# Winter Field Data Report for Water Quality Study for Hylife Foods Facility Expansion

*Final Report*

October 20, 2021

Prepared for:

Hylife Foods LP

Prepared by:

Stantec Consulting Ltd.

111440368

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Prepared by _____
(signature)

**Johanna Theroux, M.Sc.**

(signature)

**Megan Hughesman, M.Sc., P.Geol.**

Approved by _____
(signature)

**Stephen Biswanger, P.Eng.**

# Table of Contents



## LIST OF TABLES



## LIST OF FIGURES

## LIST OF APPENDICES

# Abbreviations

| | |
|---|---|
| BOD | Biochemical Oxygen Demand |
| DO | Dissolved Oxygen |
| DOC | Dissolved Organic Carbon |
| IWWTF | Industrial Wastewater Treatment Facility |
| N | Nitrogen |
| NTU | Nephelometric Turbidity Unit |
| P | Phosphorus |
| TDS | Total Dissolved Solids |
| TIC | Total Inorganic Carbon |
| TKN | Total Kjeldahl Nitrogen |
| TN | Total Nitrogen |
| TOC | Total Organic Carbon |
| TP | Total Phosphorus |
| TSS | Total Suspended Solids |
| WSC | Water Survey of Canada |

# 1.0 BACKGROUND

The planned expansion of the Hylife Foods LP (Hylife) pork processing facility in Neepawa, Manitoba to process up to 9,000 hogs/day will increase the volume of wastewater to be treated by the associated R3 Innovations Inc. Industrial Wastewater Treatment Facility (R3 Innovations IWWTF). R3 Innovations has been in operation since the IWWTF was licensed in 2009. The processing increase will result in a need for R3 Innovations to treat and discharge up to an additional 720 $m^3$/day of effluent (totaling 2,290 $m^3$/day) to the Whitemud River, a 46% increase over the existing licensed effluent volume of 1,570 $m^3$/day. In addition, the Town of Neepawa currently operates a wastewater treatment lagoon system that discharges seasonally into the Whitemud River upstream of the R3 Innovations discharge point. The Town of Neepawa is currently upgrading their lagoon system with a new outfall structure and a continuous discharge and is scheduled to be operational in late 2020.

A review of the available information on the Whitemud River identified relatively little current hydrological and water quality information to describe the Whitemud River. Previous assessments of the Whitemud River, by Earth Tech (2008) for the initial development and licensing of R3 Innovations, included water quality data from the Province of Manitoba from 1990-1992 and hydrological data from the Water Survey of Canada (WSC) gauging stations 05LL011 and 05LL009 from 1961-1992.

A water quality study is underway to increase understanding of the current conditions in the Whitemud River (current state) and to support definition of the required R3 Innovations IWWTF treatment upgrades necessary to accomodate the planned increase in wastewater production. The study includes consideration of the combined effects of increased effluent discharge from R3 Innovations and the Town of Neepawa's upgraded lagoon wastewater treatment system on the Whitemud River.

The water quality assessment includes development of an open-water water quality model supported by data collected in 2019 with empirical context provided for the winter based on early 2020 data. This report summarizes the data collected in Winter (February) 2020.

# 2.0 WINTER WATER QUALITY PROGRAM

The field program for winter 2020 was developed by Stantec with consideration of the 2019 open water field program, the previous Earth Tech program, and knowledge of current conditions. Site selection was based off the 2019 field program, with six sites along the Whitemud River and the R3 Innovations effluent outfall selected for water quality monitoring, water sampling, and flow monitoring. In addition, water sampling and water quality monitoring was conducted at the point where the discharge from the wetland area downstream of the R3 outfall met the Whitemud River (Appendix A; Figure 1).

## 2.1 TIMING OF EVENTS

The winter water quality field program was completed over a total of four days from February 24-28, 2020. The collected data, in combination with other available data, will characterize the receiving conditions in the Whitemud River during ice-covered conditions. The winter 2020 dataset does not include the effect of the planned continuous release of the Town of Neepawa's wastewater lagoon system, which is expected to be online in late 2020.

## 2.2 SAMPLING SITES

The rationale and description of the six sampling sites along the Whitemud River is presented in Section 2.2 of the open water field data report (Stantec 2019). The R3 Innovations outfall was also selected for water quality and flow monitoring during the winter 2020 field program since it is the direct wastewater input of interest for the Hylife expansion. The R3 Innovations effluent discharges via outfall to a low-lying wetland area covering approximately 1.13 ha of land north of the effluent outfall. The wetland area drains to the Whitemud River via an apparent outlet 300 m downstream (northeast) of the R3 Innovations outfall structure at UTM coordinates 14 U 469135 m E 5565220 m N. A second apparent outlet from the wetland to the Whitemud River was also noted during the winter field program. It is located at UTM coordinates 14U 468998 m E 5565186 m N (150 m upstream of the primary/larger outlet). To better understand the effect of the effluent flowing through the wetland area, water quality monitoring and sampling was conducted at the confluence of the primary wetland outlet and the Whitemud River (Appendix B; Photo ID 5 and 6).

## 2.3 PARAMETERS

### 2.3.1 *In-Situ* Water Monitoring

*In-situ* water quality data was collected at all six (6) sites on the Whitemud River, the R3 Innovations effluent outfall, and the primary wetland outlet/river confluence as part of the winter water quality field program. Water monitoring was conducted at surface (approximately 10 cm below the bottom of the ice in hole) and bottom (approximately 10 cm above the bottom of the channel bed) at Sites 1-6 along the

Whitemud River, and in the mid-stream at the primary confluence and the R3 Innovations effluent. The *in-situ* parameters measured included:

- Water temperature (°C)
- Dissolved oxygen (DO) (mg/L)
- Specific Conductivity (µS/cm)
- pH
- Oxidation Reduction Potential (ORP) (mV)
- Turbidity (NTU)
- Total dissolved solids (TDS)(g/L)

Water velocity was also measured *in-situ* at Sites 1-6 and at the R3 Innovations outfall. Water velocity was not measured at the confluence to the Whitemud River, as it was assumed that the R3 Innovations outfall was the primary source of water flow into, and out of, the wetland. To estimate volumetric flow, the following *in-situ* measurements were made:

- Depth (m)– 1 m intervals across the channel width at Sites 1-6; point measurement at the R3 Innovations outfall
- Velocity (m/s)– 1 m intervals across the channel width at Sites 1-6 at 60% depth; point measurement at the R3 Innovations outfall

### 2.3.2 Water Sampling

Water samples were collected at all 6 sites on the Whitemud River, the R3 Innovations effluent outfall, and the primary wetland outlet/river confluence for analysis of the following parameters by an accredited laboratory (ALS Laboratories):

- Alkalinity – $HCO_3$, $CO_3$, OH (mg/L)
- Biochemical Oxygen Demand – Nitrogenous and Carbonaceous (mg/L)
- Silica – Reactive Soluble (mg/L)
- Total Metals (µg/L)
- Ammonia (mg/L)
- Carbon – Total Inorganic, Organic and Dissolved (mg/L)
- Total Nitrogen (mg/L)
- Chlorophyll a (mg/L)
- Phosphorus – Soluble Reactive, Inorganic, Acid-Hydrolyzable, Dissolved and Particulate (mg/L)
- Fecal Coliforms (#/100 mL)
- *E.coli* (*Escherichia coli*) (#/100 mL)
- Nitrate and Nitrite (mg-N/L)

- Total and Volatile Suspended Solids (mg/L)
- Chloride and Fluoride (mg/L)

The analyte parameters were selected to be consistent with the 2019 open water field program, and to provide data for the winter water quality assessment.

# 3.0 METHODS

## 3.1 SITE SELECTION AND ACCESSIBILITY

Sites 1-6 were selected to be consistent with the 2019 open water field program. The primary wetland outlet/river confluence site was selected to characterize the effect of the wetland on the R3 Innovations effluent quality and temperature before mixing with the river. Sites were accessed by vehicle on service, municipal, or private roads and by traversing riverbanks and on-ice by foot. Sampling and monitoring at Sites 2, 3, 4, 5, and 6 was conducted approximately 50-75 m upstream from the open water field program locations to avoid areas of open water, suspected thin ice, large rocks and boulders, in order to prevent damage to the ice auger and reduce safety risks.

## 3.2 WATER QUALITY MONITORING

*In-situ* water quality monitoring was conducted at Sites 1-6, immediately downstream of the R3 Innovations outfall, and in the wetland, just upstream of the confluence of the primary wetland outlet/Whitemud River. *In-situ* water quality parameters were measured using a handheld multi-parameter Horiba U-52, rented from Maxim Environmental and Safety Inc. The unit was calibrated by Maxim Environmental and Safety Inc. on February 17, 2020 and was further calibrated in the field on February 27, 2020. Water quality monitoring was conducted at three subsampling locations across the stream width (left, middle, and right, facing downstream) for Sites 1-3 and at two subsampling locations across the stream width (left and right, facing downstream) for Sites 4-6 (Figure 3-1). The left, middle and right subsampling locations across the stream were selected based on sufficient depth of water under ice which often did not correspond to equally spaced subsampling locations (Figure 3-2). Surface (approximately 10 cm below ice-bottom) and bottom (approximately 10 cm from river bottom) measurements (denoted with suffix “S” for surface and “B” for bottom, respectively) were collected at each subsampling location, except for Site 5, the wetland outlet, and the R3 Innovations effluent. At these sites, a mid-stream monitoring point within the water column was selected, due to insufficient depth of water to discern surface from bottom.

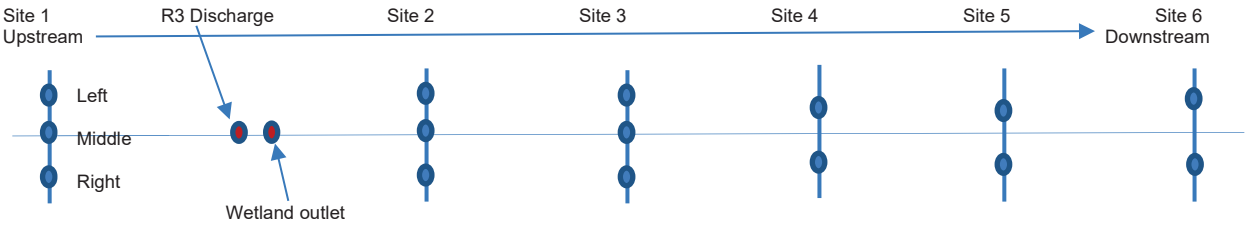



**Figure 3-1 Conceptual Representation of Water Monitoring and Sampling Design**

Methods
October 20, 2021

Channel velocity and effluent discharge data were collected to estimate effluent loading and streamflow characteristics during ice-covered conditions. Hydrological data was collected to profile stream flow characteristics and channel morphology at each of the 6 sites in the Whitemud River. At each site, the channel width was measured from ice edge to ice edge. Holes were drilled through the ice using a gasoline powered Eskimo Stingray Ice Auger (8" and 10" models) at 1 m intervals from mid-stream to nearshore, up until a minimum of 2 cm of water (or sediment bottom) was reached. Where suspected logs existed (Site 2), holes were drilled approximately 1.5 m upstream to prevent personal injury and/or damage to auger blades (Figure 3-2).

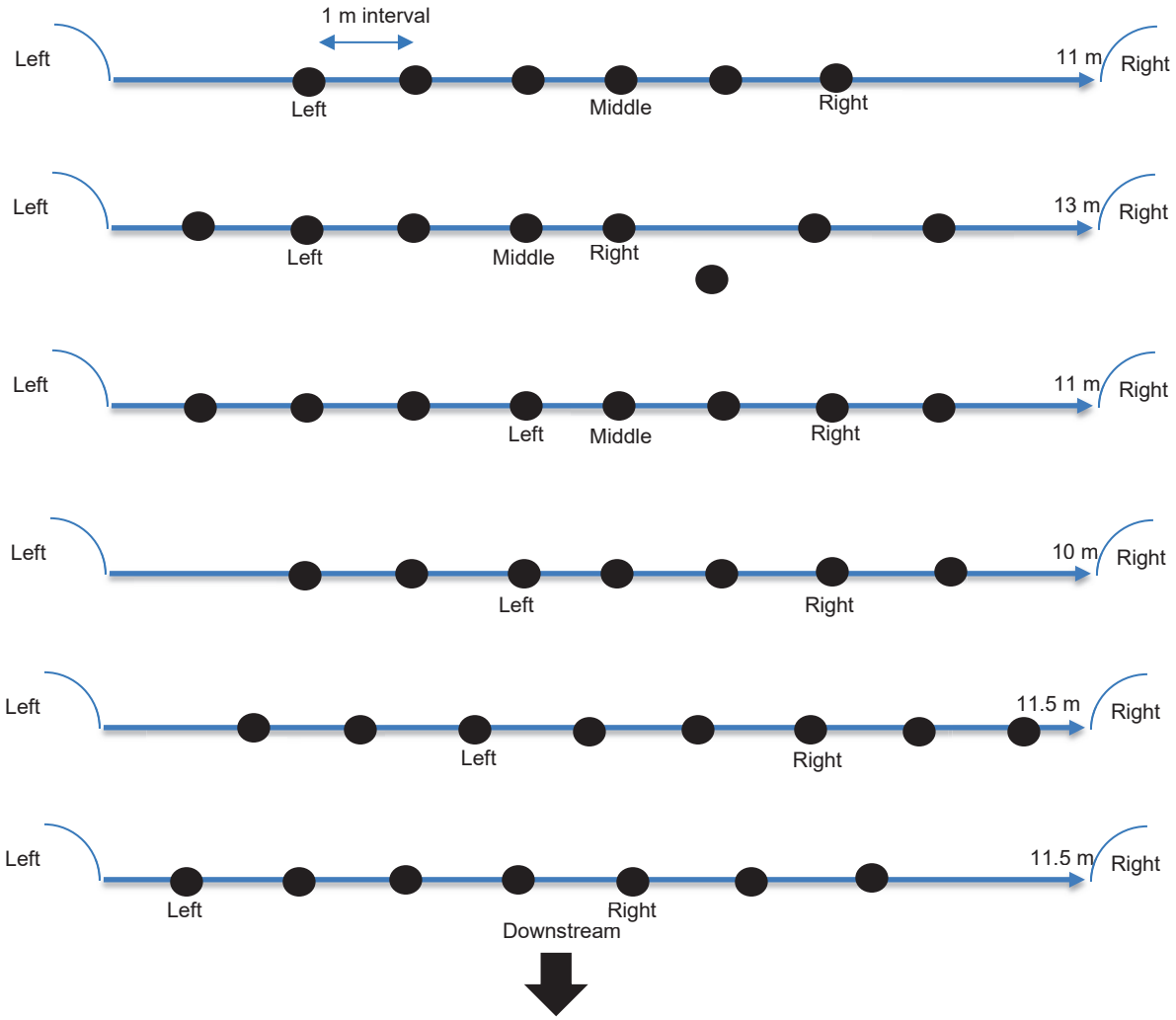



**Figure 3-2 Visual Representation of Monitoring/Sampling Locations at Sites 1-6 (top to bottom)**

Depth of water (m), thickness of ice (m), and water velocity (m/s) were then measured in the holes containing open water across the width of the channel at 1 m intervals using an electromagnetic flow probe (Hach Flo-Mate FH-950/MF Pro with wading rod). Velocity and depth of water were also measured in the R3 Innovations effluent discharge by placing the flow probe vertically into the outfall pipe, measuring the effluent velocity and height of water in the pipe as it was discharged to the wetland area.

A summary of the *in-situ* winter water monitoring program, including sites and associated parameters, is presented in Table 3-1.

**Table 3-1 Summary of the *In-Situ* Water Monitoring Program**

| February 2020 | Parameters | Location |
|---|---|---|
| Water Quality | • Water temperature (°C)<br>• Dissolved oxygen (DO) (mg/L)<br>• Specific Conductivity (µS/cm)<br>• pH<br>• Oxidation Reduction Potential (ORP) (mV)<br>• Turbidity (NTU)<br>• Total dissolved solids (TDS)(g/L) | Sites 1-3<br>• left, middle, right, facing downstream; surface and bottom<br>Sites 4 and 6<br>• left and right facing downstream; surface and bottom<br>Site 5<br>• left and right facing downstream, approximately mid-depth<br>R3 Innovations outfall<br>• directly downstream of outfall structure (0.5 m), at approximately mid-depth<br>Wetland outlet<br>• in open-water at wetland outlet, mid-stream at approximately mid-depth |
| Hydrology | • Depth (m)<br>• Velocity (m/s) | Sites 1-6<br>• 1 m intervals across channel width measured at 60% depth |
| | • In-culvert velocity, culvert width and water depth measurement in-culvert | • R3 Innovations outfall |

## 3.3 FIELD OBSERVATIONS

Sites were characterized through general field observations such as snow conditions, weather conditions, and notable site features. Notable observations included the open water in the wetland area with visible steam at the effluent outfall, vegetation growth of duckweed (*Lemna minor*), and visible small bodied fish (Appendix B; Photo ID 1 and 3). Observations indicated that the entire wetland area was open water. An open water plume (approximately 1-2 m in width), was also visible extending from the wetland outlet into the Whitemud River and continuing approximately 110 m downstream, covering an area of approximately 165 $m^2$ in the Whitemud River (Appendix B; Photo ID 5 and 8). In the open water plume, North American

River Otters (*Lontra canadensis*) were also observed. At Site 6, flooding of the roadway from the fall was evident, as the road was covered in ice. Open water was also observed near the culverts at Site 6 (Appendix B; Photo ID 24). Snow thickness varied across sites ranging from approximately 3-5 cm at Site 6, to approximately 20 cm at Sites 1 and 3 (Appendix B; Photo ID 9 and 22).

### Table 3-2 Field Observations during the Winter 2020 Field Program

| Site | Weather | Snow thickness (cm) | Notes |
|---|---|---|---|
| 1 | Clear, sunny, -4°C | 15-20 | • Audible flowing water under ice<br>• Sand/mud substrate encountered on left bank |
| 2 | Calm, cloudy, -5°C | 5-10 | • Woody deadfall encountered in-stream<br>• Thick ice encountered |
| 3 | Overcast, -7°C | 15-20 | • Thick ice encountered |
| 4 | Overcast, calm, light snow, -14°C | 3-5 | • Sand/mud substrate encountered under ice |
| 5 | Overcast, calm, light snow, -16°C | 5-10 | • Sand/mud substrate encountered under ice |
| 6 | Cloudy, -7°C | 3-5 | • Open water visible near culverts<br>• Ice from flooding evident overtop of road |
| R3 Discharge | Mix of sun and cloud, -5°C | Open water | • Open water covering entire wetland area<br>• Steam coming off water from discharge<br>• Small bodied fish observed and duckweed (*Lemna minor*) abundant |
| Wetland outlet | Mix of sun and cloud, -5°C | Open water | • Several otters (*Lontra canadensis*) observed in open water plume in the Whitemud River downstream of wetland outlet.<br>• Open water plume approximately 1-2 m wide from wetland outlet to approximately 110 m downstream |

# 4.0 WINTER FIELD PROGRAM RESULTS

## 4.1 WATER QUALITY RESULTS

### 4.1.1 *In-Situ* Water Quality

*In-situ* water quality results for Sites 1-6, the R3 Innovations effluent, and the wetland outlet are tabulated in Appendix C; Table C-1.

#### 4.1.1.1 Dissolved Oxygen

Malfunction of the Horiba U-52, as indicated by unreasonably high dissolved oxygen (DO) measurements ranging from 20.07 mg/L to 49.82 mg/L, precluded reliable dissolved oxygen (DO) readings. The instrument was pre-calibrated on February 17, and field calibrated on February 26, 2020, per the manufacturer's published instructions, using National Institute of Standards and Technology traceable solutions and standards.

#### 4.1.1.2 Temperature

Temperature readings at all sites showed similar readings from surface and bottom, with temperature ranging at Sites 1-6 from 0.17°C at Site 5 to 1.45°C at Site 4 (Figure 4-1). Temperature of the R3 Innovations effluent measured directly under the outfall pipe was 27.78°C. As the effluent passed through the wetland area, temperature was reduced as shown in the temperature reading at the wetland outlet of 3.58°C, contributing to the visible open water in the Whitemud River (Appendix B; Photo ID 5 and 8).

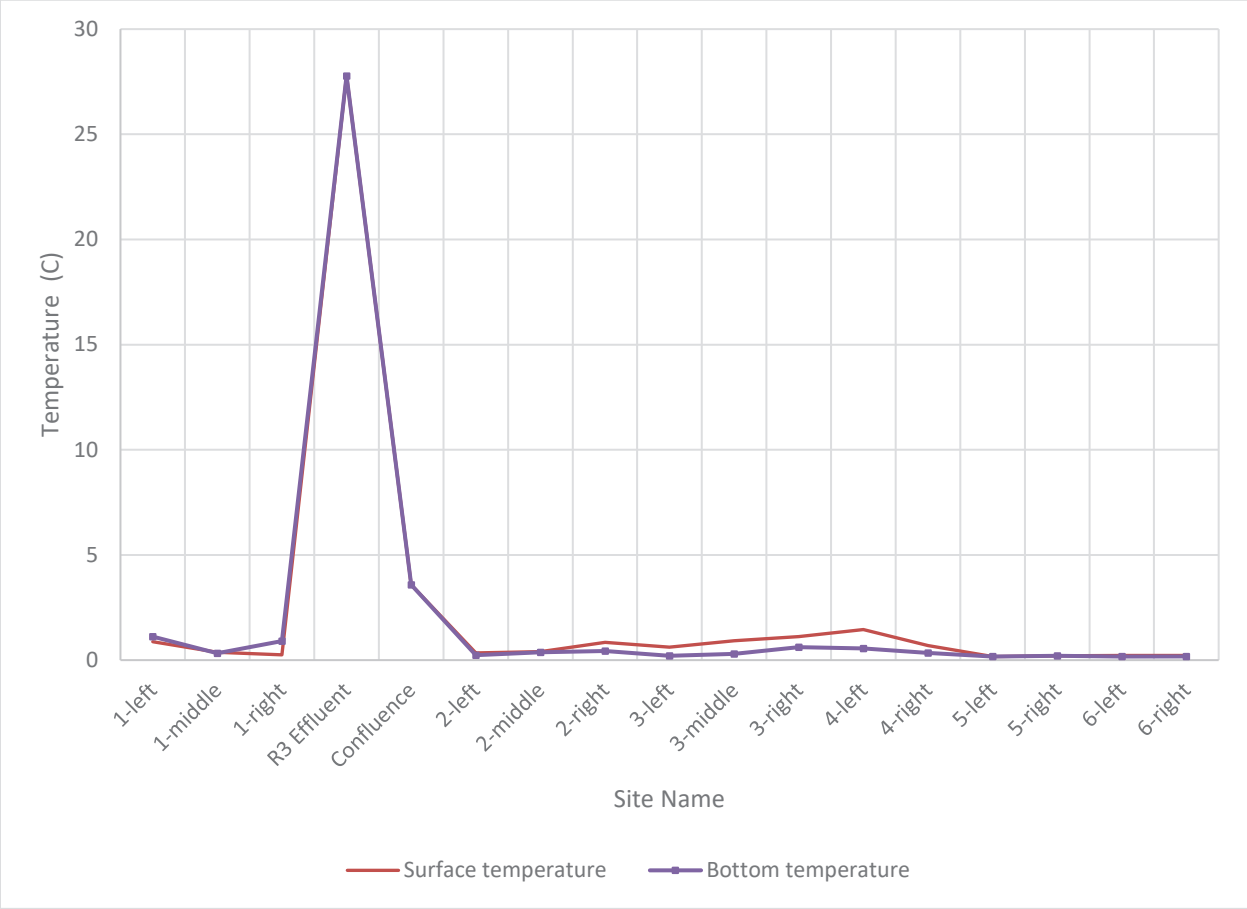



**Figure 4-1 Temperature Readings from Surface and Bottom (or mid-stream where not discernible) at Sites 1-6, the R3 Innovations Effluent, and the Confluence of the Wetland Area and the Whitemud River**

#### 4.1.1.3 Turbidity

Turbidity measurements varied across Whitemud River Sites 1-6 with a minimum of 0 NTU (Site 1) to a maximum of 13 NTU (Site 3). The R3 Innovations effluent had a turbidity level of 79.5 NTU that decreased to 26.8 NTU at the wetland outlet (Figure 4-2). Turbulence at the outfall was observed as shown in Appendix B; Photo ID 25. For Whitemud River Sites 1-6, turbidity showed lower levels recorded at Site 1 (0 NTU) and increased levels downstream at Sites 4, 5 and 6 with turbidity readings of 8.0-12.6 NTU.

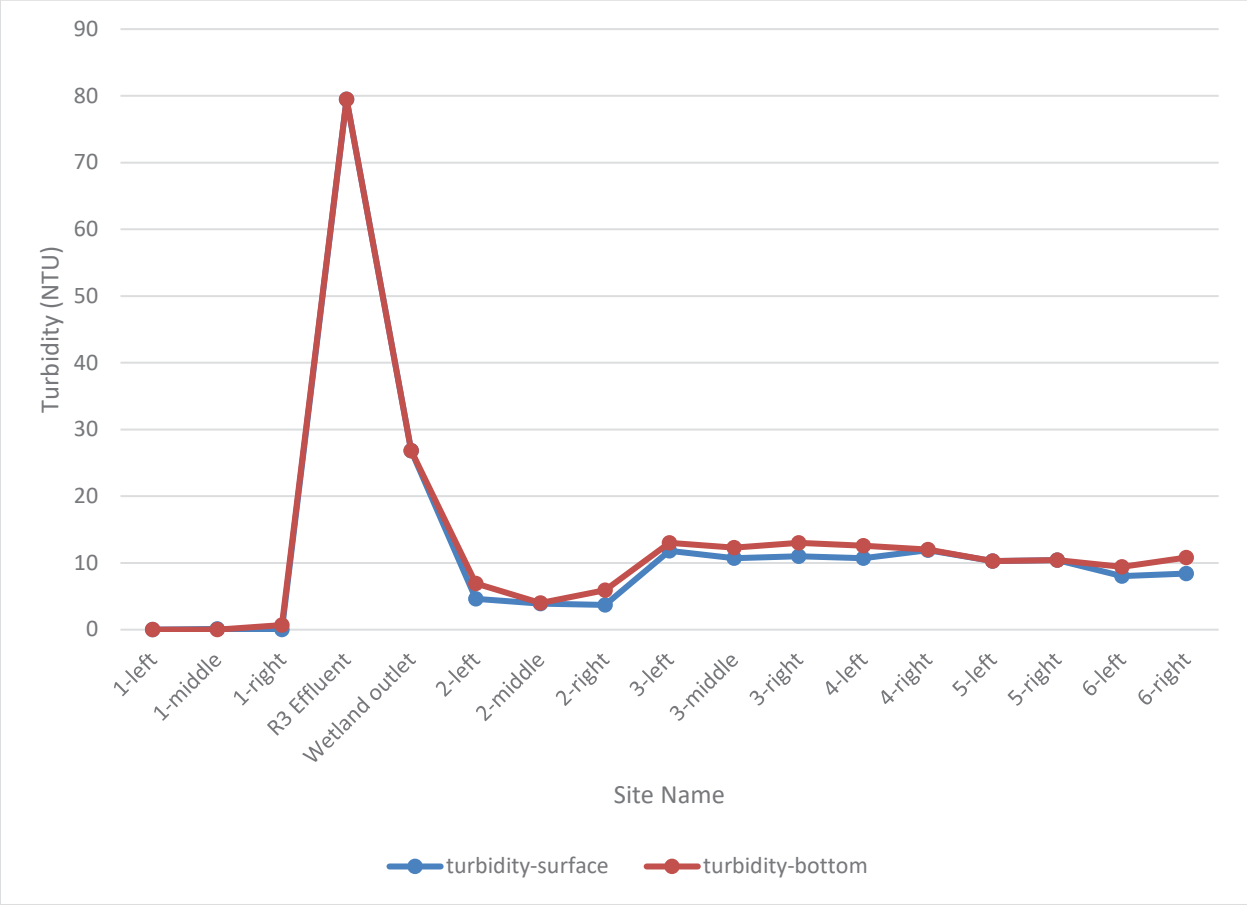



**Figure 4-2 Turbidity Readings at Surface and Bottom (or mid-stream where not discernible) at Sites 1-6, the R3 Innovations Effluent, and the Confluence of the Wetland Area and the Whitemud River**

### 4.1.1.4 Conductivity

Conductivity was elevated at the R3 Innovations outfall, with a reading of 1.65 µs/cm, which fell to 1.61 µs/cm at the wetland outlet. Lower conductivity levels were observed at Site 1 (0.989 µs/cm) and increased downstream at Sites 4, 5 and 6 with conductivity readings between 1.05 µs/cm and 1.1 µs/cm (Figure 4-3).

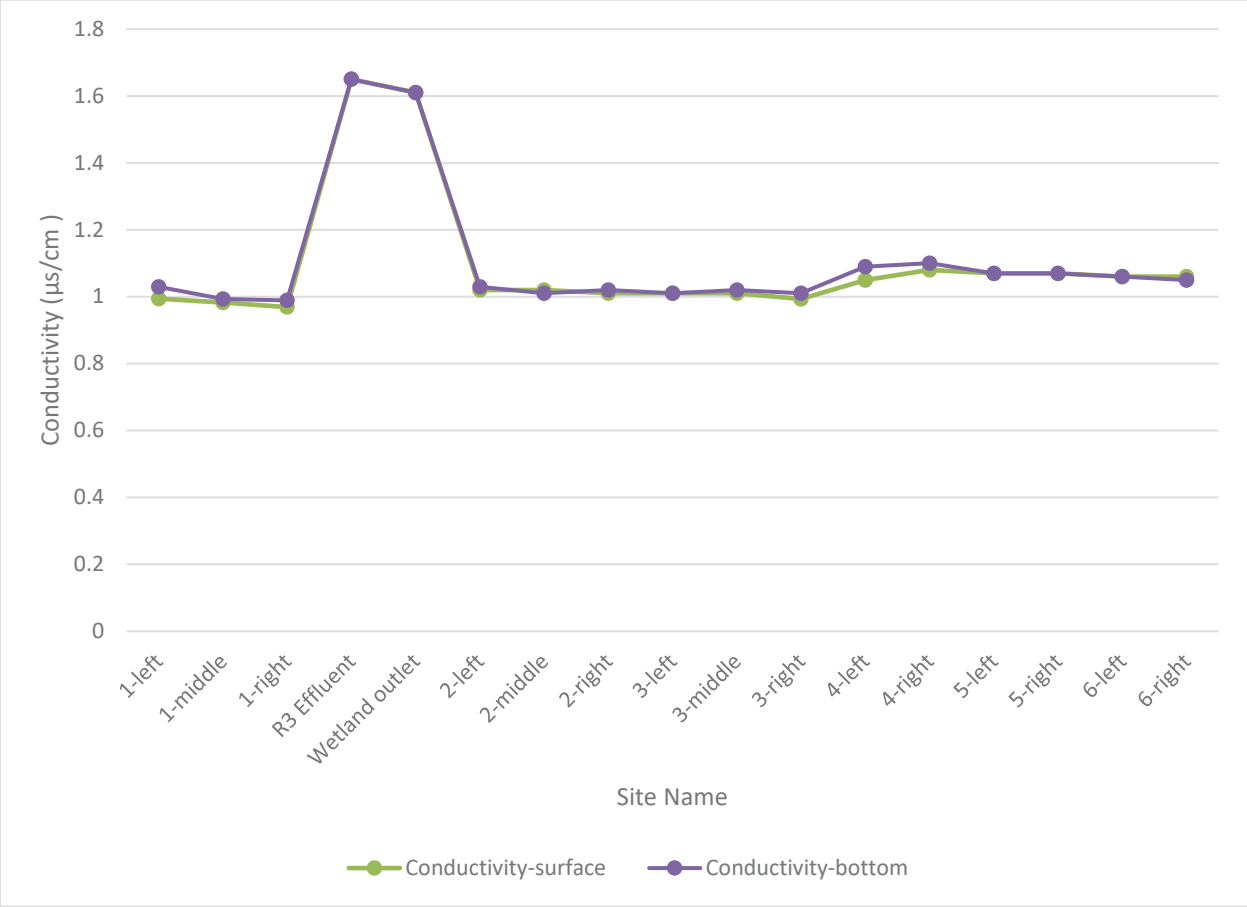



**Figure 4-3 Conductivity Readings at Surface and Bottom (or mid-stream where not discernible) at Sites 1-6, the R3 Innovations Effluent, and the Confluence of the Wetland Area and the Whitemud River**

#### 4.1.1.5 Hydrology

In general, the channel shape at each site was approximately trapezoidal in shape, with the deepest portion of the channel near the middle of the stream width for Sites 1,2,3 and 4. The deepest portions of Sites 5 and 6 were towards the right bank, facing downstream (Table 4-1). Approximate stream widths (interpreted as width of the ice at each cross-section) at each site varied from 10-13 m; the presence of snow and shoreline vegetation obstructed a precise indication of the ice edge at each of the sites. Snow depth at each site varied from approximately 3 cm (Site 4 and 6) to 20 cm (Site 3). Ice thickness at each site also varied, ranging from 0.3 m (Site 1) to 1.14 m (Site 2). Water depth under ice varied across all sites with maximum depth of water under ice ranging from 0.22 m (Site 5) to 0.68 m (Site 2).

## Table 4-1 Hydrology data collected at Sites 1-6 for the Winter 2020 Field Program

**Site 1**

| Hole #* | Water depth (m) | Ice thickness (m) | water under ice (m) | Flow (m/s) | Flow rate (m3/s) |
|---|---|---|---|---|---|
| 1 | 0.54 | 0.45 | 0.09 | 0.061 | 0.005 |
| 2 | 0.58 | 0.45 | 0.13 | 0.078 | 0.010 |
| 3 | 0.7 | 0.42 | 0.28 | 0.028 | 0.008 |
| 4 | 0.78 | 0.36 | 0.42 | 0.037 | 0.016 |
| 5 | 0.72 | 0.3 | 0.42 | 0.144 | 0.060 |
| 6 | 0.44 | 0.4 | 0.04 | 0.004 | 0.000 |
| Total Flow Rate ($m^3/s$) | | | | | 0.100 |

**Site 2**

| Hole #* | Water depth (m) | Ice thickness (m) | water under ice (m) | Flow (m/s) | Flow rate (m3/s) |
|---|---|---|---|---|---|
| 1 | no water | 1.14 | 0 | n/a | n/a |
| 2 | 1.32 | 1.14 | 0.18 | 0.071 | 0.013 |
| 3 | 1.52 | 1.12 | 0.4 | 0.06 | 0.024 |
| 4 | 1.68 | 1 | 0.68 | 0.193 | 0.131 |
| 5 | 1.45 | 1.06 | 0.39 | 0.059 | 0.023 |
| 6 | 0.52 | 0.51 | 0.01 | -0.06 | n/a |
| 7 | no water | 0.4 | 0 | n/a | n/a |
| 8 | no water | 0.4 | 0 | n/a | n/a |
| Total Flow Rate ($m^3/s$) | | | | | 0.191 |

**Site 3**

| Hole #* | Water depth (m) | Ice thickness (m) | water under ice (m) | Flow (m/s) | Flow rate (m3/s) |
|---|---|---|---|---|---|
| 1 | no water | 0.83 | 0 | n/a | n/a |
| 2 | 0.9 | 0.83 | 0.07 | -0.015 | n/a |
| 3 | 1.06 | 0.95 | 0.11 | 0.041 | 0.005 |
| 4 | 1.18 | 0.95 | 0.23 | 0.080 | 0.018 |
| 5 | 1.32 | 0.85 | 0.47 | 0.196 | 0.092 |
| 6 | 1.34 | 0.72 | 0.62 | 0.253 | 0.157 |
| 7 | 1.2 | 0.65 | 0.55 | 0.097 | 0.053 |
| 8 | 0.62 | 0.56 | 0.06 | 0.040 | 0.002 |
| Total Flow Rate ($m^3/s$) | | | | | 0.328 |

**Site 4**

| Hole #* | Water depth (m) | Ice thickness (m) | water under ice (m) | Flow (m/s) | Flow rate (m3/s) |
|---|---|---|---|---|---|
| 1 | No water | 0.55 | 0 | n/a | n/a |
| 2 | 0.76 | 0.58 | 0.18 | 0.042 | 0.008 |
| 3 | 0.96 | 0.7 | 0.26 | 0.16 | 0.042 |
| 4 | 1.06 | 0.78 | 0.28 | 0.178 | 0.050 |
| 5 | 1.06 | 0.9 | 0.16 | 0.086 | 0.014 |
| 6 | 1.06 | 0.8 | 0.26 | 0.086 | 0.022 |
| 7 | 0.88 | 0.7 | 0.18 | 0.125 | 0.023 |
| Total Flow Rate ($m^3/s$) | | | | | 0.158 |

**Site 5**

| Hole #* | Water depth (m) | Ice thickness (m) | water under ice (m) | Flow (m/s) | Flow rate (m3/s) |
|---|---|---|---|---|---|
| 1 | 0.64 | 0.42 | 0.22 | 0.222 | 0.049 |
| 2 | 0.56 | 0.4 | 0.16 | 0.206 | 0.033 |
| 3 | 0.56 | 0.4 | 0.16 | 0.145 | 0.023 |
| 4 | 0.56 | 0.4 | 0.16 | 0.26 | 0.042 |
| 5 | 0.57 | 0.42 | 0.15 | 0.184 | 0.028 |
| 6 | 0.48 | 0.4 | 0.08 | 0.099 | 0.008 |
| 7 | 0.48 | 0.44 | 0.04 | 0.017 | 0.001 |
| 8 | no water | 0.48 | 0 | n/a | n/a |
| Total Flow Rate ($m^3/s$) | | | | | 0.183 |

**Site 6**

| Hole #* | Water depth (m) | Ice thickness (m) | water under ice (m) | Flow (m/s) | Flow rate (m3/s) |
|---|---|---|---|---|---|
| 1 | 1.02 | 0.68 | 0.34 | 0.208 | 0.071 |
| 2 | 1.02 | 0.82 | 0.2 | 0.139 | 0.028 |
| 3 | 0.96 | 0.86 | 0.1 | 0.157 | 0.016 |
| 4 | 1 | 0.8 | 0.2 | 0.114 | 0.023 |
| 5 | 0.88 | 0.72 | 0.16 | 0.033 | 0.005 |
| 6 | no water | 0.6 | 0 | n/a | n/a |
| 7 | no water | 0.6 | 0 | n/a | n/a |
| Total Flow Rate ($m^3/s$) | | | | | 0.142 |

**R3 Discharge**

| Rep # | Height of water | Flow (m/s) | Diameter of pipe (m) |
|---|---|---|---|
| 1 | 16.5 | 1.113 | 0.2 |
| 2 | 16.5 | 1.075 | 0.2 |
| 3 | 16.5 | 1.039 | 0.2 |
| Volumetric Flow Rate ($m^3/s$) | | | 0.03 |

*Measured in 1 m intervals from left to right bank, facing downstream

Culvert flow velocity was measured for the R3 Innovations effluent and channel flow velocity was calculated for Whitemud River Sites 1-6 using the method described in Appendix D of the open water report (Stantec 2019). A summary of the calculated volumetric flow rate at each site is presented in Table 4-1. Water Survey of Canada gauging stations on the Whitemud River are limited to seasonal operation (May-November) so comparisons to measured values were not possible for the winter field program.

### 4.1.2 Laboratory Results

Laboratory results for all sampling locations are tabulated in Appendix C; Table C-2. For water chemistry, field duplicate samples were within data quality limits (relative percent difference <25% if over 5x detection limit, and <100% if under 5x detection limit) with the exceptions of chlorophyll-a and pheophytin at Site 3-middle sample.

Parameters commonly used to characterize the effect of municipal and industrial wastewater discharges include BOD, coliforms, *E.coli*, DO, and nutrients. Concentrations of several parameters including nutrients such as nitrogen and phosphorus (total and dissolved), and total ammonia-N across Sites 1-6 are displayed in Figure 4-4.

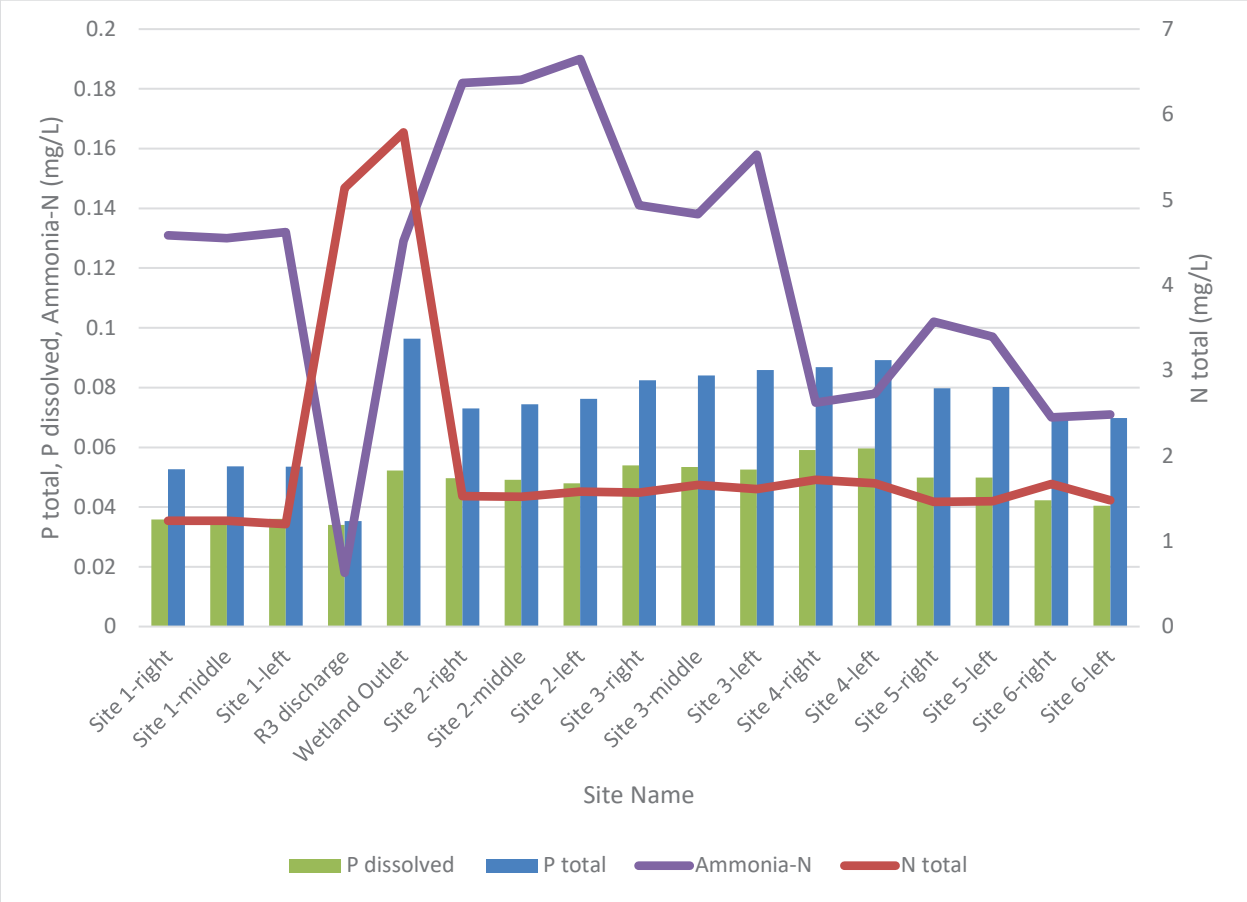



**Figure 4-4 Nutrient Concentrations Observed in the Winter 2020 Field Program**

The laboratory results show that *E.coli* concentrations varied across all sites; however, relatively elevated levels were seen at Site 2. *E.coli* ranged from a minimum concentration of 2/100 mL (Site 1) to a maximum concentration of 344/100 mL (Site 3). With the exception of Site 6-left sample, which reported a biochemical oxygen demand (BOD) of 33 mg/L, all other sites reported BOD concentrations near the laboratory detection limit of 2 mg/L

In the winter water quality program, nutrients were generally observed to increase from Site 1 to Site 2, with values generally decreasing further downstream. Across all sites, total nitrogen concentrations ranged from 1.2 mg/L (Site 1) to 1.72 mg/L (Site 4) and total phosphorus concentrations ranged from 0.05 mg/L (Site 1) to 0.09 mg/L (Site 4). For Total Ammonia-N, the most elevated concentrations were observed at Site 2 (0.18 mg/L – 0.19 mg/L) and the lowest concentrations were observed in the R3 discharge (0.018 mg/L) and at the downstream end of the study area (0.07 mg/L-0.071 mg/L) (Site 6, Figure 4-4).

Chloride and fluoride were analyzed during the winter water quality program. The results showed elevated concentrations of both parameters in the effluent, with concentrations decreasing to relatively constant levels downstream (Figure 4-5).

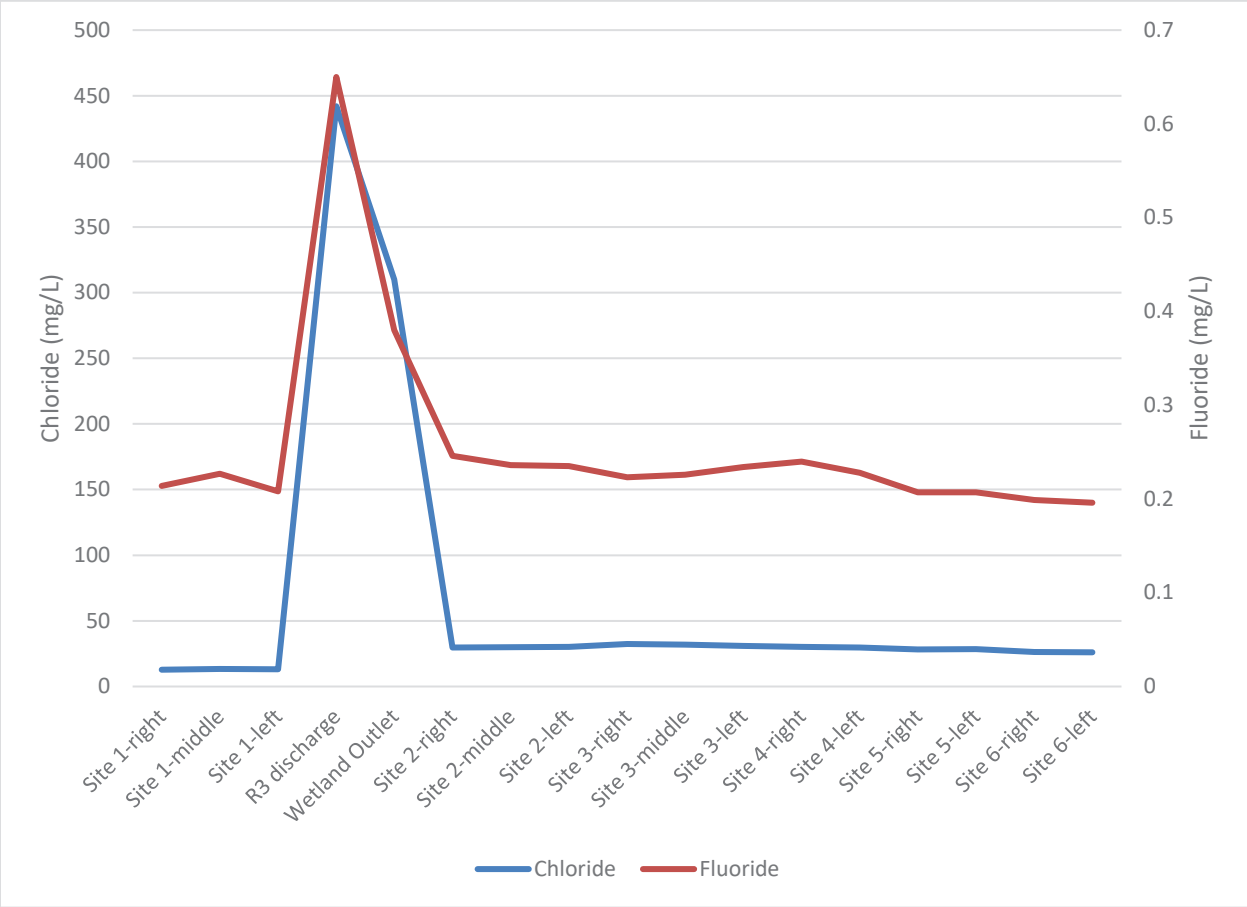



**Figure 4-5 Chloride and Fluoride Concentrations Observed in the Winter 2020 Water Quality Program**

To determine the effect of the R3 Innovations effluent moving through the wetland area prior to discharging into the Whitemud River, samples were collected both directly from the R3 Innovations discharge and at the wetland outlet, located approximately 300 m downstream of the discharge, just before discharging to the Whitemud River. The results showed that nutrient parameters such as TIC, TOC, DOC, N, and P increased through the wetland area to the wetland outlet. Concentrations were relatively consistent (but elevated compared to Site 1 concentrations) from Site 2 downstream to Site 6 (Figure 4-6).

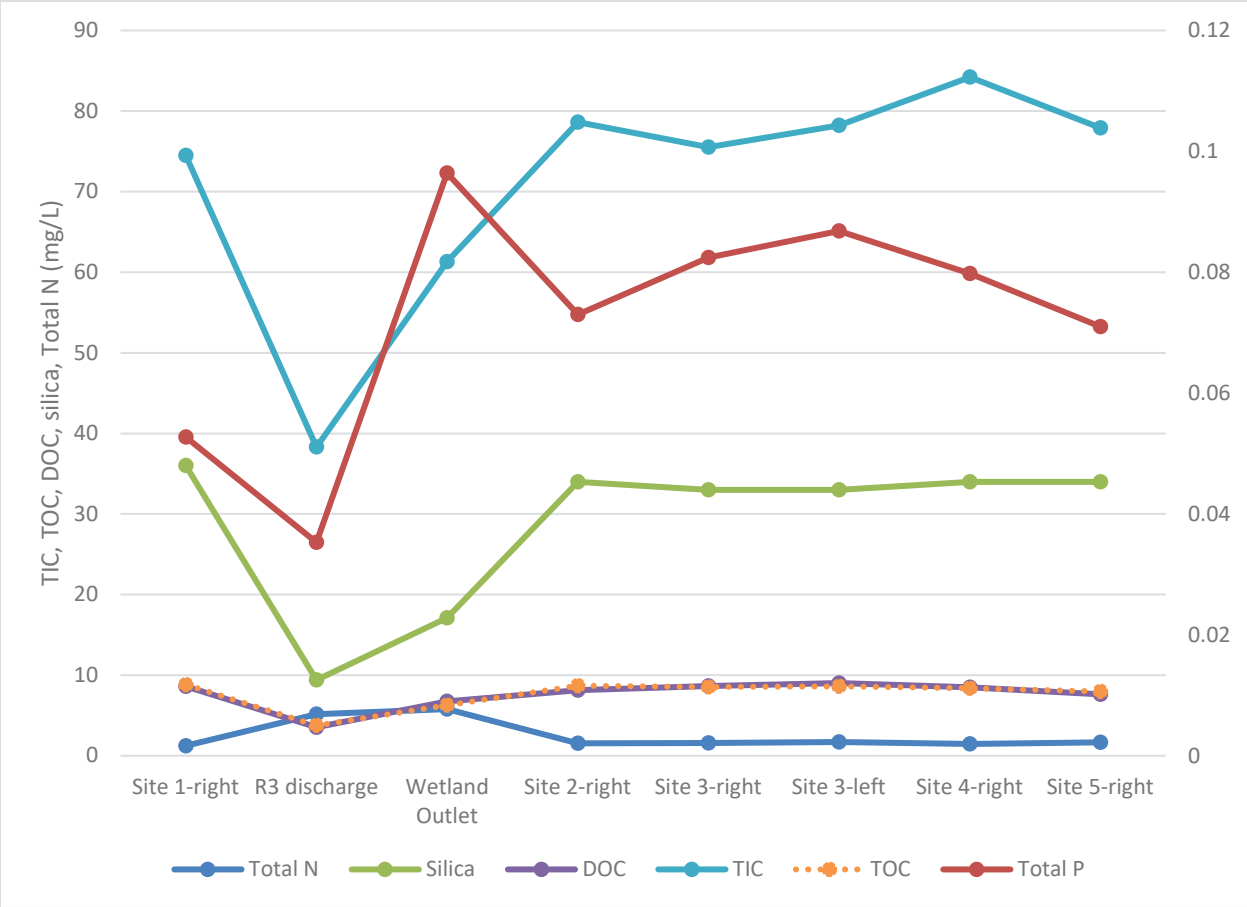



**Figure 4-6 Results of Laboratory Parameters Showing Effect of Wetland Area Downstream of R3 Innovations Outfall**

# 5.0 SUMMARY

The results of the February 2020 winter field program indicate that nutrients such as P (total, dissolved, inorganic, particulate) and ammonia are present in low concentrations (relative to background levels at Site 1) in the R3 Innovations effluent and appear to increase at the wetland outlet. Parameters including TIC, TOC, and DOC were present at low concentrations (relative to background at Site 1) at the R3 Innovations discharge and the wetland outlet, returning to background concentrations at Site 2 and remaining near background concentrations moving further downstream. Silica, used as an indicator for the presence of diatomic algae in the Whitemud River, was also present at low concentrations (relative to background; Site 1) in the R3 Innovations effluent and the wetland outlet, an expected result given the composition of the industrial wastewater, and returned to near background levels at Site 2. Chloride concentrations appeared to increase downstream of the R3 Innovations discharge (29.7 mg/L), relative to background levels observed at Site 1 (13.2 mg/L), indicating the potential presence of additional inputs at downstream locations from natural or manmade sources. Fluoride concentrations appeared to decrease to near background downstream of the R3 outfall (0.208 mg/L at Site 1-left compared to 0.196 mg/L at Site 6-left).

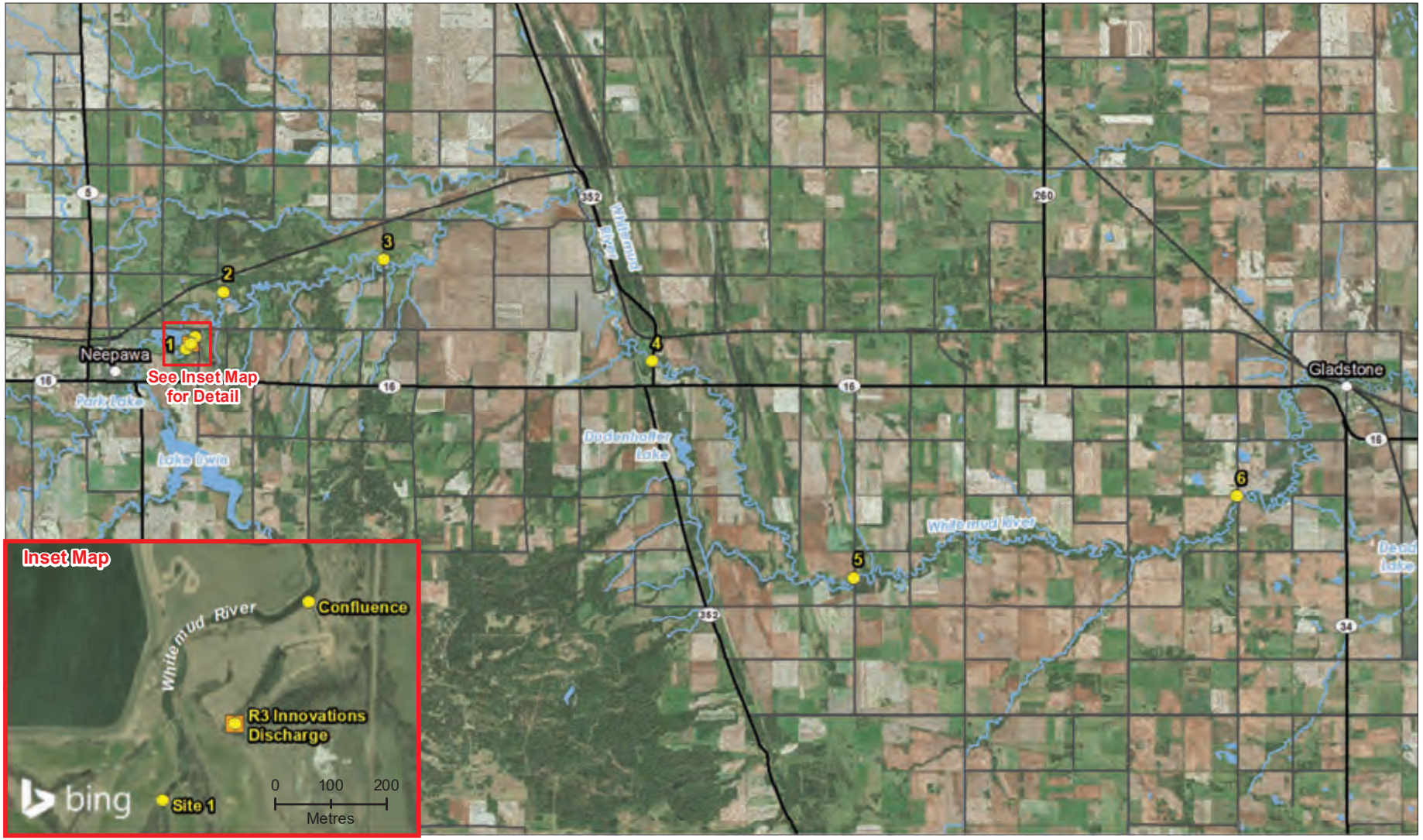
# 6.0 REFERENCES

Earth Tech. 2008. Request for Alteration to the Town of Neepawa's Industrial Wastewater Treatment Facility, Neepawa, Manitoba. Earth Tech Canada Inc. Winnipeg, Manitoba.

Stantec. 2019. Field Data Report for Water Quality Study for Hylife Foods Facility Expansion. Stantec Consulting Ltd. Winnipeg, MB.

# APPENDICES

# Appendix A FIGURES




**Legend**

- Aquatic Study Site
- R3 Innovations Outfall
- Major Road
- Minor Road
- Railway
- Watercourse
- Waterbody

N

0 2 4 Kilometres
(At original document size of 8.5x11)
1:175,000

***Notes***

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Microsoft product sceen shot reprinted with permission from Microsoft Corporation

Stantec

*Project Location*
Whitemud River, Manitoba

Prepared by ACampigotto on 2020-03-21
Reviewed by JTheroux on 2020-03-21

*Client/Project*
Hylife Foods LP
Water Quality Study

111440368

*Figure No.*
**1-1**

*Title*
**Site Location Map**

G:_GIS_Project_Folder\111440368_HylifeFoods\ArcMaps\WaterQualitySitesAndOutfall_20200321.mxd Revised: 2020-03-23 By: ACampigotto

# Appendix B WINTER PHOTOLOG

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 1

**Photo Location:**
Wetland area downstream of R3 Innovations outfall

**Direction:**
north

**Survey Date:**
2/24/2020

**Comments:**
Abundant open water, duckweed and small bodied fish present

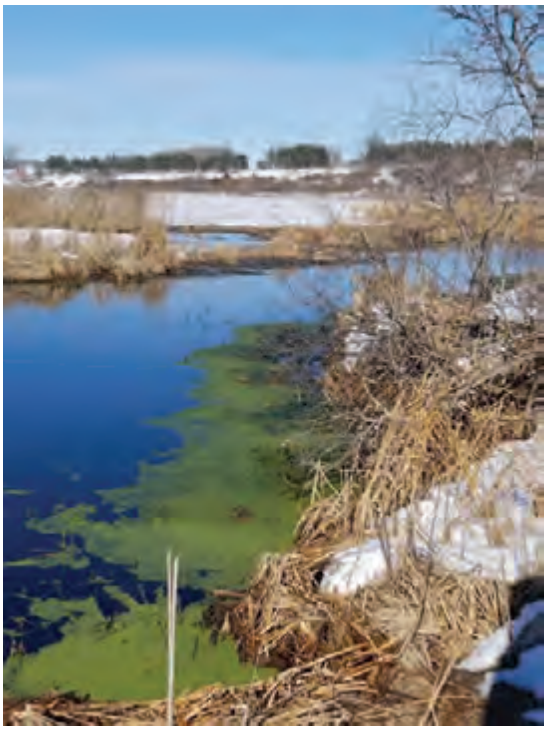
**Photograph ID:** 2

**Photo Location:**
Wetland area downstream of R3 Innovations outfall

**Direction:**
northeast

**Survey Date:**
2/24/2020

**Comments:**



Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 3

**Photo Location:**
R3 Innovations effluent outfall structure

**Direction:**
n/a

**Survey Date:**
2/24/2020

**Comments:**
Continous discharge with temperature of approximately 27C

**Photograph ID:** 4

**Photo Location:**
Secondary confluence observed on Whitemud River

**Direction:**
south

**Survey Date:**
2/24/2020

**Comments:**
Identified by area of open water coming off wetland area

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 5

**Photo Location:**
Primary confluence observed on Whitemud River

**Direction:**
southeast

**Survey Date:**
2/24/2020

**Comments:**
Sampling location "Confluence"

**Photograph ID:** 6

**Photo Location:**
Open water plume downstream of confluence on Whitemud River

**Direction:**
southeast

**Survey Date:**
2/24/2020

**Comments:**

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 7

**Photo Location:**
Open water plume downstream of confluence, facing upstream

**Direction:**
west

**Survey Date:**
2/24/2020

**Comments:**

**Photograph ID:** 8

**Photo Location:**
Open water plume, facing downstream

**Direction:**
northeast

**Survey Date:**
2/24/2020

**Comments:**
Plume approximately 1-2 m wide, 75 m length

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 9

**Photo Location:**
Site 1, facing right bank

**Direction:**
east

**Survey Date:**
2/24/2020

**Comments:**
holes drilled approximately 1 m apart

**Photograph ID:** 10

**Photo Location:**
Site 2

**Direction:**
west

**Survey Date:**
2/26/2020

**Comments:**
water monitoring

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 11

**Photo Location:**
Site 2, facing downstream

**Direction:**
west

**Survey Date:**
2/26/2020

**Comments:**

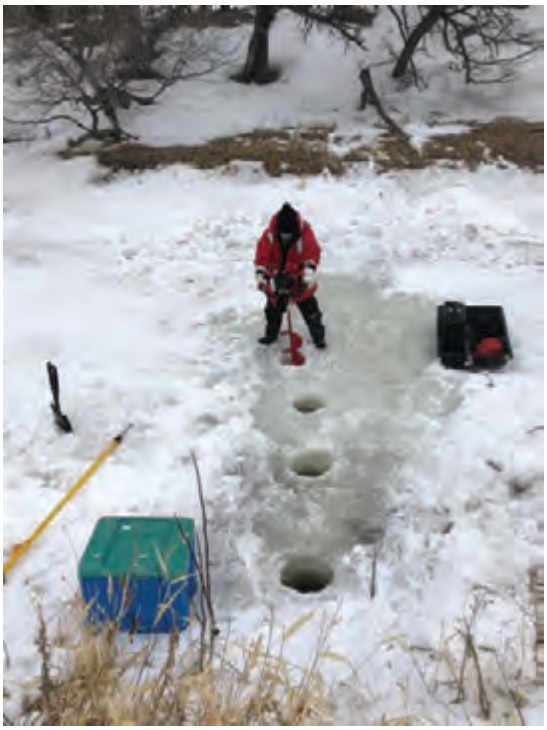
**Photograph ID:** 12

**Photo Location:**
Site 3 hydrology

**Direction:**
north

**Survey Date:**
2/25/2020

**Comments:**
holes drilled approximately 1 m apart



Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 13

**Photo Location:**
Site 3

**Direction:**
east

**Survey Date:**
2/25/2020

**Comments:**
>1 m of ice cover and showing distance to road culvert

**Photograph ID:** 14

**Photo Location:**
Site 4, right bank

**Direction:**
south

**Survey Date:**
2/27/2020

**Comments:**
<5 cm snow cover

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 15

**Photo Location:**
Site 4, facing upstream

**Direction:**
west

**Survey Date:**
2/27/2020

**Comments:**

**Photograph ID:** 16

**Photo Location:**
site 4, left bank

**Direction:**
north

**Survey Date:**
2/27/2020

**Comments:**

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 17

**Photo Location:**
Site 5, facing left bank

**Direction:**
north

**Survey Date:**
2/27/2020

**Comments:**
showing holes drilled

**Photograph ID:** 18

**Photo Location:**
Site 5, facing downstream

**Direction:**
east

**Survey Date:**
2/27/2020

**Comments:**

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 19

**Photo Location:**
Site 5, facing upstream

**Direction:**
west

**Survey Date:**
2/27/2020

**Comments:**

**Photograph ID:** 20

**Photo Location:**
Site 6, facing upstream

**Direction:**
southwest

**Survey Date:**
2/27/2020

**Comments:**

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 21

**Photo Location:**
Site 6, facing downstream

**Direction:**
east

**Survey Date:**
2/27/2020

**Comments:**

**Photograph ID:** 22

**Photo Location:**
Site 6, facing left bank

**Direction:**
north

**Survey Date:**
2/27/2020

**Comments:**

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 23

**Photo Location:**
Site 6

**Direction:**
n/a

**Survey Date:**
2/27/2020

**Comments:**
hydrology

**Photograph ID:** 24

**Photo Location:**
Site 6, facing upstream from bridge

**Direction:**
west

**Survey Date:**
2/27/2020

**Comments:**
showing open water areas and ice jamming

Stantec

# Photographic Log

| | | | |
|---|---|---|---|
| **Client:** | **Hylife** | **Project:** | **111440368** |
| **Site Name:** | **Water Quality Study** | **Site Location:** | **Neepawa, MB** |

**Photograph ID:** 25

**Photo Location:**
Wetland area, downstream of outfall

**Direction:**
n/a

**Survey Date:**
2/24/2020

**Comments:**
showing turbulence

# Appendix C WATER MONITORING AND LABORATORY DATA

**Table C-1 Winter *in-situ* Winter Water Monitoring Data**

| Site name | Site 1 | | | | | | R3 Innovations Discharge | | Wetland outlet | Site 2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring point | 1-left | | 1-middle | | 1-right | | | | | 2-left | | 2-middle | | 2-right | |
| Site ID | FL1-s | FL1-b | FM1-s | FM1-b | FR1-s | FR1-b | Hylife Outfall | Hylife Outfall | | FL2-s | FL2-b | FM2-s | FM2-b | FR2-s | FR2-b |
| Hole number monitored (facing downstream) | 1 | 1 | 4 | 4 | 5 | 5 | under pipe | 3 m downstream of pipe | n/a | 2 | 2 | 4 | 4 | 5 | 5 |
| Date | 24-Feb-20 | 24-Feb-20 | 24-Feb-20 | 24-Feb-20 | 24-Feb-20 | 24-Feb-20 | 24-Feb-20 | 24-Feb-20 | 24-Feb-20 | 26-Feb-20 | 26-Feb-20 | 26-Feb-20 | 26-Feb-20 | 26-Feb-20 | 26-Feb-20 |
| Time | 13:10 | 13:05 | 13:20 | 13:15 | 13:30 | 13:25 | 14:35 | 14:40 | 16:38 | 16:20 | 16:15 | 16:10 | 16:05 | 16:00 | 15:55 |
| Temperature (°C) | 0.88 | 1.12 | 0.37 | 0.32 | 0.25 | 0.91 | 27.78 | 27.52 | 3.58 | 0.35 | 0.24 | 0.4 | 0.38 | 0.84 | 0.44 |
| DO (mg/L) | 20.07 | 36.72 | 45.84 | 47.98 | 44.22 | 35.03 | 13.72 | 10.82 | 25.16 | 39.02 | 42.13 | 43.91 | 46.33 | 41.38 | 43.77 |
| Conductivity (uS/cm) | 0.994 | 1.03 | 0.983 | 0.993 | 0.969 | 0.989 | 1.65 | 1.64 | 1.61 | 1.02 | 1.03 | 1.02 | 1.01 | 1.01 | 1.02 |
| pH | 7.77 | 7.54 | 7.51 | 7.61 | 7.69 | 7.72 | 7.77 | 7.76 | 7.87 | 7.91 | 7.79 | 7.93 | 7.78 | 7.93 | 7.79 |
| ORP (mV) | 166 | 178 | 186 | 180 | 176 | 174 | 132 | 136 | 122 | 139 | 157 | 164 | 177 | 176 | 187 |
| Turbidity (NTU) | 0 | 0 | 0.1 | 0 | 0 | 0.7 | 79.5 | 90.2 | 26.8 | 4.6 | 6.9 | 3.9 | 4 | 3.7 | 5.9 |
| TDS (g/L) | 0.635 | 0.665 | 0.629 | 0.636 | 0.62 | 0.633 | 1.05 | 1.05 | 1.03 | 0.654 | 0.656 | 0.652 | 0.649 | 0.649 | 0.656 |

| Site name | Site 3 | | | | | | Site 4 | | | | Site 5 | | Site 6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring point | 3-left | | 3-middle | | 3-right | | 4-left | | 4-right | | 5-left | 5-right | 6-left | | 6-right | |
| Site ID | FL3-s | FL3-b | FM3-s | FM3-b | FR3-s | FR3-b | FL4-s | FL4-b | FR4-s | FR4-b | FL5 | FR5 | FL6-s | FL6-b | FR6-s | FR6-b |
| Hole number drilled/location | 4 | 4 | 5 | 5 | 7 | 7 | 3 | 3 | 6 | 6 | 3 | 6 | 1 | 1 | 5 | 5 |
| Date | 25-Feb-20 | 25-Feb-20 | 25-Feb-20 | 25-Feb-20 | 25-Feb-20 | 25-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 | 27-Feb-20 |
| Time | 9:05 | 9:00 | 8:55 | 8:50 | 8:45 | 8:40 | 8:20 | 8:15 | 8:30 | 8:25 | 10:35 | 10:40 | 14:00 | 13:55 | 14:10 | 14:05 |
| Temperature (°C) | 0.62 | 0.21 | 0.92 | 0.3 | 1.12 | 0.62 | 1.45 | 0.55 | 0.7 | 0.34 | 0.17 | 0.2 | 0.22 | 0.17 | 0.22 | 0.18 |
| DO (mg/L) | 37.19 | 44.21 | 46.34 | 49.82 | 45.95 | 37.07 | 31.26 | 29.1 | 36.25 | 36.69 | 31.88 | 29.84 | 27.38 | 27.01 | 26.58 | 27.51 |
| Conductivity (uS/cm) | 1.01 | 1.01 | 1.01 | 1.02 | 0.993 | 1.01 | 1.05 | 1.09 | 1.08 | 1.1 | 1.07 | 1.07 | 1.06 | 1.06 | 1.06 | 1.05 |
| pH | 7.97 | 7.74 | 7.88 | 7.71 | 7.83 | 7.66 | 7.76 | 7.5 | 7.87 | 7.68 | 7.54 | 7.64 | 7.74 | 7.57 | 7.69 | 7.65 |
| ORP (mV) | 146 | 154 | 145 | 151 | 144 | 150 | 205 | 228 | 185 | 200 | 190 | 173 | 194 | 204 | 192 | 196 |
| Turbidity (NTU) | 11.8 | 13 | 10.7 | 12.3 | 11 | 13 | 10.7 | 12.6 | 11.9 | 12 | 10.3 | 10.4 | 8 | 9.4 | 8.4 | 10.8 |
| TDS (g/L) | 0.645 | 0.648 | 0.644 | 0.655 | 0.634 | 0.646 | 0.671 | 0.697 | 0.689 | 0.702 | 0.683 | 0.682 | 0.676 | 0.677 | 0.678 | 0.673 |

Table C-2 Laboratory Analytical Results for the Winter 2020 Field Program

| | | Site Name | Site 1-right | Site 1-middle | Site 1-left | R3 Effluent | Wetland outlet | Site 2-right | Site 2-middle | Site 2-left | Site 3-right | Site 3-middle | Site 3-middle duplicate | Site 3-left | Site 4-right | Site 4-left | Site 5-right | Site 5-left | Site 5-left duplicate | Site 6-right | Site 6-left |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ALS** | | **Sample ID** | FRI | FMI | FLI | HYLIFE | CONFLUENCE | FR2 | FM2 | FL2 | FR3 | FM3 | FM3 DUP | FL3 | FR4 | FL4 | FR5 | FL5 | DUP-FL5 | FR6 | FL6 |
| **3/12/2020** | | **ALS ID** | L2420941-1 | L2420941-2 | L2420941-3 | L2420941-4 | L2420941-5 | L2422058-1 | L2422058-3 | L2422058-2 | L2421538-2 | L2421538-3 | L2421538-4 | L2421538-1 | L2422058-4 | L2422058-5 | L2422109-1 | L2422109-2 | L2422109-3 | L2422109-4 | L2422109-5 |
| **L2420941** | | **Date Sampled** | 2/24/2020 1:45:00 PM | 2/24/2020 1:40:00 PM | 2/24/2020 1:35:00 PM | 2/24/2020 2:49:00 PM | 2/24/2020 4:55:00 PM | 2/26/2020 4:30:00 PM | 2/26/2020 4:35:00 PM | 2/26/2020 4:43:00 PM | 2/26/2020 9:14:00 AM | 2/26/2020 9:20:00 AM | 2/26/2020 9:20:00 AM | 2/26/2020 9:32:00 AM | 2/27/2020 8:37:00 AM | 2/27/2020 8:45:00 AM | 2/27/2020 11:12:00 AM | 2/27/2020 10:59:00 AM | 2/27/2020 10:59:00 AM | 2/27/2020 2:29:00 PM | 2/27/2020 2:15:00 PM |
| **Analyte** | **Units** | **LOR** | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water |
| Volatile Suspended Solids | mg/L | 2 | 2.2 | 2.1 | 2.2 | <2.0 | 2.7 | 3.5 | <2.0 | 2.7 | 3.9 | 3.9 | 3.5 | 3.5 | 3.1 | 3.9 | <2.0 | IP | 2.2 | <2.0 | <2.0 |
| Total Suspended Solids | mg/L | 2 | 2.1 | <2.0 | 2.1 | <2.0 | 5.1 | 5.6 | 5.1 | 4 | 10.5 | 9.1 | 9.5 | 9.7 | 6.4 | 6.9 | 2.7 | <2.0 | 3.6 | 3.5 | 2.5 |
| Alkalinity, Total (as CaCO3) | mg/L | 1 | 402 | 398 | 397 | 184 | 279 | 412 | 415 | 415 | 393 | 396 | 396 | 401 | 405 | 406 | 406 | 401 | 406 | 408 | 404 |
| Ammonia, Total (as N) | mg/L | 0.01 | 0.131 | 0.13 | 0.132 | 0.018 | 0.129 | 0.182 | 0.183 | 0.19 | 0.141 | 0.138 | 0.139 | 0.158 | 0.075 | 0.078 | 0.102 | 0.097 | 0.094 | 0.07 | 0.071 |
| Bicarbonate (HCO3) | mg/L | 1.2 | 490 | 485 | 484 | 225 | 341 | 485 | 486 | 492 | 458 | 463 | 463 | 468 | 486 | 488 | 496 | 489 | 495 | 498 | 493 |
| Carbonate (CO3) | mg/L | 0.6 | <0.60 | <0.60 | <0.60 | <0.60 | <0.60 | 8.76 | 10.1 | 7.2 | 10.3 | 10.1 | 9.84 | 10.9 | 4.08 | 3.6 | <0.60 | <0.60 | <0.60 | <0.60 | <0.60 |
| Chloride (Cl) | mg/L | 1 | 12.8 | 13.3 | 13.2 | 442 | 310 | 29.7 | 30 | 30.1 | 32.5 | 32 | 32.1 | 31 | 30.3 | 29.8 | 28.2 | 28.4 | 28.3 | 26.3 | 26.1 |
| Fluoride (F) | mg/L | 0.04 | 0.214 | 0.227 | 0.208 | 0.65 | 0.38 | 0.246 | 0.236 | 0.235 | 0.223 | 0.226 | 0.218 | 0.234 | 0.24 | 0.228 | 0.207 | 0.207 | 0.204 | 0.199 | 0.196 |
| Hydroxide (OH) | mg/L | 0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 | <0.34 |
| Nitrate and Nitrite as N | mg/L | 0.07 | 0.34 | 0.343 | 0.337 | 4.35 | 4.72 | 0.538 | 0.534 | 0.546 | 0.663 | 0.645 | 0.646 | 0.686 | 0.824 | 0.767 | 0.632 | 0.629 | 0.628 | 0.733 | 0.716 |
| Nitrate (as N) | mg/L | 0.04 | 0.34 | 0.343 | 0.337 | 4.35 | 4.72 | 0.538 | 0.534 | 0.546 | 0.663 | 0.645 | 0.646 | 0.686 | 0.824 | 0.767 | 0.632 | 0.629 | 0.628 | 0.733 | 0.716 |
| Nitrite (as N) | mg/L | 0.02 | <0.020 * | <0.020 * | <0.020 * | <0.050 * | <0.050 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * | <0.020 * |
| Total Kjeldahl Nitrogen | mg/L | 0.2 | 0.9 | 0.9 | 0.86 | 0.79 | 1.06 | 0.99 | 0.99 | 1.04 | 0.91 | 1.02 | 0.97 | 0.92 | 0.89 | 0.92 | 0.83 | 0.84 | 0.88 | 0.93 | 0.76 |
| Total Nitrogen | mg/L | 0.2 | 1.24 | 1.24 | 1.2 | 5.14 | 5.79 | 1.53 | 1.52 | 1.58 | 1.57 | 1.66 | 1.62 | 1.61 | 1.72 | 1.68 | 1.46 | 1.47 | 1.51 | 1.67 | 1.48 |
| Orthophosphate-Dissolved (as P) | mg/L | 0.003 | 0.0238 * | 0.0159 * | 0.0157 * | 0.0217 * | 0.0330 * | 0.0235 * | 0.0248 * | 0.0236 * | 0.0388 | 0.0444 | 0.0393 | 0.0395 | 0.0288 * | 0.0160 * | 0.0243 | 0.0232 | 0.0234 | 0.0191 | 0.017 |
| Phosphorus (P)-Total Dissolved | mg/L | 0.003 | 0.0358 | 0.0353 | 0.0361 | 0.034 | 0.0522 | 0.0497 | 0.0491 | 0.048 | 0.0539 | 0.0534 | 0.0526 | 0.0526 | 0.0591 | 0.0596 | 0.0499 | 0.0499 | 0.0509 | 0.0423 | 0.0405 |
| Phosphorus (P)-Total Reactive | mg/L | 0.003 | 0.0306 | 0.0160 * | 0.0185 * | 0.0211 * | 0.0419 * | 0.0203 * | 0.0208 * | 0.0203 * | 0.0453 | 0.0455 | 0.0457 | 0.0457 | 0.0278 * | 0.0206 * | 0.0312 | 0.0229 | 0.0248 | 0.0224 | 0.0419 |
| Phosphorus (P)-Total | mg/L | 0.003 | 0.0527 | 0.0536 | 0.0535 | 0.0353 | 0.0964 | 0.073 | 0.0744 | 0.0762 | 0.0824 | 0.0841 | 0.0814 | 0.0859 | 0.0868 | 0.0892 | 0.0798 | 0.0802 | 0.0785 | 0.071 | 0.0698 |
| Phosphorus (P)-Total Inorganic | mg/L | 0.003 | 0.0504 | 0.0495 | 0.0493 | 0.028 | 0.0852 | 0.0702 | 0.0669 | 0.0724 | 0.0742 | 0.0762 | 0.0756 | 0.0751 | 0.078 | 0.0809 | 0.0749 | 0.0752 | 0.0725 | 0.065 | 0.0659 |
| Phosphorus (P)-Total Acid-Hydrolyzable | mg/L | 0.0042 | 0.0198 | 0.0335 | 0.0309 | 0.0069 | 0.0433 | 0.0499 | 0.0462 | 0.0521 | 0.0289 | 0.0307 | 0.0299 | 0.0294 | 0.0502 | 0.0604 | 0.0437 | 0.0523 | 0.0476 | 0.0426 | 0.024 |
| Phosphorus (P)-Total Particulate | mg/L | 0.0042 | 0.0169 | 0.0183 | 0.0174 | <0.0042 | 0.0441 | 0.0233 | 0.0253 | 0.0282 | 0.0286 | 0.0307 | 0.0288 | 0.0333 | 0.0276 | 0.0296 | 0.0299 | 0.0303 | 0.0276 | 0.0287 | 0.0294 |
| Silica, Reactive (as SiO2) | mg/L | 1 | 36 | 36 | 36 | 9.4 | 17.1 | 34 | 34 | 35 | 33 | 35 | 34 | 33 | 33 | 34 | 34 | 34 | 34 | 34 | 33 |
| Dissolved Organic Carbon | mg/L | 0.5 | 8.6 | 8.46 | 8.87 | 3.54 | 6.75 | 8.13 | 8.69 | 8.74 | 8.64 | 8.75 | 8.74 | 8.73 | 9.02 | 8.64 | 8.5 | 8.29 | 8.29 | 7.61 | 8.07 |
| Total Inorganic Carbon | mg/L | 0.5 | 74.5 | 77.3 | 77.5 | 38.3 | 61.3 | 78.6 | 79 | 81.5 | 75.5 | 74.7 | 75.8 | 76.6 | 78.2 | 76.8 | 84.2 | 83 | 81 | 77.9 | 80.5 |
| Total Organic Carbon | mg/L | 0.5 | 8.83 | 9.37 | 8.76 | 3.75 | 6.28 | 8.7 | 8.56 | 8.72 | 8.52 | 8.51 | 8.5 | 8.52 | 8.63 | 8.6 | 8.38 | 8.37 | 8.36 | 7.96 | 8.1 |
| Escherichia Coli | MPN/100mL | 1 | 2 * | 2 * | 2 * | <1 * | 214 * | 313 * | 328 * | 344 * | 210 | 291 * | 186 | 185 | 67 | 77 | 38 | 26 | 28 | 8 | 8 |
| Fecal Coliforms | MPN/100mL | 1 | 3 * | 5 * | 3 * | <1 * | 121 * | 196 * | 285 * | 236 * | 172 | 145 | 144 | 196 | 68 | 91 | 20 | 31 | 26 | 9 | 8 |
| Aluminum (Al)-Total | mg/L | 0.003 | 0.022 | 0.0222 | 0.0241 | <0.0030 | 0.0555 | 0.0469 | 0.0547 | 0.0469 | 0.105 | 0.105 | 0.101 | 0.109 | 0.0898 | 0.0895 | 0.0477 | 0.0376 | 0.0434 | 0.0354 | 0.0381 |
| Antimony (Sb)-Total | mg/L | 0.0001 | <0.00010 | <0.00010 | <0.00010 | 0.00031 | 0.00014 | 0.00013 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | 0.0001 | <0.00010 |
| Arsenic (As)-Total | mg/L | 0.0001 | 0.00573 | 0.00585 | 0.00577 | 0.00025 | 0.00351 | 0.00549 | 0.00549 | 0.00556 | 0.00531 | 0.00521 | 0.00526 | 0.00521 | 0.00461 | 0.00472 | 0.00451 | 0.0045 | 0.00444 | 0.00367 | 0.0036 |
| Barium (Ba)-Total | mg/L | 0.0001 | 0.271 | 0.272 | 0.267 | 0.0193 | 0.164 | 0.28 | 0.285 | 0.283 | 0.262 | 0.265 | 0.271 | 0.272 | 0.266 | 0.262 | 0.283 | 0.279 | 0.284 | 0.279 | 0.272 |
| Beryllium (Be)-Total | mg/L | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Bismuth (Bi)-Total | mg/L | 0.00005 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Boron (B)-Total | mg/L | 0.01 | 0.057 | 0.057 | 0.052 | 0.085 | 0.068 | 0.064 | 0.063 | 0.064 | 0.058 | 0.062 | 0.059 | 0.058 | 0.063 | 0.063 | 0.063 | 0.063 | 0.062 | 0.063 | 0.063 |
| Cadmium (Cd)-Total | mg/L | 0.000005 | 0.0000064 | 0.0000053 | 0.0000112 | <0.0000050 | 0.0000121 | 0.0000075 | 0.0000075 | 0.0000094 | 0.0000128 | 0.0000092 | 0.0000132 | 0.000014 | 0.0000111 | 0.0000096 | 0.0000076 | 0.0000093 | 0.0000072 | 0.0000077 | 0.0000085 |
| Calcium (Ca)-Total | mg/L | 0.05 | 119 | 122 | 109 | 37.1 | 81 | 117 | 116 | 119 | 116 | 120 | 116 | 113 | 118 | 117 | 120 | 119 | 115 | 117 | 115 |
| Cesium (Cs)-Total | mg/L | 0.00001 | <0.000010 | <0.000010 | <0.000010 | 0.000059 | 0.000024 | 0.000022 | 0.000013 | 0.000012 | 0.000016 | 0.000018 | 0.000018 | 0.00002 | 0.000015 | 0.000014 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| Chromium (Cr)-Total | mg/L | 0.0001 | <0.00010 | 0.0001 | 0.00011 | 0.00027 | 0.00017 | 0.00017 | 0.00018 | 0.00015 | 0.00029 | 0.00034 | 0.00026 | 0.00028 | 0.00025 | 0.00024 | 0.00014 | 0.00012 | 0.00015 | 0.00012 | 0.00012 |
| Cobalt (Co)-Total | mg/L | 0.0001 | 0.00018 | 0.00019 | 0.00019 | 0.001 | 0.00054 | 0.00026 | 0.00026 | 0.00026 | 0.00029 | 0.00031 | 0.00029 | 0.00031 | 0.00025 | 0.00025 | 0.00024 | 0.00023 | 0.00023 | 0.00022 | 0.00023 |
| Copper (Cu)-Total | mg/L | 0.0005 | 0.00078 | 0.0008 | 0.0014 | 0.00111 | 0.00129 | 0.00084 | 0.0009 | 0.00094 | 0.00104 | 0.00126 | 0.00118 | 0.00104 | 0.00102 | 0.00103 | 0.00087 | 0.00081 | 0.00086 | 0.00078 | 0.00092 |
| Iron (Fe)-Total | mg/L | 0.01 | 0.219 | 0.225 | 0.229 | 0.05 | 0.418 | 0.286 | 0.319 | 0.295 | 0.41 | 0.42 | 0.404 | 0.436 | 0.326 | 0.327 | 0.34 | 0.338 | 0.333 | 0.291 | 0.284 |
| Lead (Pb)-Total | mg/L | 0.00005 | <0.000050 | 0.000071 | 0.000104 | <0.000050 | 0.000128 | 0.0001 | 0.000102 | 0.000098 | 0.000228 | 0.000191 | 0.000226 | 0.000187 | 0.000137 | 0.000137 | 0.000081 | 0.000083 | 0.000068 | 0.000075 | 0.000073 |
| Lithium (Li)-Total | mg/L | 0.001 | 0.0534 | 0.0537 | 0.0478 | 0.0142 | 0.0325 | 0.0525 | 0.0512 | 0.0529 | 0.049 | 0.051 | 0.0497 | 0.049 | 0.0542 | 0.0532 | 0.0523 | 0.0516 | 0.0512 | 0.0525 | 0.0514 |
| Magnesium (Mg)-Total | mg/L | 0.005 | 56 | 55.7 | 57 | 108 | 81.1 | 60.4 | 61.3 | 61.4 | 62.6 | 64.4 | 63.7 | 63.7 | 62.6 | 61.4 | 60.1 | 59.7 | 60.5 | 59.3 | 58.4 |
| Manganese (Mn)-Total | mg/L | 0.0001 | 0.524 | 0.519 | 0.535 | 0.198 | 0.321 | 0.472 | 0.485 | 0.48 | 0.276 | 0.277 | 0.277 | 0.282 | 0.166 | 0.16 | 0.29 | 0.293 | 0.287 | 0.184 | 0.182 |
| Molybdenum (Mo)-Total | mg/L | 0.00005 | 0.00169 | 0.00161 | 0.00153 | 0.00855 | 0.00478 | 0.0021 | 0.00213 | 0.00212 | 0.00209 | 0.00218 | 0.00219 | 0.00211 | 0.00302 | 0.00204 | 0.00175 | 0.00178 | 0.00172 | 0.00161 | 0.00159 |
| Nickel (Ni)-Total | mg/L | 0.0005 | 0.00107 | 0.0011 | 0.00122 | 0.00988 | 0.00493 | 0.00175 | 0.00174 | 0.00164 | 0.00197 | 0.00224 | 0.00192 | 0.00196 | 0.00199 | 0.00195 | 0.00185 | 0.00181 | 0.0018 | 0.00185 | 0.00176 |
| Phosphorus (P)-Total | mg/L | 0.03 | 0.062 | 0.059 | 0.063 | 0.059 | 0.101 | 0.075 | 0.075 | 0.075 | 0.086 | 0.092 | 0.085 | 0.091 | 0.085 | 0.092 | 0.084 | 0.088 | 0.081 | 0.082 | 0.065 |
| Potassium (K)-Total | mg/L | 0.05 | 8.57 | 8.42 | 8.37 | 47.8 | 26.4 | 9.81 | 9.72 | 10.1 | 10.4 | 10.1 | 10.3 | 10.3 | 10.2 | 9.99 | 9.21 | 9.45 | 9.17 | 8.91 | 8.76 |
| Rubidium (Rb)-Total | mg/L | 0.0002 | 0.00195 | 0.00192 | 0.00214 | 0.0612 | 0.0283 | 0.00441 | 0.00435 | 0.00442 | 0.00469 | 0.0047 | 0.00471 | 0.0047 | 0.00402 | 0.00383 | 0.00333 | 0.00339 | 0.00337 | 0.00307 | 0.00308 |
| Selenium (Se)-Total | mg/L | 0.00005 | 0.000184 | 0.000185 | 0.000182 | 0.00007 | 0.000163 | 0.000244 | 0.00023 | 0.00021 | 0.000221 | 0.000222 | 0.000201 | 0.000195 | 0.000213 | 0.000235 | 0.000217 | 0.000225 | 0.000196 | 0.000209 | 0.000181 |
| Silicon (Si)-Total | mg/L | 0.1 | 18.4 | 18.3 | 18.4 | 5.52 | 12.1 | 17.6 | 17.6 | 17.6 | 18.1 | 18.5 | 18.6 | 18 | 17.9 | 17.8 | 17.8 | 18.1 | 18.1 | 17.6 | 17.4 |
| Silver (Ag)-Total | mg/L | 0.00001 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |

Table C-2 Laboratory Analytical Results for the Winter 2020 Field Program

| | | Site Name | Site 1-right | Site 1-middle | Site 1-left | R3 Effluent | Wetland outlet | Site 2-right | Site 2-middle | Site 2-left | Site 3-right | Site 3-middle | Site 3-middle duplicate | Site 3-left | Site 4-right | Site 4-left | Site 5-right | Site 5-left | Site 5-left duplicate | Site 6-right | Site 6-left |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ALS** | | **Sample ID** | FRI | FMI | FLI | HYLIFE | CONFLUENCE | FR2 | FM2 | FL2 | FR3 | FM3 | FM3 DUP | FL3 | FR4 | FL4 | FR5 | FL5 | DUP-FL5 | FR6 | FL6 |
| **3/12/2020** | | **ALS ID** | L2420941-1 | L2420941-2 | L2420941-3 | L2420941-4 | L2420941-5 | L2422058-1 | L2422058-3 | L2422058-2 | L2421538-2 | L2421538-3 | L2421538-4 | L2421538-1 | L2422058-4 | L2422058-5 | L2422109-1 | L2422109-2 | L2422109-3 | L2422109-4 | L2422109-5 |
| **L2420941** | | **Date Sampled** | 2/24/2020 1:45:00 PM | 2/24/2020 1:40:00 PM | 2/24/2020 1:35:00 PM | 2/24/2020 2:49:00 PM | 2/24/2020 4:55:00 PM | 2/26/2020 4:30:00 PM | 2/26/2020 4:35:00 PM | 2/26/2020 4:43:00 PM | 2/26/2020 9:14:00 AM | 2/26/2020 9:20:00 AM | 2/26/2020 9:20:00 AM | 2/26/2020 9:32:00 AM | 2/27/2020 8:37:00 AM | 2/27/2020 8:45:00 AM | 2/27/2020 11:12:00 AM | 2/27/2020 10:59:00 AM | 2/27/2020 10:59:00 AM | 2/27/2020 2:29:00 PM | 2/27/2020 2:15:00 PM |
| **Analyte** | **Units** | **LOR** | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water | Water |
| Sodium (Na)-Total | mg/L | 0.05 | 22.9 | 23.1 | 23.3 | 138 | 74.3 | 25.9 | 26.3 | 26.4 | 27.5 | 28.1 | 28 | 27.8 | 26.6 | 26.1 | 25.2 | 25.3 | 25.3 | 24.5 | 24.1 |
| Strontium (Sr)-Total | mg/L | 0.0002 | 0.424 | 0.437 | 0.381 | 0.11 | 0.264 | 0.424 | 0.429 | 0.426 | 0.42 | 0.433 | 0.434 | 0.42 | 0.43 | 0.425 | 0.431 | 0.438 | 0.413 | 0.425 | 0.419 |
| Sulfur (S)-Total | mg/L | 0.5 | 56.4 | 55.9 | 56.2 | 10.7 | 33.5 | 53 | 52.9 | 53.1 | 53.5 | 54.2 | 54.8 | 54 | 55.8 | 55.6 | 48.8 | 49.7 | 49.3 | 46.8 | 46 |
| Tellurium (Te)-Total | mg/L | 0.0002 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Thallium (Tl)-Total | mg/L | 0.00001 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| Thorium (Th)-Total | mg/L | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Tin (Sn)-Total | mg/L | 0.0001 | <0.00010 | 0.00013 | <0.00010 | <0.00010 | 0.00012 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | 0.00014 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Titanium (Ti)-Total | mg/L | 0.0003 | 0.00067 | 0.00089 | 0.00076 | <0.00030 | 0.0017 | 0.00145 | 0.0018 | 0.00158 | 0.00319 | 0.0036 | 0.0035 | 0.00349 | 0.00268 | 0.00277 | 0.00153 | 0.00158 | 0.00142 | 0.00112 | 0.00134 |
| Tungsten (W)-Total | mg/L | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Uranium (U)-Total | mg/L | 0.00001 | 0.00398 | 0.00411 | 0.00328 | 0.000012 | 0.00184 | 0.00377 | 0.00378 | 0.0039 | 0.00409 | 0.00406 | 0.00414 | 0.00403 | 0.00413 | 0.00403 | 0.00359 | 0.00353 | 0.0034 | 0.0034 | 0.00335 |
| Vanadium (V)-Total | mg/L | 0.0005 | <0.00050 | 0.00054 | <0.00050 | <0.00050 | 0.00064 | 0.00056 | 0.00058 | 0.00057 | 0.00077 | 0.00079 | 0.00083 | 0.00085 | 0.00086 | 0.00084 | 0.00066 | 0.00064 | 0.00065 | 0.00064 | 0.00062 |
| Zinc (Zn)-Total | mg/L | 0.003 | <0.0030 | <0.0030 | <0.0030 | 0.0099 | 0.0056 | <0.0030 | <0.0030 | <0.0030 | 0.0087 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| Zirconium (Zr)-Total | mg/L | 0.0002 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | 0.00024 | 0.00023 | 0.00023 | 0.00024 | 0.00029 | 0.00023 | <0.00020 | <0.00020 | <0.00020 | 0.00021 | <0.00020 |
| Biochemical Oxygen Demand | mg/L | 2 | 3.1 | 3.2 | <2.0 | <2.0 | <2.0 | <2.0 | 2.9 | <2.0 | <2.0 | <2.0 | 2.7 | <2.0 | 3.7 | <6.0 | <2.0 | <2.0 | <2.0 | <2.0 | 33 |
| BOD Carbonaceous | mg/L | 2 | <2.0 | <2.0 | <2 | <2 | <2 | <2.0 | <2.0 | <2.0 | 2.3 | <2.0 | 2.9 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Chlorophyll a | ug/L | 0.1 | 2.01 | 2.05 | 2.22 | <0.10 | 2.27 | 1.24 | 3.12 | 3.08 | 1.67 | 1.71 | 2.6 | 1.62 | 3.17 | 2.62 | 2 | 1.26 | 1.37 | 2.06 | 1.38 |
| Phaeophytin a | ug/L | 0.1 | 2.35 | 2.47 | 2.57 | <0.10 | 2.02 | 1.97 | 3.75 | 3.67 | 2.65 | 2.88 | 4.11 | 2.57 | 4.2 | 3.64 | 2.91 | 1.96 | 2.09 | 2.8 | 2.13 |
| | | | | | | | | | | | | | | | | | | | | | |
| * = Result Qualified | Mouse-over the result to see the qualification. | | | | | | | | | | | | | | | | | | | | |