Real-Time Water Quality Annual Report

Northern Harvest Smolt Ltd.

January 1st to December 31st, 2022

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment & Climate Change
Water Resources Management Division

Introduction

- The Real-Time Water Quality (RTWQ) Monitoring Network near Stephenville, NL consists of three groundwater well monitoring stations funded by Northern Harvest Smolt Ltd. The program is a partnership between Northern Harvest and the Newfoundland & Labrador Department of Environment and Climate Change (ECC).

- Each of the three stations consists of groundwater water quality and quantity monitoring equipment (water level) which transmits data in near real-time every 2-3 hours.

- The well stations are known as: MW5/6; FMW10 and FMW12. They were installed in November 2019 by ECC staff and first deployed on November 6th 2019. The instruments remain in the monitoring wells year-round unless removed temporarily for maintenance and calibration.

- These stations measure the following water parameters: temperature, pH, specific conductivity, total dissolved solids (TDS), oxidation-reduction potential (ORP) and water quantity (depth). Parameters are recorded on an hourly basis during the deployment period and are available in real-time online:

  NLGWMW5/6: https://www.mae.gov.nl.ca/wrmd/ADRS/v6/Template_Station.asp?station=NLGWMW56
  NLGWFMW10: https://www.mae.gov.nl.ca/wrmd/ADRS/v6/Template_Station.asp?station=NLGWFMW10
  NLGWFMW12: https://www.mae.gov.nl.ca/wrmd/ADRS/v6/Template_Station.asp?station=NLGWFMW12

- MW5/6 – This 50mm well is one of the thirteen wells that make up the Northern Harvest near field monitoring well network within 500m of the water supply area. This is a relatively shallow well at 2.92m

- FMW10 - This 50mm well is one of the five wells that make up the Northern Harvest far-field monitoring network set up outside the 500m radius of the hatchery. This well is relatively deep at 22.54.

- FMW12 – This 152mm well is one of the thirteen wells that make up the Northern Harvest near-field monitoring network within 500m of the water supply area. This well is relatively deep at 29.25.

- The purpose of this network is to monitor, process, and distribute water quality/quantity data to Northern Harvest Smolt Ltd. and ECC for assessment and management of water resources, as well as to provide an early warning for any potential or emerging water issues, allowing mitigative measures to be implemented in a timely manner.
- ECC will provide Northern Harvest Smolt Ltd. with deployment and annual reports. Data is also available in near real-time on ECC's website.

Figure 1: Map of Northern Harvest Smolt Ltd. Real Time Water Monitoring Network

- Gaps in the water quality data are the result of transmission loss by the stations or the removal of inaccurate data due to ongoing station maintenance during that time period.
- The first deployment for the 2022 season began in August 2021.
- The instruments were next removed for full maintenance in April 2022, followed by October 2022 and February 2023.

(a)MW5/6 **(b) FMW10**

(c) FMW12

Figure 2: Northern Harvest Real Time Monitoring Network: (a) MW5/6, (b) FMW10, (c) FMW12

Maintenance and Calibration

- To ensure accurate data collection of the real time groundwater monitoring network, maintenance and calibration of the water quality instrumentation is performed approximately every four months
- Maintenance includes a thorough cleaning of each instrument and replacement of any small sensor parts that are damaged or unsuitable for reuse. Once the instrument is cleaned, ECC staff carefully calibrate each sensor attachment for pH, specific conductivity and ORP to ensure accurate data collection.
- Installation and removal dates for 2022 are summarized in Table 1 below.

Table 1: Water quality instrument deployment start and end dates for 2022

Station	Installation	Removal	Duration (days)
MW5/6	August 27, 2021	April 12, 2022	225
	April 13, 2022	October 12, 2022	179
	October 13, 2022	February 27, 2023	134
FMW10	August 27, 2021	April 12, 2022	225
	April 13, 2022	October 12, 2022	179
	October 13, 2022	February 27, 2023	134
FMW12	August 27, 2021	April 12, 2022	225
	April 13, 2022	October 12, 2022	179
	October 13, 2022	February 27, 2023	134

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of each deployment period. The procedure is based on the approach used by the United States Geological Survey.
- During the maintenance phase, water levels are measured manually and a volume equivalent to three well casings is purged from each well prior to re-installation and the collection of grab samples. This process flushes stagnant water from the wells and ensures that the water being observed is aquifer water.

- After full purging of the well, the sonde is deployed and initial field readings are recorded. A grab sample is taken when possible to compare the values of pH and specific conductance against the deployed sonde's initial values.
- Three instruments are owned by Northern Harvest and will be installed in the wells on a rotating basis to ensure data accuracy.
- Deployment comparison rankings for the stations are summarized in Table 2.

Table 2: QA/QC comparison rankings for Northern Harvest Stations

Station	Date	Action	Instrument #	pH	Specific Conductivity
MW56	27-Aug-21	Deployment	19E100387	Good	Good
	13-Apr-22	Deployment	19D105282	Good	Good
	13-Oct-22	Deployment	19D105281	Marginal	Good
FMW10	27-Aug-21	Deployment	19D105282	Good	Excellent
	13-Apr-22	Deployment	19D105281	Excellent	Good
	13-Oct-22	Deployment	19E100387	Good	Good
FMW12	27-Aug-21	Deployment	19D105281	*	*
	13-Apr-22	Deployment	19E100387	*	*
	13-Oct-22	Deployment	19D105282	Excellent	Excellent

*Ranking not available due to issues with collecting grab sample

Data Interpretation

- The following graphs and discussion illustrate water quality and level related events from January 1st to December 31st, 2022 at Northern Harvest Smolt facility.
- All data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

Water Temperature

- In 2022, water temperature ranged from 0.47°C to 14.51°C within the real-time well network (Table 3).
- MW5/6 had the largest range of water temperatures, reaching a low in January and peaking in September, with a range of 14.04°C over the course of 2022.
- At FMW10, water temperature was relatively stable, with a notable decrease during the summer and increase again into winter (Figure 3).
- FMW12 was very stable throughout the year, varying within a small range with a median of 6.87 (Figure 3).

Table 3: Water Temperature (°C) Summary Statistics from the Well Network

	MW5/6	FMW10	FMW12
MIN.	0.47	6.55	6.82
MAX.	14.51	7.87	6.98
MEDIAN	8.06	6.99	6.87

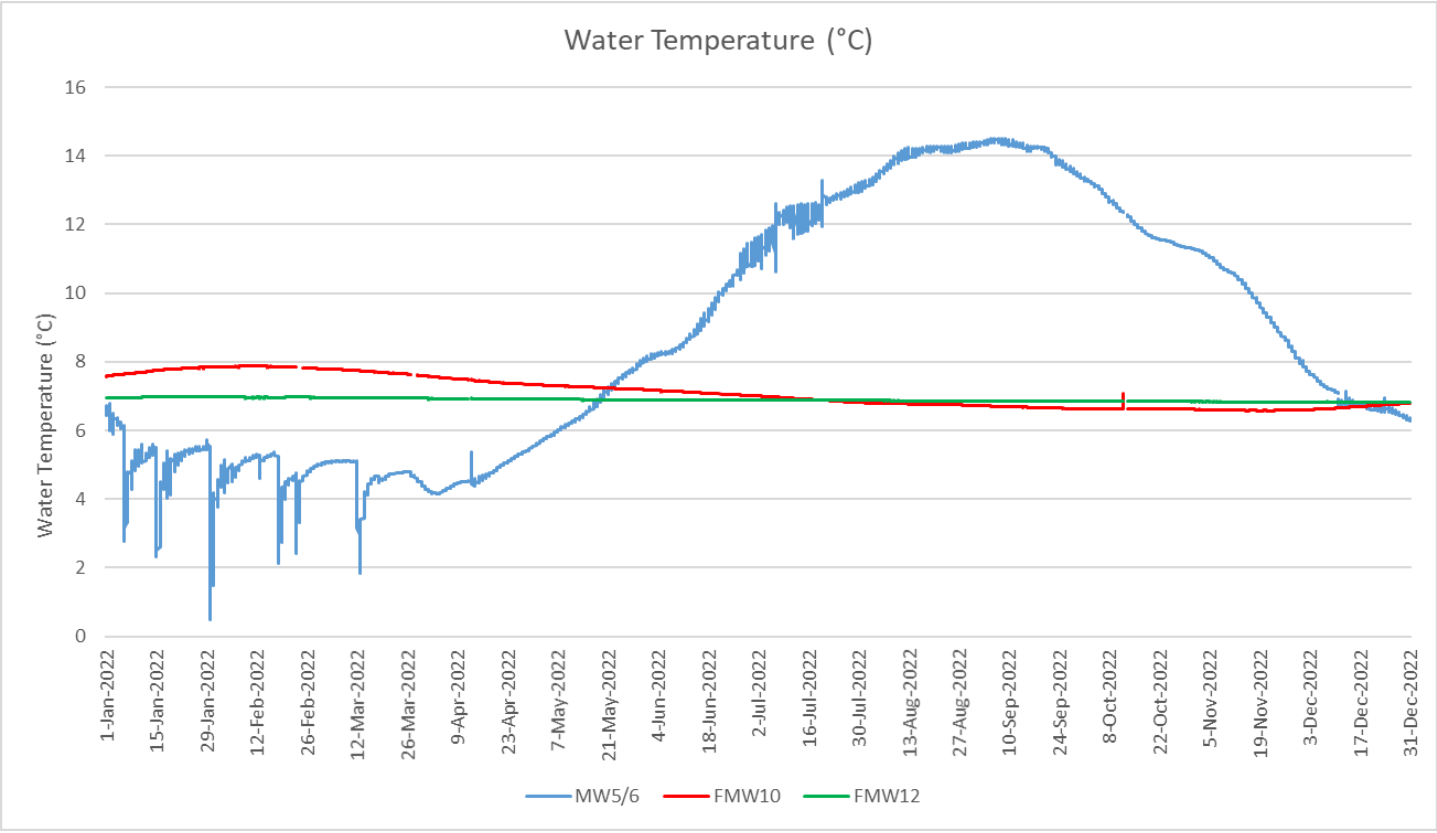

Figure 3: Water Temperature (°C) – Northern Harvest Smolt Ltd. Network

Water Depth

- During the deployment, MW5/6 was relatively stable while FMW12 showed a slight decreasing trend throughout 2022 (Table 4).
- FMW10 showed the most variability, increasing until early March before increasing into April. Water level then increased gradually from June into December. This may be indicative of a seasonal trend.

Table 4: Water Elevation (m) Summary Statistics from the Well Network

	MW5/6	FMW10	FMW12
MIN.	1.69	6.44	6.43
MAX.	2.47	9.86	7.75
RANGE	0.78	3.42	1.32
MEDIAN	2.06	8.21	7.25

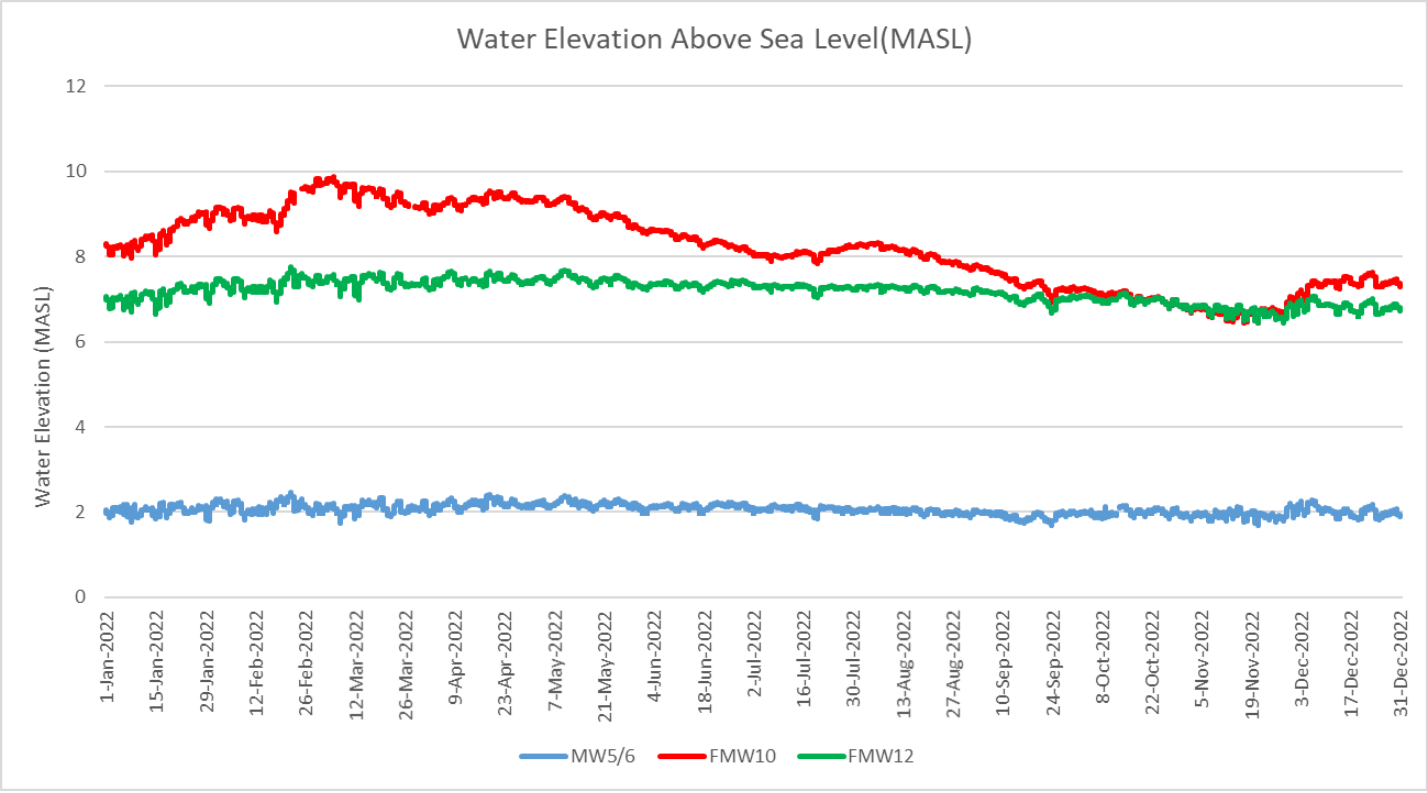

Figure 4: Water Elevation (m) – Northern Harvest Smolt Ltd. Network

pH

- In 2022, pH ranged from 5.62 (at MW5/6) to 8.08 (at FMW12) pH units within the real-time well network (Table 5).
- MW5/6 displayed moderate variation until April when the variation was reduced by calibration.
- Both FMW10 and FMW12 displayed little variation throughout 2022 (Figure 5).

Table 5: pH (pH units) Summary Statistics from the Well Network

	MW5/6	FMW10	FMW12
MIN.	5.62	7.46	7.7
MAX.	6.75	7.8	8.08
MEDIAN	6.06	7.73	7.99

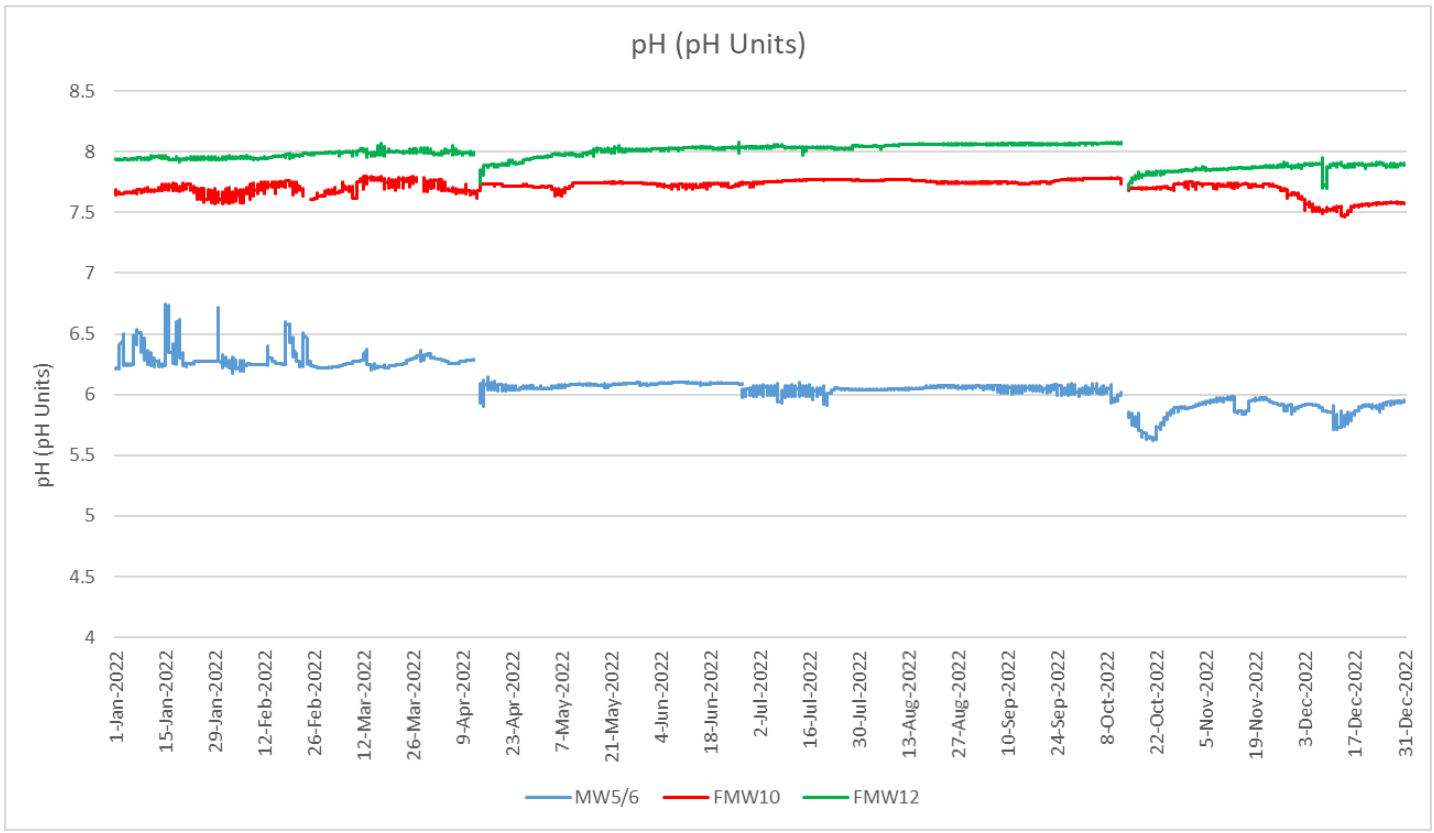

Figure 5: pH – Northern Harvest Smolt Ltd. Network

Specific Conductance and TDS

- In 2022, specific conductance ranged from 53.05 µS/cm to 632.23 µS/cm within the real-time well network (Table 6).
- During 2022, FMW12 shows little variation while FMW10 slowly decreases until July at which point it begins to increase. At MW5/6, values fluctuated until mid October when conductance increased rapidly for several days before dropping again quickly. Values then fluctuated for the remainder of 2022 (Figure 6).

Table 6: Specific Conductance (µS/cm) & TDS (g/L) Summary Statistics from the Well Network

	MW5/6	FMW10	FMW12		MW5/6	FMW10	FMW12
SPECIFIC CONDUCTANCE				**TOTAL DISSOLVED SOLIDS**			
MIN.	53.05	293.73	341.19	**MIN.**	0.03	0.19	0.22
MAX.	632.23	478.52	370.65	**MAX.**	0.41	0.31	0.24
MEDIAN	162.02	362.24	362.06	**MEDIAN**	0.11	0.24	0.24

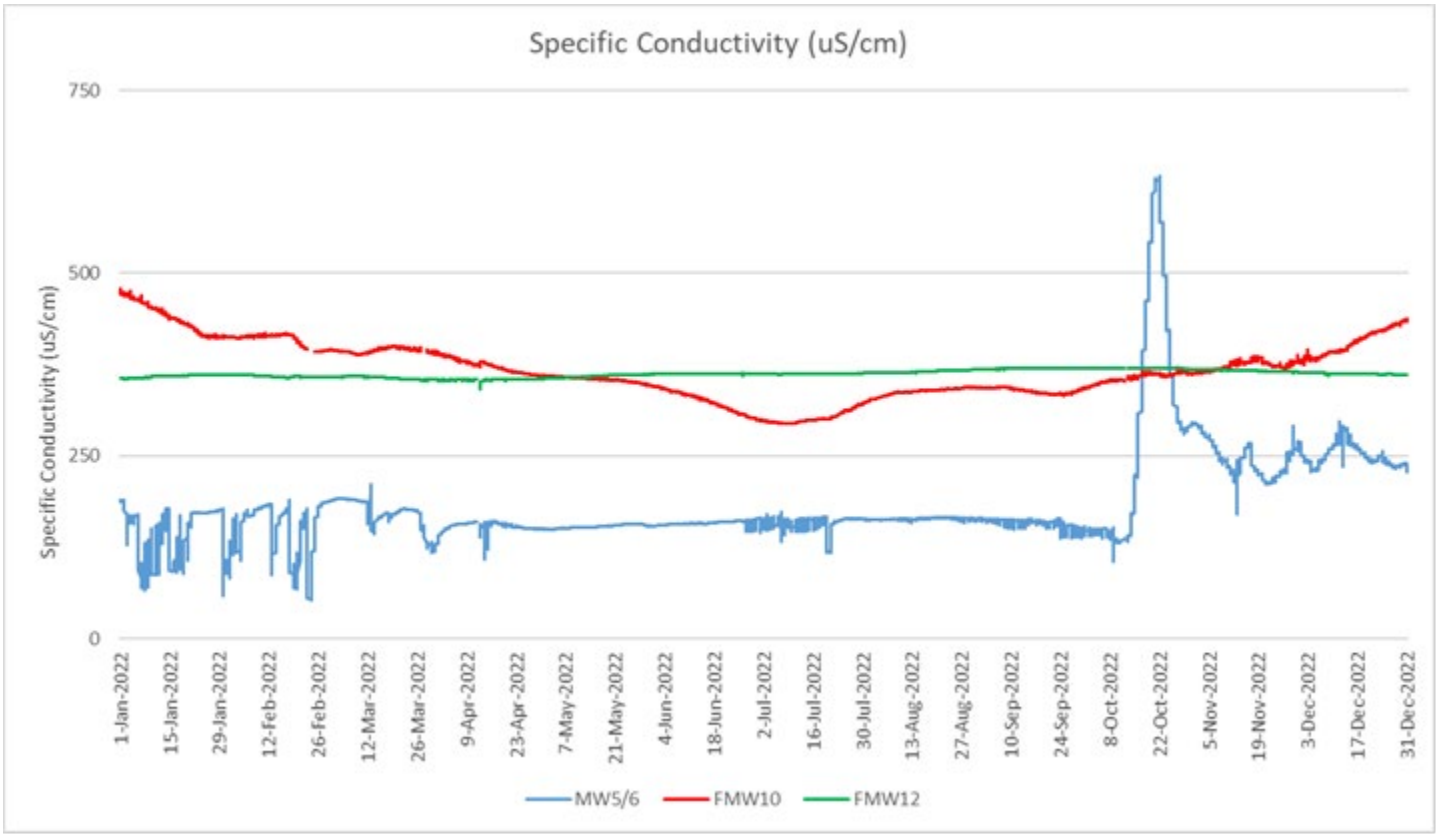

Figure 6: Specific Conductance – Northern Harvest Smolt Ltd. Network

- During 2022, total dissolved solids (TDS) ranged from 0.03 mg/L to 0.41 mg/L within the real time well network (Table 6).
- TDS varied little at FMW12 and decreased at FMW10 until July at which point it increases. At MW5/6 TDS was the lowest in the network until mid October when an unknown event rapidly increased TDS for several days. Values then decreased but continued to fluctuate throughout the remainder of the year (Figure 7).

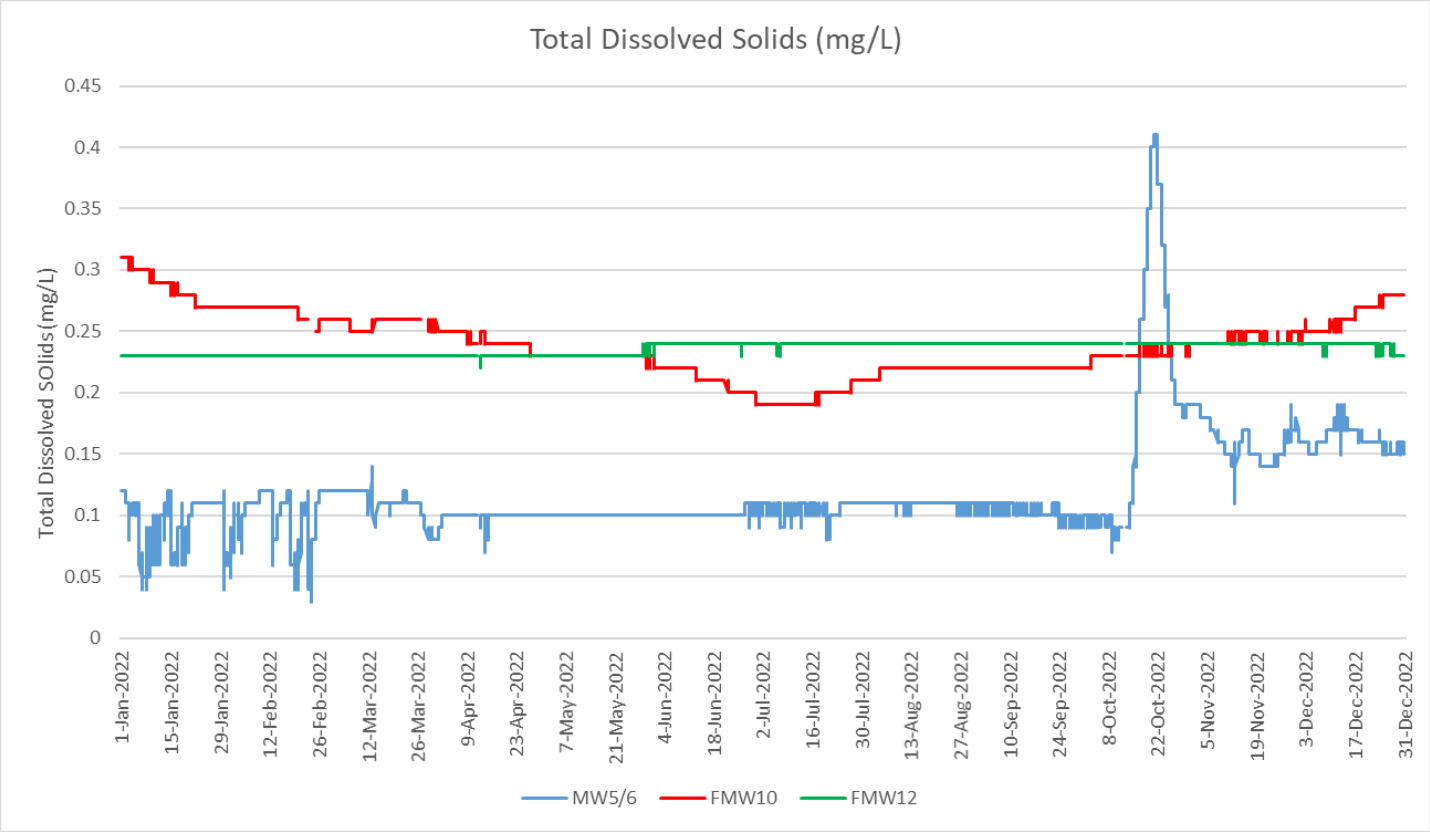

Figure 7: Total Dissolved Solids – Northern Harvest Smolt Ltd. Network

Oxidation – Reduction Potential (ORP)

- During 2022, oxidation-reduction potential (ORP) ranged from -470.48 mV to 426.40 mV within the real time well network (Table 7).
- During the 2022 deployment year, all stations appeared to be oxidative in nature. However for the second deployment, April to October, MW5/6 was reductive and exhibited large fluctuations throughout the remainder of the year. FMW12 was also very slow to readjust after maintenance in April and October.

Table 7: Oxidation-Reduction Potential (ORP) Summary Statistics from the Well Network

	MW5/6	FMW10	FMW12
MIN.	-470.48	237	9.95
MAX.	416.44	426.40	377.77
MEDIAN	22.32	353.45	359.55

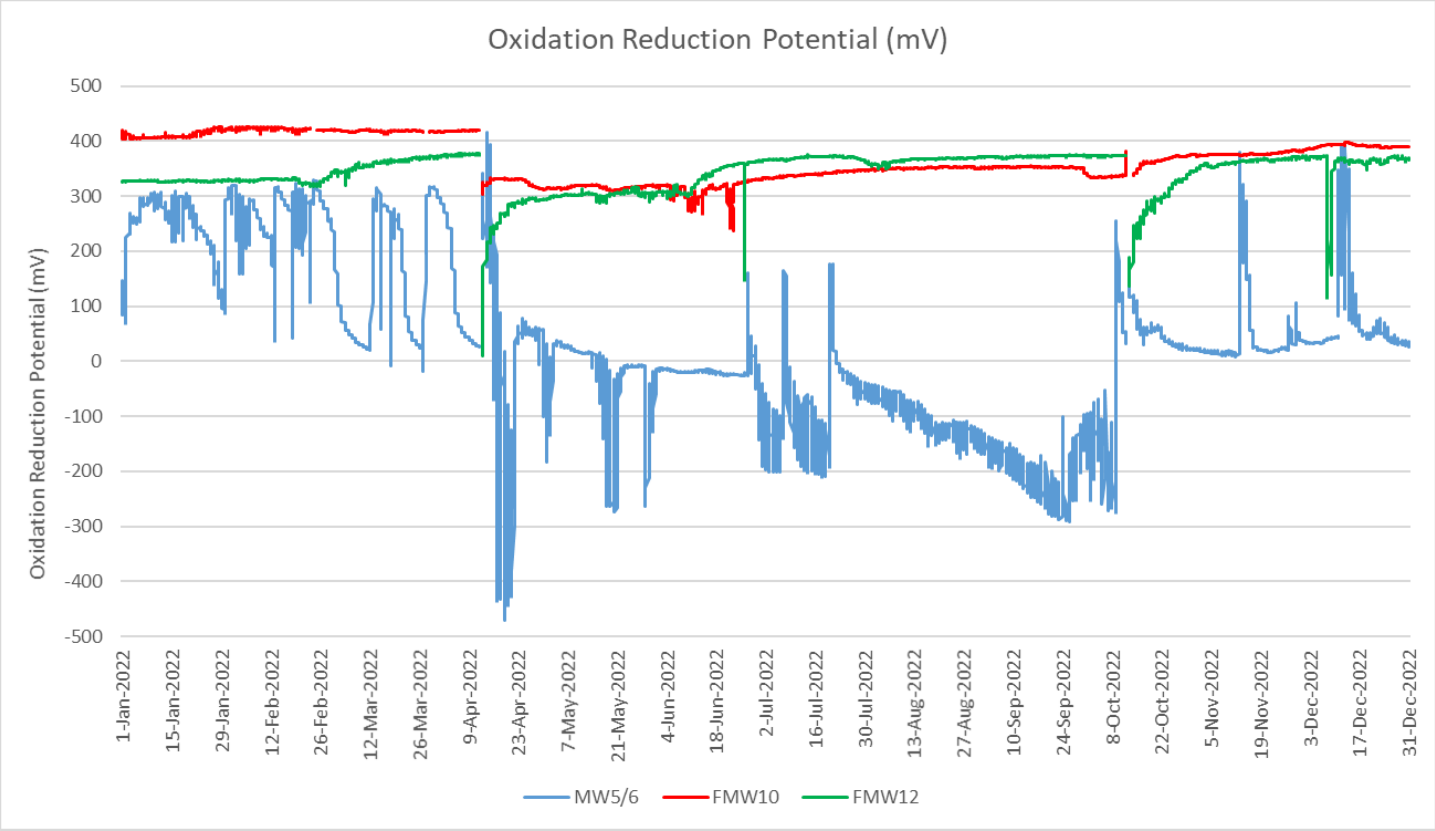

Figure 8: Oxidation-Reduction Potential (ORP) – Northern Harvest Smolt Ltd. Network

Conclusions

- The real-time water quality and quantity monitoring network at Northern Harvest Smolt Ltd was established on November 6, 2019 when instruments were initially deployed at each of the three wells in the network: MW5/6, FMW10, and FMW12.
- Since initial deployment, data has been monitored closely to determine if the instruments are accurately placed in the well casings and if there are other issues such as sensor errors.
- QA/QC rankings were obtained when grab samples could be collected. Equipment was upgraded in the fall of 2022 to ensure grab samples could be collected at FMW12.
- Water temperature at MW5/6 showed the most variability in the network due seasonal temperature change, while temperatures at FMW10 showed a slight decrease. FMW12 was stable throughout 2022.
- Over the course of the year, water depth was relatively stable at MW5/6, while the data illustrates a slight decrease at both FMW10 and FMW12.
- pH at MW5/6 was slightly acidic and showed the most variability in the network. pH values at FMW10 and FMW12 were relatively similar: stable and slightly basic.
- Specific conductivity was generally lowest at MW5/6 until an event occurred over several days in mid October, rapidly increasing conductance, which then decreased and fluctuated for the remainder of 2022. Levels at FMW10 slowly decreased and the increased. FMW12 were relatively stable throughout the year.
- ORP for FMW10 and FMW12 stations was generally oxidative, except at MW5/6 which indicated reductive. There were numerous fluctuations throughout the year at all three stations, but MW5/6 experienced fluctuations more frequently and to a higher degree.
- During 2022, the instruments performed well with few issues. The groundwater pump failure was resolved in 2022.

Path Forward

- Staff will continue to monitor the data for issues.
- If necessary, deployment techniques will be evaluated and modified, ensuring secure and suitable conditions for RTWQ monitoring.
- ECC will continue to work on its Automatic Data Retrieval System (ADRS), to incorporate new capabilities in data management and data display.
- Open communication lines will continue to be maintained between ECC and Northern Harvest Smolt Ltd in order to respond to emerging issues on a proactive basis. Northern Harvest Smolt Ltd. will receive deployment reports and an annual report summarizing the events of the deployment season.

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Appendix 1: Air Temperature and Precipitation at Stephenville, NL