2016 Water Quality Report

for the

Slave and Hay Transboundary Rivers

as a requirement of the

Alberta-Northwest Territories Bilateral Water Management Agreement

Surface water quality data collected during 2016

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Prepared by:

Andrea Czarnecki, Water Quality Scientist
Water Resources Division
Department of Environment and Natural Resources
Government of the Northwest Territories

- and -

Gongchen Li, Transboundary Water Quality Specialist
Transboundary Waters Secretariat
Environment and Parks
Government of Alberta

Executive Summary

The Bilateral Management Committee (BMC) has released this Annual Water Quality Report as a component of the 2016-2017 Alberta (AB)-Northwest Territories (NWT) BMC Annual Report to Ministers. The report presents an assessment of the water quality data collected in the 2016 calendar year and the cooperative efforts of the AB-NWT water quality technical team in the 2016-2017 fiscal year.

The AB-NWT Bilateral Water Management Agreement (Agreement) commits AB and NWT to establish transboundary water quality triggers and objectives for rivers classified as Class 3. The Agreement defines water quality triggers as an early warning of potential changes in typical and extreme conditions, which requires Jurisdictional and/or Bilateral Water Management to confirm. A water quality objective is defined as the site-specific water quality conditions that the responsible Party or Parties will meet in accordance with the Risk Informed Management approach. While the BMC is working on the development of transboundary water quality objectives, this report was prepared primarily based on interim transboundary water quality triggers. For this 2016 assessment, the historical annual 50th percentile (Trigger 1) and where available, the historical seasonal 90th percentile (Trigger 2) were used to identify changes in typical and extreme conditions.

Trigger 1 was assessed by flagging a parameter if more than half of its values were above the historical annual 50th percentile. Trend results were reviewed for all Trigger 1 flagged parameters to determine if levels were changing over time. For the Slave River, any flagged parameters were evaluated further if they revealed an increasing trend or parameters in both 2015 and 2016. This was done by combining the 2015 and 2016 water quality data and statistically comparing that to the historical data using the Wilcoxon-Mann-Whitney test. The test is used to identify any statistically significant differences between the two datasets and can highlight parameters that may warrant additional attention.

To assess Trigger 2, a parameter with concentrations above the historical seasonal 90th percentile was flagged and compared to its historical open-water or under-ice maximum value. Any parameter with a value above its corresponding historical open-water or under-ice maximum value was evaluated further in the following manner: 1) trend results were reviewed, 2) flow conditions were examined, and 3) values were compared to existing guidelines.

For the Slave River assessment, 538 water quality results were assessed against Trigger 1 and Trigger 2. These results were generated from water samples collected in 2016 by Environment and Climate Change Canada (ECCC) from the Slave River at Fitzgerald on nine occasions. Sixty-six parameters from each sample were reviewed as part of this assessment.

Twenty-seven of the 66 parameters were flagged during the 2016 Trigger 1 assessment. Of the 27 parameters, seven were also flagged during the 2015 assessment. These included alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium. These seven parameters plus dissolved organic carbon, which revealed an increasing trend in 2015, were assessed with the Wilcoxon-Mann-Whitney test. This analysis revealed a statistically significant difference for dissolved magnesium and nitrate/nitrite, suggesting that concentrations for

these two parameters are higher in the last two years than in the past. For the other six parameters, no significant differences were revealed.

The Trigger 2 assessment revealed considerably more values above Trigger 2 in 2016 (67 of 538 results) than in 2015 (9 of 590 results). The majority of values above Trigger 2 occurred in June following the peak of the spring freshet and in September following a large rain event (Figure 4 – quantity section). The elevated water quality values for several parameters and the new maximum values for total bismuth, total cobalt, total nickel, total selenium, total thallium, total uranium and nitrate/nitrite are likely attributable to the two high flow events because high flows tend to carry more particulate matter to which many metals and other substances are attached. High concentrations of total suspended solids were also observed at the same time as the high flow events. The massive wild fire that occurred from May to July in the Fort McMurray area might have also contributed to the elevated water quality values.

For the Hay River assessment, 164 water quality results were compared to Trigger 1 and Trigger 2. The water quality results were generated from water samples collected in 2016 by Environment and Climate Change Canada from the Hay River near the Alberta/NWT Boundary on four occasions. Forty-one parameters from each sample were reviewed as part of this assessment.

Eleven of the 41 parameters were flagged during the 2016 Trigger 1 assessment. Of these, the historical dataset for total vanadium was reviewed because a pre-existing statistically significant increasing annual trend was revealed. It was found that recent data are very similar to historical levels and vanadium is not a concern at this time. The Trigger 2 assessment showed that five of the 41 parameters (5 of 164 results) had values above Trigger 2, but none were above their respective historical seasonal maximum values.

Another requirement of the Agreement is the reporting of the detection of toxic, bioaccumulative and persistent substances in the surface water of the two transboundary rivers. During the summer of 2016, three (GNWT) water samples from each river were analyzed for 14 substances subject to virtual elimination (VE). One or more substances subject to VE were detected on each sampling occasion in each river, but at very low concentrations. Comparisons with the available corresponding United States Environmental Protection Agency (USEPA) Chronic Aquatic Life Criteria show that the levels detected pose no risk to aquatic life. Laboratory contamination or historical residues are likely causes for the detection of these substances.

Overall, there were no concerns identified in the 2016 water quality assessment of the Slave and Hay rivers. With regard to Trigger 1, the BMC will follow up and confirm whether the dissolved magnesium and nitrate/nitrite levels are changing in the Slave. With regard to Trigger 2, the new maximum values for seven parameters in the Slave River were likely attributable to water sampling during peak flows in June and September and the possible influence of the Fort McMurray wild fire. Water quality sampled in the later months was within the historical seasonal ranges for all parameters. Monitoring and assessment for all conventional parameters as well as the substances subject to VE, in both rivers, will continue.

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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 (Agreement) was signed. The purpose of the BWMA is to establish and implement a framework to achieve the principles of the Master Agreement. The BWMA will facilitate improved monitoring and reporting of upstream effects from development. It includes provisions to create ecosystem objectives, such as 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 Agreement, the BMC has released this Annual Water Quality Report. 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 to the 2016 water quality assessment (Section 3);

iii. Present and discuss the results of the 2016 water quality assessment (Sections 4, 5 & 6); and,

iv. Describe the activities of the AB-NWT water quality technical team for the 2016-2017 fiscal year and any BWMA 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 was used for this assessment.

Since 1960, ECCC has operated the Slave River at Fitzgerald monitoring site 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 location, water samples have been collected from two to thirteen times a year. In 2016, water quality samples were collected on nine occasions, in January, February, March, May, June, July, August, September and October. These samples were analyzed for conventional parameters including physical parameters, major ions, nutrients and metals, as well as organic substances such as pesticides, Polychlorinated Biphenyls (PCBs) and hydrocarbons.

Since 1990, Crown-Indigenous Relations and Northern Affairs Canada (prior to April 1, 2014) and the GNWT (post April 1, 2014) have operated the Slave River at Fort Smith monitoring site 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 location, water and suspended sediment samples have been collected from one to twelve times a year. In 2016, water and suspended sediment samples were collected on three occasions during the open-water season. These samples were analyzed for conventional parameters including physical parameters, major ions, nutrients, total and dissolved metals, as well as organic substances such as pesticides, PCBs, hydrocarbons and dioxins and furans.

To fulfill the water quality reporting requirements of the Agreement, the conventional water quality results generated from the Slave River at Fitzgerald monitoring site and the results for the substances subject to virtual elimination generated from the Slave River at Fort Smith monitoring site were reviewed (Table 1).

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 2016 water quality assessment

Parameter Grouping	**Parameters**
Physical Parameters	alkalinity, dissolved oxygen, pH, specific conductance, total dissolved solids, total suspended solids, turbidity
Major Ions	dissolved calcium, dissolved chloride, dissolved magnesium, dissolved sodium, dissolved potassium, dissolved sulphate
Nutrients	ammonia, dissolved nitrogen, nitrate/nitrite, dissolved organic carbon, particulate organic carbon, dissolved phosphorus, total phosphorus
Metals (dissolved and total)	aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, zinc
Virtual Elimination Organic Substances	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). This site has 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 Program. 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 2016, water quality samples were collected on four occasions in April, May, July and August. These samples were analyzed for conventional parameters including major ions, nutrients and metals, as well as organic substances such as pesticides, PCBs and hydrocarbons.

Since 1995, Indigenous and Northern Affairs Canada (prior to April 1, 2014) and the GNWT (post 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 2016, water and suspended sediment samples were collected three times during the open-water season and analyzed for conventional parameters including major ions, nutrients and metals as well as organic substances such as pesticides, PCBs and hydrocarbons.

To fulfill the water quality reporting requirements of the Agreement, the water quality results for conventional and the substances subject to virtual elimination (VE) generated from the Hay River near the Alberta/NWT Border were reviewed (Table 2).

Table 2: Hay River parameters reviewed for the 2016 water quality assessment

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

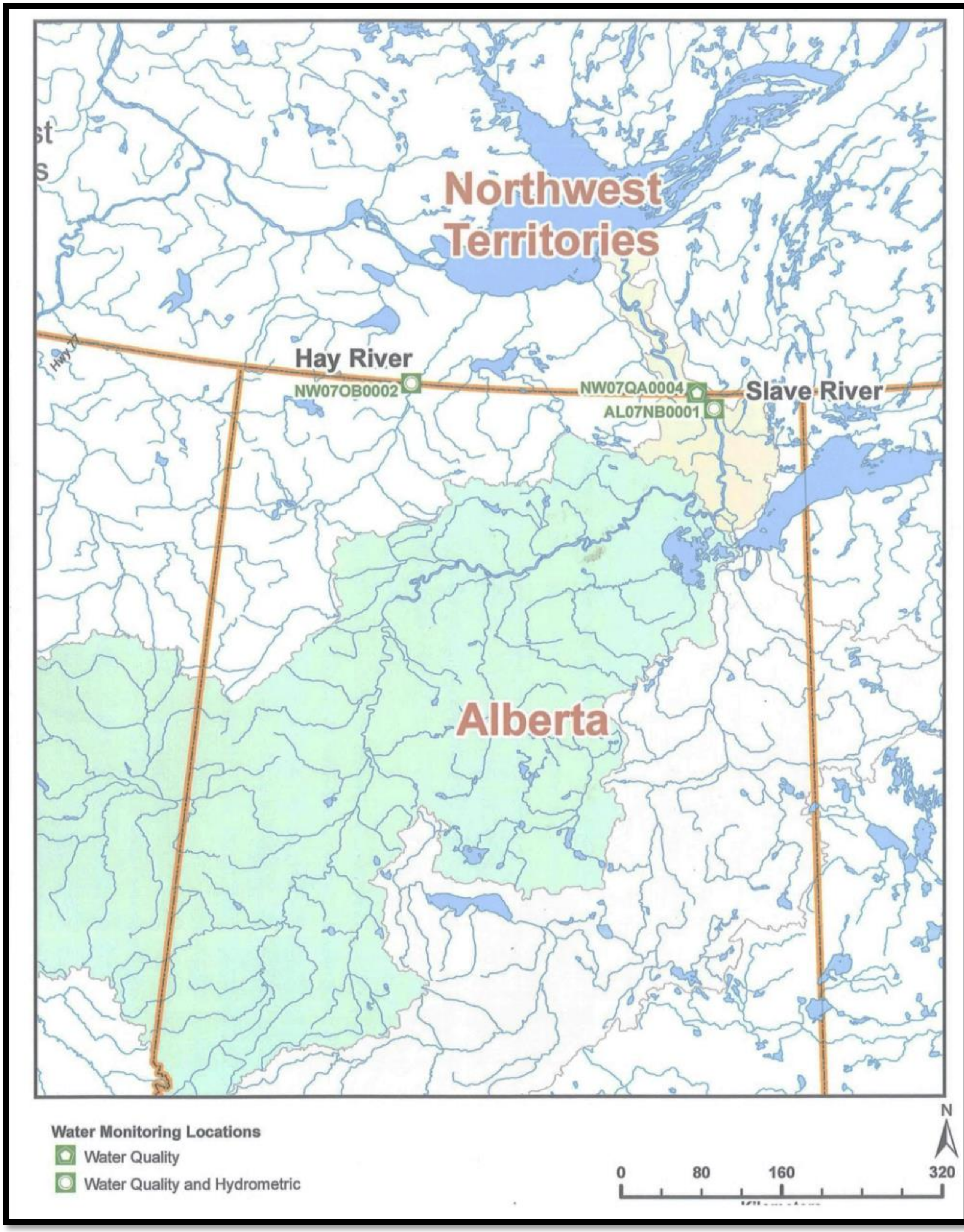


Figure 1: AB-NWT BWMA Water Quality Monitoring Sites

3. Approach to Annual Water Quality Assessment

3.1. Introduction

Under the Risk Informed Management (RIM) approach, the Hay and Slave rivers were 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.

In the Agreement, a water quality trigger is defined as a pre-defined early warning of potential changes in typical (Trigger 1) and/or extreme (Trigger 2) 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 were calculated using the background concentration procedure (CCME 2003), where the ambient background concentrations of a parameter in water are determined and used to define the water quality triggers at the site under consideration. Where water quality parameters exhibited seasonal differences, seasonal interim site-specific water quality triggers were calculated.

A water quality objective is defined in the Agreement as a conservative value that is protective of all uses of the water body, including the most sensitive use (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. These factors directly influence the types of statistical tests that can be used to assess trend 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.

The time series for the Slave River was 1972-2012 (post-filling of the Williston Reservoir) and the time series for Hay River was 1988-2014 (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. The development of seasonal triggers is suggested in the BWMA. To this end, 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 (spring, summer and fall) and under ice (winter).

With the prepared historical dataset, annual and seasonal interim water quality triggers (i.e., 50^{th} and 90^{th} 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. This year, 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 Agreement was signed in March 2015. All triggers (original and updated) for both rivers are included in Appendices 1 and 2 of this report.

3.3. Interim Water Quality Triggers Assessment

Since the interim water quality triggers are based on percentiles that have been observed in the past, they are useful to assess potential changes in ambient water quality. As these percentiles (triggers) are set conservatively, not all values above a percentile (trigger) necessarily signal a concern, but can be used to identify those 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 (50^{th} annual percentile) was selected as the Interim Trigger 1 (hereinafter referred to as Trigger 1) which was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2.

To assess typical conditions, 2016 data were compared to Trigger 1. It is important to note that values above the median are expected. Hence, for this report, a parameter was only flagged if the number of values above Trigger 1 occurred more often than expected. For example:

Slave River

With nine sample occasions on the Slave River in 2016, a parameter will:

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

Hay River

With four sample occasions on the Hay River in 2016, 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 90^{th} percentile was selected as the Interim Trigger 2 (hereinafter referred to as Trigger 2) which was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2. Theoretically, 10% of values for each parameter are expected to be above the 90^{th} percentile (Trigger 2) if no change has occurred to the water in any given year. This would denote no change in water quality.

To assess extreme conditions, the 2016 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.

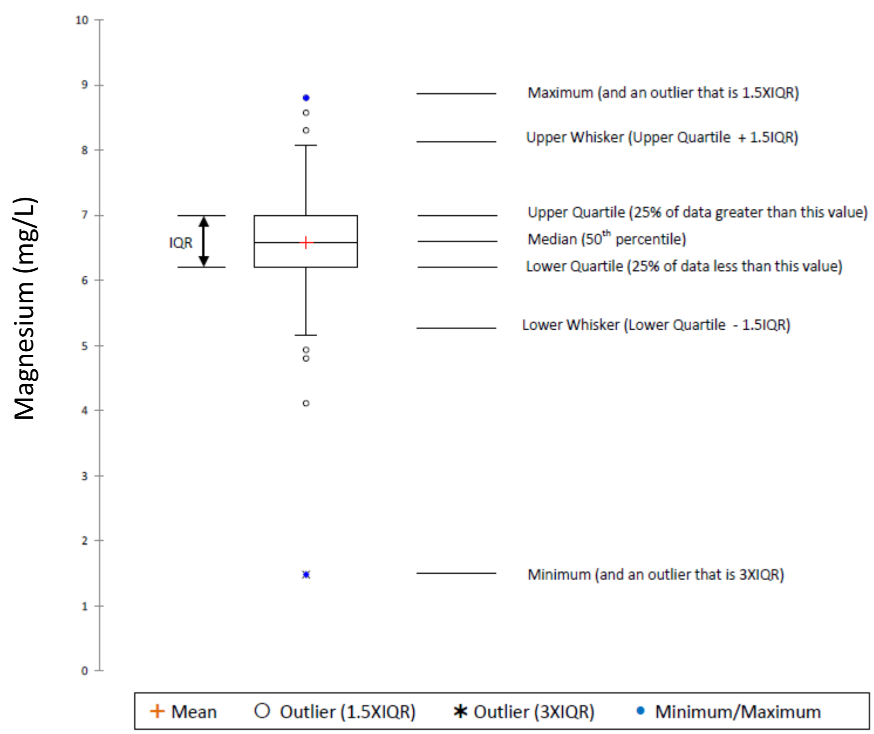
(i) Evaluating Trigger 1 Flagged Parameters

- Long-term trends (annual, seasonal and annual step-wise) were examined for Trigger 1 flagged parameters to evaluate whether there are statistically significant trends developing and whether the trend is in a direction of concern. In this report, a trend was declared statistically significant if the p-value for the test was less than 0.05.

- For the Slave River only, flagged parameters that revealed an increasing trend and/or parameters that were flagged in both 2015 and 2016 were evaluated further. This evaluation was done by combining the 2015 and 2016 water quality data and statistically comparing that to the historical data using the Wilcoxon-Mann-Whitney test. The test is used to identify any statistically significant differences[1] between the two datasets and can highlight parameters that may warrant additional attention. The data and test results were also examined visually using box and whisker plots. The Wilcoxon-Mann-Whitney test was not applied to the Hay River as the combined two-year sample size for 2015 and 2016 was too small (n=7).

Box and whisker plots are very useful to summarize a particular dataset. The central "box" covers the middle 50% of the data; the top and bottom of the box are the upper and lower quartiles (75%, 25% respectively). The horizontal line inside the box is the median (the mean is plotted as "+"). The whiskers extend above and below the box. The lower whisker is drawn from the lower quartile to the smallest point within 1.5 interquartile ranges (IQR) from the lower quartile. The upper whisker is drawn from the upper quartile to the largest point within 1.5 interquartile ranges from the upper quartile. Any values found beyond the whiskers can be considered outliers.

An example of a box and whisker plot using actual historical (1978-2014) dissolved magnesium data from the Slave River at Fitzgerald is shown below. Here, 50% of the dataset lies between 6.2 (lower quartile) and 7.0 (upper quartile) which means that 25% of the data fall below 6.2 mg/L and 25% are greater than 7.0 mg/L. The median is 6.6 mg/L and there are seven outliers (two of which are the minimum value and maximum value of 1.5 mg/L and 8.8 mg/L, respectively).



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

(ii) Evaluating Trigger 2 Flagged Parameters

- Values above Trigger 2 were compared to their respective historical annual and seasonal maximum values to provide context. Any parameter above its corresponding open-water or under-ice seasonal maximum value was evaluated further by:

  - Reviewing long-term trends (annual, seasonal and annual step-wise);

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

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

(iii) Further Evaluation

- If there are unexplained Trigger 1 and 2 flagged parameters of concern, these 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 Agreement are committed to pollution prevention and sustainable development. Substances subject to VE that are monitored as part of this Agreement are listed in Table 1 and Table 2. As part of the assessment, the 2016 data for substances subject to VE are reviewed, and the presence of each substance subject to VE is reported and discussed.

4. Results – Slave River

For this assessment, 538[2] individual conventional water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2016 by ECCC from the Slave River at Fitzgerald on nine occasions (January, February, March, May, June, July, August, September and October). Sixty-six parameters[3] from each sample were reviewed as part of this assessment.

4.1. Slave River 2016 Trigger 1 Assessment

The 2016 water quality results were screened to determine the number of water quality values that were higher than the annual median. If more than 50% of the values were higher than the median, the parameter was flagged. In 2016, 27 of the 66 parameters were flagged (Table 3). Seven of these 27 parameters, including alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium, were also flagged in 2015. One other parameter, dissolved organic carbon, was flagged in 2016 but was not flagged in the 2015 assessment.

Table 3: Slave River 2016 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2016 Values higher than Trigger 1	Annual Trend?	Open Water Trend?	Under Ice Trend?
Alkalinity (mg/L)	84.2	7/8	no	no	no
Specific Conductance (us/cm)	211	8/9	no	no	no
Turbidity (NTU)	54.9	6/9	no	no	no
Total Dissolved Solid (mg/L)	133	5/9	no	no	no
Total Suspended Solid (mg/L)	76.0	5/9	no	no	no
Dissolved Calcium (mg/L)	28.3	5/8	no	no	↓
Dissolved Magnesium (mg/L)	6.58	7/8	no	no	no
Dissolved Sulphate (mg/L)	18.0	6/8	↑	↑	no
Nitrate/Nitrite (mg/L)	0.080	8/8	↑	↑	n/a
Total Phosphorous (mg/L)	0.087	6/9	no	no	no

[2] Two bottles from the July sampling event were lost in transit from the field to the laboratory. This resulted in 538 water quality results available for assessment.

[3] Although there are 70 parameters listed in Table 8 (BWMA, Appendix E4), only 66 parameters underwent Trigger 1 assessments. Interim triggers are still under development for dissolved mercury, total mercury, pH and dissolved oxygen.

Parameter	Trigger 1	Number of 2016 Values higher than Trigger 1	Annual Trend?	Open Water Trend?	Under Ice Trend?
Dissolved Organic Carbon (mg/L)	5.58	5/9	↑	↑	no
Particulate Organic Carbon (mg/L)	1.85	5/8	no	no	no
Dissolved Chromium (µg/L)	0.124	5/8	no	no	n/a
Dissolved Molybdenum (µg/L)	0.75	5/8	no	no	n/a
Dissolved Selenium (µg/L)	0.21	6/8	no	no	n/a
Dissolved Strontium (µg/L)	134	6/8	no	no	n/a
Dissolved Uranium (µg/L)	0.41	6/8	no	no	n/a
Total Arsenic (µg/L)	1.09	5/8	no	no	n/a
Total Beryllium (µg/L)	0.064	5/8	no	no	n/a
Total Chromium (µg/L)	1.41	5/8	no	↓	n/a
Total Cobalt (µg/L)	1.00	5/8	no	no	no
Total Iron (µg/L)	1990	5/8	no	no	no
Total Manganese (µg/L)	57.6	5/8	no	no	no
Total Nickel (µg/L)	3.38	5/8	no	no	no
Total Thallium (µg/L)	0.028	5/8	no	no	no
Total Uranium (µg/L)	0.492	5/8	no	no	n/a
Total Vanadium (µg/L)	2.40	5/8	no	no	no

n/a: insufficient data to assess trend
↑: represents statistically significant increasing trend
↓: represents statistically significant decreasing trend
no: represents no statistically significant trend

4.2. Slave River 2016 Trigger 2 Assessment

The 2016 water quality results were screened to determine how many values were higher than the 90 percentile. The number of 2016 water quality values with concentrations higher than Trigger 2 was determined. In 2016, 46 of the 66 parameters (67 of 538 individual water quality results) had one or more values above Trigger 2 and are listed in Table 4. Almost all of the values above Trigger 2 occurred in June (44 of 67) and September (18 of 67) (Table 4).

Table 4: Slave River 2016 Trigger 2 Assessment Summary

Parameter	Trigger 2	2016 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value	National or Provincial Guideline	Trend in Corresponding Season
Alkalinity (mg/L) Spring (June)	92.8	96.9	121	121	20[2]	no
Specific Conductance (us/cm) Spring (June)	260	261	364	364	/	no
Turbidity (NTU) Spring (June)	730	3930	6450	6450	Narrative[2]	no
Turbidity (NTU) Fall (September)	86.7	226	6450	6450	Narrative[2]	no
Total Dissolved Solids (mg/L) Open Water (June)	196	230	265	360	/	no
Total Suspended Solids (mg/L) Spring (June)	1091	2730	4880	4880	Narrative[2]	no
Total Suspended Solids (mg/L) Fall (September)	132	273	4880	4880	Narrative[2]	no
Dissolved Calcium (mg/L) Spring (June)	33.5	38.8	42	42.0	/	no
Dissolved Magnesium (mg/L) Winter (January)	7.08	7.15	8.08	8.80	/	no
Dissolved Magnesium (mg/L) Spring (June)	7.41	7.83	8.80	8.80	/	no
Dissolved Magnesium (mg/L) Fall (September)	7.48	7.56	8.80	8.80	/	no
Dissolved Potassium (mg/L) Fall (September)	1.02	1.09	2.58	3.63	/	no
Dissolved Sulphate (mg/L) Spring (June)	27.0	33.4	37.2	37.2	309[2]	↑
Dissolved Sulphate (mg/L) Fall (September)	21.7	22.2	37.2	37.2	309[2]	↑
Nitrate/Nitrite (mg/L) Annual (February)	0.18	0.28	0.30	0.30	/	↑
Nitrate/Nitrite (mg/L) Annual (March)	0.18	0.26	0.30	0.30	/	↑
Nitrate/Nitrite (mg/L) Annual (June)	0.18	0.41	0.29	0.30	/	↑
Nitrate/Nitrite (mg/L) Annual (October)	0.18	0.23	0.29	0.30	/	↑
Dissolved Nitrogen (mg/L) Spring (June)	0.55	0.82	0.67	2.00	/	↑

Parameter	Trigger 2	2016 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value	National or Provincial Guideline	Trend in Corresponding Season
Dissolved Nitrogen (mg/L) Fall (September)	0.35	0.43	0.67	2.00	/	↑
Dissolved Organic Carbon (mg/L) Spring (June)	13.8	15.4	22.1	40.4	/	↑
Dissolved Organic Carbon (mg/L) Fall (September)	8.7	15.4	22.1	40.4	/	↑
Particulate Organic Carbon (mg/L) Spring (June)	12.9	50.3	68.5	68.5	/	no
Particulate Organic Carbon (mg/L) Fall (September)	3.60	5.42	68.5	68.5	/	no
Dissolved Phosphorous (mg/L) Fall (October)	0.013	0.014	0.136	0.136	Narrative[2]	no
Total Phosphorous (mg/L) Spring (June)	0.687	2.52	4.67	4.67	Narrative[2]	no
Total Phosphorous (mg/L) Fall (September)	0.137	0.267	4.67	4.67	Narrative[2]	no
Dissolved Antimony (µg/L) Annual (June)	0.32	0.46		0.70	/	no
Dissolved Barium (µg/L) Annual (June)	54.5	68.8		76.6	/	no
Dissolved Boron (µg/L) Annual (June)	19.0	21.4		28.3	/	no
Dissolved Copper (µg/L) Annual (June)	3.9	5.3		10.6	/	no
Dissolved Copper (µg/L) Annual (September)	3.9	5.6		10.6	/	no
Dissolved Molybdenum (µg/L) Annual (June)	0.95	1.85		2.56	/	no
Dissolved Nickel (µg/L) Annual (June)	2.20	3.60		4.46	/	no
Dissolved Nickel (µg/L) Annual (September)	2.20	2.43		4.46	/	no
Dissolved Selenium (µg/L) Annual (June)	0.31	0.50	0.50	0.50	/	no
Dissolved Uranium (µg/L) Annual (June)	0.51	0.98		1.19	/	no
Total Aluminum (µg/L) Open Water (June)	5666	20500	48700	48700	/	↓
Total Antimony (µg/L) Annual (June)	0.26	0.43		1.36	/	no

Parameter	Trigger 2	2016 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value	National or Provincial Guideline	Trend in Corresponding Season
Total Arsenic (µg/L) Annual (June)	3.3	9.8		11.3	5[1,2]	no
Total Barium (µg/L) Spring (June)	308	1530	1730	1730	/	no
Total Barium (µg/L) Fall (September)	100	171	1730	1730	/	no
Total Beryllium (µg/L) Open Water (June)	0.52	1.99	2.19	2.19	/	↓
Total Bismuth (µg/L) Annual (June)	0.05	0.12	0.11	0.11	/	no
Total Boron (µg/L) Annual (June)	20.1	36.7	39.3	39.3	1500[1,2]	↑
Total Cadmium (µg/L) Spring (June)	1.28	2.19	15.00	15.00	0.09[1], 0.20[2]	no
Total Chromium (µg/L) Open Water (June)	9.5	41.4	50.4	50.4	/	↓
Total Cobalt (µg/L) Spring (June)	6.7	33.6	30.3	30.3	2.5[2]	no
Total Cobalt (µg/L) Fall (September)	1.6	2.8	30.3	30.3	2.5[2]	no
Total Copper (µg/L) Spring (June)	21.0	86.7	97.0	97.0	2.94[1], 7[2]	no
Total Copper (µg/L) Fall (September)	4.3	9.4	97.0	97.0	2.52[1], 7[2]	no
Total Iron (µg/L) Open Water (June)	15250	60400	128000	128000	300[1]	no
Total Lead (µg/L) Spring (June)	10.8	49.3	50.9	50.9	4.4[1,2]	no
Total Lead (µg/L) Fall (September)	3.0	4.1	50.9	50.9	3.5[1,2]	no
Total Lithium (µg/L) Open Water (June)	18.4	43.2	56.9	56.9	/	↓
Total Manganese (µg/L) Open Water (June)	319	1350	1980	1980	/	no
Total Nickel (µg/L) Spring (June)	20.8	103	92.9	92.9	116.1[1], 65[2]	no
Total Nickel (µg/L) Fall (September)	6.0	10	92.9	92.9	101.2[1], 56[2]	no
Total Selenium (µg/L) Annual (June)	0.39	0.99	0.88	0.88	1[1,2]	no

Parameter	Trigger 2	2016 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value	National or Provincial Guideline	Trend in Corresponding Season
Total Silver (µg/L) Open Water (June)	0.13	0.67	0.50	0.69	0.25	↓
Total Strontium (µg/L) Open Water (June)	185	340	353	353	/	no
Total Thallium (µg/L) Annual (June)	0.14	0.57	0.48	0.48	0.8[1,2]	no
Total Uranium (µg/L) Annual (June)	1.1	5.2	4.9	4.9	15[1,2]	no
Total Vanadium (µg/L) Spring (June)	17.7	66.7	84.8	84.8	/	no
Total Vanadium (µg/L) Fall (September)	3.9	6.5	84.8	84.8	/	no
Total Zinc (µg/L) Spring (June)	61	296	561	561	30[1,2], 30[1,2]	no
Total Zinc (µg/L) Fall (September)	13	26	561	561	30[1,2], 30[1,2]	no

[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)

/: no corresponding guideline for the parameter

OW: Open-Water; UI: Under-Ice

↑: represents statistically significant increasing trend

↓: represents statistically significant decreasing trend

no: represents no statistically significant trend

Several 2016 parameters, including alkalinity, total cadmium, total copper, total iron, total lead and total zinc, had values that were higher than either the CCME and/or Alberta aquatic life guideline (Table 4). The levels for these parameters in the Slave River have historically been high. The site-specific interim water quality triggers that have been developed for this water quality assessment are based on the historical record and therefore allow for more relevant comparisons to determine if change is occurring.

4.3. Slave River 2016 Evaluation of Trigger 1 and 2 Flagged Parameters

Trigger 1

The trend results were reviewed for the 27 parameters that were flagged during the 2016 Trigger 1 assessment (Table 3). Of these, statistically significant pre-existing increasing annual trends (up to 2014) were identified for dissolved organic carbon, dissolved sulphate and nitrate/nitrite (Table 3; HDR, 2017). These pre-existing trends were identified in the 2015 water quality report. In addition, seven 2016 parameters, including alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium, were also flagged in the 2015 water quality report.

The above-mentioned eight parameters (alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, dissolved organic carbon, nitrate/nitrite and dissolved strontium) were further assessed by combining the 2015 and 2016 water quality data for each parameter and statistically comparing that to the historical data using the Wilcoxon-Mann-Whitney test[45]. When the two datasets (2015 and 2016 and historical data) were compared, the test revealed a significant difference for dissolved magnesium and nitrate/nitrite suggesting that concentrations for these two parameters are higher in the last two years than in the past. For the other six parameters, no significant differences were revealed.

Summary discussions for dissolved magnesium and nitrate/nitrite follow in sections 4.3.1 and 4.3.1.

Trigger 2

A total of 46 parameters had concentrations above Trigger 2 in 2016. Of these 46, nine parameters, including nitrate/nitrite, dissolved nitrogen, total bismuth, total cobalt, total nickel, total selenium, total silver, total thallium and total uranium, were above their respective historical open-water maximum values. All of these, except dissolved nitrogen and total silver, were also above their historical overall maximum values.

These new seasonal maximum values occurred either in June or September (2016) at a time when water flows in the Slave River were considerably higher than normal (Figure 2). The peak of the 2016 spring freshet occurred on June 21, only seven days prior to the June water quality sample being collected. In the fall, a large rain event occurred upstream on September 11, just nine days prior to the September water quality sample being collected. These elevated water quality results are likely attributable to these two high flow events because high flows tend to carry more particulate matter to which many metals and other substances are attached. High concentrations of turbidity and total suspended solids (TSS) were also observed in June and September (Table 4).

The relationship between TSS and the abovementioned parameters was explored using the Spearman rank-order correlation analysis[6] which measures the strength of association between two variables.

[4] 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). 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 ($p<0.05$).

[5] Microsoft Excel Add-In XLSTAT 2014.2.03 was used to assess these parameters.

[6] The non-parametric Spearman rank-order correlation provides a test statistic called r_s (rho) that ranges between -1 and 1 indicating perfect negative correlation, no correlation, and perfect positive correlation (Dytham, 2003). A significance level of 0.05 was used and NCSS v.11 statistical software was used to conduct the correlation analysis.

The metals revealed moderate to large positive associations with TSS, with p-values less than the significance level of 0.05, indicating significant correlations (Table 5). For this reason, total bismuth, total cobalt, total nickel, total selenium, total silver, total thallium and total uranium have been exempted from this Trigger 2 evaluation as the higher values associated with these parameters are attributable to the high flows in the river and the associated high levels of TSS at the time of sample collection.

The association between dissolved nitrogen and TSS was less strong but significant (Table 5). The association between nitrate/nitrite and TSS was weak with inconclusive evidence about the significance of the association between the two variables (Table 5).

A summary discussion for dissolved nitrogen follows in section 4.3.3.

Table 5: NCSS Correlation Analysis Results

Parameter (with TSS)	**Correlation Coefficient (r_s)**	**p-value**
Flow @ Fitzgerald (m^3/s)	0.6109	< 0.0001
Total Bismuth	0.9540	< 0.0001
Total Cobalt	0.9101	< 0.0001
Total Nickel	0.9007	< 0.0001
Total Selenium	0.6191	< 0.0001
Total Silver	0.6941	< 0.0001
Total Thallium	0.9206	< 0.0001
Total Uranium	0.7158	<0.0001
Nitrate/Nitrite	-0.0252	0.8695
Dissolved Nitrogen	0.3090	< 0.0001

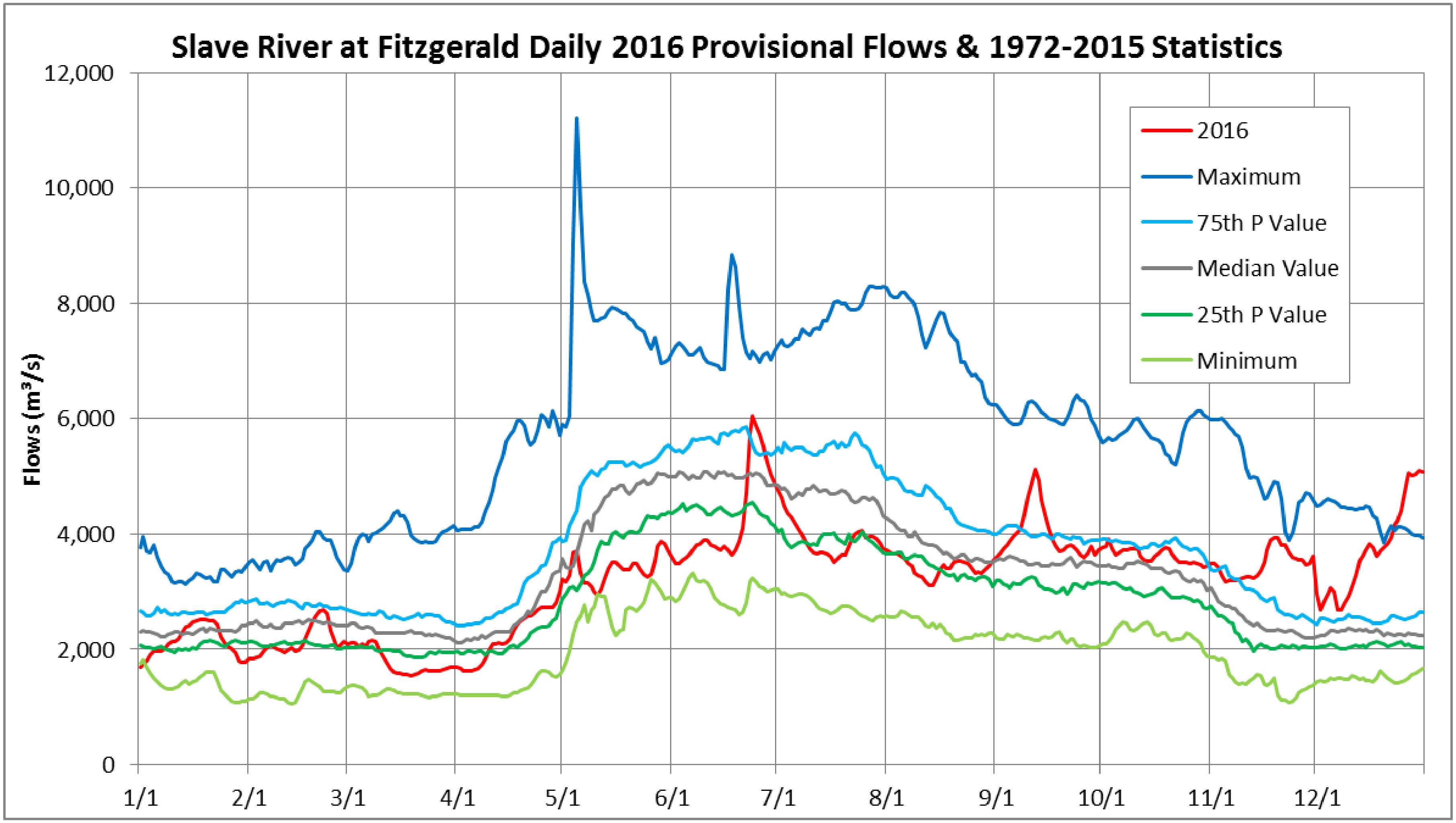


Figure 2: Slave River at Fitzgerald Daily 2016 Flows and 1972-2015 Statistics

4.3.1. Dissolved Magnesium

In 2015 and 2016, dissolved magnesium concentrations were above Trigger 1 in 7 of 9 and 7 of 8 samples, respectively. Figure 3 is a scatter plot of the entire dissolved magnesium dataset (1978-2016) and illustrates how the data compare to Trigger 1 (annual median). The Wilcoxon-Mann-Whitney analysis for dissolved magnesium revealed a statistically significant difference (p=0.011) between the 2015 and 2016 (median: 6.89 mg/L) and historical (median: 6.58 mg/L) concentrations suggesting that levels of dissolved magnesium in the Slave River are higher (the increase is statistically significant) in the last two years than in the recorded past (Figure 4).

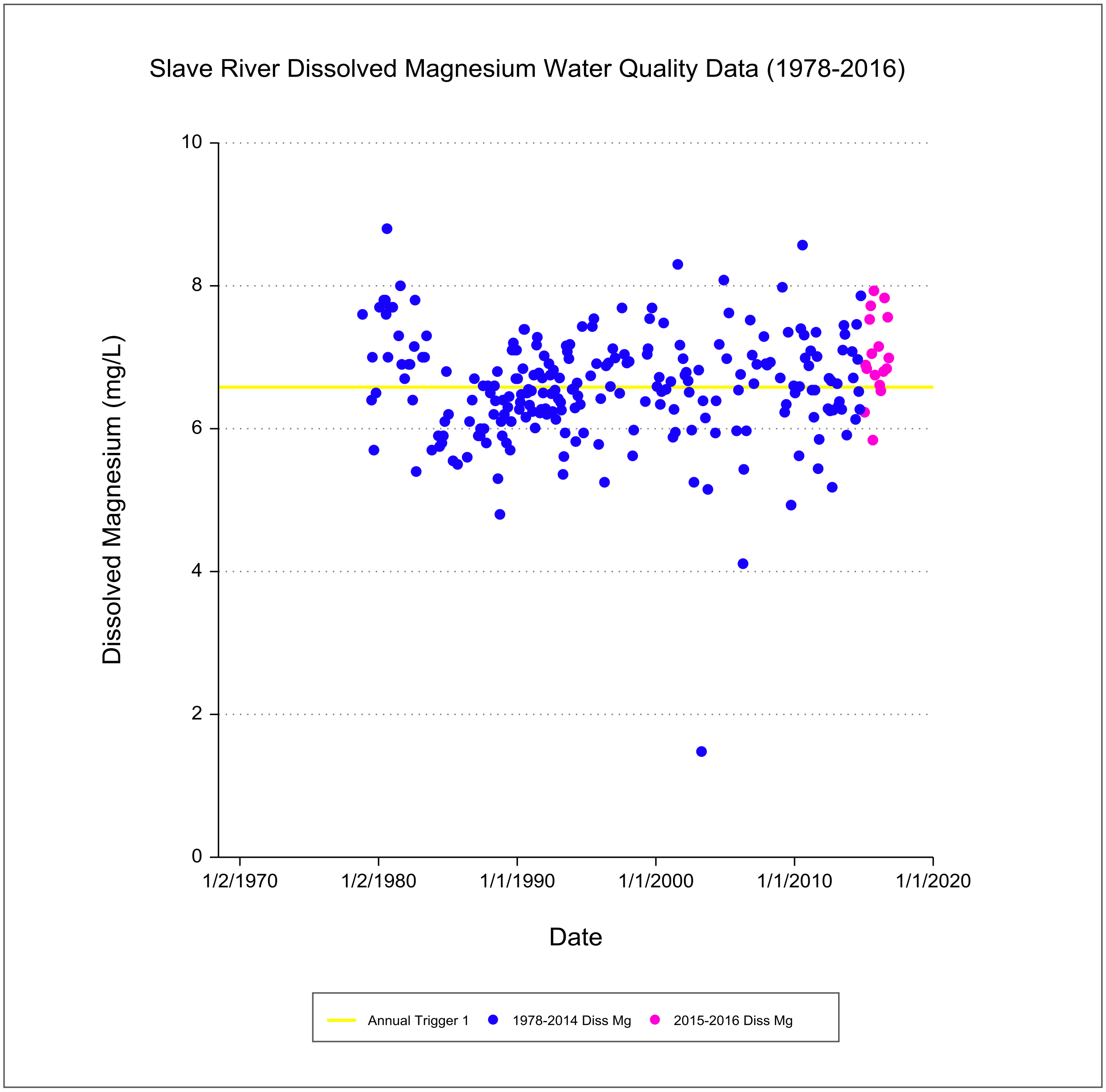


Figure 3: Slave River Dissolved Magnesium Water Quality Data (1978-2016)

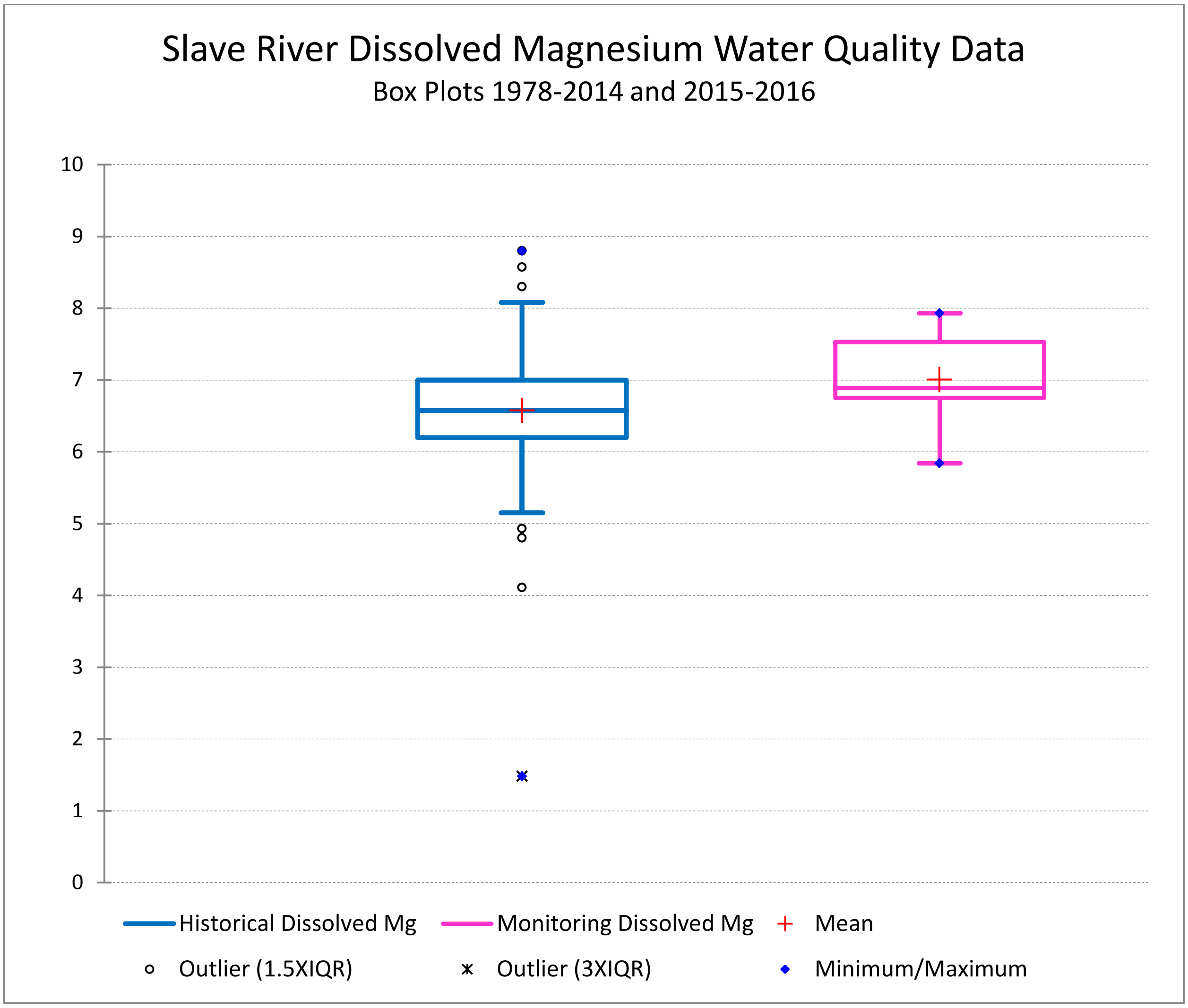


Figure 4: Box & Whisker Plots comparing SR 2015 & 2016 and Historical Dissolved Magnesium Data

Moving forward, given the statistically significant difference between the historical and the 2015 and 2016 data as well as the recurring flagged Triggers 1 and 2, the BMC will conduct additional exploratory analyses as part of the assessment and evaluation process to determine if further investigation is required.

4.3.2. Nitrate/Nitrite

In 2015 and 2016, nitrate/nitrite concentrations were above Trigger 1 in 8 of 9 and 8 of 8 samples, respectively. Figure 5 is a scatter plot of the entire nitrate/nitrite dataset (2005-2016) and illustrates how the data compare to Trigger 1 (annual median).

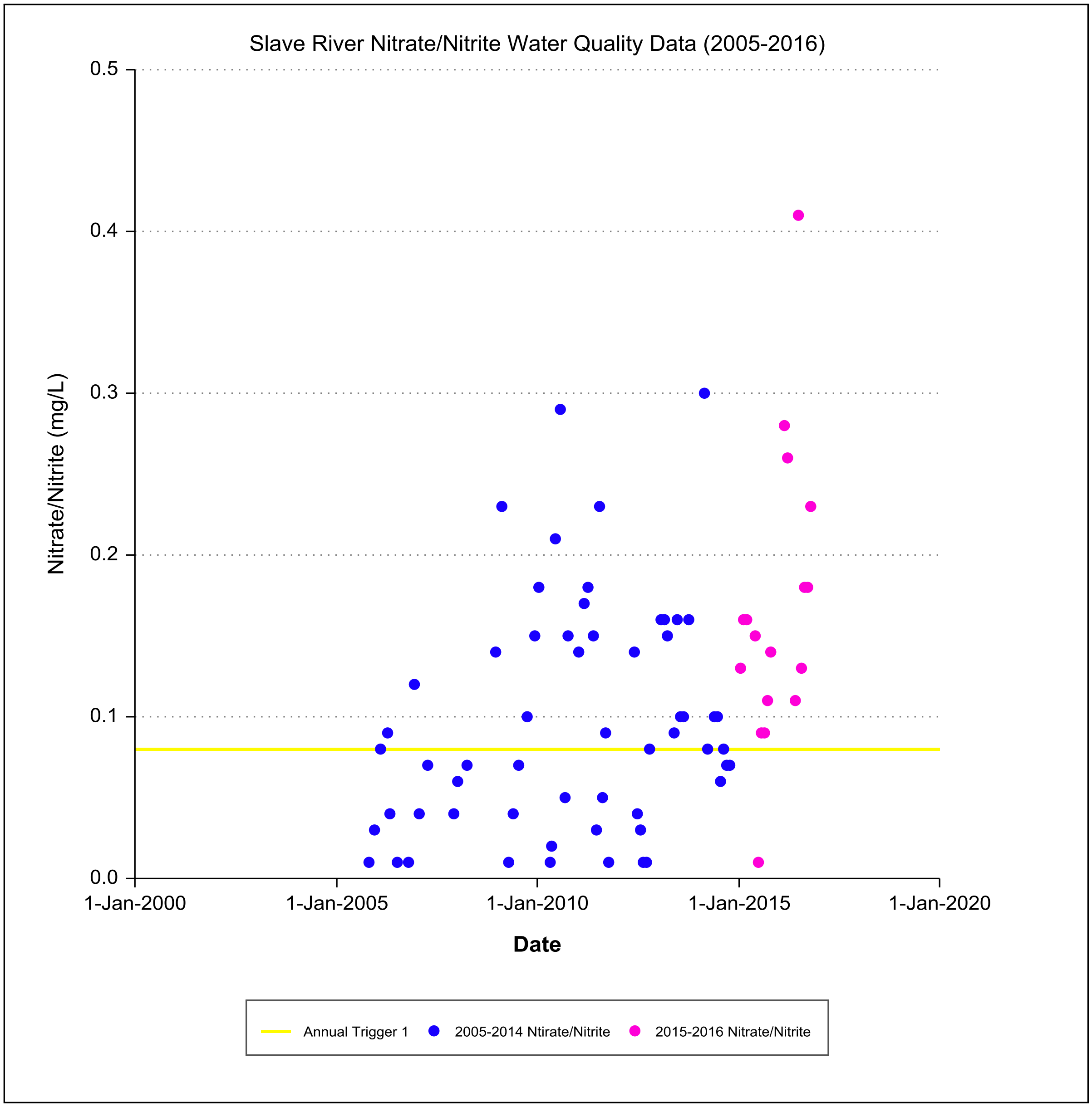


Figure 5: Slave River Nitrate/Nitrite Water Quality Data (2005-2016)

The Wilcoxon-Mann-Whitney analysis for nitrate/nitrite revealed a statistically significant difference (p=0.001) between the 2015 and 2016 and historical concentrations suggesting that nitrate/nitrite levels in the Slave River are higher (the increase is statistically significant) in the last two years than in the recent recorded past (2005-2014) (Figure 6).

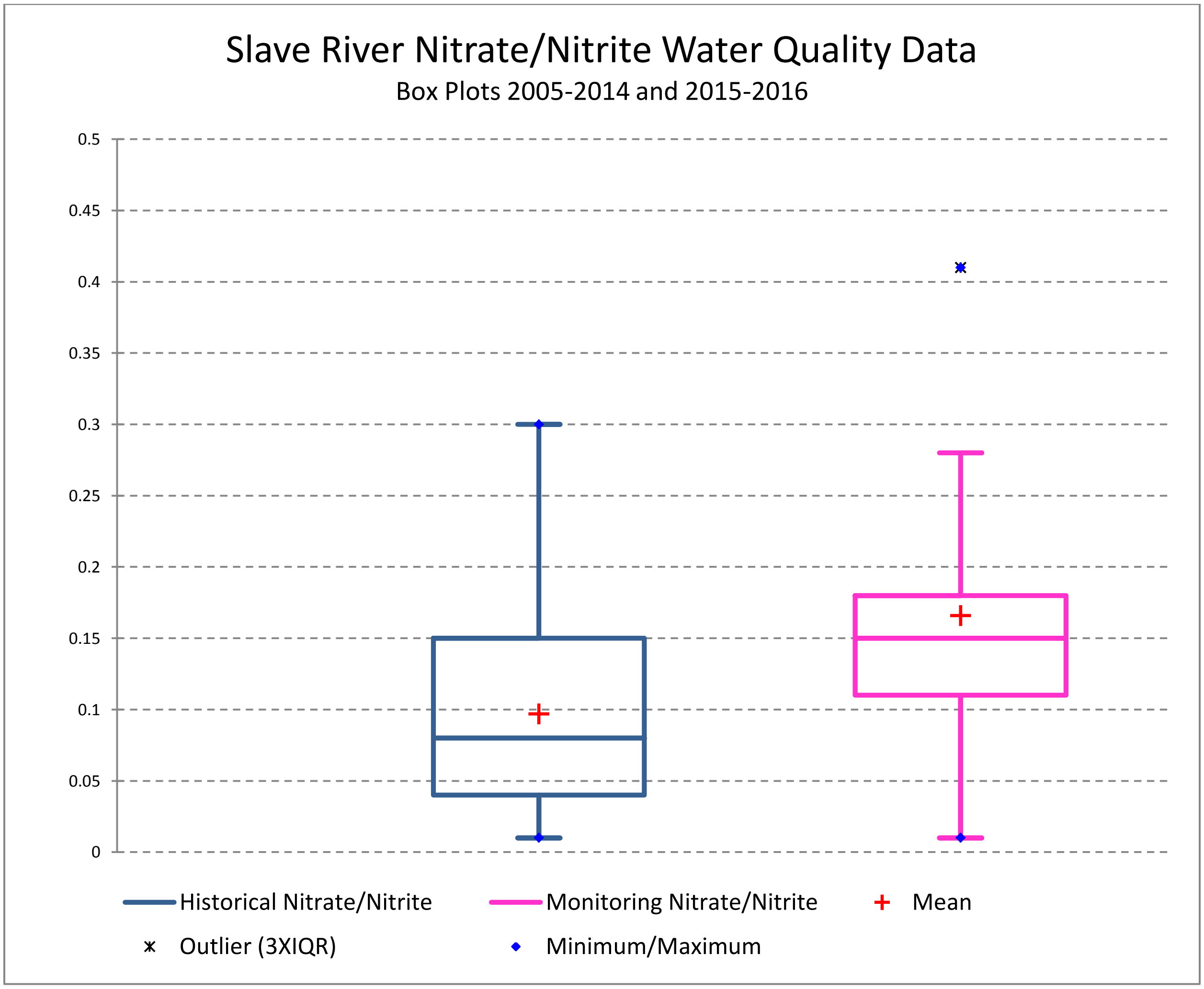


Figure 6: Box and Whisker Plots comparing SR 2015 & 2016 and Historical Nitrate/Nitrite Data

A previous trend analysis revealed a statistically significant increasing annual trend (p=0.0108) for the 2005-2014[7] period which seemed to be driven by the levels of nitrate/nitrite in the open-water season (p=0.0045) (Figure 7; HDR, 2017). For a parameter that is trending upwards, it is not surprising to observe more values above Trigger 1 than what is expected.

[7] The period of missing open-water monitoring data between 2007 and 2009 is noted.

Moving forward, given: 1) the significant increasing pre-existing trends (annual and open-water), 2) the statistically significant difference between the historical and the 2015 and 2016 levels and, 3) the recurring flagged Triggers 1 and 2, the BMC will conduct additional exploratory analyses as part of the assessment and evaluation process to determine if further investigation is required.

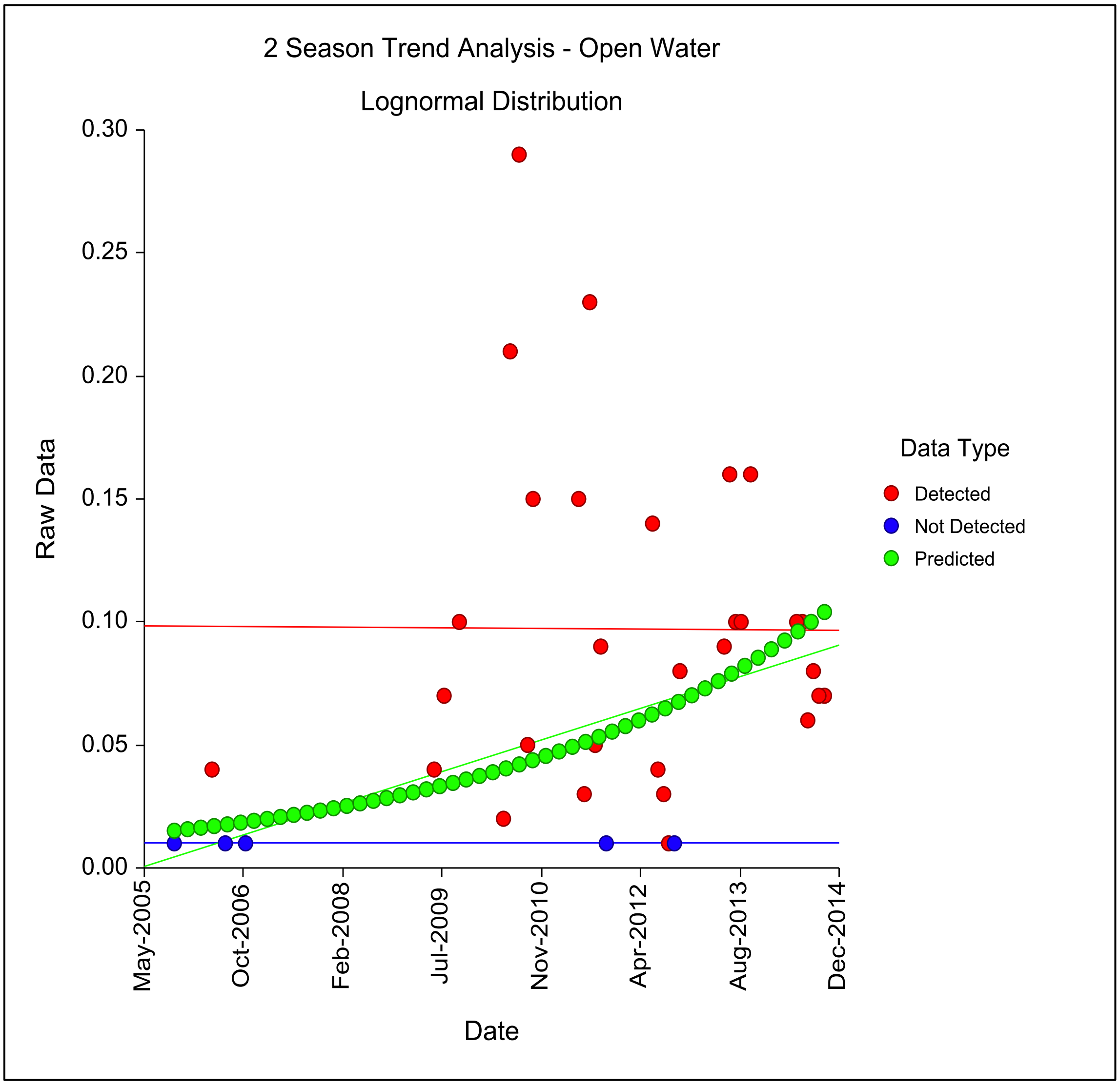


Figure 7: Open Water Trend Analysis for Nitrate/Nitrite in the Slave River (2005-2014)

4.3.3. Dissolved Nitrogen

In June, the dissolved nitrogen (0.82 mg/L) value was above the spring Trigger 2 (0.55 mg/) and its corresponding historical open-water maximum value (0.67 mg/L). The September value (0.43 mg/L) also was above the fall Trigger 2 (0.35 mg/L). Despite the likely linkages with the two high flow events that occurred in June and September, dissolved nitrogen was assessed further in order to provide additional context given the less strong correlation identified with TSS and the possible association with nitrate/nitrite levels. Figure 8 is a scatter plot of the entire spring dissolved nitrogen datasets (1978-2016) and illustrates how the data compare to the spring Trigger 2.

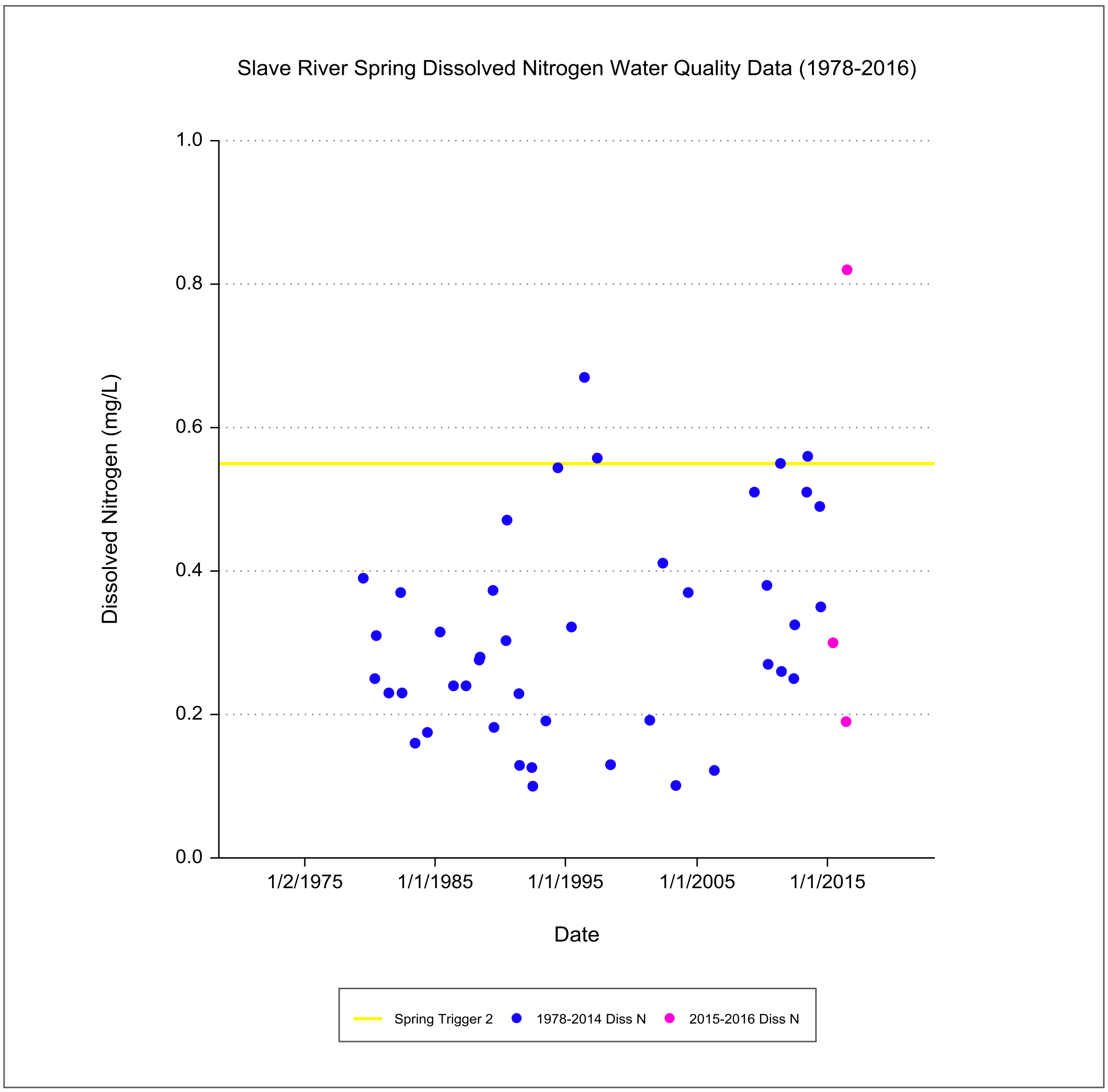


Figure 8: Slave River Spring Dissolved Nitrogen Water Quality Data (1978-2016)

For dissolved nitrogen, a previous trend analysis revealed a slight but statistically significant increasing annual trend ($p=0.0032$) for the period between 1978 and 2014 (Figure 9; HDR, 2017) which may have been affected by an outlier in 2010. To further investigate, the dissolved nitrogen data for the same period (2005-2014) as nitrate/nitrite was extracted and explored. This investigation did not yield a significant trend ($p>0.05$).

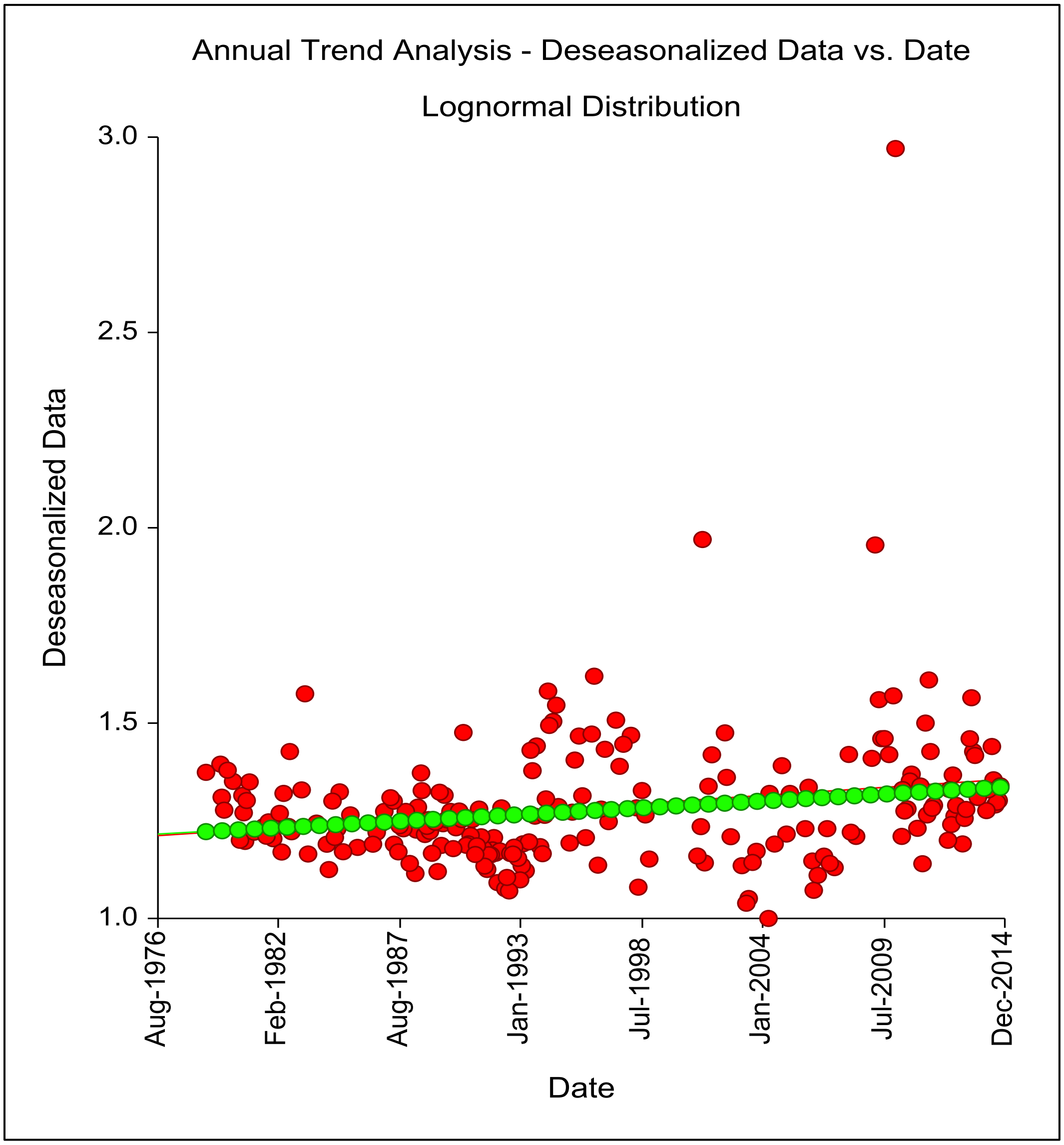


Figure 9: Annual Trend Analysis – Dissolved Nitrogen in the Slave River (1978-2014)

Further analysis of nitrogen constituents in the Slave River showed that ammonia levels have remained very low over the 2005-2016 period, with nitrate/nitrite levels increasing and levels of dissolved organic nitrogen decreasing. This infers that the nitrogen constituents in the Slave River might be changing over time (

Figure 10). The weaker correlation between dissolved nitrogen and TSS could be caused by other factors. Moving forward, the BMC will continue to assess the changes of nitrogen constituents in subsequent assessments. CCME and Alberta aquatic life guidelines for nitrate/nitrite do not exist.

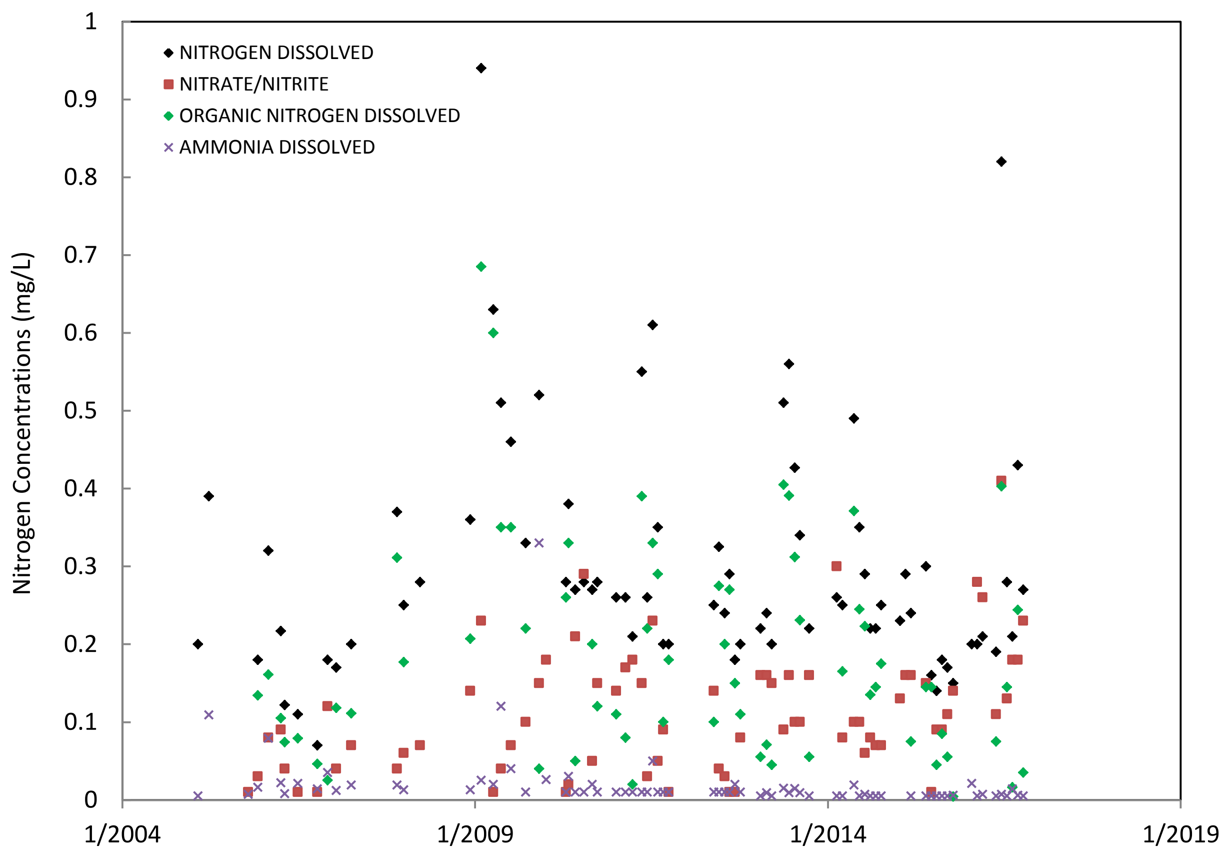


Figure 10: Nitrogen Constituents in the Slave River from 2004 to 2016

5. Results – Hay River

For this assessment, 164 individual conventional water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2016 by ECCC from the Hay River near the Alberta/NWT Boundary on four occasions (April, May, July and August). Forty-one[8] parameters from each sample were reviewed as part of this assessment.

5.1. Hay River 2016 Trigger 1 Assessment

As an initial screening step, the number of 2016 water quality values that were higher than Trigger 1 (annual median) was determined. If the number of values higher than Trigger 1 was more than what was expected in a typical year (i.e., more than 50% of the values were above the median), the parameter was flagged. In 2016, eleven of the 41 parameters were flagged (see Table 6). None of these parameters had been flagged during the 2015 Trigger 1 assessment.

Table 6: Hay River 2016 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2016 Values higher than Trigger 1	Annual Trend?	Open Water Trend?	Under Ice Trend?
Total Dissolved Solids (mg/L)	267	3/4	no	no	no
Nitrate/Nitrite (mg/L)	0.090	3/4	no	n/a	n/a
Dissolved Nitrogen (mg/L)	0.72	4/4	no	no	↓
Dissolved Organic Carbon (mg/L)	26.2	3/4	no	no	no
Total Antimony (µg/L)	0.11	3/4	no	no	n/a
Total Boron (µg/L)	31.95	3/4	no	no	n/a
Total Manganese (µg/L)	97.4	3/4	no	no	no
Total Nickel (µg/L)	3.90	3/4	no	no	no
Total Selenium (µg/L)	0.24	3/4	no	no	n/a
Total Uranium (µg/L)	0.65	3/4	no	no	n/a
Total Vanadium (µg/L)	0.95	3/4	↑	no	no

n/a: insufficient data to assess trend
↑: represents statistically significant increasing trend
↓: represents statistically significant decreasing trend
no: represents no statistically significant trend

[8] Although there are 70 parameters listed in Table 8 (BWMA, Appendix E), interim water quality triggers are only available for 41 parameters due to limited historical data. As more data is collected, triggers will be developed for all parameters.

5.2. Hay River 2016 Trigger 2 Assessment

To assess Trigger 2, the number of 2016 water quality values with concentrations higher than Trigger 2 was determined. In 2016, five of the 41 parameters had one or more values above Trigger 2 (5 of 164 individual water quality results), but none were above their historical seasonal maximum values.

Table 7: Hay River 2016 Trigger 2 Assessment Summary

Parameter	Trigger 2	2016 Value above Trigger 2	Historical OW or UI Seasonal Maximum Value	Historical Annual Maximum Value	National or Provincial Guideline	Trend in Corresponding Season?
Specific Conductance (us/cm) Open Water (August)	405	413	513	860	/	no
Total Dissolved Solids (mg/L) Open Water (August)	310	320	708	2700	/	no
Dissolved Magnesium (mg/L) Open Water (August)	14.5	15.0	19.0	32.6	/	no
Dissolved Sodium (mg/L) Open Water (August)	16.0	16.6	18.6	35.1	/	no
Total Strontium (µg/L) Open Water (August)	156	162	190	346	/	no

/: no corresponding guideline for the parameter
OW: Open-Water; UI: Under-Ice
no: represents no statistically significant trend

5.3. Hay River 2016 Evaluation of Trigger 1 and 2 Flagged Parameters

Trigger 1

Trend results were reviewed for the five parameters that were flagged during the Trigger 1 assessment. Of these, total vanadium exhibited a pre-existing (up to 2014) statistically significant increasing annual trend (Table 6; HDR, 2017) and has been evaluated further.

A summary discussion for total vanadium follows in section 5.3.1.

Trigger 2

None of the five flagged parameters were above their respective historical seasonal maximum values and therefore no parameters are discussed further.

5.3.1. Total Vanadium

In 2016, three of four values were above Trigger 1; but none were above Trigger 2. In 2015, though total vanadium was not flagged during the Trigger 1 assessment, a pre-existing statistically significant annual trend (1988-2014; Figure 11) was revealed. The weak, but statistically significant trend ($p=0.0246$) may have been affected by an outlier value observed in 2007 (Figure 11).

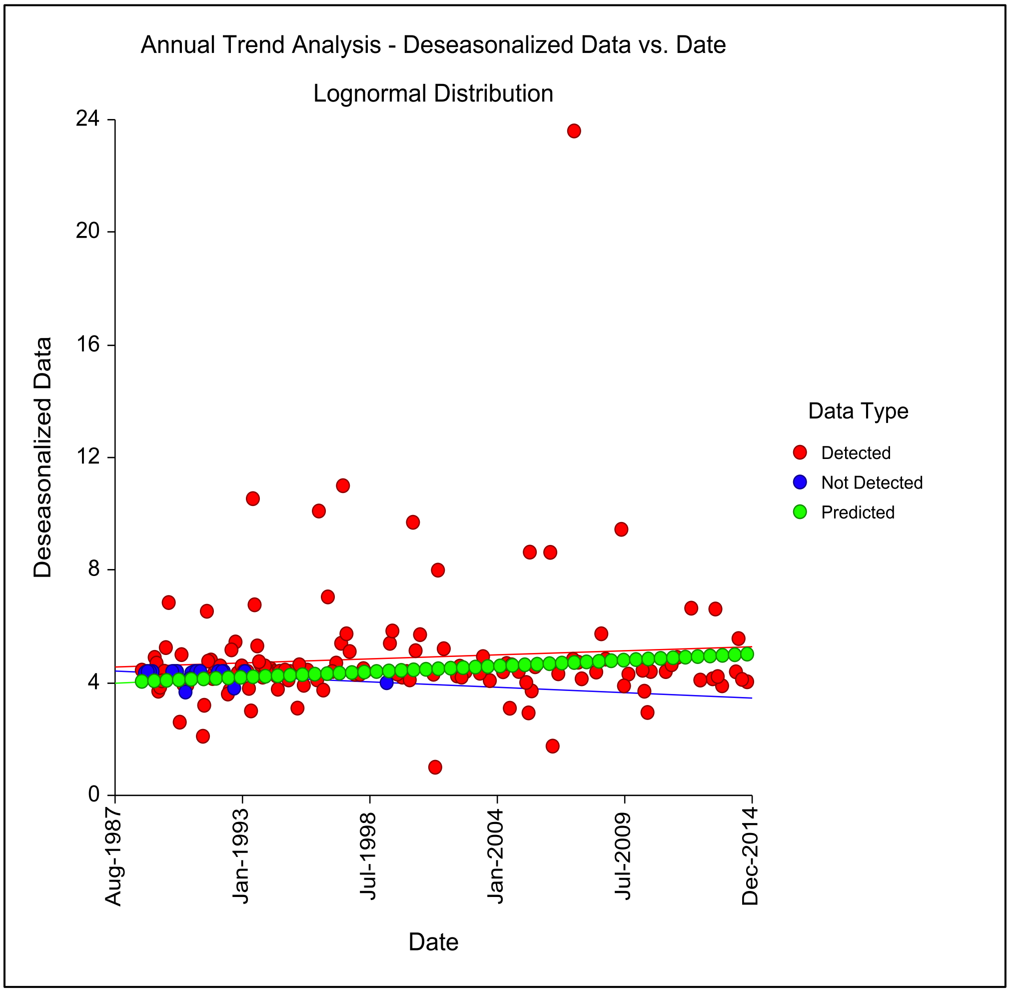


Figure 11: Annual Trend Analysis – Total Vanadium in the Hay River (1988-2014)

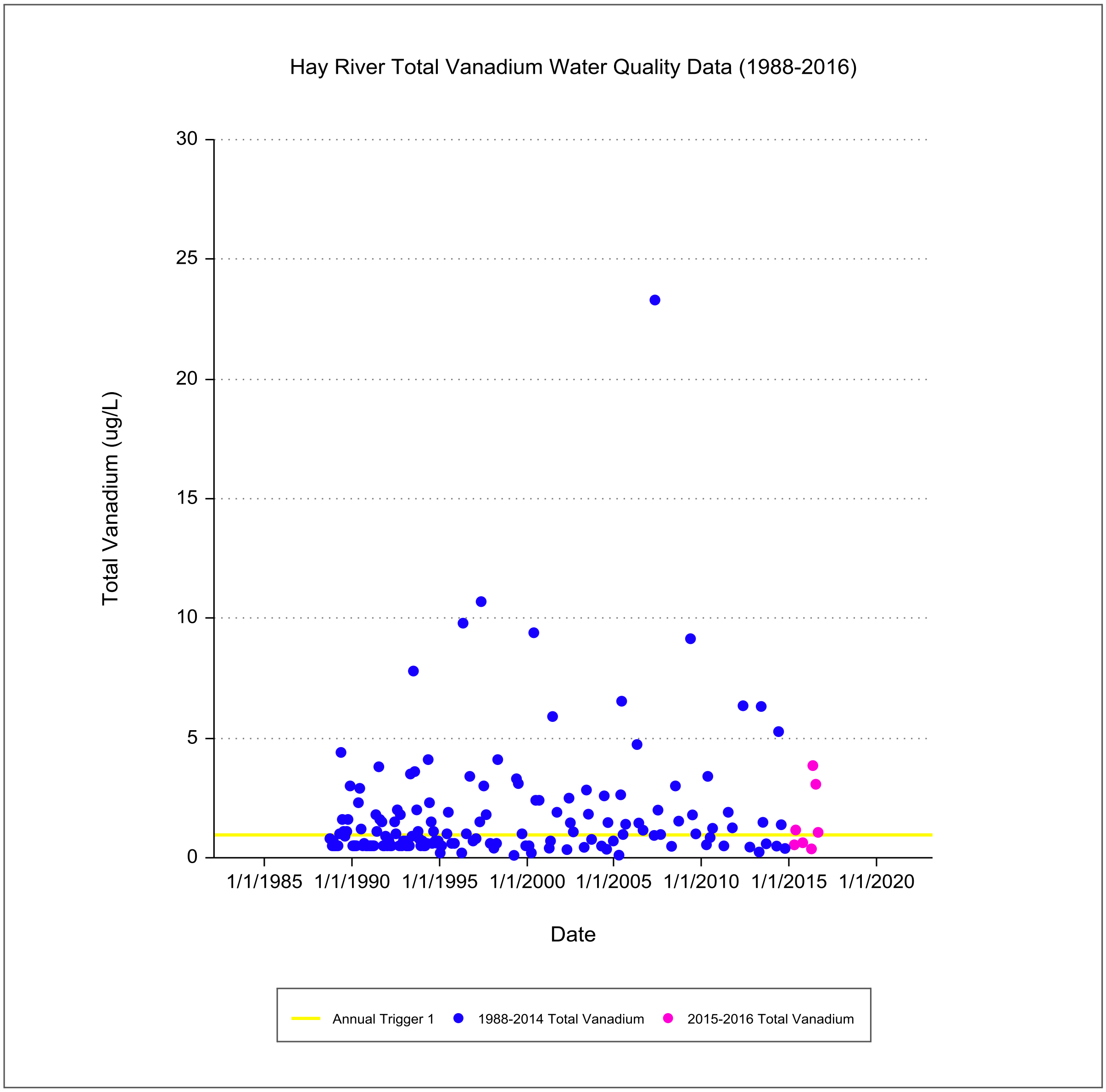


Figure 12: Hay River Total Vanadium Water Quality Data (1988-2016)

Figure 12 is a scatter plot of the entire total vanadium dataset for the Hay River. Adding the 2015 and 2016 data (pink dots) to the historical data illustrates that the two-year median is still at the historical median level and most of the data are at or below the historical median. This suggests that vanadium levels are not a concern. Although monitoring for total vanadium in the Hay River will continue, further investigation is not necessary. The Wilcoxon-Mann-Whitney test was not used to assess the total vanadium data due to the small two-year sample size for 2015 and 2016 of 7 (n=7).

6. Toxic, Bioaccumulative, Persistent Substances

To meet the commitment of virtual elimination (VE) of persistent, bioaccumulative, toxic substances that are listed in the Agreement, the BMC reports on the detection of any substance subject to VE that are currently monitored in the Slave and Hay rivers (Table 8). The BMC will maintain and periodically update this list as information becomes available. Should an unmonitored toxic, bioaccumulative and persistent substance be detected by another party, this information will be evaluated by the BMC to determine if the substance should be added to relevant monitoring programs. Monitoring of these substances will be prioritized commensurate with the level of risk.

Table 8: Substances Subject to Virtual Elimination

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

6.1. VE Substances Assessment and Evaluation

In 2016, three GNWT water samples were collected in June, July and September from both rivers and analyzed for the substances listed in Table 8. One or more of these substances subject to VE were detected on each occasion in both rivers but 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 much lower than levels that could cause concern. Endosulfan in the Slave River was the highest measured substance subject to VE (0.21 ng/L); however, levels were far below the respective USEPA freshwater aquatic life chronic criteria of 56 ng/L, thereby posing no risk to aquatic life. The laboratory results for each detected substance subject to VE are listed in Table 9 and Table 10. Laboratory contamination or historic residues are the likely sources for substances subject to VE that were detected.

Table 9: VE Substances detected in the Slave River in 2016

VE Substance	2016 Result (ng/L)	Lab/Method Blank Result (ng/L)	USEPA Recommended Chronic Aquatic Life Criteria (ng/L)
Chlordane-oxy (July)	0.057	<0.0402	4.3
Chlordane-oxy (Sept)	0.027	<0.014	4.3
Endosulfan Sulphate (June)	0.21	<0.100	56
Heptachlor (Sept)	0.042	<0.0402	3.8
HCH gamma (Sept)	0.021	<0.038	950
Hexachlorobutadiene (July)	0.071	0.028	
Hexachlorobutadiene (Sept)	0.016	0.011	
Hexachlorobenzene (July)	0.086	0.02	
Hexachlorobenzene (Sept)	0.027	0.019	
Octachlorostyrene (July)	0.008	<0.0020	
Total PCBs (Sept)	0.137	0.129	14

Table 10: VE Substances detected in the Hay River in 2016

VE Substance	2016 Result (ng/L)	Lab/Method Blank Result (ng/L)	USEPA Recommended Chronic Aquatic Life Criteria (ng/L)
Heptachlor (Sept)	0.145	<0.0402	3.8
HCH-alpha (July)	0.053	<0.0402	
HCH-alpha (Sept)	0.018	<0.015	
Hexachlorobutadiene (June)	0.03	<0.0203	
Hexachlorobutadiene (July)	0.02	0.01	
Hexachlorobutadiene (Sept)	0.009	0.011	
Hexachlorobenzene (Sept)	0.025	0.019	
Total PCBs (Sept)	0.142	0.129	14

7. BWMA Water Quality Tasks Underway

When the Agreement was signed in March of 2015, the Parties acknowledged that work was required in several areas to fully implement the Agreement. The Parties agreed that they would learn together through implementation. Tasks for the 2017-18 fiscal year and beyond include:

1) Jointly review and assess the 2017 Slave and Hay rivers water quality data.

2) Review the water quality monitoring data generated by ECCC and the GNWT on the Hay River to examine the viability of merging datasets to increase the annual sample size.

3) Confirm whether levels of dissolved magnesium and nitrate/nitrite in the Slave River are changing.

4) Continue to explore approaches to assess trends in water quality to inform the annual water quality assessment. Other MRB jurisdictional staff will be invited to participate.

5) Continue to discuss approaches to develop triggers and objectives to identify changes in water quality. Other MRB jurisdictional staff will be invited to participate.

6) Continue the mercury water quality sampling program in the Slave and Hay Rivers so that interim open-water water quality triggers for mercury can be developed.

   Twenty-one Slave River and nine Hay River water samples have been collected and analyzed for mercury since 2013 and 2016, respectively. Figure 13 and Figure 14 show that mercury concentrations in the Slave and Hay Rivers vary between rivers and throughout the open-water season. The figures also illustrate how mercury concentrations can differ from year to year highlighting the importance of long-term data collection prior to the development of site-specific water quality triggers. To date, all data, except for a sample collected in July of 2013 from the Slave River, are below the CCME freshwater aquatic life guideline (26 ng/L) and well below Health Canada's drinking water quality guideline for mercury (1000 ng/L).

   The BMC anticipates that the minimum number of results required to develop open-water interim water quality triggers for mercury will be available in 2018 and 2020 for the Slave River and Hay rivers, respectively.

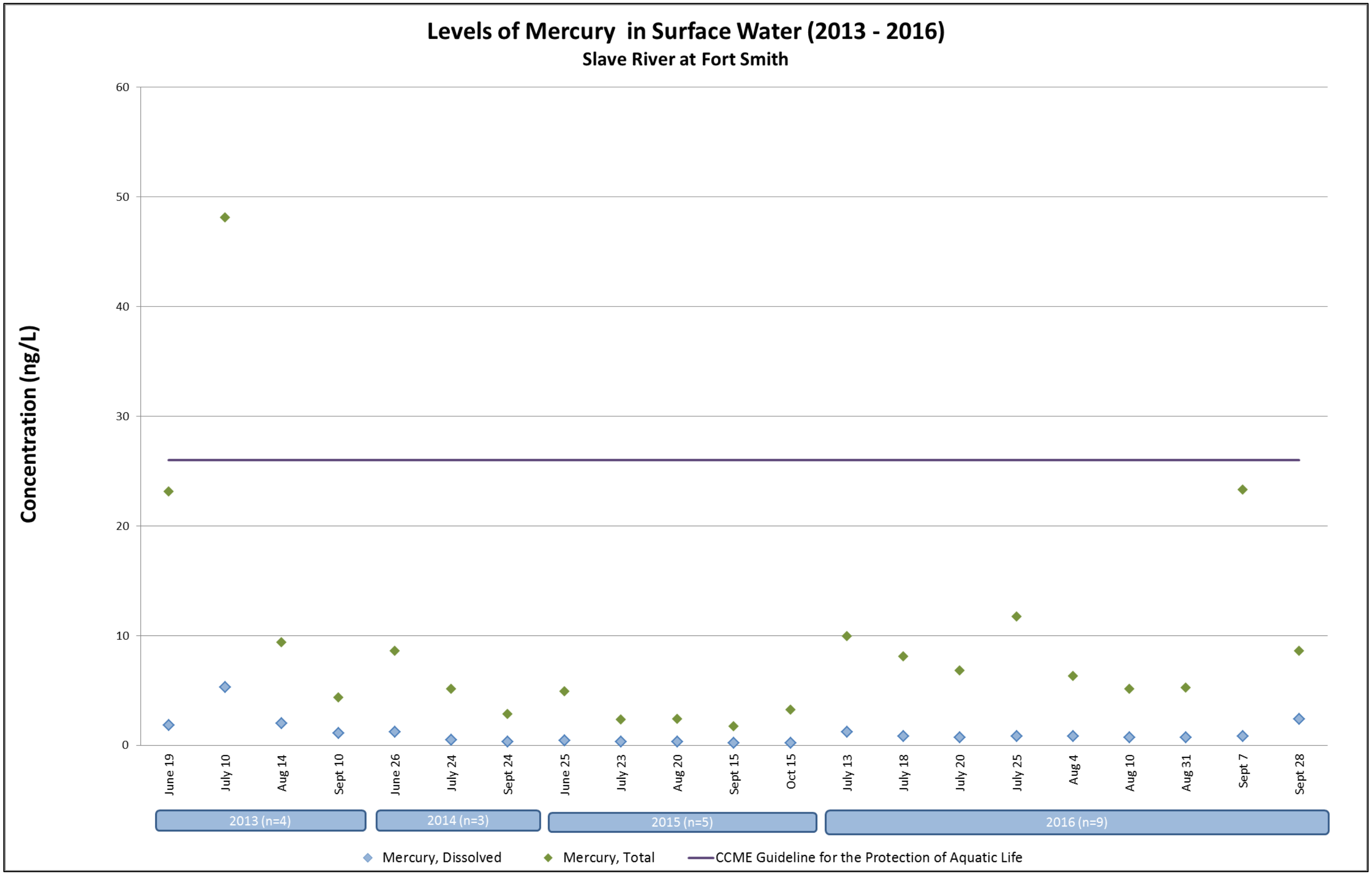


Figure 13: Mercury Levels in Surface Water – Slave River at Fort Smith

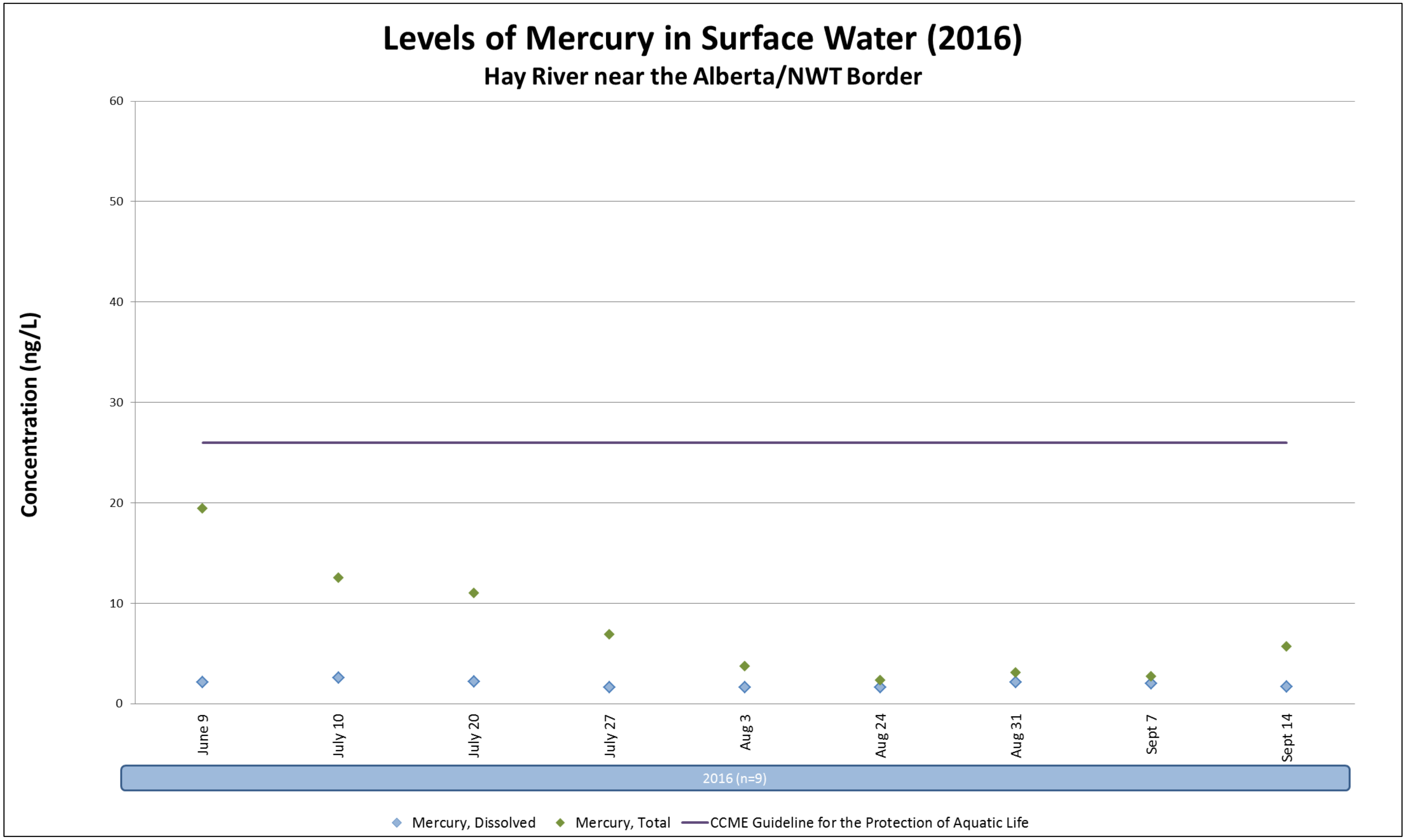


Figure 14: Mercury Levels in Surface Water – Hay River near the Alberta/NWT Border

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. Water Quality Trigger 1 is intended to identify changes in typical conditions and Water Quality Trigger 2 is intended to identify changes in extreme conditions.

For the 2016 Slave River data, 27 of the 66 parameters were 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. These seven parameters, as well as dissolved organic carbon which revealed a pre-existing increasing trend, were assessed using the Wilcoxon-Mann-Whitney test. The test results suggested that concentrations of dissolved magnesium and nitrate/nitrite are higher in the last two years than in the past. No significant differences were revealed for the other six parameters. The Trigger 2 assessment revealed considerably more values above Trigger 2 in 2016 (67 of 538 results) than in 2015 (9 of 590 results). The majority of values above Trigger 2 occurred in June following the peak of the spring freshet and in September following a large rain event. Given the compound effects of water sampling at a time of peak flows, and the possible influence of the Fort McMurray wild fire, these new maximum values are not unexpected. The water that was sampled in later months was within historical seasonal ranges for all parameters.

In the Hay River, eleven of the 41 parameters were flagged during the Trigger 1 assessment. Of these, the historical dataset for total vanadium was reviewed because a pre-existing statistically significant increasing annual trend was revealed. It was found that recent data are very similar to historical levels and total vanadium is not a concern at this time. The Trigger 2 assessment shows that five of the 41 parameters (5 of 164 results) were above Trigger 2, but none were above their respective historical seasonal maximum values.

During the summer of 2016, three (GNWT) water samples from each river were analyzed for 14 toxic, bioaccumulative and persistent substances. One or more of these substances were detected on each sampling occasion in each river, but at very low concentrations. Comparisons with the available corresponding United States Environmental Protection Agency (USEPA) Chronic Aquatic Life Criteria show that the levels detected pose no risk to aquatic life. Historical residues or more likely, laboratory contamination, are potential causes for the detection of VE substances.

Assessment of the 2016 water quality data for the Slave and Hay rivers identified no concerns. Slave River water quality results revealed new overall maximum values for seven parameters. The new maximum values occurred following high flow events. Water quality sampled in the later months was within the historical seasonal ranges for all parameters. The BMC will confirm whether the levels of dissolved magnesium and nitrate/nitrite in the Slave River are changing. Hay River water quality results show 5 of 41 parameters (5 of 164 results) with values above Trigger 2; none of these were above their respective historical seasonal maximum values.

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Appendix 1: 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	Under Development														
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	Under Development														
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 2: 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	mg/L	Under Development														
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
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

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	
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
pH	pH units	Under Development														
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

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	
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
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

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	
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
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

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**	
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. 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. 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.