2017 Alberta-NWT Transboundary Water Quality Technical Report

for the

Slave and Hay Transboundary Rivers

a technical companion report to the

Alberta-Northwest Territories Bilateral Management Committee Annual Report to Ministers, 2017-2018

Surface water quality data collected during 2017

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Executive Summary

The Bilateral Management Committee (BMC) releases a water quality report as a component of the annual reporting requirements of the Alberta-Northwest Territories Bilateral Water Management Agreement (AB-NWT BWMA) each year. This is the third water quality report since the signing of the Agreement in 2015. It presents an assessment of the water quality data collected in the 2017 calendar year and the cooperative efforts of the AB-NWT water quality technical team in the 2017-2018 fiscal year.

Alberta and the NWT are committed to establishing transboundary water quality triggers and objectives for the Slave and Hay rivers. While the BMC continues to work on the development of transboundary water quality, site-specific interim water quality triggers set at the 50th and 90th percentile were used for this assessment. Triggers are intended to provide an early warning of potential changing water quality.

Water quality samples collected from the Slave and Hay rivers are analyzed for numerous different parameters such as major ions, nutrients and metals. For the 2017 Slave River assessment, sixty-six parameters from each of the nine samples collected throughout the year were reviewed. For the Hay River, forty different parameters from each of the four samples were reviewed.

For the Slave River, 22 of the 66 parameters were flagged as part of the Trigger 1 assessment. Of these, 7 parameters were also flagged in 2015 and 2016: alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium. Further assessment suggested that concentrations of four parameters (alkalinity, dissolved magnesium, nitrate/nitrite and dissolved sulphate) are higher in the last three years than in the past. The other three parameters did not reveal any significant differences, suggesting concentrations are at the same level now compared to historical values. Under Trigger 2, 33 of the 66 parameters were flagged. Of these, two parameters, total dissolved solids and dissolved magnesium were above their open-water maximum values but below their overall historical maximum values. The other 31 parameters were below their open-water maximum values. This indicates that the concentrations of all of these parameters are within the range considered acceptable.

For the Hay River, 5 of the 40 parameters were flagged as part of the Trigger 1 assessment. Of these, 3 parameters: nitrate/nitrite, total manganese and total uranium were also flagged in 2016. Further assessment did not reveal any significant differences suggesting that concentrations are at the same level now compared to historical values. Under Trigger 2, 23 of the 40 parameters were flagged. Of these, only particulate organic carbon was above its historical maximum value on one occasion which was likely attributable to the high flow event upstream and the associated high suspended sediment level at the time of sampling. These findings show no significant changes in the water quality of the Hay River.

The AB-NWT BWMA also commits the BMC to report on the detection of toxic, bioaccumulative and persistent substances. During the summer of 2017, three (GNWT) water samples from both the Slave and

Hay Rivers were analyzed for 14 substances that are subject to virtual elimination (VE). Some substances subject to VE were detected on each sampling occasion in each river, but at very low concentrations. Comparisons with the available corresponding CCME guidelines for the Protection of Aquatic Life and the United States Environmental Protection Agency (USEPA) Chronic Aquatic Life Criteria show that the levels detected pose no risk to aquatic life. As the amount of substance found in the samples was similar to the values detected in the blank samples, it is likely that laboratory contamination occurred.

Overall, there were no major concerns identified in the 2017 water quality assessment of the Slave and Hay rivers. With regard to future assessments, a water-quality technical sub-committee is being established under the Mackenzie River Basin Board to explore more rigorous methods to assess trends so that the BMC can confirm, for instance, whether levels of dissolved magnesium, nitrate/nitrite and dissolved sulphate in the Slave River are changing. Additionally, the sub-committee will review the existing interim triggers for both rivers to establish an agreed-to approach for their revision and amendment as the need arises. Monitoring, assessment and reporting for all conventional parameters as well as substances that are subject to VE will continue.

The Hay River near the Alberta/NWT Border

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1. Background

In 1997, Canada, British Columbia, Alberta, Saskatchewan, the Northwest Territories and the Yukon signed the Mackenzie River Basin Transboundary Waters Master Agreement. The Master Agreement commits all six governments to the following principles:

1. Managing the Water Resources in a manner consistent with the maintenance of the Ecological Integrity of the Aquatic Ecosystem;
2. Managing the use of the Water Resources in a sustainable manner for present and future generations;
3. The right of each to use or manage the use of the Water Resources within its jurisdiction, provided such use does not unreasonably harm the Ecological Integrity of the Aquatic Ecosystem in any other jurisdiction;
4. Providing for early and effective consultation, notification and sharing of information on developments and activities that might affect the Ecological Integrity of the Aquatic Ecosystem in another jurisdiction; and
5. Resolving issues in a cooperative and harmonious manner.

The Master Agreement also provides broad guidance for negotiating individual bilateral agreements between provincial and territorial jurisdictions. In March 2015, the AB-NWT Bilateral Water Management Agreement (AB-NWT BWMA) was signed. The purpose of the AB-NWT BWMA is to establish and implement a framework to achieve the principles of the Master Agreement. The AB-NWT BWMA facilitates improved monitoring and reporting and includes provisions to create water quality and quantity and biological objectives to maintain the ecological integrity of transboundary water ecosystems.

As part of the implementation of the AB-NWT BWMA, a Bilateral Management Committee (BMC) was established to implement the Agreement. The BMC is pleased to release this Annual Water Quality Report for 2017. This report is intended to:

i. Describe the Slave and Hay River transboundary water quality monitoring programs used for this assessment (Section 2);

ii. Describe the approach of the water quality assessment (Section 3);

iii. Present and discuss the results of the water quality assessment (Sections 4, 5 & 6); and,

iv. Describe the activities of the AB-NWT water quality technical team for the 2017-2018 fiscal year and any water quality-related tasks for upcoming years (Section 7).

2. Transboundary Water Quality Monitoring Programs

2.1. Slave River

Along the transboundary reach of the Slave River, there are two transboundary long-term water quality monitoring sites operated under two water quality monitoring programs.

These programs include:

1) Long-term Monitoring Network, Slave River at Fitzgerald (1960 to present), led by Environment and Climate Change Canada (ECCC).

2) Transboundary River Water Quality and Suspended Sediment Monitoring Program, Slave River at Fort Smith (1990-present), led by the Government of the Northwest Territories (GNWT).

Water quality data collected from these locations were used for this assessment.

Since 1960, ECCC has operated the Slave River at Fitzgerald monitoring site (AL07NB0001) as part of their Long-term Monitoring Network. The water quality monitoring site is located near the community of Fitzgerald in Alberta, approximately 20 km upstream from the Town of Fort Smith. Since monitoring began at this site, water samples have been collected from two to thirteen times a year. In 2017, water quality samples were collected on nine occasions, in January, February, March, May, June, July, August, September and October. The conventional data (physical parameters, major ions, nutrients and metals) from these water samples were used for this assessment.

Since 1990, Crown-Indigenous Relations and Northern Affairs Canada (up to April 1, 2014) and the GNWT (after April 1, 2014) have operated the Slave River at Fort Smith monitoring site (NWT07QA0004) as part of their Transboundary River Water Quality and Suspended Sediment Monitoring Program. The water and suspended sediment monitoring site is located below the Rapids of the Drowned near the Town of Fort Smith. Since monitoring began at this site, water and suspended sediment samples have been collected from one to twelve times a year. In 2017, water and suspended sediment samples were collected on three occasions in June, July and August. The data, specifically, the substances subject to virtual elimination from these samples were used for this assessment.

Table 1 presents a list of the water quality parameters reviewed to fulfill the water quality reporting requirements of the AB-NWT BWMA. The Slave River at Fitzgerald and Slave River at Fort Smith monitoring locations are shown in Figure 1.

Table 1: Slave River parameters reviewed for the 2017 water quality assessment

Parameter Grouping	Parameters
Physical Parameters (Slave River at Fitzgerald; ECCC data)	alkalinity, dissolved oxygen, pH, specific conductance, total dissolved solids, total suspended solids, turbidity

Parameter Grouping	Parameters
Major Ions (Slave River at Fitzgerald; ECCC data)	dissolved calcium, dissolved chloride, dissolved magnesium, dissolved sodium, dissolved potassium, dissolved sulphate
Nutrients (Slave River at Fitzgerald; ECCC data)	ammonia, dissolved nitrogen, nitrate/nitrite, dissolved organic carbon, particulate organic carbon, dissolved phosphorus, total phosphorus
Metals (dissolved and total) (Slave River at Fitzgerald; ECCC data)	aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, zinc
Substances Subject to Virtual Elimination (Slave River at Fort Smith; GNWT data)	aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclohexane (HCH; alpha, beta, gamma), mirex, DDD, DDE, DDT, toxaphene, PCBs, pentachlorobenzene

2.2. Hay River

Along the transboundary reach of the Hay River there is one long-term transboundary water quality monitoring site (Figure 1) which is sampled under two separate water quality monitoring programs:

1) Long-term Monitoring Network, Hay River near the Alberta/NWT Border (1988 to present), led by ECCC.

2) Transboundary River Water Quality and Suspended Sediment Monitoring Program, Hay River near the Alberta/NWT Border (1995-present), led by GNWT.

Since 1988, ECCC has operated the Hay River near the Alberta/NWT Border monitoring site (NW07OB0002) as part of their Long-term Monitoring Network. Samples were collected on a monthly basis from October 1988 to 1994 and have been collected three to six times a year since 1995. In 2017, water quality samples were collected on four occasions in April, May, July and October. The conventional data (physical parameters, major ions, nutrients and metals) from these water samples were used for this assessment.

Since 1995, Crown-Indigenous Relations and Northern Affairs Canada (up to April 1, 2014) and the GNWT (after April 1, 2014) have operated the Hay River near the Alberta/NWT Border monitoring site as part of their Transboundary River Water Quality and Suspended Sediment Monitoring Program. Since this program was started, water and suspended sediment samples have been collected from one to three times a year. In 2017, water and suspended sediment samples were collected three times in June, July and August. The data, specifically, the substances subject to virtual elimination from these samples were used for this assessment.

Table 2 presents a list of the water quality parameters reviewed to fulfill the water quality reporting requirements of the AB-NWT BWMA.

Table 2: Hay River parameters reviewed for the 2017 water quality assessment

Parameter Grouping	**Parameters**
Physical Parameters (ECCC data)	alkalinity, dissolved oxygen, pH, specific conductance, total dissolved solids, total suspended solids, turbidity
Major Ions (ECCC data)	dissolved calcium, dissolved chloride, dissolved magnesium, dissolved sodium, dissolved potassium, dissolved sulphate
Nutrients (ECCC data)	ammonia, dissolved nitrogen, nitrate/nitrite, dissolved organic carbon, particulate organic carbon, dissolved phosphorus, total phosphorus
Metals (total) (ECCC data)	aluminum, antimony, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, zinc
Substances Subject to Virtual Elimination (GNWT data)	aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclohexane (HCH; alpha, beta, gamma), mirex, DDD, DDE, DDT, toxaphene, PCBs, pentachlorobenzene

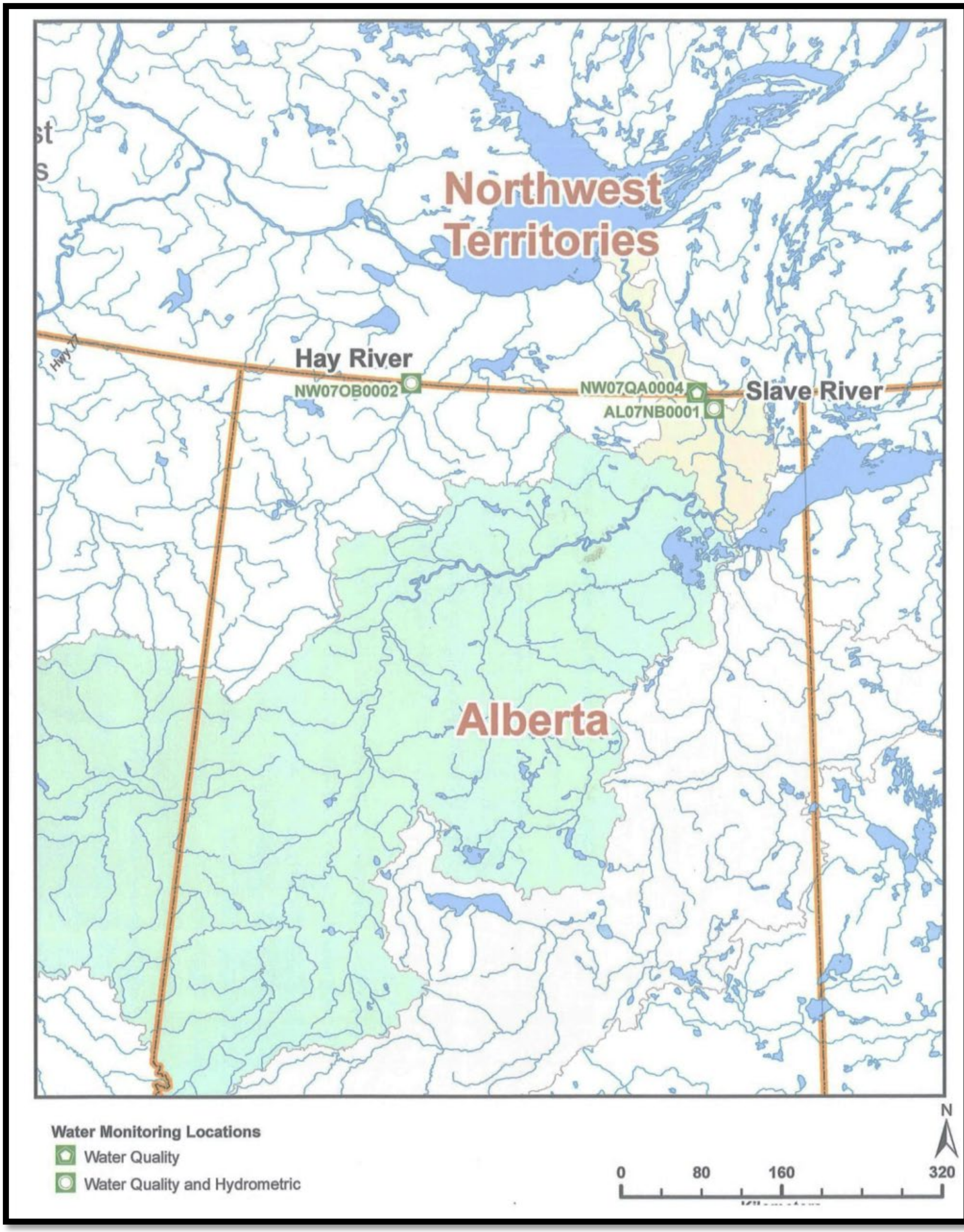

Figure 1: AB-NWT Transboundary Water Quality Monitoring Sites

3. Approach to Annual Water Quality Assessment

3.1. Introduction

Under the Alberta-NWT Bilateral Water Management Agreement (AB-NWT BWMA) , the Hay and Slave rivers have been classified as Class 3 Rivers. An important task associated with a Class 3 transboundary river designation is the development of site-specific water quality triggers and objectives. Site-specific water quality triggers and objectives provide an appropriate and relevant measure against which future water quality results can be compared and evaluated.

The AB-NWT BWMA defines a water quality trigger as a pre-defined early warning of potential changes in typical and/or extreme conditions which results in Jurisdictional and/or Bilateral Water Management to confirm that change. Triggers are an aid to manage water quality within the range of natural variability. Interim water quality triggers have been calculated based on ambient background concentrations of a parameter at the water quality site under consideration. Where water quality parameters exhibited seasonal differences, seasonal interim site-specific water quality triggers have been calculated.

In the AB-NWT BWMA, a water quality objective is defined as a conservative value that is protective of all uses of the water body, including the most sensitive use (AB-NWT BWMA 2015). At the time of signing, water quality objectives had not been determined. The Parties agreed that the approach to develop and implement transboundary water quality objectives required further discussion and resources. The Parties also agreed that the task to develop water quality objectives is a priority. Steps towards the development of objectives are underway.

While transboundary water quality objectives are being developed, the BMC is assessing the water quality of the Slave and Hay rivers at the borders using the interim water quality triggers.

3.2. Data Preparation

Initially, to determine the historical range of water quality in the Hay and Slave rivers, the Hay River dataset (1969-May 2014) and the Slave River dataset (1960-2012) were retrieved from ECCC. HDR Inc. was retained to prepare the data prior to the calculation of interim water quality triggers and assessment of long-term temporal trends. A series of steps were undertaken to prepare the data. While these steps are fully described in the Technical Report (HDR, 2015), in summary the steps included: 1) remove any data entry errors in the database, 2) identify parent samples and field blanks, and, 3) ensure consistency of parameter names and measurement units. HDR's preliminary data preparation also involved the categorization of each parameter by sample size, amount of censoring (i.e., data that is reported below laboratory method detection limits), and underlying distribution (normal, lognormal, gamma, etc.). These factors directly influence the types of statistical tests that can be used to assess trends and exceedances.

Scatter plots (time series) were produced for each parameter and visually inspected for unusual patterns, seasonality, data variability, missing values (data gaps), outliers and/or anomalous data values. From here, annual and seasonal summary statistics including counts of data, counts of censored data, means, medians, minimums, maximums and percentiles were calculated.

After reviewing the datasets, the time series used for the Slave River was 1972-2012 (data collected before and during the filling of the Williston Reservoir (1960-1971) was not comparable and therefore not used.) The time series used for the Hay River was 1988-2014 (as 1988 marks the year when consistent sampling began on the river). The data records used for some parameters were shorter than the time series described above as some parameters have shorter monitoring records.

Previous Slave and Hay River water quality studies (WER AGRA, 1993; Sanderson et al., 1997 & 2012; Glozier et al., 2009) indicate that both rivers exhibit seasonality. To this end, the development of seasonal triggers was recommended and a year was divided into four seasons where possible: spring (May and June), summer (July and August), fall (September and October) and winter (from November to April). Where sample size was insufficient for developing four seasonal triggers, the year was divided into two seasonal periods: open water (May through October) and under ice (November through April).

With the prepared historical dataset, annual and seasonal interim water quality triggers (i.e., 50th and 90th percentiles) were calculated for the Slave River at Fitzgerald and the Hay River near the Alberta/NWT Border monitoring sites. These can be found in Appendix E of the AB-NWT BWMA.

Originally, when the interim water quality triggers were calculated in 2014, only the data up to and including May of 2014 for the Hay River and October of 2012 for the Slave River were available. In 2016, the Hay and Slave River interim water quality triggers were updated to reflect a period of record that ends in October of 2014. October (2014) marks the month in which the last Slave and Hay River water quality samples were collected (in that calendar year) before the AB-NWT BWMA was signed in March 2015. All triggers (original and updated) for both rivers are included in Appendices 2 and 3 of this report.

3.3. Interim Water Quality Triggers Assessment

Since the interim water quality triggers (i.e., percentiles) are based on values that have been observed in the past, they are useful to help identify potential changes in water quality. As the triggers are set conservatively, not all values above a trigger necessarily signal a concern, but are used to highlight parameters that should be examined further to determine if a change is occurring.

Trigger 1 (Median) Assessment

Trigger 1 is intended to be an early warning signal of changes in typical conditions. For this report, the annual median (50th percentile calculated using multiple years of all-season data) was selected as the Interim Trigger 1 (Trigger 1). Trigger 1 was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2.

To assess typical current conditions, 2017 data were compared to Trigger 1. It is important to note that values above the median are expected. Therefore, for this report, a parameter was only initially flagged if the number of values above Trigger 1 occurred more often than expected. For example:

Slave River

With 9 sample occasions on the Slave River in 2017, a parameter will:

- not be flagged if 4 or less values are greater than Trigger 1 (i.e., less than half (50%) of the values are above Trigger 1)
- be flagged if 5 or more values are greater than Trigger 1 (i.e., more than half (50%) of the values are above Trigger 1)

Hay River

With 4 sample occasions on the Hay River in 2017, a parameter will:

- not be flagged if 2 or less values are greater than Trigger 1
- be flagged if 3 or more values greater than Trigger 1

Trigger 2 (90th Percentile) Assessment

Trigger 2 is intended to be an early warning signal of changes in extreme conditions. For this report, the seasonal 90th percentile was selected as the Interim Trigger 2 (Trigger 2). Trigger 2 was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2. By definition, 10% of values for each parameter are expected to be above the 90th percentile (Trigger 2) each year if there has been no change to the water (no change in water quality).

To assess current extreme conditions, the 2017 data were compared to Trigger 2. For both the Slave and Hay rivers, parameters were flagged for further review if a value was above Trigger 2.

Evaluation of Flagged Parameters

Each parameter flagged by Trigger 1 or 2 assessments was further evaluated through a series of steps.

(i) Evaluating Trigger 1 Flagged Parameters

Parameters flagged in consecutive years (e.g., 2015, 2016 and/or 2017) were evaluated further. This involved combining the recent monitoring dataset (2015-2017) and statistically comparing it to the historical dataset using the Wilcoxon-Mann-Whitney test. The test is used to identify statistically significant differences[1] between the two datasets which may suggest that water quality for a particular parameter is changing and that additional attention may be warranted. Further, any parameters that were highlighted following the Wilcoxon-Mann-Whitney test were

[1] A difference was declared statistically significant if the p-value for the test was less than 0.05.

examined for long term trends and whether the trend is in a direction of concern. In this report, a trend was declared statistically significant if the p-value was less than 0.05.

(ii) Evaluating Trigger 2 Flagged Parameters

Values above Trigger 2 were compared to their respective historical seasonal and historical maximum values to provide context. Any parameter above its historical seasonal (where available) and or historical maximum value was evaluated further by:

- Examining flow conditions and the suspended sediment levels to examine whether the values above Trigger 2 were attributable to any special flow conditions at the time of sampling; and,

- Comparing values to national and/or provincial water quality guidelines, where guidelines exist.

(iii) Further Evaluation

Any unexplained Trigger 1 and 2 flagged parameters will undergo further investigation. The investigative phase may include, but not be limited to, the following steps:

- Examine water quality data from sampling sites such as Rivière Des Rochers, Athabasca River at Baseline 27 and Peace River at Peace Point to see if similar patterns are emerging upstream.

- Identify anthropogenic sources that could be responsible.

- Evaluate whether the existing monitoring program is adequate.

3.4. Toxic, Bioaccumulative and Persistent Substances Assessment

The Parties have agreed to the objective of virtual elimination (VE) of substances that are human-made, toxic, bioaccumulative and persistent. The Parties to this AB-NWT BWMA are committed to pollution prevention and sustainable development. Substances subject to VE that are monitored as part of this AB-NWT BWMA are listed in Table 1 and Table 2. As part of this assessment, the 2017 data for substances subject to VE are reviewed, and the presence of each substance subject to VE is reported and discussed.

4. Slave River Water Quality Assessment

For this assessment, 594 individual conventional water quality results were assessed against Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2017 by ECCC from the Slave River at Fitzgerald on nine occasions (January, February, March, May, June, July, August, September and October). Sixty-six parameters[2] from each sample were reviewed as part of this assessment.

4.1. Slave River 2017 Trigger 1 Assessment

The 2017 water quality results were screened to determine the number of water quality values that were higher than Trigger 1 (all-season median). If more than 50% of the values were higher than Trigger 1, the parameter was flagged. In 2017, 22 of the 66 parameters were flagged (Table 3). Seven of these 22 parameters, including alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium were also flagged in 2015 and 2016; 6[3] parameters were flagged in 2016 (but not in 2015); and 9[4] parameters were flagged for the first time.

Table 3: Slave River 2017 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2017 Values higher than Trigger 1
Alkalinity (mg/L)	84.2	6/9
Specific Conductance (us/cm)	211	6/9
Total Dissolved Solid (mg/L)	133	5/9
Dissolved Calcium (mg/L)	28.3	6/9
Dissolved Magnesium (mg/L)	6.58	6/9
Dissolved Potassium (mg/L)	0.91	7/9
Dissolved Sulphate (mg/L)	18.0	5/9
Nitrate/Nitrite (mg/L)	0.080	9/9
Dissolved Nitrogen (mg/L)	0.224	8/9
Dissolved Organic Carbon (mg/L)	5.58	5/9

[2] Although there are 70 parameters listed in Table 8 (AB-NWT BWMA, Appendix E4), only 66 parameters underwent the Trigger 1 assessment as interim triggers are still under development for pH, dissolved oxygen and dissolved and total mercury.
[3] Total Dissolved Solids, Dissolved Organic Carbon, Particulate Organic Carbon, Dissolved Chromium, Dissolved Molybdenum and Dissolved Selenium
[4] Dissolved Nitrogen, Dissolved Potassium, Dissolved Arsenic, Dissolved Boron, Dissolved Cadmium, Dissolved Lithium, Dissolved Zinc, Total Selenium and Total Strontium

Parameter	Trigger 1	Number of 2017 Values higher than Trigger 1
Particulate Organic Carbon (mg/L)	1.85	5/9
Dissolved Arsenic (µg/L)	0.41	5/9
Dissolved Boron (µg/L)	13.8	5/9
Dissolved Cadmium (µg/L)	0.02	5/9
Dissolved Chromium (µg/L)	0.124	5/9
Dissolved Lithium (µg/L)	3.98	5/9
Dissolved Molybdenum (µg/L)	0.75	6/9
Dissolved Selenium (µg/L)	0.21	7/9
Dissolved Strontium (µg/L)	134	5/9
Dissolved Zinc (µg/L)	0.8	6/9
Total Selenium (µg/L)	0.23	5/9
Total Strontium (µg/L)	140	6/9

All 22 parameters were further assessed by combining the recent monitoring dataset (2015-2017) for each parameter and statistically comparing it to the historical dataset using the Wilcoxon-Mann-Whitney test[5]. When the two datasets (2015-2017 and historical data) were compared, the test revealed significant differences for alkalinity, dissolved magnesium, dissolved sulphate and nitrate/nitrite suggesting that concentrations for these parameters are higher in the last three years than in the past. Summary discussions follow for these four parameters. No statistically significant differences were revealed for the other 18 parameters and therefore they are not discussed further.

[5] This test is the non-parametric equivalent of the independent samples t-test; however, unlike the t-test, it does not make assumptions about the underlying distribution of the data (Dytham, 2003). Microsoft Excel Add-In XLSTAT 2014.2.03 was used to assess these parameters. The null hypothesis is that the two sets of data from the two different time periods are the same ($p>0.05$) versus the alternative hypothesis that they are not ($p<0.05$).

4.2. Slave River 2017 Trigger 2 Assessment

The 2017 water quality results were screened to determine how many values were higher than the seasonal 90th percentile (Trigger 2). In 2017, a total of 33 of the 66 parameters had concentrations above Trigger 2 (47 of 594 individual water quality results; Table 4). Of these 33 parameters, only two parameters, including total dissolved solids and dissolved magnesium, were above their historical open-water maximum values but the values were not above the respective historical maximum values (highlighted red in Table 4). Concentrations of the remaining 31 parameters did not exceed their historical open-water values. Summary discussions for total dissolved solids and dissolved magnesium follow.

Table 4: Slave River 2017 Trigger 2 Assessment Summary

Parameter	Trigger 2 (90th %ile)	2017 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value (Date Recorded)	National or Provincial Guideline
Alkalinity (mg/L)					
Winter (January)	93.3	94.2	104	121 (May 2002)	--
Spring (June)	92.8	98.6	121		--
Fall (October)	92.2	98.5	97.7		--
Specific Conductance (μS/cm)					
Winter (January)	240	254	262	364 (June 1980)	--
Total Dissolved Solids (mg/L)					
Open Water (May)	196	220	265	360 (April 1994)	--
Open Water (June)	196	302	265		--
Dissolved Calcium (mg/L)					
Fall (October)	30.9	32.4	41.7	42 (July 1981)	--
Dissolved Magnesium (mg/L)					
Winter (January)	7.08	7.59	8.08	8.80 (August 1980)	--
Spring (June)	7.41	7.79	7.80		--
Fall (October)	7.48	8.01	7.86		--

Parameter	Trigger 2 (90th %ile)	2017 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value (Date Recorded)	National or Provincial Guideline
Nitrate/Nitrite (mg/L)					
Annual (January)	0.183	0.270	0.300	0.300 (Feb 2014)	--
Annual (February)	0.183	0.200	0.300		--
Annual (May)	0.183	0.240	0.300		--
Dissolved Nitrogen (mg/L)					
Spring (May)	0.55	0.58	0.67	2.00 (Jan 2010)	--
Dissolved Organic Carbon (mg/L)					
Spring (May)	13.8	15.9	20.2	40.4 (Jan 1997)	--
Particulate Organic Carbon (mg/L)					
Spring (May)	12.9	14.3	18.5	68.5 (July 2010	--
Spring (June)	12.9	18.1	18.5		--
Aluminum Total (µg/L)					
Open Water (May)	5666	5880	48700	48700 (July 2010)	--
Antimony Total (µg/L)					
Annual (May)	0.255	0.263	0.498	1.36 (April 2006)	--
Arsenic Total (µg/L)					
Annual (May)	3.26	3.46	11.30	11.30 (July 2011)	5[1,2]
Barium Dissolved (µg/L)					
Annual (May)	54.5	56	76.6	76.6 (July 2011)	--
Annual (June)	54.5	56.7	76.6		--
Barium Total (µg/L)					
Spring (May)	308	341	564	1730 (July 2011)	--
Beryllium Total (µg/L)					
Open Water (May)	0.515	0.524	2.19	2.19 (July 2001)	--
Bismuth Total (µg/L)					
Annual (May)	0.051	0.056	0.112	0.112 (July 2011)	--
Annual (June)	0.051	0.058	0.112		--

Parameter	Trigger 2 (90^{th} %ile)	2017 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value (Date Recorded)	National or Provincial Guideline
Boron Total (µg/L)					
Annual (May)	20.1	23.8	39.3	39.3 (July 2011)	1500[1,2]
Chromium Total (µg/L)					
Open Water (May)	9.5	10.4	50.4	50.4 (July 2001)	--
Cobalt Total (µg/L)					
Spring (May)	6.65	7.3	13.85	30.3 (July 2001)	1.0[2]
Copper Dissolved (µg/L)					
Annual (May)	3.87	4.28	10.6	10.6 (April 2008)	--
Copper Total (µg/L)					
Spring (May)	21.0	22.4	46	97 (July 2001)	2.5[1] 7[2]
Molybdenum Dissolved (µg/L)					
Annual (May)	0.946	1.00	2.56	2.56 (July 2011)	--
Annual (June)	0.946	1.09	2.56		--
Nickel Dissolved (µg/L)					
Annual (May)	2.20	3.57	4.46	4.46 (July 2011)	--
Nickel Total (ug/L)					
Spring (May)	20.8	24.7	41.6	92.9 (July 2001)	25.0[1] 54[2]
Selenium Dissolved (µg/L)					
Annual (May)	0.31	0.35	0.5	0.5 (July 2011)	--
Annual (June)	0.31	0.35	0.5		--
Silver Total (µg/L)					
Open Water (May)	0.128	0.195	0.5	0.685 (Feb 2009)	0.25[1,2]
Strontium Dissolved (µg/L)					
Annual (October)	156	169	186	186 (Oct 2006)	--
Strontium Total (µg/L)					
Open Water (June)	185	196	353	353 (July 2011)	--
Thallium Total (µg/L)					

Parameter	Trigger 2 (90th %ile)	2017 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value (Date Recorded)	National or Provincial Guideline
Annual (May)	0.136	0.179	0.480	0.480 July 2011)	0.8[1,2]
Uranium Dissolved (µg/L)					
Annual (May)	0.511	0.656	1.19	1.19 (July 2011)	--
Annual (June)	0.511	0.543	1.19		--
Uranium Total (µg/L)					
Annual (May)	1.09	1.56	4.91	4.91 (July 2011)	15[1,2]
Annual (June)	1.09	1.13	4.91		15[1,2]
Vanadium Total (µg/L)					
Spring (May)	17.71	18.5	40.5	84.8 (July 2001)	--
Zinc Total (µg/L)					
Spring (May)	61	71.5	192	561 (July 2001)	7[1] 30[2]

[1]CCME Water Quality Guidelines for the Protection of Aquatic Life

[2] Environmental Quality Guidelines for Alberta Surface Waters

OW: Open Water; UI: Under Ice; Season (Annual, Open Water, Under Ice, Spring, Summer, Fall or Winter) represents the season from which the trigger was derived; month (in parentheses) represents the month in which the sample was collected.

In 2017, total copper and total zinc had values that were higher than the CCME guideline for the protection of aquatic life (Table 4). Historically, the levels for these parameters in the Slave River have been high which is why the site-specific interim water quality triggers that have been developed for this water quality assessment are so useful to help determine if change is occurring because they are based on the historical record. Levels of total arsenic, boron, nickel, silver, thallium and uranium were all below their respective CCME guideline.

4.3. Slave River 2017 Results and Discussion

Each year since 2015, alkalinity, dissolved magnesium, dissolved sulphate and nitrate/nitrite have been above Trigger 1 more than expected and as mentioned, results of the Wilcoxon-Mann-Whitney test suggest that concentrations for these parameters are higher in the last three years than in the past which suggests that trends may be forming.

In 2014, the GNWT and Alberta commissioned HDR, Inc. to assess long term trends on the conventional parameters in the Slave and Hay Rivers. Focussing here on the above-mentioned four Slave River parameters, the assessment (HDR, 2015) revealed increasing trends using maximum likelihood estimation (MLE) non-detects regression for dissolved sulphate (n=259; p=0.0195) and nitrate/nitrite (n=58; p=0.0108), but not for alkalinity (n=250; p=0.2745) and dissolved magnesium (n=234; p=0.8616). In other words, the HDR assessment has suggested that levels of dissolved sulphate and nitrate/nitrite in the Slave River have increased gradually since monitoring began for these parameters whereas levels of alkalinity and dissolved magnesium have remained relatively the same. One drawback of using the monotonic regression method for trend assessment is that it does not account for the existence of structural breaks in a parameter's time series. It attempts to fit an "average" trend based on the patterns in the observations over time. A structural break may occur when the trend changes its magnitude, direction, or significance over time. Because it is known that over time water quality does not necessarily trend in the same direction or increase or decrease at the same rate, HDR used the piece-wise polynomial regression (PWPR) approach to augment the results of the regression analysis and provide further insight into a parameter's behaviour. Together, the two approaches reveal additional underlying patterns for these four parameters. Short discussions for alkalinity, dissolved magnesium, dissolved sulphate and nitrate/nitrite follow.

Alkalinity

Each year since 2015, alkalinity concentrations have been above Trigger 1 more than expected. Additionally, the results of the Wilcoxon-Mann-Whitney test suggest that concentrations for this parameter are statistically higher ($n_{2015\text{-}2017}$=26; $n_{1972\text{-}2014}$=250; p=0.009) in the last three years than in the past.

Figures 2 & 3 show the results of the MLE and PWPR techniques on the alkalinity series (1972-2014) measured in the Slave River. The MLE non-detects regression shows no trend (p-value = 0.2745 > 0.05) in the deseasonalized data (Figure 2). Figure 3 shows the result of the PWPR technique and illustrates a very slight downward trend in deseasonalized data until June 1988, followed by no observable trend.

At this time, it is unlikely that alkalinity is an issue in the Slave River but it will continue to be monitored.

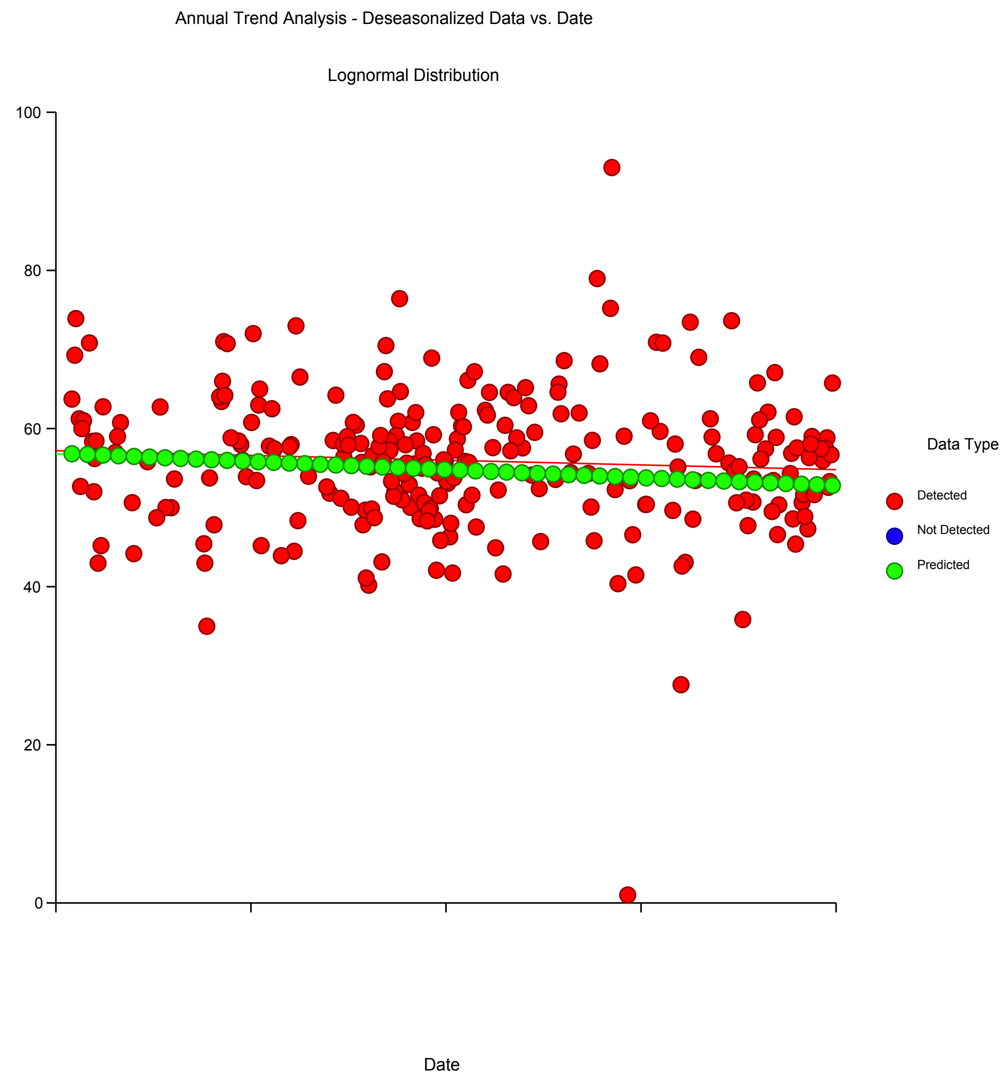

Figure 2: Annual MLE Non-Detects Regression for Alkalinity in the Slave River (1972-2014)

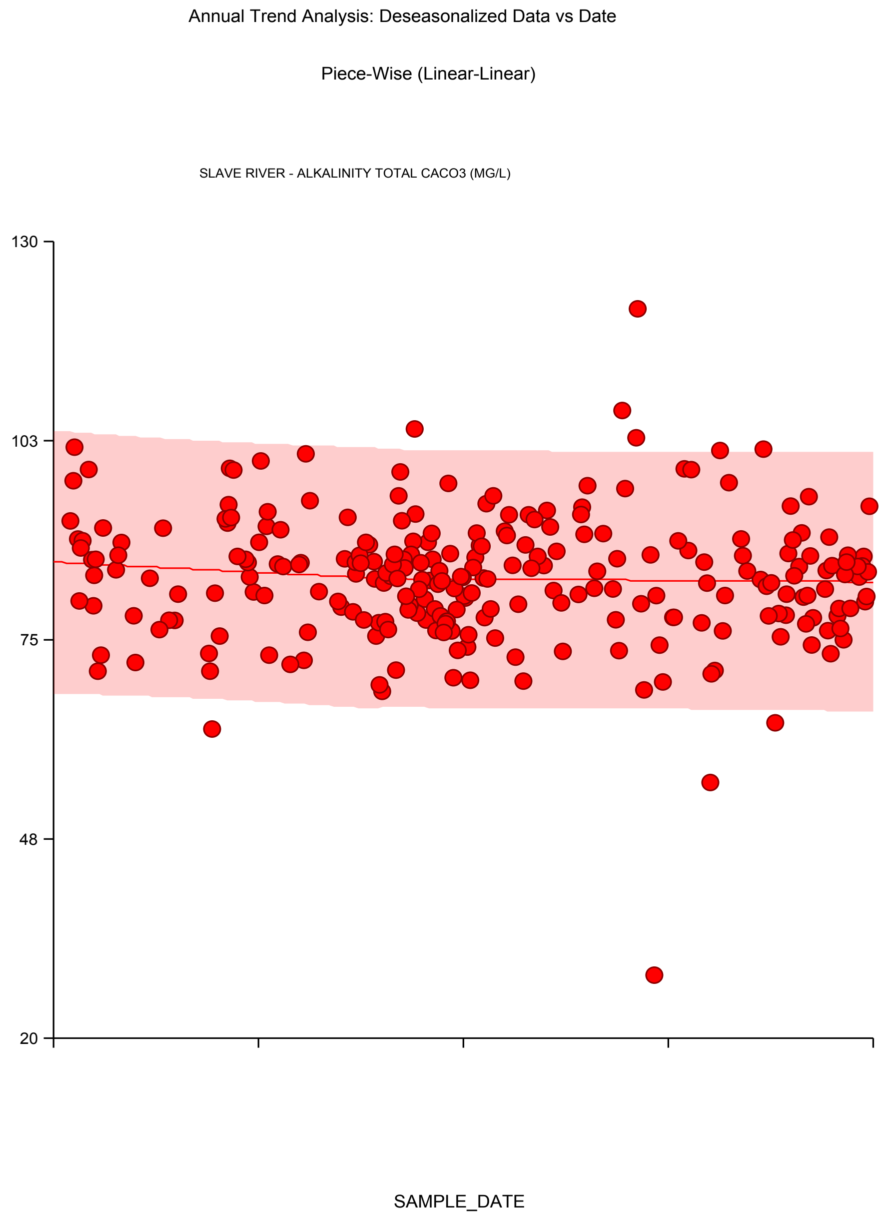

Figure 3: Piece-wise Polynomial Regression for Alkalinity in the Slave River (1972-2014)

Dissolved Magnesium

Each year since 2015, dissolved magnesium has been above Trigger 1 more than expected. Additionally, the results of the Wilcoxon-Mann-Whitney test suggest that concentrations for this parameter are statistically higher (n2015-2017=26; n1978-2014=234; p=0.003) in the last three years than in the past.

Figures 4 & 5 show the results of the MLE and PWPR approaches on the dissolved magnesium series (1978-2014) measured in the Slave River. As illustrated in Figure 4, the MLE predicted regression line shows no trend in the deseasonalized data (p-value = 0.8616). However, Figure 5 shows the result of the PWPR technique and illustrates a downward trend until July 1984, followed by a slight upward trend, both of which are statistically significant. In other words, on average, there is no overall trend over the period of record but a piece-wise pattern has been revealed by the PWPR assessment.

Based on the above findings and the repeated occasions that dissolved magnesium values have been above Trigger 2 (2015: 2 of 9 samples; 2016: 3 of 8 samples; 2017: 3 of 9 samples), the BMC has prioritized this particular parameter for further evaluation to confirm changes in the levels of dissolved magnesium in the Slave River in recent years.

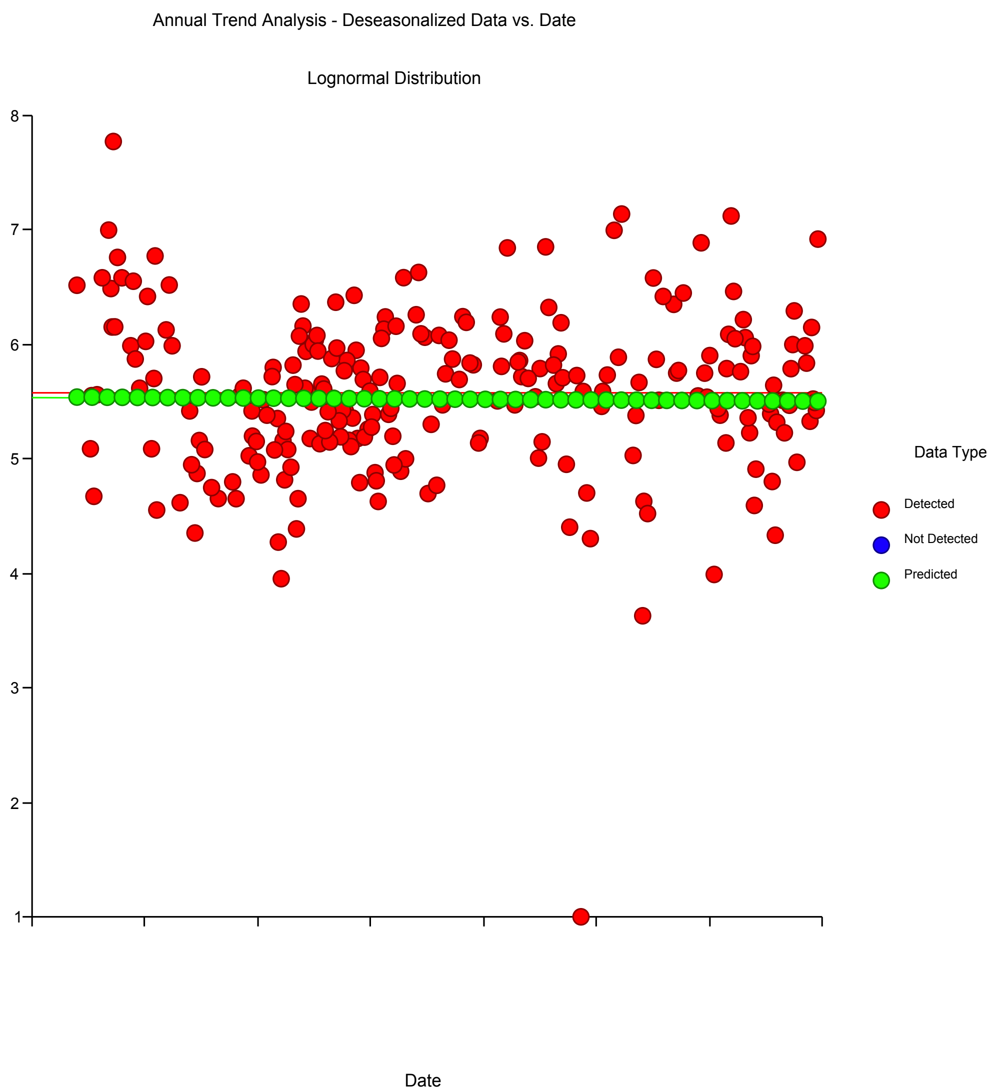

Figure 4: Annual MLE Non-Detects Regression for Dissolved Magnesium in the Slave River (1978-2014)

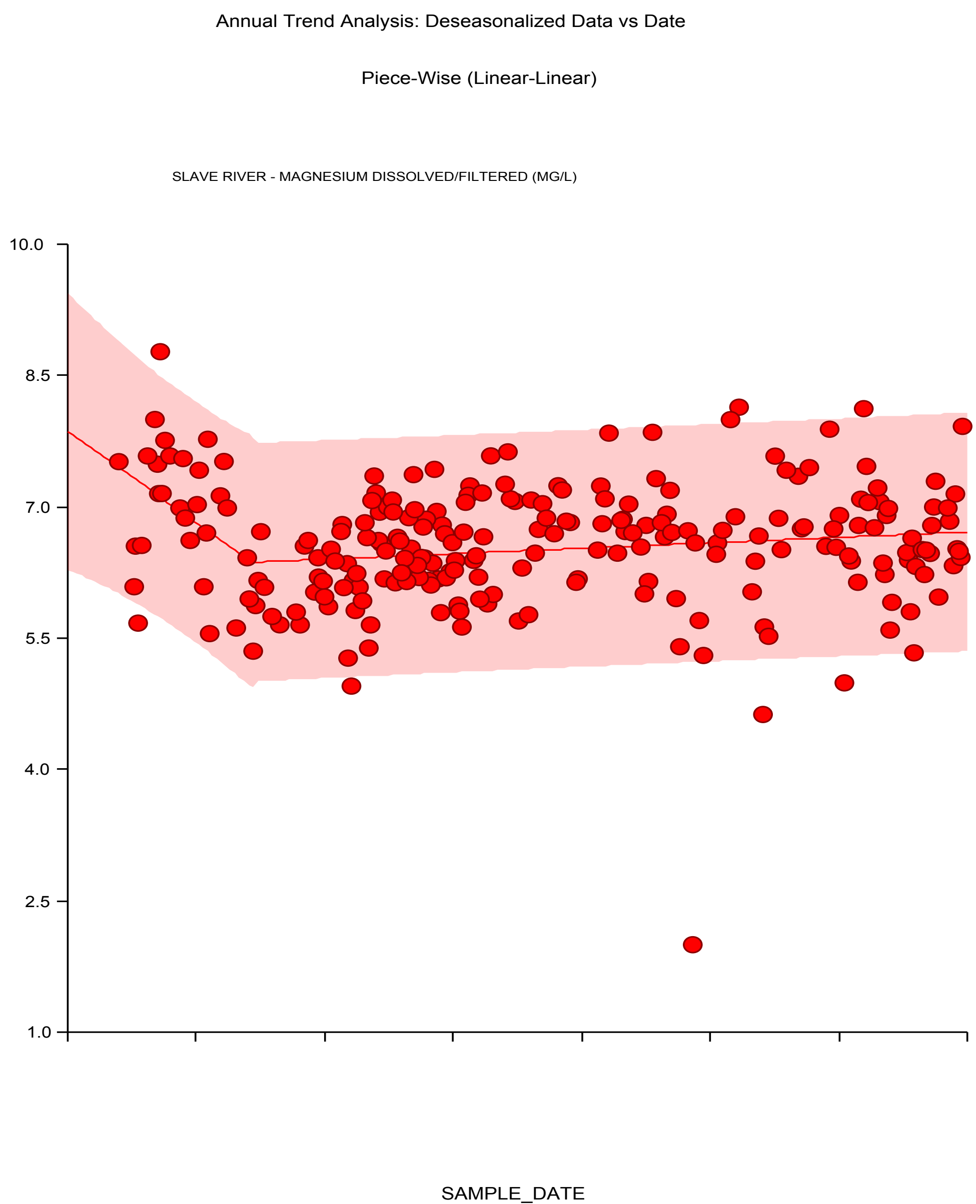

Figure 5: Piece-wise Polynomial Regression for Dissolved Magnesium in the Slave River (1978-2014)

Dissolved Sulphate

Each year since 2015, dissolved sulphate has been above Trigger 1 more than expected and the results of the Wilcoxon-Mann-Whitney test suggest that concentrations for this parameter are statistically higher ($n_{2015-2017}$=26; $n_{1972-2014}$=259; p=0.041) in the last three years than in the past.

Figures 6 & 7 show the results of the MLE and PWPR approaches on the dissolved sulphate series (1972-2014) for the Slave River. As illustrated in Figure 6, the predicted regression line yielded a positive slope and a probability value of 0.0195 (<0.05) which suggests a statistically significant increasing trend. Whereas the PWPR plot (Figure 7) shows no trend until January 1987 followed by a slight upward trend, which is not significant. In other words, on average, there is a trend over the period of record but it seems to be attributable by the weak upward slope in the latter half of the dataset.

Based on the above findings, the BMC has prioritized this particular parameter for further evaluation to confirm changes in the levels of dissolved sulphate in the Slave River in recent years.

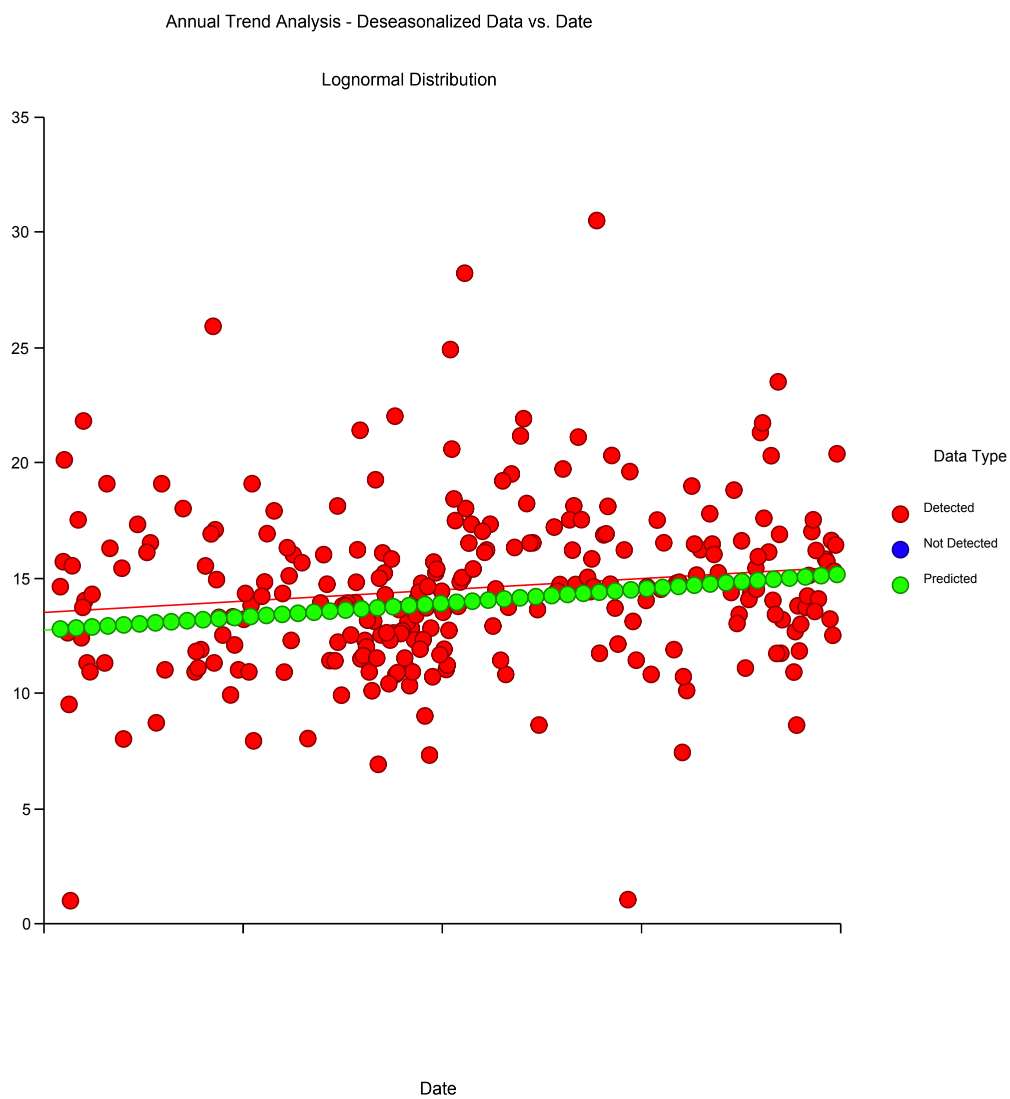

Figure 6: Annual MLE Non-Detects Regression for Dissolved Sulphate in the Slave River (1972-2014)

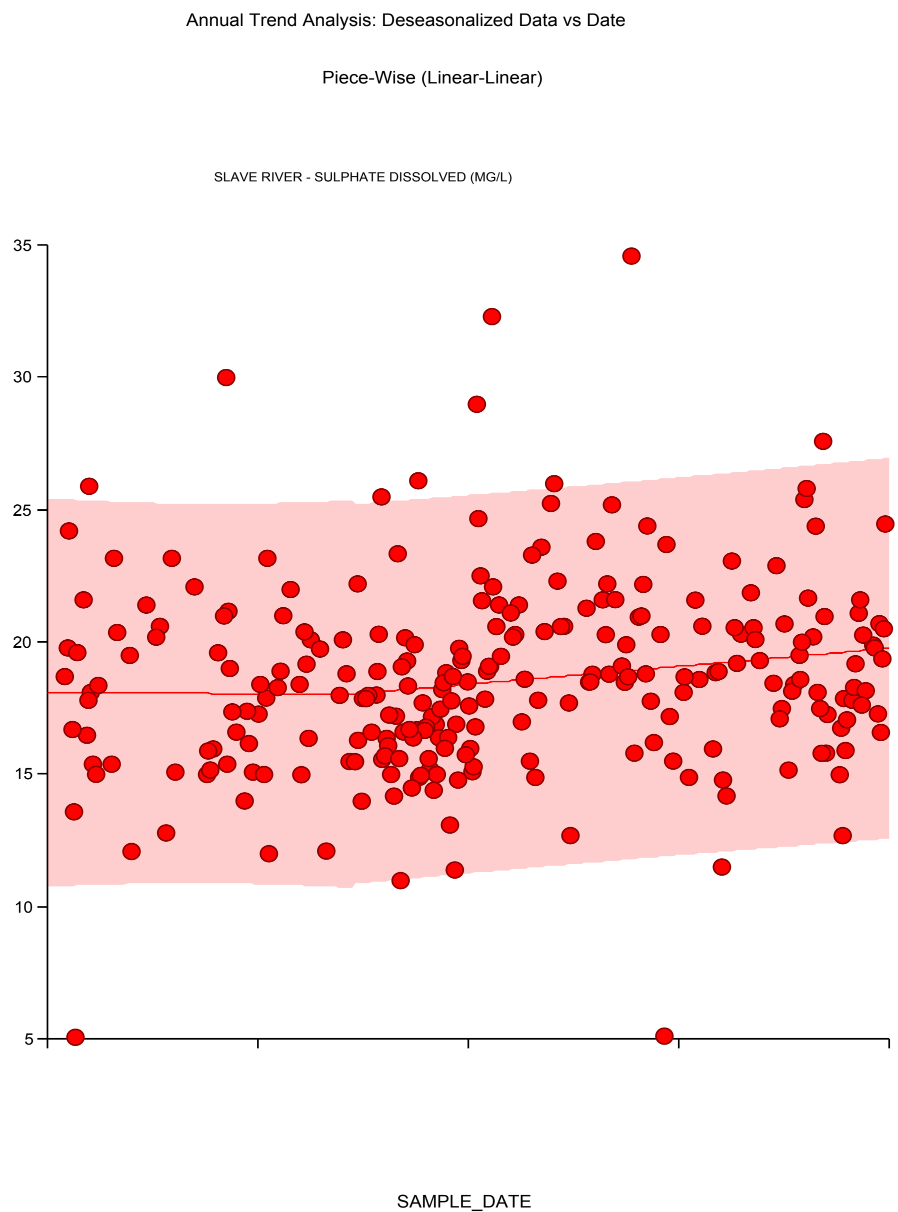

Figure 7: Piece-wise Polynomial Regression for Dissolved Sulphate in the Slave River (1972-2014)

Nitrate/Nitrite

Each year since 2015, nitrate/nitrite has been above Trigger 1 more than expected and the results of the Wilcoxon-Mann-Whitney test suggest that concentrations for this parameter are statistically higher ($n_{2015\text{-}2017}$=27; $n_{2005\text{-}2014}$=58; $p<0.0001$) in the last three years than in the past.

Figures 8 & 9 show the results of the MLE and PWPR approaches on the nitrate/nitrite series (2005-2014) for the Slave River. As illustrated in Figure 8, the predicted regression line yielded a positive slope and a probability value of 0.0108 (<0.05) which suggests a statistically significant trend under development. As well, the PWPR plot (Figure 9) shows the first segment of data trending upwards until March 2011 followed by a downward trend. While the average trend in Figure 8 shows a statistically significant trend upwards, the piecewise regression suggests that over time, the trend may actually be reversing. It is noted that the period of record is short (9 years) for this parameter and the sampling frequency in the initial period of record was less (and mostly in open-water season). Based on the above findings, the BMC has prioritized this particular parameter for further evaluation to confirm changes in the levels of dissolved nitrate/nitrite in the Slave River in recent years.

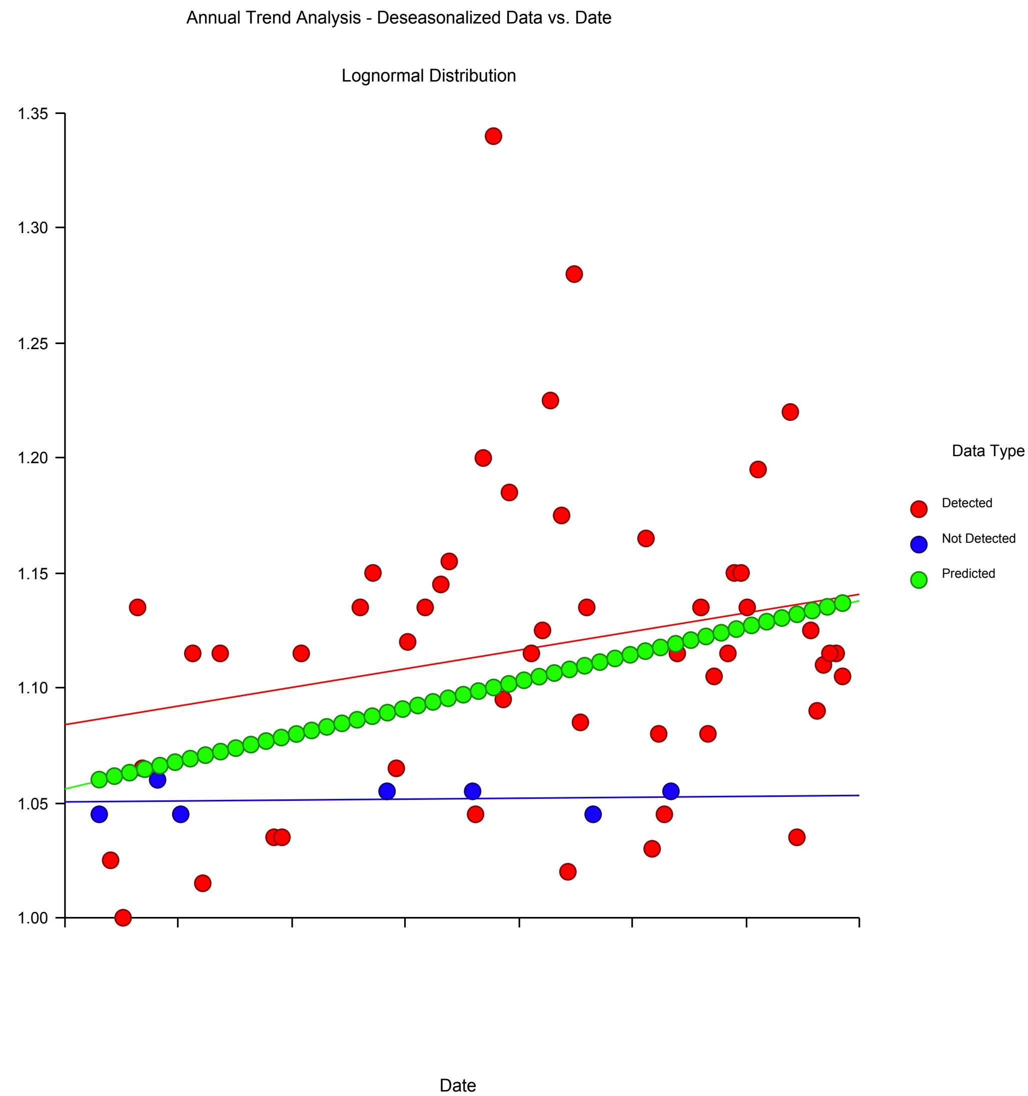

Figure 8: Annual MLE Non-Detects Regression for Nitrate/Nitrite in the Slave River (2005-2014)

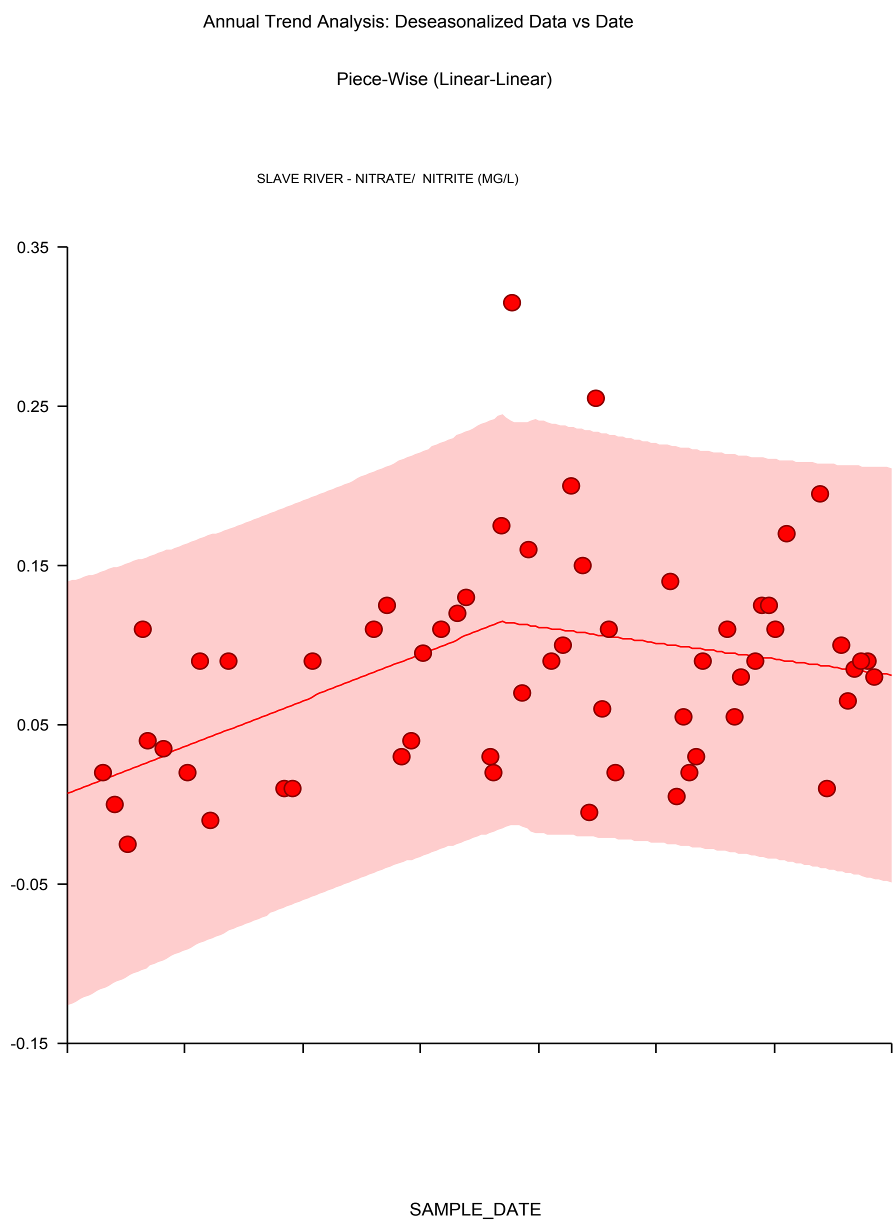

Figure 9: Piece-wise Polynomial Regression for Nitrate/Nitrite in the Slave River (2005-2014)

Total Dissolved Solids

In June 2017, total dissolved solids (TDS) measured 302 mg/L which is above both its open-water Trigger 2 (196 mg/L) and its historical open-water maximum value (265 mg/L)[6]. Figure 10 is a scatter plot of the entire total dissolved solids dataset (1993-2017) and illustrates how the data compare to Trigger 2, and the historical open-water and overall maximum values.

The elevated spring value is likely due to the timing when the sample was collected. Upon review of the 2017 Slave River hydrograph (Figure 1; 2017 AB/NWT Water Quantity Technical Report), flows in late June of 2017 were a little lower for that time of year which can create a reverse-dilution effect whereby dissolved substances (including TDS) measure higher. It is unlikely that TDS is an issue in the Slave River but it will continue to be monitored.

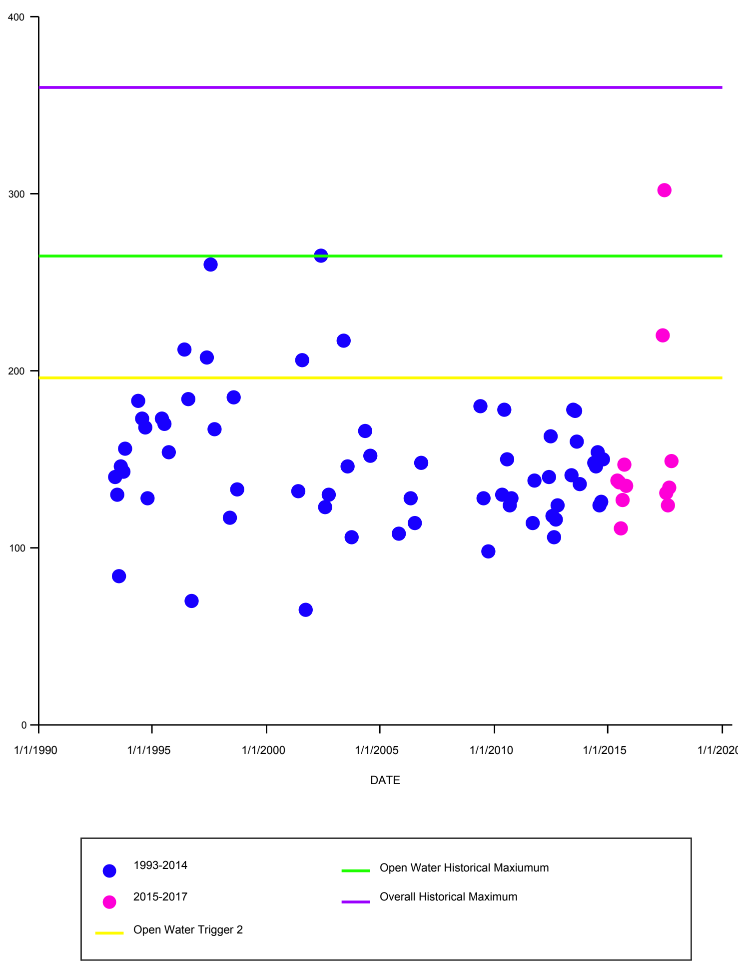

Figure 10: Slave River Open-Water Total Dissolved Solids Water Quality Data (1993-2017)

[6] The overall historical TDS maximum value in the Slave River is 360 mg/L measured in April, 1994.

5. Hay River Water Quality Assessment

For this assessment, 160 individual conventional water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2017 by ECCC from the Hay River near the Alberta/NWT Boundary on four occasions (April, May, July and October). Forty[7] parameters from each sample were reviewed as part of this assessment.

5.1. Hay River 2017 Trigger 1 Assessment

The 2017 water quality results were screened to determine the number of water quality values that were higher than the all-season median (Trigger 1). If more than 50% of the values were higher than the median, the parameter was flagged. In 2017, five of the 40 parameters were flagged (Table 5). Three of these, nitrate/nitrite, total manganese and total uranium, were flagged in 2016 whereas particulate organic carbon and total iron were flagged for the first time in 2017. The five parameters were further assessed by combining the 2015-2017 water quality data for each parameter and statistically comparing that to the historical data using the Wilcoxon-Mann-Whitney test. When the two datasets (2015-2017 and historical) were compared, no statistically significant differences were revealed and therefore they are not discussed further.

Table 5: Hay River 2017 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2017 Values higher than Trigger 1
Nitrate/Nitrite (mg/L)	0.095	4/4
Particulate Organic Carbon (mg/L)	1.16	3/4
Total Iron (µg/L)	1980	3/4
Total Manganese (µg/L)	95	3/4
Total Uranium (µg/L)	0.654	4/4

5.2. Hay River 2017 Trigger 2 Assessment

The 2017 water quality results were screened to determine how many values were higher than the seasonal 90th percentile (Trigger 2). In 2017, 23 of the 40 parameters had one or more results above Trigger 2 (24 of 160 individual water quality results; Table 6). Almost all of the values above Trigger 2

[7] Although there are 70 parameters listed in Table 8 (AB-NWT BWMA, Appendix E), interim water quality triggers are only available for 40 parameters due to limited historical data. As more data are collected, triggers will be developed for all parameters.

occurred in May (19 of 24). Other than particulate organic carbon (POC), none of the flagged parameters were above their respective historical seasonal maximum values and are not discussed further. POC consists of organic particles (broken-down pieces of plants and organisms) suspended in the water column and exists alongside suspended sediments, both of which vary naturally with river discharge. Given that the May levels of suspended sediments in the Hay River were 10 times higher than the levels measured later in the open water season, the high levels of POC are likely part of the break up process whereby sediments and organic particles are flushed into the river and carried downstream during periods of high flow such as the spring melt.

Table 6: Hay River 2017 Trigger 2 Assessment Summary

Parameter	Trigger 2	2017 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value (Date Recorded)	National or Provincial Guideline
Alkalinity (mg/L)					
Open Water (October)	128.4	144	181	305 (March 1993)	--
Specific Conductance (µS/cm)					
Open Water (October)	405	408	513	860 (Feb 1995)	--
Total Suspended Solids (mg/L)					
Open Water (May)	216	643	774	774 (May 2007)	--
Turbidity (NTU)					
Open Water (May)	148	509	590	590 (May 2007)	--
Dissolved Calcium (mg/L)					
Open Water (October)	49.2	53.4	66.4	115 (March 1993)	--
Dissolved Magnesium (mg/L)					
Open Water (October)	14.54	14.8	19	32.60 (March 1993)	--
Particulate Organic Carbon (mg/L)					
Open Water (May)	4.75	31.2	20	20 (May 2007)	--
Open Water (July)	4.75	5.61	20		--
Phosphorus Total (µg/L)					
Open Water (May)	0.254	0.542	0.720	0.72 (May 2007)	--
Aluminum Total (µg/L)					
Open Water (May)	2010	4280	7620	7620 (May 2007)	--
Antimony Total (µg/L)					
Open Water (May)	0.167	0.244	0.257	0.257 (May 2007)	--

Parameter	Trigger 2	2017 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value (Date Recorded)	National or Provincial Guideline
Barium Total (µg/L)					
Open Water (May)	102	211	477	477 (July 2005)	--
Beryllium Total (µg/L)					
Open Water (May)	0.172	0.418	0.548	0.548 (April 2007)	--
Chromium Total (µg/L)					
Open Water (May)	3.26	7.65	11.9	11.9 (May 2007)	--
Cobalt Total (µg/L)					
Open Water (May)	2.72	7.9	8.96	8.96 (May 2007)	0.96[2]
Copper Total (µg/L)					
Open Water (May)	6.98	17.9	23.8	23.8 (May 2007)	2.5[1], 7[2]
Iron Total (µg/L)					
Open Water (May)	6402	15900	21500	21500 (May 2007)	300[1]
Lead Total (µg/L)					
Open Water (May)	3.38	9.14	11.20	11.20 (May 2007)	2.47[1, 2]
Manganese Total (µg/L)					
Open Water (May)	168	463	485	1340 (Feb 1998)	--
Nickel Total (µg/L)					
Open Water (May)	9.03	21.20	26.90	26.90 (May 2007)	82.0[1], 44[2]
Silver Total (µg/L)					
Open Water (May)	0.064	0.148	0.183	0.183 (May 2007)	0.25[1,2]
Thallium Total (µg/L)					
Open Water (May)	0.064	0.161	0.205	0.205 (May 2007)	0.8[1,2]
Vanadium Total (µg/L)					
Open Water (May)	6.24	15.5	23.30	23.30 (May 2007)	--
Zinc Total (µg/L)					
Open Water (May)	22.4	65.3	90.8	90.8 (May 2007)	7.0[1] 30[2]

[1]CCME Water Quality Guidelines for the Protection of Aquatic Life (chronic)

[2] Environmental Quality Guidelines for Alberta Surface Waters (for the Protection of Aquatic Life- chronic) OW: Open Water; UI: Under Ice

Season (Annual, Open Water, Under Ice, Spring, Summer, Fall or Winter) represents the season from which the trigger was derived for the assessment; month (in parentheses) represents the month in which the sample was collected.

6. Toxic, Bioaccumulative, Persistent Substances

To meet the commitment of virtual elimination (VE) of persistent, bioaccumulative, toxic substances that are listed in the AB-NWT BWMA, the BMC reports on the detection of any substance subject to VE that are currently monitored in the Slave and Hay rivers (Table 7). The BMC will maintain and periodically update this list as information becomes available on any new toxic, bioaccumulative and persistent substances or if the substance has been detected in other monitoring programs or by researchers.

Table 7: Substances Subject to Virtual Elimination

Substance Subject to VE
Aldrin
Chlordane
Dieldrin
Endosulphan
Endrin
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorcyclohexane (HCH; alpha, beta, gamma)
Mirex
DDD, DDE, DDT
Toxaphene
PCBs
Pentachlorobenzene

6.1. VE Substances Assessment and Evaluation

In 2017, three water samples were collected and analyzed for the substances listed in Table 7. The laboratory results are included in Table 8 and Table 9. Although some of these substances were detected concentrations were very low. For context, comparisons with the available corresponding United States Environmental Protection Agency (USEPA) Chronic Aquatic Life Criteria show that the levels detected were considerably lower than levels that could cause concern. Similar to last year, endosulphan in the Slave River was the highest measured substance subject to VE (0.71 ng/L); however, levels were below the CCME guideline for the protection of aquatic life of 3 ng/L and far below the respective USEPA freshwater aquatic life chronic criteria of 56 ng/L, thereby posing no risk to aquatic life.

There are several plausible reasons as to why these are being detected in the rivers: laboratory contamination, historical residues in the catchment, and long-range atmospheric transport. Sometimes the analytical laboratory that is used to analyze the water accidentally contaminates the sample. Alternatively, given that these substances are persistent in the environment, it could be the historical residuals of each substance that are being detected. Given these substances are generally not used in the basin, they could also be a result of long-range transport.

Table 8: Substances subject to virtual elimination and were detected in the Slave River in 2017

SLAVE RIVER VE SUMMARY

Substance Subject to VE	June	July	September	USEPA Chronic Aquatic Life Criteria	CCME
Aldrin	ND	0.037	ND	3000	
Chlordane - alpha	ND	ND	ND	4.3	
Chlordane - gamma	0.048	0.032	ND	4.3	
Chlordane - oxy	0.035	0.106	ND	4.3	
Dieldrin	ND	0.025	ND	56	3
Endosulphan Sulphate	ND	ND	ND	56	3
alpha endosulphan	0.499	0.71	0.206	56	3
beta endosulphan	0.352	0.508	0.237	56	3
Endrin	ND	ND	ND	36	
Heptachlor	ND	ND	0.135	3.8	
Heptachlor Epoxide	0.025	0.103	ND		
Hexachlorobenzene	0.032	0.033	0.021		
Hexachlorobutadiene	0.049	0.046	0.04		1300
Hexachlorcyclohexane (HCH alpha)	ND	0.038	ND		
Hexachlorcyclohexane (HCH beta)	0.044	ND	ND		
Hexachlorcyclohexane (HCH gamma)	ND	0.032	ND	950	10
Mirex	ND	ND	ND	1	
DDD	ND	ND	ND		
DDE	ND	ND	ND		
DDT	ND	ND	ND	1	
Toxaphene	ND	ND	ND	0.2	
PCBs	0.102	0.245	0.0795	14	
Pentachlorobenzene	ND	ND	ND		6000

https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
Blue highlighted is actute not chronic. Accessed December 2018.
ND: non-detect

Table 9: Substances subject to virtual elimination and were detected in the Hay River in 2017

HAY RIVER VE SUMMARY

Substance Subject to VE	June	July	September	USEPA Chronic Aquatic Life Criteria	CCME
Aldrin	ND	0.017	ND	3000	
Chlordane - alpha	ND	ND	ND	4.3	
Chlordane - gamma	ND	0.041	ND	4.3	
Chlordane - oxy	0.028	0.035	ND	4.3	
Dieldrin	ND	0.019	ND	56	3
Endosulphan Sulphate	ND	ND	ND	56	3
alpha endosulphan	0.474	0.566	0.234	56	3
beta endosulphan	0.497	0.314	0.629	56	3
Endrin	ND	0.035	ND	36	
Heptachlor	ND	ND	0.109	3.8	
Heptachlor Epoxide	0.043	0.065	ND		
Hexachlorobenzene	0.052	0.047	0.021		
Hexachlorobutadiene	0.068	0.043	0.039		1300
Hexachlorcyclohexane (HCH alpha)	ND	0.025	ND		
Hexachlorcyclohexane (HCH beta)	ND	ND	ND		
Hexachlorcyclohexane (HCH gamma)	0.069	ND	ND	950	10
Mirex	ND	ND	ND	1	
DDD	ND	ND	ND		
DDE	ND	ND	ND		
DDT	ND	ND	ND	1	
Toxaphene	ND	ND	ND	0.2	
PCBs	0.17	0.227	0.0742	14	
Pentachlorobenzene	ND	0.051	ND		6000

https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
Blue highlighted is acute not chronic. Accessed December 2018.
ND: non-detect

7. AB-NWT Water Quality Tasks Underway

Throughout the year, GNWT and the Government of Alberta technical staff work together on water quality tasks related to the implementation of the AB-NWT BWMA. Ongoing tasks include:

1) Assessment of 2018 water quality data for the Slave and Hay rivers.

2) Review of the Hay River water quality data generated by the GNWT to examine the viability of merging the GNWT dataset with the ECCC dataset. Merging the data will result in a more robust dataset for the Hay River which will allow for a more thorough statistical assessment.

3) Ongoing water quality sampling for the analysis of ultra-low levels of mercury in the Slave and Hay Rivers. As of 2017, 32 Slave River water samples and 23 Hay River water samples have been collected specifically for the analysis of ultra-low mercury (Appendix A). These samples are being collected to develop Slave and Hay River open-water triggers for total and dissolved mercury.

4) Preparing for the establishment of a basin-wide water quality subcommittee to determine approaches/methods to assess change in transboundary water bodies. Consensus-based approaches for trend assessment as well as trigger and objective development are critical with regard to reporting on water quality across jurisdictions. The increased levels of alkalinity, dissolved magnesium, nitrate/nitrite and dissolved sulphate can be investigated further throughout the process.

8. Conclusion

Interim transboundary water quality triggers established for the Slave and Hay rivers are designed to provide an early warning of potential changes in water quality. Trigger 1 is intended to identify changes in typical conditions and Trigger 2 is intended to identify changes in extreme conditions.

For the Slave River, twenty two of the 66 parameters were initially flagged during the Trigger 1 assessment. Seven of these parameters (alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium) were also flagged in 2015 & 2016. The Wilcoxon-Mann-Whitney test suggested that concentrations of alkalinity, dissolved magnesium, nitrate/nitrite and dissolved sulphate are higher in the last three years than in the past. The BMC will further evaluate changes for these three parameters. No significant differences were found for the other three parameters. Thirty-three of the 66 parameters (47 of 594 individual results) were flagged through Trigger 2 assessment. Of these, two were above their respective seasonal maximum values but both below their respective historical maximum values.

For the Hay River, five of the 40 parameters were initially flagged during the Trigger 1 assessment. Three of these parameters (nitrate/nitrite, total manganese and total uranium) were also flagged in 2016. The Wilcoxon-Mann-Whitney test did not reveal any significant differences between the historical data and the recent data for the five parameters. Twenty-three of the 40 parameters were flagged during the Trigger 2 assessment. Only POC exceeded its historical seasonal maximum, which was likely attributable to spring freshet upstream of the site.

During the summer of 2017, three samples from each river were analyzed for 14 toxic, bioaccumulative and persistent substances in water. Some of these substances were detected on each sampling occasion in each river, but at very low concentrations. Comparisons with the available corresponding USEPA Chronic Aquatic Life Criteria show that the levels detected pose no risk to aquatic life. Historical residues in the catchment or laboratory contamination are potential causes for the detection of VE substances.

Assessment of the 2017 water quality data for the Slave and Hay rivers did not identify any major concerns. The AB/NWT BMC is preparing to work with the other MRB jurisdictions to establish a water quality technical committee to use more rigorous methods to assess trends in the transboundary rivers. Monitoring and assessment for all conventional parameters as well as the substances that are subject to virtual elimination will continue.

9. References

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Appendix 1: Mercury Levels in the Slave and Hay Rivers

In 2015 at the time of signing the AB-NWT BWMA, insufficient data were available to develop water quality triggers for mercury. Due to the ability of mercury to bioaccumulate in organisms, the collection and analysis of mercury samples from the Slave and Hay became a priority. Thirty-two mercury samples from the Slave River and 23 mercury samples from the Hay River have been collected.

Figures 13 and 14 illustrate that levels of mercury vary between the rivers and throughout the open-water season. The graphs also show that even within the same river, levels of mercury can differ from one year to the next highlighting the importance of long-term monitoring prior to the development of site-specific water quality triggers.

To date, all data, except for two Slave River samples (July 2013 and Sept 2016), are below the CCME freshwater aquatic life guideline (26 ng/L) and well below Health Canada's drinking water quality guideline (1000 ng/L) for mercury.

The collection of water samples from the Slave and Hay Rivers for the analysis of total and dissolved mercury will continue during the 2018 & 2019 field seasons. Site-specific water quality triggers for mercury in both rivers will be derived and used in the 2019 water quality report.

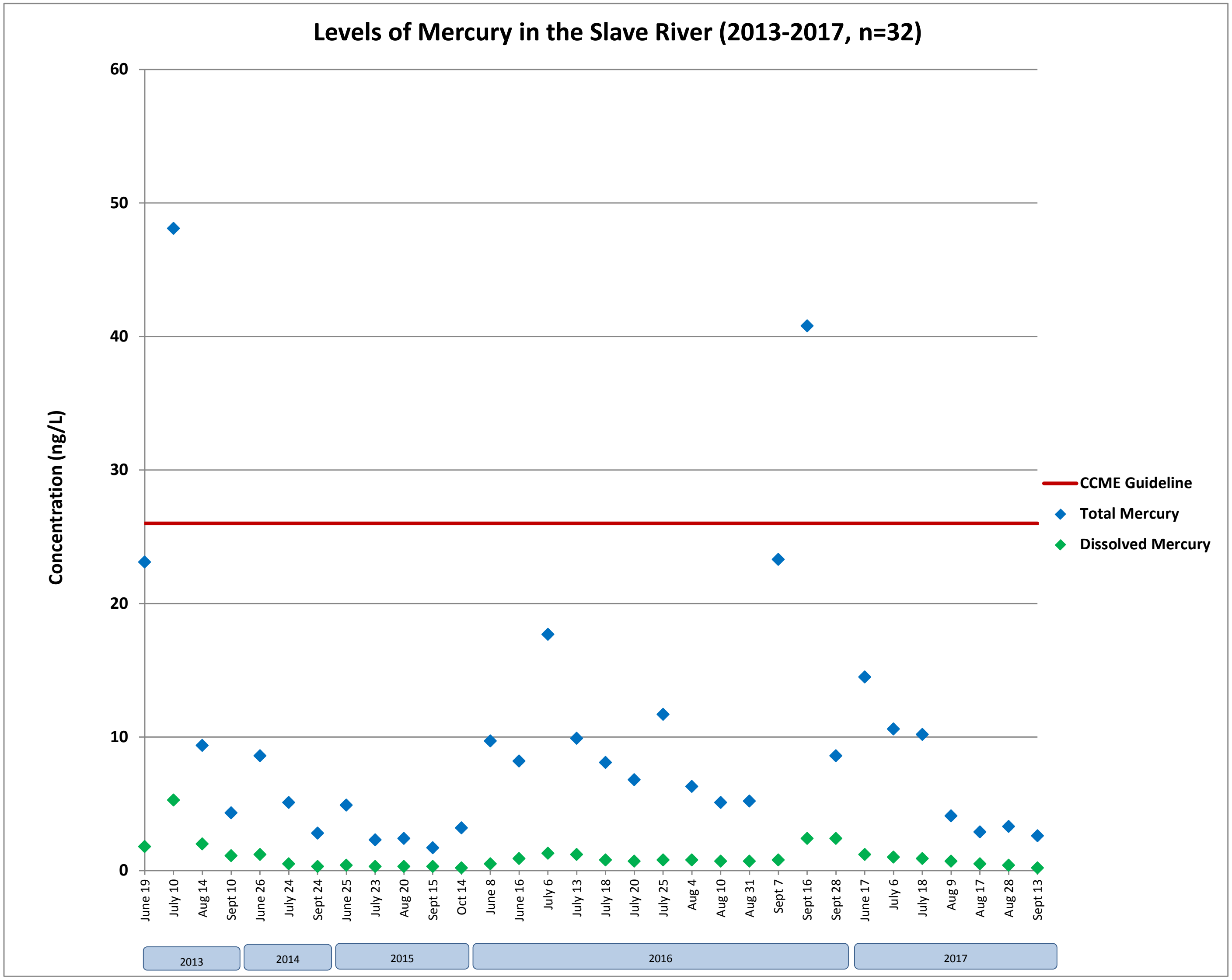

Figure 11: Mercury Levels in Surface Water – Slave River at Fort Smith (2013-2017)

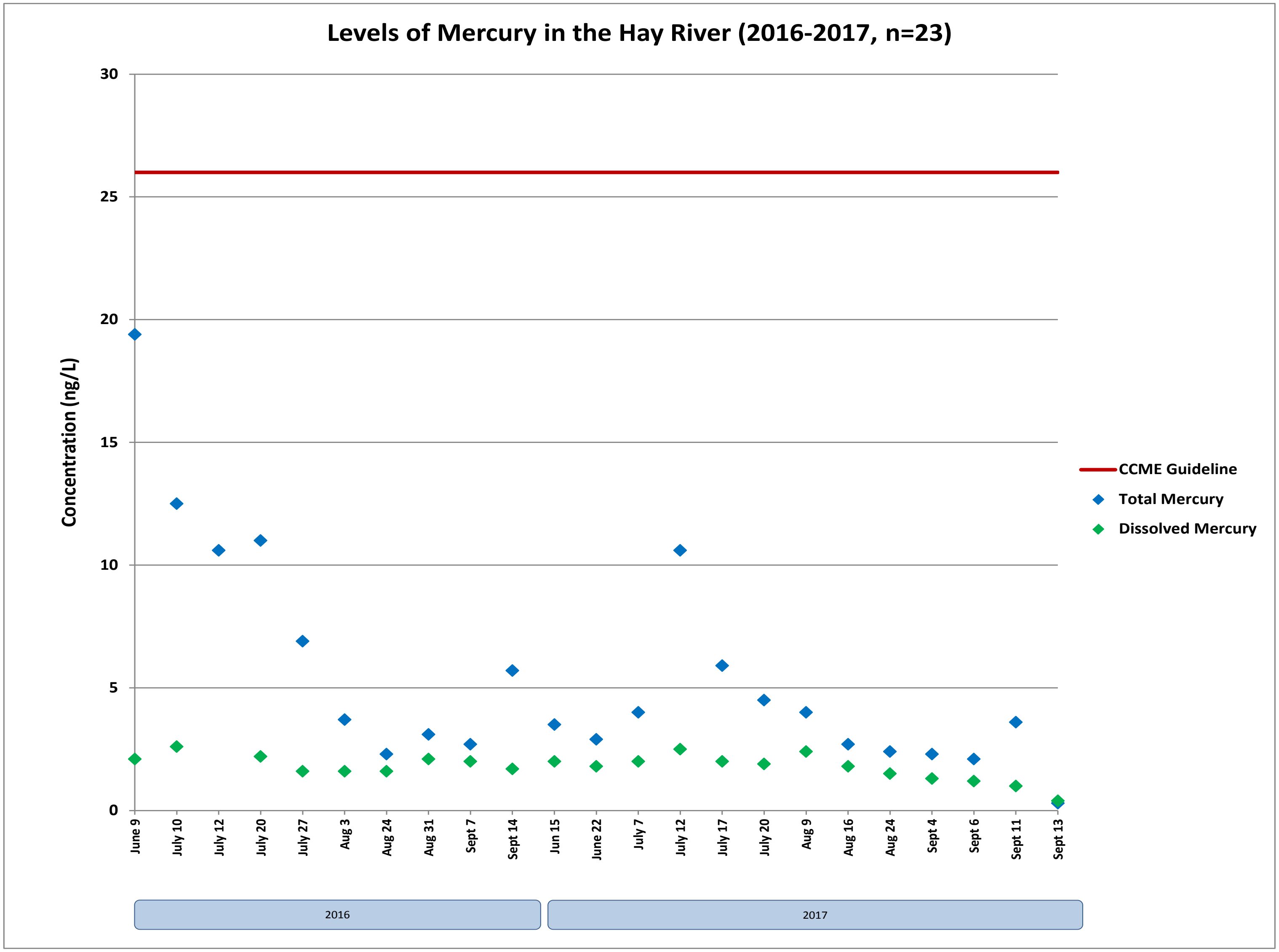

Figure 12: Mercury Levels in Surface Water – Hay River near Alberta/NWT Border (2016-2017)

Appendix 2: Slave River Interim Water Quality Triggers [Original (POR_1) and Updated (POR_2)]

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
ALKALINITY	mg/L	n	46	50	49	53	41	44	98	103	136	147	98	103	234	250
POR_1: Jan 1972 - Oct 2012		max	121.0	121.0	110.0	110.0	97.7	97.7	104.0	104.0	121.0	121.0	104.0	104.0	121.0	121.0
POR_2: Jan 1972 - Oct 2014		50th P	84.7	85.0	85.9	85.9	81.0	80.8	84.4	84.3	83.7	83.7	84.4	84.3	84.3	84.2
		90th P	93.5	92.8	97.0	96.9	92.3	92.2	93.6	93.3	95.6	95.1	93.6	93.3	94.6	94.2
ALUMINUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	45.7	45.7	55.4	55.4	93.1	93.1	226.0	226.0	93.1	93.1	226.0	226.0	226.0	226.0
POR_2: May 2006 - Oct 2014		50th P	34.0	30.4	20.3	20.8	43.2	36.7	17.3	14.8	33.2	31.1	17.3	14.8	29.1	25.3
		90th P		45.0		53.8		92.3	170.8	127.3	77.1	58.7	170.8	127.3	90.4	65.2
ALUMINUM TOTAL	µg/L	n	21	25	18	22	21	24	48	53	60	71	48	53	108	124
POR_1: Apr 1993 - Oct 2012		max	15065	15065	48700	48700	2750	2750	9140	9140	48700	48700	9140	9140	48700	48700
POR_2: Apr 1993 - Oct 2014		50th P	1990	1990	2095	1870	696	671	223	198	1395	1330	223	198	907	859
		90th P	6058	5674	20710	16790	2084	2015	5132	4882	6192	5666	5132	4882	5690	5470
AMMONIA DISSOLVED	mg/L	n	19	23	18	22	20	23	42	47	57	68	42	47	99	115
POR_1: Apr 1993 - Oct 2012		max	0.120	0.120	0.085	0.085	0.114	0.114	0.330	0.330	0.120	0.120	0.330	0.330	0.330	0.330
POR_2: Apr 1993 - Oct 2014		50th P	0.019	0.015	0.013	0.011	0.011	0.010	0.018	0.013	0.013	0.011	0.018	0.013	0.014	0.013
		90th P	0.045	0.044	0.069	0.064	0.033	0.032	0.107	0.104	0.052	0.046	0.107	0.104	0.067	0.053
ANTIMONY DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.315	0.315	0.634	0.634	0.359	0.359	0.695	0.695	0.634	0.634	0.695	0.695	0.695	0.695
POR_2: May 2006 - Oct 2014		50th P	0.165	0.171	0.155	0.143	0.147	0.139	0.193	0.148	0.152	0.148	0.193	0.148	0.155	0.148
		90th P		0.294		0.571		0.308	0.544	0.430	0.338	0.316	0.544	0.430	0.359	0.316
ANTIMONY TOTAL	µg/L	n	11	15	10	14	12	15	26	31	33	44	26	31	59	75
POR_1: Mar 2002 - Oct 2012		max	0.310	0.310	0.498	0.498	0.113	0.112	1.360	1.360	0.498	0.498	1.360	1.360	1.360	1.360
POR_2: Mar 2002 - Oct 2014		50th P	0.145	0.178	0.139	0.137	0.085	0.084	0.198	0.135	0.118	0.115	0.198	0.135	0.130	0.121
		90th P	0.296	0.269	0.468	0.357	0.111	0.110	0.568	0.444	0.242	0.242	0.568	0.444	0.291	0.255
ARSENIC DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.580	0.580	0.580	0.650	0.500	0.500	0.640	0.640	0.580	**0.650**	0.640	0.640	0.640	**0.650**
POR_2: May 2006 - Oct 2014		50th P	0.400	0.465	0.500	0.510	0.440	0.425	0.300	0.265	0.445	0.470	0.300	0.265	0.410	0.410
		90th P		0.574		0.647		0.494	0.514	0.422	0.570	0.584	0.514	0.422	0.560	0.580
ARSENIC TOTAL	µg/L	n	10	14	9	13	11	14	23	28	30	41	23	28	53	69
POR_1: Apr 2003 - Oct 2012		max	4.26	4.26	11.30	11.30	1.34	**1.81**	4.67	4.67	11.30	11.30	4.67	4.67	11.30	11.30
POR_2: Apr 2003 - Oct 2014		50th P	1.48	1.55	1.32	1.32	1.06	1.06	0.64	0.48	1.21	1.27	0.64	0.48	1.08	1.09
		90th P	4.21	4.22		8.08	1.29	1.58	3.83	3.34	3.59	3.64	3.83	3.34	3.53	3.26

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
BARIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	54.3	**55.2**	76.6	76.6	50.6	50.6	49.8	49.8	76.6	76.6	49.8	49.8	76.6	76.6
POR_2: May 2006 - Oct 2014		50th P	48.8	49.4	52.0	52.0	44.2	44.1	44.9	43.6	48.1	47.5	44.9	43.6	47.0	46.4
		90th P		54.9		72.9		50.2	49.1	48.7	55.1	55.2	49.1	48.7	54.3	54.5
BARIUM TOTAL	µg/L	n	35	39	33	37	36	39	86	91	104	115	86	91	190	206
POR_1: Nov 1983 - Oct 2012		max	564	564	1730	1730	131	131	320	320	1730	1730	320	320	1730	1730
POR_2: Nov 1983 - Oct 2014		50th P	116	116	108	107	73	72	80	80	93	89	80	80	80	80
		90th P	391	308	541	522	102	100	160	160	296	287	160	160	206	208
BERYLLIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.013	0.013	0.016	0.016	0.010	0.010	0.019	0.019	0.016	0.016	0.019	0.019	0.019	0.019
POR_2: May 2006 - Oct 2014		50th P	0.006	0.007	0.007	0.007	0.006	0.006	0.002	0.002	0.006	0.006	0.002	0.002	0.005	0.005
		90th P		0.013		0.016		0.010	0.014	0.011	0.012	0.013	0.014	0.011	0.011	0.012
BERYLLIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	0.955	0.955	2.190	2.190	0.210	0.210	0.620	0.620	2.190	2.190	0.620	0.620	2.190	2.190
POR_2: Apr 1993 - Oct 2014		50th P	0.140	0.160	0.128	0.120	0.060	0.060	0.050	0.050	0.110	0.106	0.050	0.050	0.070	0.064
		90th P	0.681	0.529	1.990	1.754	0.174	0.168	0.318	0.282	0.686	0.515	0.318	0.282	0.500	0.414
BISMUTH DISSOLVED	µg/L	n	7	11	7	11	9	12	15	20	23	34	15	20	38	54
POR_1: Jul 2006 - Oct 2012		max	0.0180	0.0180	0.0040	0.0040	0.0030	0.0030	0.0090	0.0090	0.0180	0.0180	0.0090	0.0090	0.0180	0.0180
POR_2: Jul 2006 - Oct 2014		50th P	0.0020	0.0020	0.0010	0.0017	0.0020	0.0015	0.0020	0.0010	0.0020	0.0020	0.0020	0.0010	0.0020	0.0016
		90th P		0.0152		0.0038		0.0030	0.0090	0.0087	0.0040	0.0035	0.0090	0.0087	0.0060	0.0040
BISMUTH TOTAL	µg/L	n	8	12	8	12	9	12	22	27	25	36	22	27	47	63
POR_1: Apr 2003 - Oct 2012		max	0.069	0.069	0.112	0.112	0.020	**0.028**	0.062	0.062	0.112	0.112	0.062	0.062	0.112	0.112
POR_2: Apr 2003 - Oct 2014		50th P	0.025	0.032	0.023	0.020	0.015	0.015	0.011	0.005	0.020	0.020	0.011	0.005	0.018	0.017
		90th P		0.064		0.091		0.026	0.055	0.052	0.058	0.051	0.055	0.052	0.052	0.051
BORON DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	18.3	**23.6**	28.3	28.3	19.4	19.4	14.1	14.1	28.3	28.3	14.1	14.1	28.3	28.3
POR_2: May 2006 - Oct 2014		50th P	14.5	17.3	15.9	17.6	14.9	15.3	10.0	10.0	15.0	17.0	10.0	10.0	12.7	13.8
		90th P		22.2		26.9		19.2	13.5	12.9	18.9	20.1	13.5	12.9	17.9	19.0
BORON TOTAL	µg/L	n	11	15	10	14	12	15	26	31	33	44	26	31	59	75
POR_1: Mar 2002 - Oct 2012		max	25.2	**27.3**	39.3	39.3	18.9	18.9	19.5	19.5	39.3	39.3	19.5	19.5	39.3	39.3
POR_2: Mar 2002 - Oct 2014		50th P	15.9	18.7	15.4	16.9	14.8	15.4	10.9	10.6	15.0	16.5	10.9	10.6	13.9	14.1
		90th P	23.9	26.3	37.3	31.6	18.3	18.8	17.7	17.0	19.0	24.6	17.7	17.0	18.9	20.1
CADMIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.022	**0.036**	0.056	0.056	0.025	0.025	0.355	0.355	0.056	0.056	0.355	0.355	0.355	0.355
POR_2: May 2006 - Oct 2014		50th P	0.016	0.016	0.016	0.019	0.015	0.016	0.101	0.073	0.016	0.016	0.101	0.073	0.021	0.020
		90th P		0.032		0.050		0.025	0.316	0.281	0.025	0.025	0.316	0.281	0.112	0.109

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
CADMIUM TOTAL	µg/L	n	36	40	34	38	35	38	87	92	105	116	87	92	192	208
POR_1: Nov 1983 - Oct 2012		max	15.00	15.00	11.30	11.30	1.23	1.23	3.40	3.40	15.00	15.00	3.40	3.40	15.00	15.00
POR_2: Nov 1983 - Oct 2014		50th P	0.40	0.40	0.30	0.25	0.10	0.10	0.11	0.10	0.20	0.20	0.11	0.10	0.20	0.20
		90th P	1.45	1.28	3.52	3.06	0.94	0.91	1.00	1.00	1.52	1.33	1.00	1.00	1.20	1.11
CALCIUM DISSOLVED/FILTERED	mg/L	n	47	51	49	53	44	47	104	109	140	151	104	109	244	260
POR_1: Jan 1972 - Oct 2012		max	37.5	37.5	42.0	42.0	41.7	41.7	40.5	40.5	42.0	42.0	40.5	40.5	42.0	42.0
POR_2: Jan 1972 - Oct 2014		50th P	28.9	29.0	28.8	29.1	26.8	26.8	28.3	28.3	28.2	28.3	28.3	28.3	28.3	28.3
		90th P	33.9	33.5	34.3	34.1	30.7	30.9	31.9	31.8	32.7	32.2	31.9	31.8	32.2	32.1
CARBON DISSOLVED ORGANIC	mg/L	n	41	45	41	45	37	40	89	94	119	130	89	94	208	224
POR_1: Nov 1978 - Oct 2012		max	20.20	20.20	22.10	22.10	11.90	11.90	40.40	40.40	22.10	22.10	40.40	40.40	40.40	40.40
POR_2: Nov 1978 - Oct 2014		50th P	8.11	8.60	7.84	7.95	5.80	5.95	4.00	4.00	7.20	7.40	4.00	4.00	5.45	5.58
		90th P	13.24	13.82	12.36	12.99	9.04	8.72	6.22	6.11	11.90	12.60	6.22	6.11	10.60	11.00
CARBON PARTICULATE ORGANIC	mg/L	n	41	44	42	46	39	42	93	98	122	132	93	98	215	230
POR_1: Nov 1978 - Oct 2012		max	18.50	18.50	68.50	68.50	5.25	**6.45**	24.20	24.20	68.50	68.50	24.20	24.20	68.50	68.50
POR_2: Nov 1978 - Oct 2014		50th P	4.16	4.26	3.80	3.75	1.70	1.70	0.72	0.72	2.80	2.72	0.72	0.72	1.85	1.85
		90th P	12.98	12.85	26.97	22.53	2.90	3.60	8.85	7.99	13.05	12.14	8.85	7.99	10.60	10.31
CHLORIDE DISSOLVED	mg/L	n	47	51	49	53	44	47	103	108	140	151	103	108	243	259
POR_1: Jan 1972 - Oct 2012		max	8.01	8.01	6.78	6.78	9.01	**9.05**	11.00	11.00	9.01	**9.05**	11.00	11.00	11.00	11.00
POR_2: Jan 1972 - Oct 2014		50th P	4.40	4.00	3.77	3.89	5.97	6.20	5.42	5.40	4.57	4.56	5.42	5.40	5.00	5.00
		90th P	7.02	6.86	5.90	6.01	7.27	7.50	7.60	7.52	7.00	7.08	7.60	7.52	7.20	7.20
CHROMIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.170	0.170	0.221	0.221	0.230	0.230	2.090	2.090	0.230	0.230	2.090	2.090	2.090	2.090
POR_2: May 2006 - Oct 2014		50th P	0.123	0.123	0.100	0.100	0.124	0.122	0.251	0.156	0.120	0.120	0.251	0.156	0.130	0.124
		90th P		0.164		0.209		0.218	1.532	1.099	0.205	0.178	1.532	1.099	0.480	0.428
CHROMIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	22.10	22.10	50.40	50.40	4.70	4.70	12.40	12.40	50.40	50.40	12.40	12.40	50.40	50.40
POR_2: Apr 1993 - Oct 2014		50th P	3.63	3.63	2.90	2.60	1.19	1.17	0.64	0.50	2.21	2.10	0.64	0.50	1.55	1.41
		90th P	15.25	11.72	31.00	28.40	3.51	3.42	8.70	8.01	14.70	9.50	8.70	8.01	9.50	9.06
COBALT DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.102	0.102	0.118	0.118	0.105	0.105	0.276	0.276	0.118	0.118	0.276	0.276	0.276	0.276
POR_2: May 2006 - Oct 2014		50th P	0.064	0.066	0.047	0.047	0.060	0.061	0.050	0.042	0.060	0.060	0.050	0.042	0.060	0.055
		90th P		0.096		0.112		0.098	0.219	0.180	0.104	0.095	0.219	0.180	0.144	0.136
COBALT TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	13.85	13.85	30.30	30.30	2.70	2.70	8.88	8.88	30.30	30.30	8.88	8.88	30.30	30.30
POR_2: Nov 1983 - Oct 2014		50th P	2.15	2.25	1.76	1.61	0.80	0.80	0.50	0.50	1.44	1.40	0.50	0.50	1.00	1.00
		90th P	8.41	6.65	14.30	11.82	1.72	1.60	3.25	3.04	6.20	5.88	3.25	3.04	5.25	5.20

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
COPPER DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	3.61	**3.81**	5.56	5.56	3.87	3.87	10.60	10.60	5.56	5.56	10.60	10.60	10.60	10.60
POR_2: May 2006 - Oct 2014		50th P	2.08	2.46	2.07	2.13	1.34	1.33	2.43	1.85	1.84	2.07	2.43	1.85	2.07	2.00
		90th P		3.75		5.29		3.59	8.28	6.45	4.04	3.83	8.28	6.45	4.21	3.87
COPPER TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	46.00	46.00	97.00	97.00	8.90	8.90	30.20	30.20	97.00	97.00	30.20	30.20	97.00	97.00
POR_2: Nov 1983 - Oct 2014		50th P	7.05	7.43	5.00	4.75	2.78	2.76	2.00	1.80	4.39	4.26	2.00	1.80	3.90	3.85
		90th P	23.91	20.98	41.10	33.58	4.57	4.26	10.42	10.40	18.43	18.10	10.42	10.40	15.34	15.10
DISSOLVED OXYGEN	mg/L	n		25		24		31		60		80		60		140
		max		12.40		14.50		15.46		16.60		15.46		16.60		16.60
POR_2: Aug 1989 - Oct 2014		min		6.00		6.40		9.00		9.40		6.00		9.40		6.00
		10th P		6.00		6.40		9.00		9.40		6.00		9.40		6.16
		50th P		9.47		8.21		10.90		13.00		9.58		13.00		11.41
		90th P		10.84		9.12		13.01		14.06		11.90		14.06		13.60
IRON DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	165	165	156	**200**	266	266	527	527	266	266	527	527	527	527
POR_2: May 2006 - Oct 2014		50th P	115	116	67	88	103	103	77	67	102	102	77	67	91	91
		90th P		164		193		250	424	339	197	189	424	339	211	193
IRON TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	41900	41900	128000	128000	7280	7280	23000	23000	128000	128000	23000	23000	128000	128000
POR_2: Apr 1993 - Oct 2014		50th P	4065	4690	4020	3140	1813	1750	473	412	2910	2865	473	412	2015	1990
		90th P	12450	12250	71100	62020	5246	5192	11180	10380	16160	15250	11180	10380	15250	12550
LEAD DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.239	0.239	0.773	0.773	0.203	0.203	0.814	0.814	0.773	0.773	0.814	0.814	0.814	0.814
POR_2: May 2006 - Oct 2014		50th P	0.096	0.100	0.100	0.110	0.129	0.084	0.213	0.149	0.101	0.100	0.213	0.149	0.129	0.110
		90th P		0.209		0.672		0.186	0.803	0.758	0.255	0.217	0.803	0.758	0.417	0.403
LEAD TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	22.20	22.20	50.90	50.90	4.80	4.80	27.40	27.40	50.90	50.90	27.40	27.40	50.90	50.90
POR_2: Nov 1983 - Oct 2014		50th P	3.18	3.30	2.77	2.60	1.25	1.20	0.90	0.86	2.30	2.20	0.90	0.86	1.67	1.60
		90th P	11.72	10.79	24.40	20.72	3.06	3.00	6.62	6.60	8.95	8.91	6.62	6.60	8.28	7.60
LITHIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	5.34	**5.85**	6.09	6.09	5.45	5.45	3.90	3.90	6.09	6.09	3.90	3.90	6.09	6.09
POR_2: May 2006 - Oct 2014		50th P	4.23	4.76	4.70	5.05	4.39	4.92	3.20	3.20	4.43	5.00	3.20	3.20	3.90	3.98
		90th P		5.79		5.94		5.42	3.90	3.89	5.40	5.53	3.90	3.89	5.30	5.34
LITHIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	36.25	36.25	56.90	56.90	12.20	12.20	34.40	34.40	56.90	56.90	34.40	34.40	56.90	56.90
POR_2: Apr 1993 - Oct 2014		50th P	8.00	8.39	9.20	7.00	6.10	6.10	4.00	3.90	7.22	7.10	4.00	3.90	6.10	6.08
		90th P	20.79	18.91	54.10	49.70	10.15	9.70	11.86	11.76	21.04	18.40	11.86	11.76	16.05	14.36

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
MAGNESIUM DISSOLVED/FILTERED	mg/L	n	42	46	42	46	40	43	94	99	124	135	94	99	218	234
POR$_1$: Nov 1978 - Oct 2012		max	7.80	7.80	8.80	8.80	7.70	**7.86**	8.08	8.08	8.80	8.80	8.08	8.08	8.80	8.80
POR$_2$: Nov 1978 - Oct 2014		50th P	6.49	6.49	6.91	6.95	6.52	6.50	6.58	6.59	6.55	6.55	6.58	6.59	6.56	6.58
		90th P	7.40	7.41	7.94	7.86	7.42	7.48	7.06	7.08	7.54	7.54	7.06	7.08	7.44	7.45
MANGANESE DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR$_1$: May 2006 - Oct 2012		max	4.87	4.87	3.40	3.40	5.63	5.63	13.60	13.60	5.63	5.63	13.60	13.60	13.60	13.60
POR$_2$: May 2006 - Oct 2014		50th P	2.17	2.17	1.61	1.65	2.80	2.50	4.32	3.87	2.09	2.12	4.32	3.87	3.12	2.53
		90th P		4.35		3.35		5.19	13.60	13.47	4.51	3.85	13.60	13.47	9.07	6.63
MANGANESE TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR$_1$: Mar 1993 - Oct 2012		max	658	658	1980	1980	135	135	761	761	1980	1980	761	761	1980	1980
POR$_2$: Mar 1993 - Oct 2014		50th P	85	88	104	84	51	50	16	14	72	71	16	14	58	58
		90th P	471	370	1350	1115	81	89	359	330	361	319	359	330	356	311
MERCURY TOTAL	ng/L	Under Development														
MERCURY DISSOLVED	ng/L	Under Development														
MOLYBDENUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR1: May 2006 - Oct 2012		max	1.045	1.045	2.560	2.560	0.810	0.810	1.070	1.070	2.560	2.560	1.070	1.070	2.560	2.560
POR$_2$: May 2006 - Oct 2014		50th P	0.759	0.796	0.872	0.859	0.700	0.699	0.739	0.715	0.787	0.778	0.739	0.715	0.770	0.746
		90th P		1.035		2.239		0.808	0.954	0.873	1.000	0.976	0.954	0.873	0.954	0.946
MOLYBDENUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR1: Apr 1993 - Oct 2012		max	1.750	1.750	3.000	3.000	0.900	0.900	1.000	1.000	3.000	3.000	1.000	1.000	3.000	3.000
POR$_2$: Apr 1993 - Oct 2014		50th P	0.596	0.570	0.800	0.675	0.636	0.627	0.606	0.631	0.631	0.626	0.606	0.631	0.629	0.629
		90th P	0.900	0.900	2.400	2.120	0.800	0.800	0.800	0.800	1.124	1.050	0.800	0.800	0.900	0.898
NICKEL DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR1: May 2006 - Oct 2012		max	2.74	**2.80**	4.46	4.46	1.48	1.48	2.26	2.26	4.46	4.46	2.26	2.26	4.46	4.46
POR$_2$: May 2006 - Oct 2014		50th P	1.37	1.63	1.64	1.60	1.06	1.03	1.15	0.90	1.25	1.29	1.15	0.90	1.24	1.21
		90th P		2.78		4.00		1.40	2.20	2.13	2.37	2.45	2.20	2.13	2.16	2.20
NICKEL TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR1: Nov 1983 - Oct 2012		max	41.55	41.55	92.90	92.90	8.60	8.60	25.50	25.50	92.90	92.90	25.50	25.50	92.90	92.90
POR$_2$: Nov 1983 - Oct 2014		50th P	6.85	7.05	5.55	5.20	2.80	2.78	1.70	1.55	5.00	4.90	1.70	1.55	3.50	3.38
		90th P	26.44	20.80	41.00	36.68	6.21	6.00	9.97	9.18	19.96	18.96	9.97	9.18	15.72	15.80

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
NITRATE/NITRITE	mg/L	n	8	12	7	11	9	12	18	23	24	35	18	23	42	58
POR_1: Oct 2005 - Oct 2012		max	0.210	0.210	0.290	0.290	0.150	**0.160**	0.230	**0.300**	0.290	0.290	0.230	**0.300**	0.290	**0.300**
POR_2: Oct 2005 - Oct 2014		50th P	0.040	0.095	0.050	0.070	0.050	0.070	0.085	0.120	0.045	0.070	0.085	0.120	0.070	0.080
		90th P		0.195		0.278		0.157	0.185	0.210	0.220	0.180	0.185	0.210	0.201	0.183
NITROGEN DISSOLVED	mg/L	n	39	43	41	45	36	39	86	91	116	127	86	91	202	218
POR1: Nov 1978 - Oct 2012		max	0.670	0.670	0.610	0.610	0.464	0.464	2.000	2.000	0.670	0.670	2.000	2.000	2.000	2.000
POR_2: Nov 1978 - Oct 2014		50th P	0.270	0.280	0.240	0.242	0.180	0.183	0.206	0.210	0.233	0.240	0.206	0.210	0.219	0.224
		90th P	0.544	0.548	0.425	0.428	0.356	0.352	0.527	0.516	0.417	0.461	0.527	0.516	0.451	0.465
pH	pH units	n		25		24		31		60		145		102		247
		max		12.40		14.50		15.46		16.6		8.30		8.22		8.30
POR_2: Jan 1972 - Oct 2014		min		6.00		6.40		9.00		9.40		7.33		6.80		6.80
		10th P		6.00		6.40		9.00		9.40		7.36		6.82		7.33
		50th P		9.47		8.21		10.90		13.00		7.97		7.89		7.91
		90th P		10.84		9.12		13.01		14.06		8.12		8.06		8.10
PHOSPHOROUS TOTAL	mg/L	n	42	46	45	49	39	42	87	92	126	137	87	92	213	229
POR_1: Jul 1974 - Oct 2012		max	2.280	2.280	4.670	4.670	0.229	0.229	1.230	1.230	4.670	4.670	1.230	1.230	4.670	4.670
POR_2: Jul 1974 - Oct 2014		50th P	0.207	0.209	0.189	0.170	0.078	0.078	0.030	0.030	0.132	0.130	0.030	0.030	0.088	0.087
		90th P	0.695	0.687	1.718	1.670	0.140	0.137	0.382	0.359	0.660	0.586	0.382	0.359	0.518	0.491
PHOSPHOROUS TOTAL DISSOLVED	mg/L	n	40	44	41	45	38	41	83	88	119	130	83	88	202	218
POR_1: Nov 1978 - Oct 2012		max	0.136	0.136	0.100	0.100	0.075	0.075	0.123	0.123	0.136	0.136	0.123	0.123	0.136	0.136
POR_2: Nov 1978 - Oct 2014		50th P	0.016	0.015	0.012	0.012	0.010	0.009	0.008	0.008	0.010	0.010	0.008	0.008	0.010	0.010
		90th P	0.061	0.055	0.033	0.032	0.014	0.013	0.020	0.020	0.034	0.033	0.020	0.020	0.030	0.030
POTASSIUM DISSOLVED/FILTERED	mg/L	n	47	51	49	53	44	47	104	109	140	151	104	109	244	260
POR_1: Jan 1972 - Oct 2012		max	2.58	2.58	2.01	2.01	1.48	1.48	3.63	3.63	2.58	2.58	3.63	3.63	3.63	3.63
POR_2: Jan 1972 - Oct 2014		50th P	1.20	1.21	0.95	0.96	0.86	0.87	0.84	0.84	0.95	0.97	0.84	0.84	0.90	0.91
		90th P	2.16	2.12	1.26	1.26	1.00	1.02	1.50	1.50	1.53	1.61	1.50	1.50	1.50	1.50
SELENIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.355	**0.370**	0.500	0.500	0.210	0.210	0.270	**0.290**	0.500	0.500	0.270	**0.290**	0.500	0.500
POR_2: May 2006 - Oct 2014		50th P	0.270	0.270	0.270	0.270	0.180	0.170	0.210	0.210	0.230	0.240	0.210	0.210	0.210	0.210
		90th P		0.366		0.463		0.207	0.258	0.268	0.338	0.334	0.258	0.268	0.310	0.311
SELENIUM TOTAL	µg/L	n	10	14	9	13	11	14	23	28	30	41	23	28	53	69
POR_1: Apr 2003 - Oct 2012		max	0.405	**0.650**	0.880	0.880	0.235	0.235	0.470	0.470	0.880	0.880	0.470	0.470	0.880	0.880
POR_2: Apr 2003 - Oct 2014		50th P	0.290	0.305	0.270	0.270	0.180	0.180	0.230	0.230	0.255	0.250	0.230	0.230	0.230	0.230
		90th P	0.404	0.528		0.728	0.232	0.225	0.334	0.314	0.404	0.414	0.334	0.314	0.382	0.390
SILVER DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.0050	0.0050	0.0050	0.0050	0.0030	0.0030	0.0730	0.0730	0.0050	0.0050	0.0730	0.0730	0.0730	0.0730
POR_2: May 2006 - Oct 2014		50th P	0.0020	0.0020	0.0020	0.0020	0.0020	0.0015	0.0040	0.0025	0.0020	0.0020	0.0040	0.0025	0.0020	0.0020
		90th P		0.0050		0.0046		0.0027	0.0490	0.0321	0.0040	0.0044	0.0490	0.0321	0.0150	0.0074

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
SILVER TOTAL	µg/L	n	17	21	14	18	16	19	39	44	47	58	39	44	86	102
POR_1: Apr 1996 - Oct 2012		max	0.152	0.152	0.487	0.487	0.500	0.500	0.685	0.685	0.500	0.500	0.685	0.685	0.685	0.685
POR_2: Apr 1996 - Oct 2014		50th P	0.100	0.086	0.050	0.043	0.016	0.015	0.100	0.065	0.048	0.039	0.100	0.065	0.069	0.049
		90th P	0.133	0.128	0.444	0.409	0.220	0.100	0.157	0.129	0.133	0.128	0.157	0.129	0.135	0.127
SODIUM DISSOLVED/FILTERED	mg/L	n	47	51	49	53	43	46	104	109	139	150	104	109	243	259
POR_1: Jan 1972 - Oct 2012		max	10.00	10.00	8.85	8.85	9.06	11.00	9.52	9.52	10.00	11.00	9.52	9.52	10.00	11.00
POR_2: Jan 1972 - Oct 2014		50th P	6.50	6.33	5.96	6.20	6.90	7.13	6.09	6.06	6.40	6.46	6.09	6.06	6.19	6.19
		90th P	8.12	8.06	7.30	7.39	8.61	8.80	7.74	7.71	8.17	8.18	7.74	7.71	7.99	8.00
SPECIFIC CONDUCTANCE (LAB)	µS/cm	n	47	51	50	54	45	48	105	110	142	153	105	110	247	263
POR_1: Jan 1972 - Oct 2012		max	364	364	300	300	280	280	262	262	364	364	262	262	364	364
POR_2: Jan 1972 - Oct 2014		50th P	212	213	213	215	200	202	210	210	211	212	210	210	210	211
		90th P	262	260	256	254	247	253	240	240	256	254	240	240	250	249
STRONTIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	151	151	180	180	186	186	157	157	186	186	157	157	186	186
POR_2: May 2006 - Oct 2014		50th P	127	127	138	139	140	138	140	133	130	134	140	133	134	134
		90th P		147		176		182	156	155	170	164	156	155	157	156
STRONTIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	199	199	353	353	195	195	205	205	353	353	205	205	353	353
POR_2: Apr 1993 - Oct 2014		50th P	139	140	155	155	141	141	133	133	147	147	133	133	139	140
		90th P	178	172	290	265	165	170	158	157	192	185	158	157	174	175
SULPHATE DISSOLVED	mg/L	n	47	51	49	53	44	47	103	108	140	151	103	108	243	259
POR_1: Jan 1972 - Oct 2012		max	31.0	31.0	37.2	37.2	24.8	24.8	31.9	31.9	37.2	37.2	31.9	31.9	37.2	37.2
POR_2: Jan 1972 - Oct 2014		50th P	20.5	20.5	18.5	18.6	17.4	17.8	17.5	17.5	18.6	19.1	17.5	17.5	18.0	18.0
		90th P	27.2	27.0	28.1	28.1	21.5	21.7	20.8	20.7	26.3	26.1	20.8	20.7	23.1	23.2
THALLIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.024	0.024	0.012	0.012	0.025	0.025	0.079	0.079	0.025	0.025	0.079	0.079	0.079	0.079
POR_2: May 2006 - Oct 2014		50th P	0.010	0.008	0.008	0.008	0.009	0.007	0.008	0.006	0.010	0.008	0.008	0.006	0.009	0.007
		90th P		0.021		0.012		0.022	0.047	0.024	0.020	0.015	0.047	0.024	0.024	0.016
THALLIUM TOTAL	µg/L	n	11	15	10	14	12	15	26	31	33	44	26	31	59	75
POR_1: Mar 2002 - Oct 2012		max	0.313	0.313	0.480	0.480	0.047	0.045	0.199	0.199	0.480	0.480	0.199	0.199	0.480	0.480
POR_2: Mar 2002 - Oct 2014		50th P	0.053	0.058	0.039	0.039	0.025	0.024	0.015	0.011	0.037	0.038	0.015	0.011	0.030	0.028
		90th P	0.281	0.218	0.440	0.312	0.045	0.043	0.129	0.108	0.148	0.141	0.129	0.108	0.138	0.136
TOTAL DISSOLVED SOLIDS	mg/L	n	15	21	14	20	16	23	40	45	45	64	40	45	85	109
POR_1: Apr 1993 - Oct 2012		max	265	265	260	260	168	168	360	360	265	265	360	360	360	360
POR_2: Apr 1993 - Oct 2014		50th P	173	163	151	151	129	128	130	129	146	145	130	129	132	133
		90th P	236	216	233	204	167	163	164	162	209	196	164	162	184	180

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
TOTAL SUSPENDED SOLIDS	mg/L	n	39	45	39	45	37	44	89	94	115	134	89	94	204	228
POR_1: Jan 1972 - Oct 2012		max	2320	2320	4880	4880	279	279	1110	1110	4880	4880	1110	1110	4880	4880
POR_2: Jan 1972 - Oct 2014		50th P	210	211	148	136	59	60	18	16	121	111	18	16	76	76
		90th P	1370	1091	1117	1023	141	132	360	343	704	557	360	343	535	463
TURBIDITY (LAB)	NTU	n	44	48	48	52	42	45	96	101	134	145	96	101	230	246
POR_1: Jan 1972 - Oct 2012		max	1910	1910	6450	6450	155	155	900	900	6450	6450	900	900	6450	6450
POR_2: Jan 1972 - Oct 2014		50th P	142	159	81	79	49	48	14	11	77	77	14	11	56	55
		90th P	850	730	1591	1351	81	87	211	195	453	448	211	195	360	361
URANIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.718	0.718	1.190	1.190	0.409	0.409	0.561	0.561	1.190	1.190	0.561	0.561	1.190	1.190
POR_2: May 2006 - Oct 2014		50th P	0.427	0.438	0.445	0.418	0.372	0.370	0.412	0.407	0.403	0.408	0.412	0.407	0.409	0.408
		90th P		0.664		1.051		0.409	0.515	0.483	0.629	0.530	0.515	0.483	0.539	0.511
URANIUM TOTAL	µg/L	n	10	14	9	13	11	14	23	28	30	41	23	28	53	69
POR_1: Apr 2003 - Oct 2012		max	1.270	1.270	4.910	4.910	0.534	0.534	1.240	1.240	4.910	4.910	1.240	1.240	4.910	4.910
POR_2: Apr 2003 - Oct 2014		50th P	0.613	0.638	0.499	0.499	0.432	0.441	0.510	0.450	0.517	0.527	0.510	0.450	0.510	0.492
		90th P	1.269	1.265		3.382	0.525	0.531	1.060	0.872	1.216	1.186	1.060	0.872	1.060	1.090
VANADIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.500	0.500	0.537	0.537	0.559	0.559	0.898	0.898	0.559	0.559	0.898	0.898	0.898	0.898
POR_2: May 2006 - Oct 2014		50th P	0.352	0.361	0.400	0.429	0.392	0.354	0.230	0.223	0.377	0.378	0.230	0.223	0.351	0.351
		90th P		0.490		0.529		0.546	0.730	0.595	0.527	0.507	0.730	0.595	0.537	0.507
VANADIUM TOTAL	µg/L	n	36	40	34	38	36	39	87	90	106	117	87	90	193	207
POR_1: Nov 1983 - Oct 2012		max	40.50	40.50	84.80	84.80	8.80	8.80	24.10	24.10	84.80	84.80	24.10	24.10	84.80	84.80
POR_2: Nov 1983 - Oct 2014		50th P	5.28	5.44	3.78	3.64	1.80	1.80	0.70	0.70	3.56	3.51	0.70	0.70	2.40	2.40
		90th P	19.47	17.71	39.85	38.77	4.71	3.90	8.40	8.04	15.97	14.94	8.40	8.04	13.60	13.57
ZINC DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	1.01	1.01	3.45	3.45	3.41	3.41	27.50	27.50	3.45	3.45	27.50	27.50	27.50	27.50
POR_2: May 2006 - Oct 2014		50th P	0.65	0.65	0.60	0.70	0.80	0.74	3.13	2.76	0.73	0.70	3.13	2.76	1.00	0.80
		90th P		0.98		3.12		2.76	19.34	13.35	2.60	1.46	19.34	13.35	7.80	6.19
ZINC TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	191.7	191.7	561.0	561.0	27.1	27.1	113.0	113.0	561.0	561.0	113.0	113.0	561.0	561.0
POR_2: Nov 1983 - Oct 2014		50th P	20.0	20.9	13.2	12.1	6.7	6.6	7.4	6.0	12.5	12.2	7.4	6.0	11.2	11.0
		90th P	79.4	61.0	146.5	133.3	14.9	13.1	38.8	35.9	62.0	59.9	38.8	35.9	49.5	49.3

Notes:
1. 50^{th} P (Trigger 1; typical conditions).
2. 90^{th} P (Trigger 1; extreme conditions).
3. POR: Period of Record.
4. Spring: May and June; Summer: July and August; Fall: September and October; Winter: November through April.
5. Open-Water: Spring, Summer and Fall; Ice-Covered: Winter.
6. Although all interim triggers (4-season, 2-season and annual) are included in this table, only if n>30 for each season (e.g., Spring, Summer, Fall and Winter) will the interim triggers be used otherwise the interim triggers in the next season classification (e.g., Open-Water and Ice-Covered, or Annual) will be used.

Appendix 3: Hay River Interim Water Quality Triggers [Original (POR_1) and Updated (POR_2)]

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
ALKALINITY	mg/L	n	34	34	29	31	26	27	62	62	89	92	62	62	151	154
POR_1: Oct 1988 - May 2014		max	110.0	110.0	129.0	129.0	181.0	181.0	305.0	305.0	181.0	181.0	305.0	305.0	305.0	305.0
POR_2: Oct 1988 - Oct 2014		50th P	68.7	68.7	102.0	100.0	113.5	116.0	190.5	190.5	93.4	94.2	190.5	190.5	117.0	116.5
		90th P	91.2	91.2	121.0	120.8	161.9	160.6	271.7	271.7	127.0	128.4	271.7	271.7	240.6	240.0
ALUMINUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*61.6*	*61.6*	*43.5*	*43.5*	*27.9*	*27.9*	*20.8*	*20.8*	*61.6*	*61.6*	*20.8*	*20.8*	*61.6*	*61.6*
POR_2: Aug 2006 - Oct 2014		*50th P*	*40.5*	*40.5*	*22.9*	*22.0*	*17.5*	*16.3*	*9.4*	*9.4*	*27.7*	*25.7*	*9.4*	*9.4*	*22.0*	*21.0*
		90th P									*49.1*	*48.6*	-		*47.7*	*47.2*
ALUMINUM TOTAL	µg/L	n	25	25	21	22	16	17	35	35	62	64	35	35	97	99
POR_1: Apr 1993 - May 2014		max	7620	7620	2200	2200	864	864	1450	1450	7620	7620	1450	1450	7620	7620
POR_2: Apr 1993 - Oct 2014		50th P	976	976	323	321	265	263	89	88	436	421	89	88	196	196
		90th P	2804	2804	989	974	699	675	211	211	2086	2010	211	211	1618	1580
AMMONIA DISSOLVED	mg/L	n	26	26	22	24	18	18	36	36	66	68	36	36	102	104
POR_1: Apr 1993 - May 2014		max	0.270	0.270	0.099	0.099	0.056	0.056	0.938	0.938	0.270	0.270	0.938	0.938	0.938	0.938
POR_2: Apr 1993 - Oct 2014		50th P	0.015	0.015	0.017	0.015	0.019	0.019	0.070	0.070	0.018	0.017	0.070	0.070	0.022	0.021
		90th P	0.097	0.097	0.060	0.058	0.046	0.046	0.217	0.217	0.054	0.053	0.217	0.217	0.140	0.138
ANTIMONY DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.280*	*0.280*	*0.165*	*0.165*	*0.215*	*0.215*	*0.190*	*0.190*	*0.280*	*0.280*	*0.190*	*0.190*	*0.280*	*0.280*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.174*	*0.174*	*0.153*	*0.152*	*0.172*	*0.165*	*0.103*	*0.103*	*0.165*	*0.161*	*0.103*	*0.103*	*0.157*	*0.155*
		90th P									*0.214*	*0.211*			*0.205*	*0.202*
ANTIMONY TOTAL	µg/L	n	14	14	13	14	7	8	12	12	34	36	12	12	46	48
POR_1: Apr 2002 - May 2014		max	0.257	0.257	0.167	0.167	0.122	0.122	0.169	0.169	0.257	0.257	0.169	0.169	0.257	0.257
POR_2: Apr 2002 - Oct 2014		50th P	0.117	0.117	0.122	0.121	0.100	0.100	0.081	0.081	0.114	0.114	0.081	0.081	0.108	0.108
		90th P	0.228	0.228	0.164	0.163			0.165	0.165	0.173	0.170	0.165	0.165	0.168	0.167
ARSENIC DISSOLVED	µg/L	n	8	8	7	8	5	6	6	6	20	22	6	6	26	28
POR1: Aug 2006 - May 2014		max	0.840	0.840	1.120	1.120	1.570	1.570	0.530	0.530	1.570	1.570	0.530	0.530	1.570	1.570
POR_2: Aug 2006 - Oct 2014		50th P	0.665	0.665	0.980	0.980	0.830	0.795	0.510	0.510	0.835	0.835	0.510	0.510	0.765	0.765
		90th P									1.219	1.197			1.153	1.131
ARSENIC TOTAL	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*5.89*	*5.89*	*2.04*	*2.04*	*1.98*	*1.98*	*1.08*	*1.08*	*5.89*	*5.89*	*1.08*	*1.08*	*5.89*	*5.89*
POR_2: Aug 2006 - Oct 2014		*50th P*	*2.97*	*2.97*	*1.61*	*1.55*	*1.37*	*1.22*	*0.89*	*0.89*	*1.62*	*1.61*	*0.89*	*0.89*	*1.49*	*1.46*
		90th P									*3.52*	*3.44*			*3.27*	*3.19*

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
BARIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*48.5*	*48.5*	*54.1*	*54.1*	*50.6*	*50.6*	*66.6*	*66.6*	*54.1*	*54.1*	*66.6*	*66.6*	*66.6*	*66.6*
POR_2: Aug 2006 - Oct 2014		*50th P*	*32.0*	*32.0*	*41.5*	*41.1*	*41.3*	*41.4*	*55.7*	*55.7*	*37.9*	*39.6*	*55.7*	*55.7*	*41.4*	*41.4*
		90th P									*50.4*	*50.0*			*58.8*	*57.9*
BARIUM TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	298	298	477	477	109	109	203	203	477	477	203	203	477	477
POR_2: Oct 1988 - Oct 2014		50th P	75	75	58	58	55	55	80	80	60	59	80	80	67	67
		90th P	119	119	97	95	83	82	110	110	102	102	110	110	106	105
BERYLLIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.017*	*0.017*	*0.017*	*0.017*	*0.014*	*0.014*	*0.023*	*0.023*	*0.017*	*0.017*	*0.023*	*0.023*	*0.023*	*0.023*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.014*	*0.014*	*0.014*	*0.014*	*0.011*	*0.011*	*0.010*	*0.010*	*0.014*	*0.014*	*0.010*	*0.010*	*0.014*	*0.013*
		90th P									*0.017*	*0.017*			*0.017*	*0.017*
BERYLLIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	0.548	0.548	0.160	0.160	0.090	0.090	0.120	0.120	0.548	0.548	0.120	0.120	0.548	0.548
POR_2: Apr 1993 - Oct 2014		50th P	0.089	0.089	0.048	0.046	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
		90th P	0.234	0.234	0.093	0.091	0.074	0.072	0.050	0.050	0.176	0.172	0.050	0.050	0.138	0.136
BISMUTH DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.0060*	*0.0060*	*0.0040*	*0.0040*	*0.0050*	*0.0050*	*0.0010*	*0.0010*	*0.0060*	*0.0060*	*0.0010*	*0.0010*	*0.0060*	*0.0060*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.0040*	*0.0035*	*0.0030*	*0.0030*	*0.0030*	*0.0025*	*0.0010*	*0.0010*	*0.0030*	*0.0030*	*0.0010*	*0.0010*	*0.0030*	*0.0030*
		90th P							*0.0010*	*0.0010*	*0.0050*	*0.0050*	*0.0010*	*0.0010*	*0.0050*	*0.0050*
BISMUTH TOTAL	µg/L	Under Review														
POR_1: Apr 2003 - Sep 2009																
POR_2: Apr 2003 - Sep 2009																
BORON DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*37.1*	*37.1*	*36.9*	*36.9*	*35.2*	*36.2*	*56.8*	*56.8*	*37.1*	*37.1*	*56.8*	*56.8*	*56.8*	*56.8*
POR_2: Aug 2006 - Oct 2014		*50th P*	*25.3*	*25.3*	*28.4*	*29.7*	*29.1*	*29.4*	*44.7*	*44.7*	*28.7*	*29.1*	*44.7*	*44.7*	*30.0*	*30.6*
		90th P									*36.7*	*36.7*			*49.5*	*48.2*
BORON TOTAL	µg/L	n	14	14	13	14	7	8	12	12	34	36	12	12	46	48
POR1: Apr 2002 - May 2014		max	39.8	39.8	46.5	46.5	35.0	**35.9**	61.4	61.4	46.5	46.5	61.4	61.4	61.4	61.4
POR_2: Apr 2002 - Oct 2014		50th P	27.5	27.5	31.5	32.0	29.2	31.2	42.3	42.3	29.2	29.9	42.3	42.3	32.0	32.6
		90th P	37.4	37.4	42.6	41.7			60.0	60.0	36.3	36.2	60.0	60.0	47.3	46.8
CADMIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.034*	*0.034*	*0.028*	***0.046***	*0.034*	*0.034*	*0.186*	*0.186*	*0.034*	***0.046***	*0.186*	*0.186*	*0.186*	*0.186*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.026*	*0.026*	*0.024*	*0.025*	*0.029*	*0.024*	*0.048*	*0.048*	*0.025*	*0.025*	*0.048*	*0.048*	*0.029*	*0.029*
		90th P									*0.034*	*0.034*			*0.064*	*0.055*
CADMIUM TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	2.56	2.56	1.57	1.57	0.40	0.40	1.10	1.10	2.56	2.56	1.10	1.10	2.56	2.56
POR_2: Oct 1988 - Oct 2014		50th P	0.20	0.20	0.10	0.10	0.10	0.10	0.20	0.20	0.12	0.11	0.20	0.20	0.19	0.17
		90th P	0.86	0.86	0.40	0.40	0.30	0.30	0.52	0.52	0.50	0.50	0.52	0.52	0.50	0.50

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
CALCIUM DISSOLVED/FILTERED	mg/L	n	34	34	30	31	26	27	62	62	90	92	62	62	152	154
POR1: Oct 1988 - May 2014		max	43.8	43.8	51.4	51.4	66.4	66.4	115.0	115.0	66.4	66.4	115.0	115.0	115.0	115.0
POR_2: Oct 1988 - Oct 2014		50th P	31.6	31.6	42.7	42.9	45.2	45.2	73.7	73.7	40.0	40.1	73.7	73.7	45.5	45.9
		90th P	40.7	40.7	48.1	48.0	60.1	59.4	99.5	99.5	49.0	49.2	99.5	99.5	87.6	87.1
CARBON DISSOLVED ORGANIC	mg/L	n	33	33	29	31	25	25	61	61	87	89	61	61	148	150
POR1: Oct 1988 - May 2014		max	29.80	29.80	40.40	40.40	37.20	37.20	72.60	72.60	40.40	40.40	72.60	72.60	72.60	72.60
POR_2: Oct 1988 - Oct 2014		50th P	24.25	24.25	26.20	26.20	30.15	30.15	28.20	28.20	25.60	25.60	28.20	28.20	26.20	26.20
		90th P	26.46	26.46	34.10	34.04	34.06	34.06	37.20	37.20	32.72	32.60	37.20	37.20	34.42	34.37
CARBON PARTICULATE ORGANIC	mg/L	n	32	32	31	31	26	27	63	63	89	90	63	63	152	153
POR1: Oct 1988 - July 2014		max	20.00	20.00	4.93	4.93	3.72	3.72	5.63	5.63	20.00	20.00	5.63	5.63	20.00	20.00
POR_2: Oct 1988 - Oct 2014		50th P	3.11	3.11	1.81	1.81	1.23	1.19	0.68	0.68	2.10	2.08	0.68	0.68	1.18	1.16
		90th P	7.47	7.47	3.89	3.89	3.23	3.22	1.57	1.57	4.77	4.75	1.57	1.57	3.85	3.84
CHLORIDE DISSOLVED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR1: Oct 1988 - July 2014		max	4.80	4.80	9.60	9.60	7.87	7.87	24.40	24.40	9.60	9.60	24.40	24.40	24.40	24.40
POR_2: Oct 1988 - Oct 2014		50th P	2.84	2.84	2.70	2.70	4.09	4.20	7.42	7.42	2.84	2.87	7.42	7.42	4.20	4.24
		90th P	4.06	4.06	4.60	4.60	6.45	6.37	12.27	12.27	5.21	5.17	12.27	12.27	10.36	10.35
CHROMIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.260*	*0.260*	*0.184*	*0.184*	*0.204*	*0.204*	*0.232*	*0.232*	*0.260*	*0.260*	*0.232*	*0.232*	*0.260*	*0.260*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.174*	*0.174*	*0.143*	*0.147*	*0.120*	*0.115*	*0.113*	*0.113*	*0.148*	*0.148*	*0.113*	*0.113*	*0.142*	*0.142*
		90th P									*0.204*	*0.203*			*0.212*	*0.207*
CHROMIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 2003 - May 2014		max	11.90	11.90	3.70	3.70	1.50	1.50	2.26	2.26	11.90	11.90	2.26	2.26	11.90	11.90
POR_2: Apr 2003 - Oct 2014		50th P	1.54	1.54	0.65	0.60	0.40	0.35	0.34	0.34	0.79	0.77	0.34	0.34	0.50	0.50
		90th P	4.96	4.96	1.95	1.90	1.10	1.05	0.66	0.66	3.37	3.26	0.66	0.66	2.79	2.70
COBALT DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.293*	*0.293*	*0.228*	*0.228*	*0.275*	*0.275*	*2.200*	*2.200*	*0.293*	*0.293*	*2.200*	*2.200*	*2.200*	*2.200*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.191*	*0.191*	*0.177*	*0.163*	*0.257*	*0.232*	*0.436*	*0.436*	*0.189*	*0.189*	*0.436*	*0.436*	*0.210*	*0.207*
		90th P									*0.275*	*0.274*			*0.501*	*0.478*
COBALT TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	8.96	8.96	2.90	2.90	1.90	1.90	2.71	2.71	8.96	8.96	2.71	2.71	8.96	8.96
POR_2: Oct 1988 - Oct 2014		50th P	1.57	1.57	0.77	0.74	0.66	0.65	0.50	0.50	0.86	0.85	0.50	0.50	0.70	0.70
		90th P	3.26	3.26	2.13	2.06	1.13	1.12	1.30	1.30	2.75	2.72	1.30	1.30	2.20	2.20
COPPER DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*5.26*	*5.26*	*2.76*	***3.25***	*2.79*	*2.79*	*2.48*	*2.48*	*5.26*	*5.26*	*2.48*	*2.48*	*5.26*	*5.26*
POR_2: Aug 2006 - Oct 2014		*50th P*	*2.85*	*2.85*	*2.15*	*2.17*	*1.93*	*1.90*	*1.66*	*1.66*	*2.29*	*2.29*	*1.66*	*1.66*	*2.04*	*2.04*
		90th P									*3.40*	*3.38*			*3.35*	*3.33*
COPPER TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	23.80	23.80	7.40	7.40	3.90	3.90	5.60	5.60	23.80	23.80	5.60	5.60	23.80	23.80
POR_2: Oct 1988 - Oct 2014		50th P	3.93	3.93	2.74	2.77	2.21	2.14	2.10	2.10	3.00	2.90	2.10	2.10	2.50	2.50
		90th P	9.68	9.68	4.86	4.82	3.29	3.26	3.10	3.10	7.01	6.98	3.10	3.10	5.08	5.08

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
DISSOLVED OXYGEN	µg/L	n	Under Review													
		max														
		min														
POR_2: Sep 1990 - Oct 2014		10th P														
		50th P														
		90th P														
IRON DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*504*	*504*	*795*	*795*	*1350*	*1350*	*1160*	*1160*	*1350*	*1350*	*1160*	*1160*	*1350*	*1350*
POR_2: Aug 2006 - Oct 2014		*50th P*	*335*	*335*	*581*	*554*	*468*	*450*	*692*	*692*	*429*	*415*	*692*	*692*	*484*	*450*
		90th P									*785*	*764*			*926*	*859*
IRON TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	21500	21500	6250	6250	2790	2790	5610	5610	21500	21500	5610	5610	21500	21500
POR_2: Apr 1993 - Oct 2014		50th P	3570	3570	1635	1580	1500	1455	2080	2080	1790	1780	2080	2080	2010	1980
		90th P	8423	8423	3010	3000	2646	2628	3112	3112	6434	6402	3112	3112	5090	5040
LEAD DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.436*	*0.436*	*0.193*	***0.213***	*0.241*	*0.241*	*0.208*	*0.208*	*0.436*	*0.436*	*0.208*	*0.208*	*0.436*	*0.436*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.179*	*0.179*	*0.156*	*0.165*	*0.121*	*0.104*	*0.047*	*0.047*	*0.154*	*0.154*	*0.047*	*0.047*	*0.148*	*0.148*
		90th P									*0.281*	*0.272*			*0.254*	*0.245*
LEAD TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	11.20	11.20	4.70	4.70	2.40	2.40	2.70	2.70	11.20	11.20	2.70	2.70	11.20	11.20
POR_2: Oct 1988 - Oct 2014		50th P	1.76	1.76	0.71	0.71	0.59	0.58	0.50	0.50	0.90	0.82	0.50	0.50	0.70	0.70
		90th P	4.38	4.38	3.23	3.16	1.51	1.44	1.30	1.30	3.40	3.38	1.30	1.30	2.57	2.55
LITHIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*14.70*	*14.70*	*14.60*	*14.60*	*14.00*	***14.50***	*27.40*	*27.40*	*14.70*	*14.70*	*27.40*	*27.40*	*27.40*	*27.40*
POR_2: Aug 2006 - Oct 2014		*50th P*	*8.17*	*8.17*	*13.10*	*13.10*	*13.60*	*13.75*	*20.50*	*20.50*	*12.75*	*12.75*	*20.50*	*20.50*	*13.30*	*13.30*
		90th P									*14.54*	*14.57*			*22.12*	*21.64*
LITHIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	28.60	28.60	21.00	21.00	34.70	34.70	70.40	70.40	34.70	34.70	70.40	70.40	70.40	70.40
POR_2: Apr 1993 - Oct 2014		50th P	12.60	12.60	14.00	13.90	14.20	14.15	24.15	24.15	13.90	13.90	24.15	24.15	15.30	15.30
		90th P	19.98	19.98	17.73	17.64	32.86	32.63	56.11	56.11	23.98	23.24	56.11	56.11	34.52	34.34
MAGNESIUM DISSOLVED/FILTERED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR_1: Oct 1988 - Jul 2014		max	13.20	13.20	14.40	14.40	19.00	19.00	32.60	32.60	19.00	19.00	32.60	32.60	32.60	32.60
POR_2: Oct 1988 - Oct 2014		50th P	8.66	8.66	12.10	12.10	13.45	13.50	21.40	21.40	11.30	11.30	21.40	21.40	13.30	13.30
		90th P	11.90	11.90	13.30	13.30	16.62	17.58	29.25	29.25	14.40	14.54	29.25	29.25	26.00	26.00
MANGANESE DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - July 2014		*max*	*27.20*	*27.20*	*35.20*	*35.20*	*96.80*	*96.80*	*367.00*	*367.00*	*96.80*	*96.80*	*367.00*	*367.00*	*367.00*	*367.00*
POR_2: Aug 2006 - Oct 2014		*50th P*	*16.45*	*16.45*	*5.65*	*4.60*	*11.00*	*15.35*	*241.50*	*241.50*	*10.70*	*10.70*	*241.50*	*241.50*	*16.45*	*16.45*
		90th P									*34.40*	*32.80*			*252.60*	*248.20*

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
MANGANESE TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	479	479	485	485	118	118	1340	1340	485	485	1340	1340	1340	1340
POR_2: Apr 1993 - Oct 2014		50th P	94	94	79	79	67	64	192	192	78	78	192	192	97	95
		90th P	198	198	132	131	116	115	666	666	169	168	666	666	296	295
MERCURY DISSOLVED	ng/L	Under Development														
MERCURY TOTAL	ng/L	Under Development														
MOLYBDENUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.986*	*0.986*	*0.968*	*0.968*	*1.240*	*1.240*	*1.020*	*1.020*	*1.240*	*1.240*	*1.020*	*1.020*	*1.240*	*1.240*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.744*	*0.744*	*0.771*	*0.792*	*0.727*	*0.749*	*0.795*	*0.795*	*0.744*	*0.763*	*0.795*	*0.795*	*0.763*	*0.768*
		90th P									*0.984*	*1.073*			*0.996*	*1.029*
MOLYBDENUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	1.100	1.100	1.890	1.890	1.600	1.600	1.200	1.200	1.890	1.890	1.200	1.200	1.890	1.890
POR_2: Apr 1993 - Oct 2014		50th P	0.769	0.769	0.876	0.872	0.700	0.710	0.622	0.622	0.756	0.781	0.622	0.622	0.749	0.751
		90th P	1.030	1.030	1.270	1.260	1.600	1.600	1.051	1.051	1.216	1.208	1.051	1.051	1.182	1.164
NICKEL DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*3.84*	*3.84*	*3.69*	*3.69*	*3.20*	*3.20*	*7.78*	*7.78*	*3.84*	*3.84*	*7.78*	*7.78*	*7.78*	*7.78*
POR_2: Aug 2006 - Oct 2014		*50th P*	*3.02*	*3.02*	*3.08*	*2.94*	*2.72*	*2.70*	*3.55*	*3.55*	*2.85*	*2.80*	*3.55*	*3.55*	*3.17*	*3.11*
		90th P									*3.76*	*3.75*			*3.80*	*3.79*
NICKEL TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR_1: Oct 1988 - May 2014		max	26.90	26.90	12.40	12.40	6.80	6.80	9.22	9.22	26.90	26.90	9.22	9.22	26.90	26.90
POR_2: Oct 1988 - Oct 2014		50th P	5.50	5.50	4.12	4.09	3.41	3.33	3.50	3.50	4.19	4.15	3.50	3.50	3.90	3.90
		90th P	11.56	11.56	8.08	8.06	5.13	5.12	5.36	5.36	9.19	9.03	5.36	5.36	7.72	7.60
NITRATE/NITRITE	mg/L	n	10	10	8	10	5	5	7	7	23	25	7	7	30	32
POR_1: Jun 2005 - May 2014		max	0.310	0.310	1.355	1.355	0.210	0.210	1.730	1.730	1.355	1.355	1.730	1.730	1.730	1.730
POR_2: Jun 2005 - Oct 2014		50th P	0.035	0.035	0.025	0.065	0.100	0.100	0.560	0.560	0.050	0.060	0.560	0.560	0.090	0.095
		90th P	0.300	0.300		1.264					0.388	0.362			0.587	0.581
NITROGEN DISSOLVED	mg/L	n	33	33	30	32	27	27	62	62	90	92	62	62	152	154
POR1: Oct 1988 - May 2014		max	1.060	1.060	1.160	1.160	1.260	1.260	3.470	3.470	1.260	1.260	3.470	3.470	3.470	3.470
POR_2: Oct 1988 - Oct 2014		50th P	0.598	0.598	0.594	0.628	0.727	0.727	0.924	0.924	0.617	0.620	0.924	0.924	0.718	0.720
		90th P	0.958	0.958	0.962	0.953	1.184	1.184	1.498	1.498	1.009	1.006	1.498	1.498	1.267	1.265

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
pH	pH units	n		34		30		27		62		91		62		153
		max		8.19		8.19		8.30		8.16		8.30		8.16		8.30
POR_2: Oct 1988 - Oct 2014		min		7.38		6.98		7.25		6.91		6.98		6.91		6.91
		10th P		7.38		6.98		7.25		6.91		6.98		6.91		6.95
		50th P		7.63		7.89		7.98		7.46		7.81		7.46		7.65
		90th P		7.95		8.13		8.16		7.79		8.12		7.79		8.06
PHOSPHOROUS TOTAL	mg/L	n	34	34	30	32	27	27	62	62	91	93	62	62	153	155
POR1: Oct 1988 - May 2014		max	0.720	0.720	0.320	0.320	0.180	0.180	0.392	0.392	0.720	0.720	0.392	0.392	0.720	0.720
POR_2: Oct 1988 - Oct 2014		50th P	0.166	0.166	0.108	0.105	0.080	0.080	0.054	0.054	0.107	0.106	0.054	0.054	0.080	0.080
		90th P	0.393	0.393	0.244	0.241	0.153	0.153	0.113	0.113	0.256	0.254	0.113	0.113	0.228	0.228
PHOSPHOROUS TOTAL DISSOLVED	mg/L	n	34	34	30	32	27	27	62	62	91	93	62	62	153	155
POR1: Oct 1988 - May 2014		max	0.447	0.447	0.072	0.072	0.097	0.097	0.255	0.255	0.447	0.447	0.255	0.255	0.447	0.447
POR_2: Oct 1988 - Oct 2014		50th P	0.025	0.025	0.024	0.022	0.026	0.026	0.027	0.027	0.025	0.024	0.027	0.027	0.026	0.026
		90th P	0.047	0.047	0.052	0.051	0.090	0.090	0.049	0.049	0.050	0.050	0.049	0.049	0.049	0.049
POTASSIUM DISSOLVED/FILTERED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR_1: Oct 1988 - Jul 2014		max	3.40	3.40	2.97	2.97	2.79	2.79	4.79	4.79	3.40	3.40	4.79	4.79	4.79	4.79
POR_2: Oct 1988 - Oct 2014		50th P	2.04	2.04	1.74	1.74	1.79	1.80	2.42	2.42	1.90	1.91	2.42	2.42	2.03	2.03
		90th P	2.68	2.68	2.70	2.70	2.55	2.53	3.12	3.12	2.67	2.66	3.12	3.12	2.87	2.87
SELENIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: May 2006 - May 2014		*max*	*0.330*	*0.330*	*0.390*	*0.390*	*0.210*	*0.210*	*0.500*	*0.500*	*0.390*	*0.390*	*0.500*	*0.500*	*0.500*	*0.500*
POR_2: May 2006 - Oct 2014		*50th P*	*0.200*	*0.200*	*0.220*	*0.225*	*0.210*	*0.210*	*0.195*	*0.195*	*0.210*	*0.210*	*0.195*	*0.195*	*0.210*	*0.210*
		90th P									*0.322*	*0.306*			*0.369*	*0.363*
SELENIUM TOTAL	µg/L	n	13	13	12	13	6	7	11	11	31	33	11	11	42	44
POR_1: Apr 2003 - Jul 2014		max	0.510	0.510	0.290	0.290	0.300	0.300	0.500	0.500	0.510	0.510	0.500	0.500	0.510	0.510
POR_2: Apr 2003 - Oct 2014		50th P	0.250	0.250	0.250	0.250	0.235	0.230	0.210	0.210	0.250	0.250	0.210	0.210	0.240	0.240
		90th P	0.482	0.482	0.287	0.286			0.476	0.476	0.372	0.354	0.476	0.476	0.387	0.385
SILVER DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.0080*	*0.0080*	*0.0090*	*0.0090*	*0.0040*	*0.0040*	*0.0470*	*0.0470*	*0.0090*	*0.0090*	*0.0470*	*0.0470*	*0.0470*	*0.0470*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.0060*	*0.0055*	*0.0050*	*0.0045*	*0.0030*	*0.0030*	*0.0030*	*0.0030*	*0.0040*	*0.0040*	*0.0030*	*0.0030*	*0.0040*	*0.0035*
		90th P									*0.0080*	*0.0074*			*0.0080*	*0.0081*
SILVER TOTAL	µg/L	n	13	13	12	13	6	7	11	11	31	33	11	11	42	44
POR_1: Apr 2003 - May 2014		max	0.183	0.183	0.029	0.029	0.012	0.012	0.057	0.057	0.183	0.183	0.057	0.057	0.183	0.183
POR_2: Apr 2003 - Oct 2014		50th P	0.040	0.040	0.015	0.012	0.007	0.007	0.007	0.007	0.017	0.017	0.007	0.007	0.013	0.012
		90th P	0.144	0.144	0.029	0.029			0.049	0.049	0.070	0.069	0.049	0.049	0.066	0.064
SODIUM DISSOLVED/FILTERED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR_1: Oct 1988 - Jul 2014		max	17.80	17.80	17.20	17.20	18.60	18.60	35.10	35.10	18.60	18.60	35.10	35.10	35.10	35.10
POR_2: Oct 1988 - Oct 2014		50th P	10.30	10.30	12.80	12.80	14.15	14.20	21.45	21.45	12.50	12.50	21.45	21.45	14.80	14.80
		90th P	13.85	13.85	14.96	14.96	17.33	17.38	32.65	32.65	15.86	15.97	32.65	32.65	27.62	27.50
SPECIFIC CONDUCTANCE (LAB)	µS/cm	n	33	33	30	32	27	28	62	62	90	93	62	62	152	155
POR1: Oct 1988 - May 2014		max	367	367	398	398	513	513	860	860	513	513	860	860	860	860

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
POR$_2$: Oct 1988 - Oct 2014		50th P	264	264	339	341	376	380	584	584	322	322	584	584	368	369
		90th P	356	356	395	396	452	449	793	793	401	405	793	793	693	690
STRONTIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*135*	*135*	*157*	*157*	*149*	***157***	*272*	*272*	*157*	*157*	*272*	*272*	*272*	*272*
POR$_2$: Aug 2006 - Oct 2014		*50th P*	*83*	*83*	*139*	*139*	*138*	*141*	*244*	*244*	*135*	*135*	*244*	*244*	*138*	*138*
		90th P									*148*	*155*			*265*	*264*
STRONTIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR$_1$: Apr 1993 - May 2014		max	138	138	162	162	190	190	346	346	190	190	346	346	346	346
POR$_2$: Apr 1993 - Oct 2014		50th P	100	100	133	134	140	141	224	224	126	126	224	224	138	138
		90th P	132	132	161	161	186	186	305	305	156	156	305	305	256	255
SULPHATE DISSOLVED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR$_1$: Oct 1988 - Jul 2014		max	93.0	93.0	104.0	104.0	102.0	102.0	151.0	151.0	104.0	104.0	151.0	151.0	151.0	151.0
POR$_2$: Oct 1988 - Oct 2014		50th P	58.5	58.5	62.6	62.6	61.1	61.6	105.0	105.0	61.0	61.1	105.0	105.0	73.4	73.5
		90th P	87.2	87.2	83.9	83.9	91.5	91.4	141.4	141.4	88.4	88.4	141.4	141.4	119.8	119.5
THALLIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR$_1$: Aug 2006 - May 2014		*max*	*0.010*	*0.010*	*0.021*	*0.021*	*0.011*	*0.011*	*0.011*	*0.011*	*0.021*	*0.021*	*0.011*	*0.011*	*0.021*	*0.021*
POR$_2$: Aug 2006 - Oct 2014		*50th P*	*0.008*	*0.008*	*0.011*	*0.011*	*0.008*	*0.008*	*0.007*	*0.007*	*0.008*	*0.008*	*0.007*	*0.007*	*0.008*	*0.008*
		90th P									*0.017*	*0.016*			*0.014*	*0.013*
THALLIUM TOTAL	µg/L	n	14	14	13	14	7	8	12	12	34	36	12	12	46	48
POR$_1$: Apr 2002 - May 2014		max	0.205	0.205	0.038	0.038	0.016	0.016	0.052	0.052	0.205	0.205	0.052	0.052	0.205	0.205
POR$_2$: Apr 2002 - Oct 2014		50th P	0.043	0.043	0.021	0.021	0.014	0.012	0.010	0.010	0.023	0.022	0.010	0.010	0.017	0.017
		90th P	0.149	0.149	0.036	0.036			0.042	0.042	0.073	0.072	0.042	0.042	0.066	0.064
TOTAL DISSOLVED SOLIDS	mg/L	n	26	26	22	24	18	18	36	36	66	68	36	36	102	104
POR$_1$: Apr 1993 - May 2014		max	288	288	308	**708**	386	386	2700	2700	386	**708**	2700	2700	2700	2700
POR$_2$: Apr 1993 - Oct 2014		50th P	206	206	255	261	277	277	414	414	249	251	414	414	267	269
		90th P	276	276	295	304	344	344	549	549	302	310	549	549	481	486
TOTAL SUSPENDED SOLIDS	mg/L	n	34	34	30	32	27	27	63	63	91	93	63	63	154	156
POR$_1$: Oct 1988 - May 2014		max	774	774	222	222	77	77	160	160	774	774	160	160	774	774
POR$_2$: Oct 1988 - Oct 2014		50th P	95	95	37	37	19	19	6	6	41	41	6	6	12	12
		90th P	285	285	148	139	51	51	12	12	218	216	12	12	148	146
TURBIDITY (LAB)	NTU	n	34	34	30	32	27	27	63	63	91	93	63	63	154	156
POR1: Oct 1988 - May 2014		max	590	590	210	210	68	68	119	119	590	590	119	119	590	590
POR$_2$: Oct 1988 - Oct 2014		50th P	71	71	29	27	20	20	13	13	33	33	13	13	18	18
		90th P	230	230	97	95	47	47	21	21	149	148	21	21	117	116
URANIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR$_1$: Aug 2006 - May 2014		*max*	*0.606*	*0.606*	*0.696*	*0.696*	*0.922*	***0.958***	*2.000*	*2.000*	*0.922*	***0.958***	*2.000*	*2.000*	*2.000*	*2.000*
POR$_2$: Aug 2006 - Oct 2014		*50th P*	*0.307*	*0.307*	*0.509*	*0.510*	*0.602*	*0.625*	*1.345*	*1.345*	*0.480*	*0.500*	*1.345*	*1.345*	*0.536*	*0.571*
		90th P									*0.691*	*0.854*			*1.472*	*1.424*
URANIUM TOTAL	µg/L	n	13	13	12	13	6	7	11	11	31	33	11	11	42	44
POR1: Apr 2003 - May 2014		max	1.820	1.820	0.983	0.983	0.994	0.994	2.140	2.140	1.820	1.820	2.140	2.140	2.140	2.140

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$	POR$_1$	POR$_2$
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
POR$_2$: Apr 2003 - Oct 2014		50th P	0.617	0.617	0.594	0.601	0.654	0.663	1.260	1.260	0.602	0.617	1.260	1.260	0.645	0.654
		90th P	1.454	1.454	0.912	0.888			2.040	2.040	0.976	0.975	2.040	2.040	1.494	1.450
VANADIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.442*	*0.442*	*0.530*	*0.530*	*0.687*	*0.687*	*0.231*	*0.231*	*0.687*	*0.687*	*0.231*	*0.231*	*0.687*	*0.687*
POR$_2$: Aug 2006 - Oct 2014		*50th P*	*0.418*	*0.418*	*0.487*	*0.482*	*0.352*	*0.336*	*0.189*	*0.189*	*0.439*	*0.434*	*0.189*	*0.189*	*0.418*	*0.418*
		90th P									*0.552*	*0.547*			*0.537*	*0.532*
VANADIUM TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR$_1$: Oct 1988 - May 2014		max	23.30	23.30	7.80	7.80	3.40	3.40	4.73	4.73	23.30	23.30	4.73	4.73	23.30	23.30
POR$_2$: Oct 1988 - Oct 2014		50th P	2.90	2.90	1.48	1.47	1.09	1.08	0.50	0.50	1.60	1.60	0.50	0.50	0.95	0.95
		90th P	9.64	9.64	3.55	3.50	2.12	2.08	0.86	0.86	6.32	6.24	0.86	0.86	4.01	3.95
ZINC DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR$_1$: Aug 2006 - May 2014		*max*	*1.98*	*1.98*	*1.41*	*1.41*	*1.54*	*1.54*	*14.40*	*14.40*	*1.98*	*1.98*	*14.40*	*14.40*	*14.40*	*14.40*
POR$_2$: Aug 2006 - Oct 2014		*50th P*	*1.25*	*1.25*	*1.21*	*1.23*	*0.90*	*0.80*	*9.65*	*9.65*	*1.19*	*1.19*	*9.65*	*9.65*	*1.28*	*1.28*
		90th P									*1.64*	*1.62*			*12.03*	*11.81*
ZINC TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR$_1$: Oct 1988 - May 2014		max	90.8	90.8	22.2	22.2	9.3	9.3	40.9	40.9	90.8	90.8	40.9	40.9	90.8	90.8
POR$_2$: Oct 1988 - Oct 2014		50th P	13.7	13.7	5.6	5.6	4.1	4.0	4.9	4.9	6.3	6.3	4.9	4.9	5.6	5.6
		90th P	32.9	32.9	12.1	12.1	7.4	7.3	17.0	17.0	22.5	22.4	17.0	17.0	21.7	21.5

Notes:
1. 50th P (Trigger 1; typical conditions).
2. 90th P (Trigger 1; extreme conditions).
3. POR: Period of Record.
4. Spring: May and June; Summer: July and August; Fall: September and October; Winter: November through April.
5. Open-Water: Spring, Summer and Fall; Ice-Covered: Winter.
6. Italicized values represent preliminary interim water quality triggers (where n<30). Interim water quality triggers will be calculated when n>30.
7. Although all interim triggers (4-season, 2-season and annual) are included in this table, only if n>30 for all seasons (e.g., Spring, Summer, Fall and Winter) will the interim triggers be used otherwise the interim triggers in the next season classification (e.g., Open-Water and Ice-Covered, or Annual) will be used.
8. Total Bismuth is under review. Discussions are required with ECCC to discuss Hay River monitoring program/results for total bismuth.