study

Baseline Monitoring Parameters		Monitoring Wells									
Parameter	Analytical Method	U4-E-01I	U4-E-01D	U4-E-02I	U4-E-02D	U4-E-04I	U4-E-04D	U4-E-05I	U4-E-05D	U4IS-MW-02I	U4IS-MW-02D
<b>Field Parameters</b>											
Ferrous Iron	HACH 8008	X	X	X	X	X	X	X	X	X	X
Ferric Iron	HACH 8147	X	X	X	X	X	X	X	X	X	X
Sulfite	HACH 8216	X	X	X	X	X	X	X	X	X	X
Sulfide	HACH 8131	X	X	X	X	X	X	X	X	X	X
DO	Horiba Water Quality Meter	X	X	X	X	X	X	X	X	X	X
ORP	Horiba Water Quality Meter	X	X	X	X	X	X	X	X	X	X
pH	Horiba Water Quality Meter	X	X	X	X	X	X	X	X	X	X
Temperature	Horiba Water Quality Meter	X	X	X	X	X	X	X	X	X	X
Turbidity	Horiba Water Quality Meter	X	X	X	X	X	X	X	X	X	X
Conductivity	Horiba Water Quality Meter	X	X	X	X	X	X	X	X	X	X
<b>Laboratory Analyses</b>											
Perchlorate	E314.0	X	X	X	X	X	X	X	X	X	X
Chlorate/Chlorite	E300.1	X	X	X	X	X	X	X	X	X	X
Chloride	E300.0	X	X	X	X	X	X	X	X	X	X
Hexavalent Chromium	SW7199	X	X	X	X	X	X	X	X	X	X
Total Chromium	SW-6010B	X	X	X	X	X	X	X	X	X	X
Chloroform	SW-846 8260B	X	X	X	X	X	X	X	X	X	X
VOCs	SW-846 8260B	X	X	X	X	X	X	X	X	X	X
Ammonium	E300/SW9056	X	X	X	X	X	X	X	X	X	X
Methane	RSK175	X	X	X	X	X	X	X	X	X	X
Alkalinity	SM 2320B	X	X	X	X	X	X	X	X	X	X
Potassium	SW6010B	X	X	X	X	X	X	X	X	X	X
Sodium	SW6010B	X	X	X	X	X	X	X	X	X	X
Calcium	200.7	X	X	X	X	X	X	X	X	X	X
Dissolved Metals	SW6010/6020	X	X	X	X	X	X	X	X	X	X
Hardness	SM2340C	X	X	X	X	X	X	X	X	X	X
Magnesium	200.7	X	X	X	X	X	X	X	X	X	X
Manganese	SW6010B	X	X	X	X	X	X	X	X	X	X
Nitrate	E300/SW9056	X	X	X	X	X	X	X	X	X	X
Sulfate	E300/SW9056	X	X	X	X	X	X	X	X	X	X
Total Nitrogen	E351.1	X	X	X	X	X	X	X	X	X	X
Total Phosphorus	E365.1	X	X	X	X	X	X	X	X	X	X
TDS	SM2540C	X	X	X	X	X	X	X	X	X	X
TOC	SM5310B	X	X	X	X	X	X	X	X	X	X
TSS	160.2	X	X	X	X	X	X	X	X	X	X

**Notes:**

BL: Baseline

EC: Electrical conductivity

DO: Dissolved Oxygen

ORP: Oxidation-reduction potential

TOC: Total organic carbon

TDS: Total dissolved solids

Dissolved metals includes the following: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, thallium, uranium, vanadium, and zinc