Aboriginal Affairs and Northern Development Canada | Affaires autochtones et Développement du Nord Canada

Report Summary:
Slave River

Water and Suspended Sediment Quality in the Transboundary Reach of the Slave River, Northwest Territories

The Slave River at Fort Smith

The Slave River is a culturally important waterway for Northerners with development activity upstream. This report summarizes 35 years of water quality data from the Slave River. The assessment revealed some long term trends in water quality parameters such as phosphorus and sulphate, as well as some long term trends in flow. The ecological significance of these trends needs to be better understood. This assessment also highlighted the need for site-specific water quality objectives to be able to better assess future water quality conditions of the river. Overall, fewer organic compounds, and at lower levels, were found in the water and suspended sediment samples taken during the Follow-Up Study (2000-2010) than in the earlier Slave River Environmental Quality Monitoring Program (1990-1995).

To ensure the health of the river, monitoring will continue. All partners should work closely together to expand the knowledge and understanding of the Slave River aquatic ecosystem.

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www.aandc-aadnc.gc.ca
1-800-567-9604
TTY only 1-866-553-0554

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The Slave River at Fort Smith

The Slave River...

- is the largest transboundary river in the Northwest Territories;
- has a huge watershed that includes the Peace River, Athabasca River, Lake Athabasca and the Lower Slave River sub-basins, which are located in the Northwest Territories and provinces of Alberta, British Columbia and Saskatchewan;
- is an important component of the Mackenzie River Basin, contributing approximately 75% of the inflow to Great Slave Lake;
- has a mean annual flow of 3400 m^3/s, which means that on average 3.4 million litres of water pass by the community of Fort Smith each second (as a comparison, the Hay River has a mean annual flow of 115 m^3/s);
- carries an average of 30 million tonnes of suspended sediment to Great Slave Lake each year, almost all of which is deposited between May and October. During these months, this is equal to about 4000 large dump truck loads each day; and,
- supports a wide variety of fur bearers, fish and the most northerly colony of white pelicans.

Over the last several decades, resource development in the upstream portion of the Slave River watershed has increased. These activities mainly include oil and gas developments; oil sands operations; pulp and paper mills; coal and uranium mining; agriculture; and forestry (Figure 1). Further, the W.A.C Bennett Dam, a hydroelectric development on the Peace River in northern British Columbia, exists upstream in the Slave River watershed. Northerners have raised concerns that these upstream developments have impacted the water resources in the NWT. These concerns are especially relevant in the North, as many residents maintain a traditional lifestyle and have a close connection to the land. In addition, climate change has the potential to influence the Slave River.

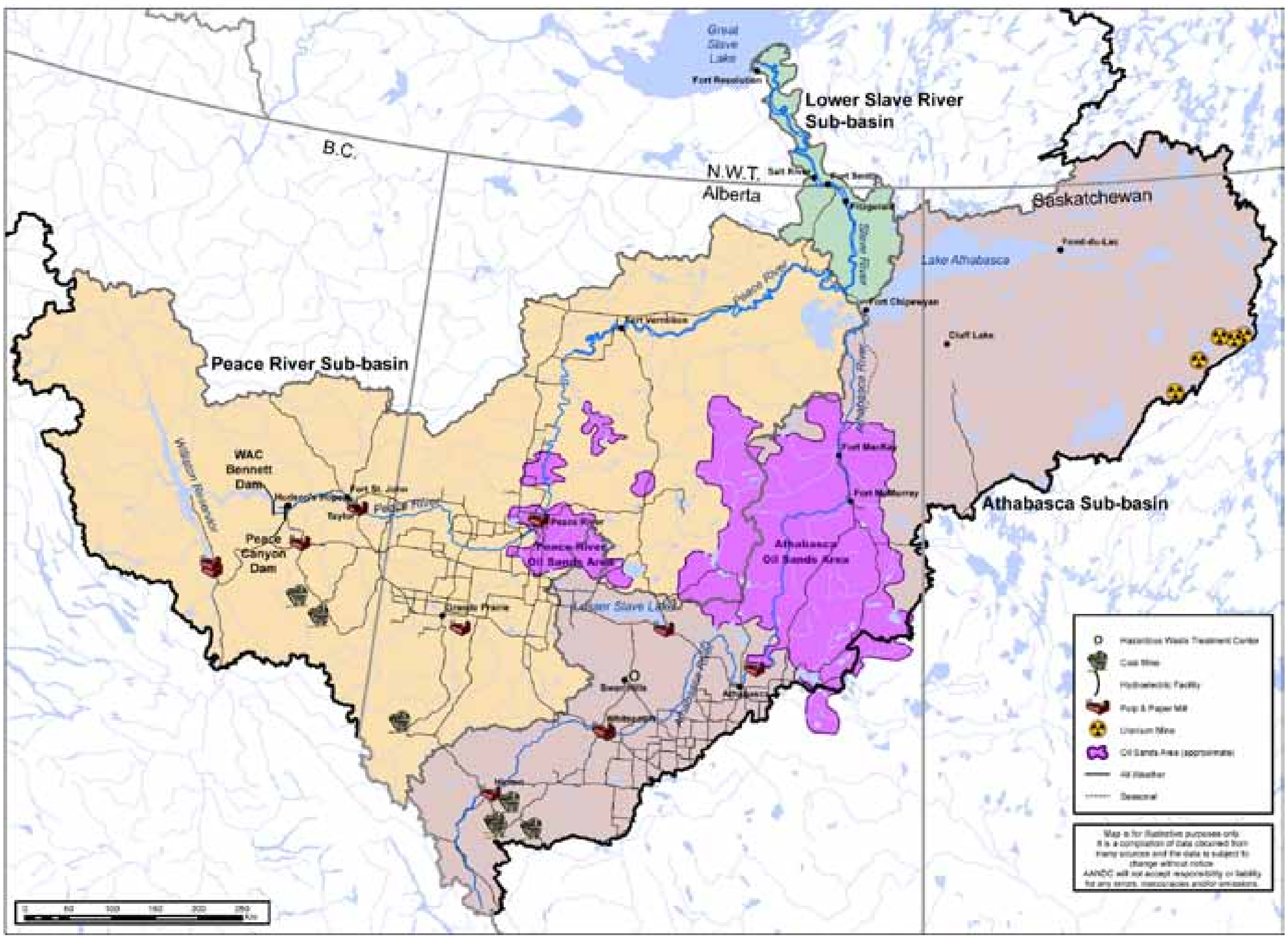


Figure 1: Current activities in the Slave River watershed (not including specific oil and gas and oil sands operations)

Purpose of the Report

Aboriginal Affairs and Northern Development Canada's (AANDC) Slave River report describes the water and suspended sediment conditions in the river.

Using information from AANDC and Environment Canada, the report aims to:

- provide a general overview of the current state of water quality, suspended sediment quality and flows in the transboundary reach of the Slave River;
- determine if water quality and flows have changed over time;
- help to address community concerns about metals and organic compounds in the river;
- support the development of water quality objectives for the transboundary bilateral agreement; and,
- outline potential areas where the existing AANDC Slave River monitoring program can be improved.

The report is just one piece of the puzzle. Combining the results from this study with information generated from other Slave River and Slave River Delta monitoring programs and research will help northerners gain a better understanding of the health of the Slave River system.

The Slave River, near the Rapids of the Drowned

Understanding Water Quality

Water quality naturally varies from place to place, with changing seasons, climate variations and the types of soil and rock through which the water moves. Water can carry plant debris, sand, silt and clay, making the water muddy or cloudy (i.e., measured as suspended sediments). Water also carries dissolved minerals and metals from rocks, and dissolved salts such as calcium and magnesium. Nutrients in water such as phosphorous and nitrogen are important for aquatic plants. In general, these substances are not considered harmful to human or aquatic life.

Water quality describes the chemical (e.g., metal concentrations), physical (e.g., temperature) and biological characteristics (e.g., bacteria levels) of water usually with respect to its suitability for a particular purpose. Although scientific measurements are used to describe the quality of water, it is not a simple thing to say that "this water is good," or "this water is bad." For example, water that is perfectly good to drink might not be good enough for a very sensitive species of fish. When a person asks about water quality, they likely want to know if the water is good enough to drink and swim in, or if the quality of the water is suitable for aquatic plants and animals.

Guidelines are established to protect water for aquatic life or designated uses such as drinking and recreation. Comparing substances found in water to guidelines is one way to determine if the Slave River water quality is "good". Good water quality generally means that the levels of substances are below the guideline values. The data from this study were compared to the Health Canada's Health-Based Guidelines for Canadian Drinking Water Quality and Recreational Water Quality, as well as to the Canadian Council of Ministers of the Environment Guidelines for the protection of freshwater aquatic life.

Another way to understand water quality is to check whether water quality conditions have changed over time. Changes could be due to human activities and/or natural occurrences. This study looked at whether water quality has changed since 1972, when regular sampling began on the Slave River.

Juanetta Sanderson, Erv Allen and Wayne Starling sampling the Slave River, September 2010.

What were the Samples Tested for?

Over 200 water samples and 27 suspended sediment samples have been collected from the Slave River and analyzed for over 500 different substances.

To understand the basic chemistry of the water and suspended sediment quality of the Slave River, samples were regularly analyzed for routine parameters (i.e., pH, total dissolved solids, total suspended solids, alkalinity and organic carbon), nutrients (i.e., phosphorus) and major ions (i.e., calcium and magnesium).

To help address concerns regarding upstream activities, water and suspended sediment samples were also tested for metals such as aluminum, arsenic, copper, lead, vanadium and zinc, as well as compounds such as chlorophenols, organochlorine pesticides, PCBs, dioxins, furans and hydrocarbons. Some of these substances can be natural, but some are known to be associated with upstream development.

Why sample suspended sediments?

Due to the size and organic content of the suspended sediment in the Slave River, metals and organic compounds tend to attach to these particles and can be carried long distances from their source.

What are metals?

Metals, such as copper and lead, occur naturally, and most can be found in the rocks and soil in the NWT. Weathering of the rocks can release metals into rivers and lakes, therefore it is relatively common to find naturally occurring metals in surface waters. Some metals are required for all living things. However, some activities such as mining and other industrial developments, the burning of fossil fuels, land clearing and even forest fires can release higher than natural levels. These can be harmful to aquatic life.

What are chlorinated compounds?

Chlorinated compounds, more commonly known as persistent organic pollutants (POPs), are made by humans. Some are pesticides for killing insects or diseases that attack crops. Certain chlorinated compounds, such as chlorophenols, can be released from pulp and paper mills and municipal facilities. In the past, polychlorinated biphenyls or PCBs were used in electrical equipment. Dioxin and furans, another group of compounds, are released into the environment through combustion and wood pulp that is bleached with chlorine to produce paper products. POPs can cause harm to living things and last a long time in nature. Most POPs in the North arrive through air or water currents from other parts of Canada and the world.

What are hydrocarbons?

Hydrocarbons also referred to as polycyclic aromatic hydrocarbons (PAHs), are chemical compounds that are present in air, water and soil in small amounts virtually everywhere. Natural sources include forest fires, volcanic eruptions and natural petroleum and natural gas deposits. PAHs are also associated with industrial oil sands projects, other industries and urban runoff. These compounds can enter the river through effluent discharge, by air or runoff from the land. Hydrocarbons can cause harm to living things.

What Data were used in the Report?

Water and suspended sediment quality data for this report were obtained from three long-term sampling sites located on the Slave River. These include:

- The Slave River at Fort Smith (mid-river) sampling site led by AANDC. This program is comprised of two parts: the Slave River Environmental Quality Monitoring Program (SREQMP; 1990-1995), and the Follow-Up Study (2000-2010).

- The Slave River at Fort Smith (shore) sampling site which has been led by AANDC since 1982.
- The Slave River at Fitzgerald sampling site which has been led by Environment Canada since 1960.

Slave River shoreline

Flow data were obtained from the hydrometric (flow) monitoring station located on the Slave River at Fitzgerald which has been operated by Environment Canada (Water Survey of Canada) since 1960.

These federal government monitoring sites were established to characterize the water quality and quantity conditions in the section of the Slave River near the provincial/territorial boundary.

So how is the Water Quality in the Slave River?

The Slave River has an average pH of 7.9 which is typical of fresh waters. The river contains moderate amounts of dissolved solids and is considered 'moderately hard'. Calcium and magnesium dissolved in water are the two most common minerals that make water "hard." Harder water means that you might need more soap to make a lather when washing dishes.

Phosphorus, an essential nutrient for the growth of aquatic plants and algae, plays an important role in the overall productivity of freshwater ecosystems (i.e., number of fish, aquatic animals, etc.). Total phosphorus levels in the Slave River range from 0.006 to 4.67 milligrams per litre (mg/L). As the median value of total phosphorus is 0.1 mg/L, the Slave River is considered eutrophic (i.e., high levels of nutrients and plant growth, low water clarity). Analysis of Slave River water data revealed an increasing trend in phosphorus since 1974. Continued sampling and observations are important to assess phosphorus levels given that land users have observed more algae on the rocks and in fishing nets, and denser willows and other plants are growing along the shore.

Sulphate and sodium concentrations have also increased in the Slave River over time, while total dissolved solids levels have decreased. Further work is required to determine the ecological significance of these trends. It is important to note that guidelines for all routine parameters were not exceeded.

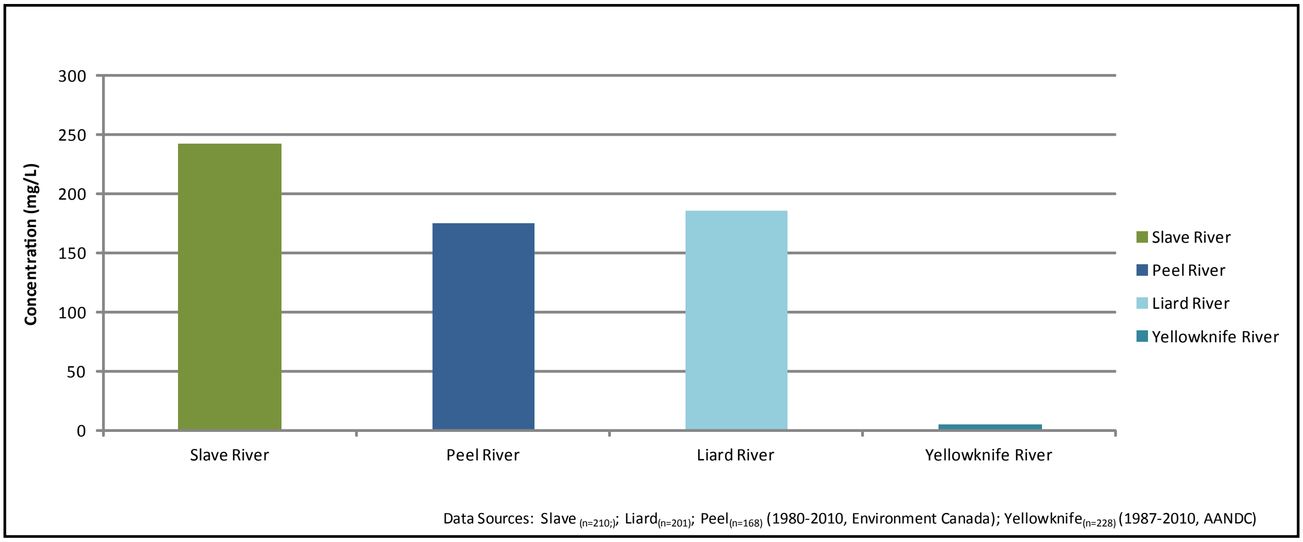


Figure 2: Comparing the Average Concentrations of Total Suspended Solids between the Slave, Peel, Liard and Yellowknife Rivers

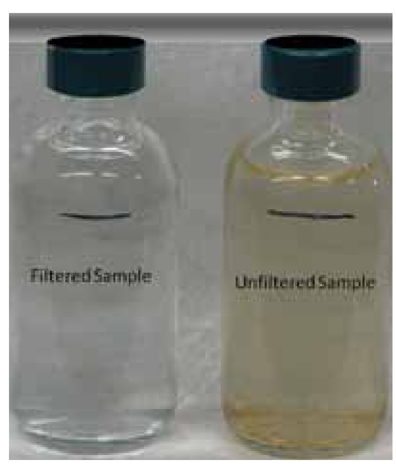
The Slave River has high levels of suspended sediment. This is mainly due to the fact that its two major tributaries, the Athabasca and Peace Rivers, flow through the Interior Plains. This is an area that is underlain with sedimentary rocks and soils that are easily eroded into little bits that get carried by the river. Suspended sediment values in the Slave River range from 3 to 5600 mg/L, with an average of 240 mg/L (Figure 2). In this graph, the sediment loads of the Slave River are compared to two other highly sediment laden rivers in the NWT, the Peel and Liard Rivers, as well as one ‘sediment-free’ river, the Yellowknife River. The Yellowknife River flows primarily through the bedrock of the Precambrian Shield; rivers in these regions are relatively free of sediment.

Sediment load affects metal levels. Rivers that carry large amounts of sediment tend to have higher levels of metals. This is because metals can adsorb (i.e., stick) to sediment particles (Figures 3 and 4). The highly sediment laden Peel, Liard and Slave Rivers have higher levels of metals than the relatively ‘sediment-free’ Yellowknife River.

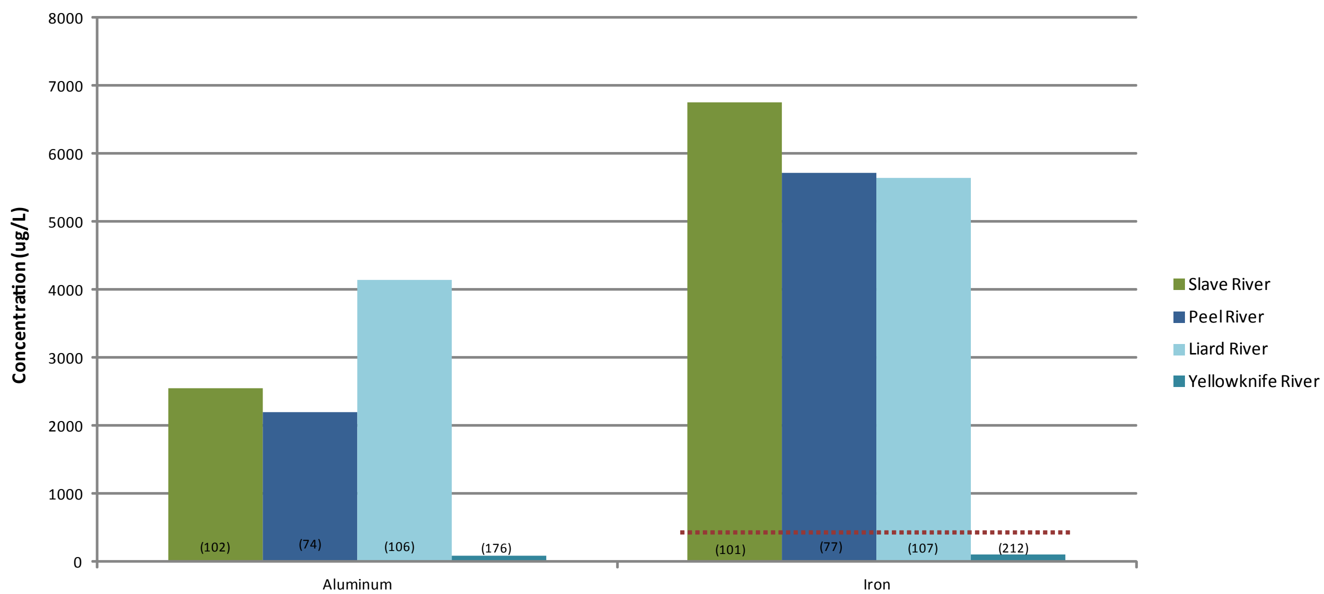
Metals in water exist in a number of soluble (i.e., dissolved) and insoluble (i.e., attached to clays or organic matter) forms, with the dissolved form being more available for uptake by aquatic animals and fish.

The dissolved levels of metals in the Slave River are considerably lower than the total levels (Figure 5).

Dissolved metal samples are filtered before analysis and include the metals in the water that you cannot see (similar to salt). Total metal samples are not filtered before analysis and include the dissolved metals as well as the metals that are attached to the suspended sediments.

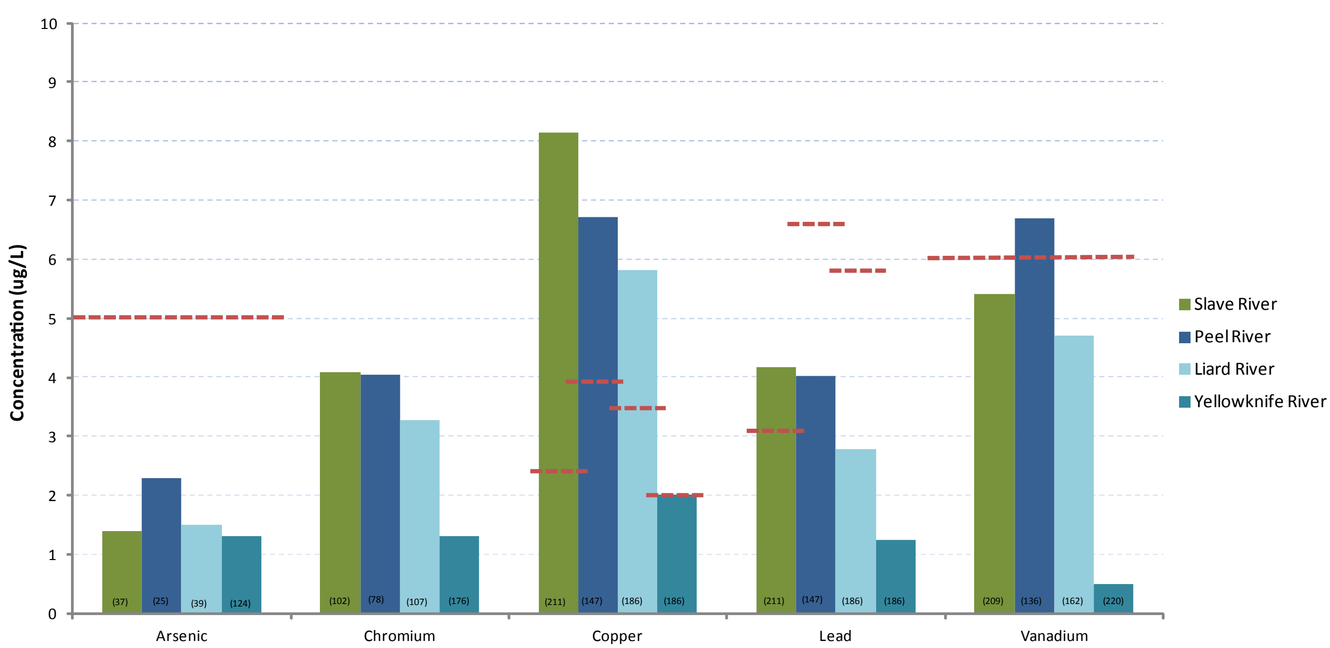


Same water, one filtered, one not filtered.



Data Sources: Slave, Liard, Peel (1980-2010, Environment Canada); Yellowknife (1987-2010, AANDC).
Note: number in parentheses represents the total number of samples collected between the dates indicated; red dotted line represents the Guideline for the Protection of Aquatic Life for Total Iron; Total Aluminium currently does not have a guideline.

Figure 3: Comparing Average Concentrations of Total Aluminum and Total Iron between the Slave, Peel, Liard and Yellowknife Rivers



Data Sources: Slave, Liard, Peel (1980-2010, Environment Canada); Yellowknife (1987-2010, AANDC). The number in parentheses represents the total number of samples collected between the dates indicated; red dotted line represents the Guidelines for the Protection of Aquatic Life; note that the guidelines for copper and lead are corrected for water hardness (the guidelines were calculated based on average water hardness levels).

Figure 4: Comparing Average Concentrations of Total Arsenic, Total Chromium, Total Copper, Total Lead and Total Vanadium between the Slave, Peel, Liard and Yellowknife Rivers

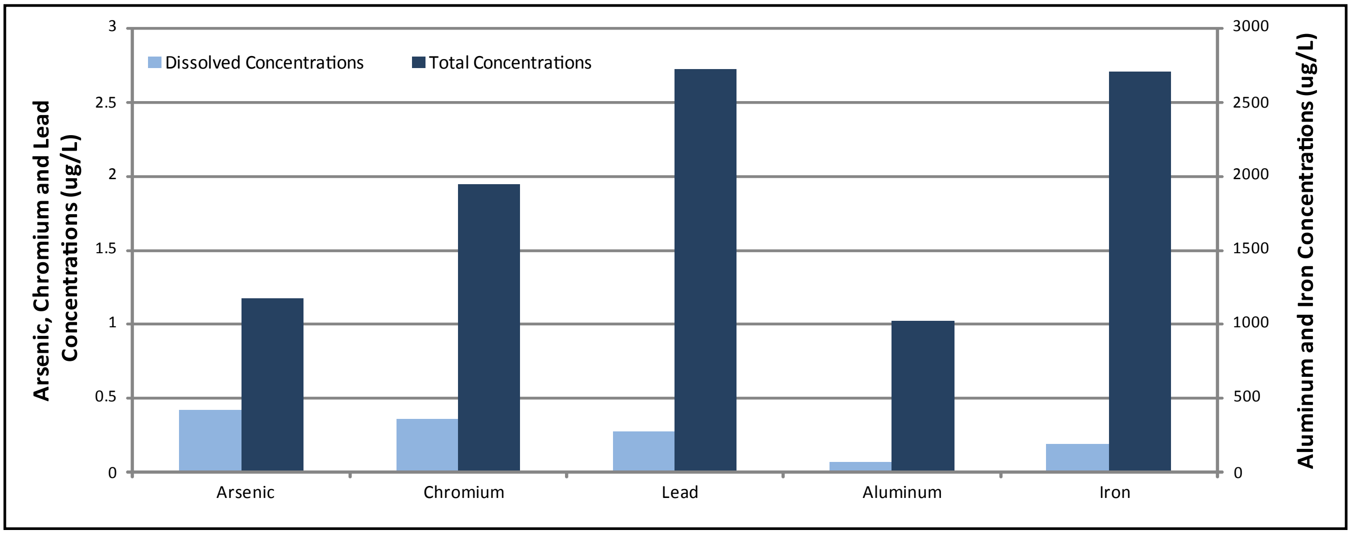


Figure 5: Average Concentrations of Total and Dissolved Arsenic, Chromium, Lead, Aluminum and Iron from the Slave River at Fitzgerald (2006-2010, n=24)

Most metals in the Slave River are attached to the suspended sediments suggesting that they are less available to aquatic life.

Metal levels in the Slave River were compared to guidelines for the protection of aquatic life. Total metals such as cadmium, chromium, copper, iron and lead were higher than their respective aquatic life guidelines more than 25% of the time. Other total metals, such as arsenic, barium, manganese, nickel, selenium, silver, vanadium and zinc exceeded their respective aquatic life guidelines less frequently (less than 25% of the time). To date, total metals including antimony, beryllium, cobalt, molybdenum, thallium and uranium have not exceeded the aquatic life guidelines.

When a guideline is exceeded it does not necessarily mean that the levels of metals are a concern or that an outside factor is affecting the water. The available guidelines to assess water quality in the NWT are generic guidelines. These guidelines are developed for a wide range of water quality conditions but are not necessarily specific to local water quality conditions. For example, if the river is naturally high in metals, the fish have likely adapted to those conditions. If, however, the metals are higher than natural levels, fish and aquatic life could be at risk. To determine if the levels of metals have changed over the years, this study examined long term trends in metals over time. Of the 10 metals[1] for which trends were assessed, only molybdenum showed a significant decreasing trend and only in the spring. Further study is required to understand the significance, if any, of this trend.

In some cases, when generic guidelines are used to assess Slave River water quality, the guidelines are exceeded as a result of high sediment loads (e.g. due to metals attaching to suspended sediment). This is illustrated with total iron levels which range from 59 to 128,000 micrograms per litre (ug/L); over 90% of the values exceed the aquatic life guideline of 300 ug/L (Figure 6). As there is no long term trend in total iron, it is likely that the iron levels are

[1] Long term trends in metals were assessed for total aluminum, chromium, copper, iron, lead, manganese, molybdenum, nickel, vanadium and zinc, as these had an adequate dataset.

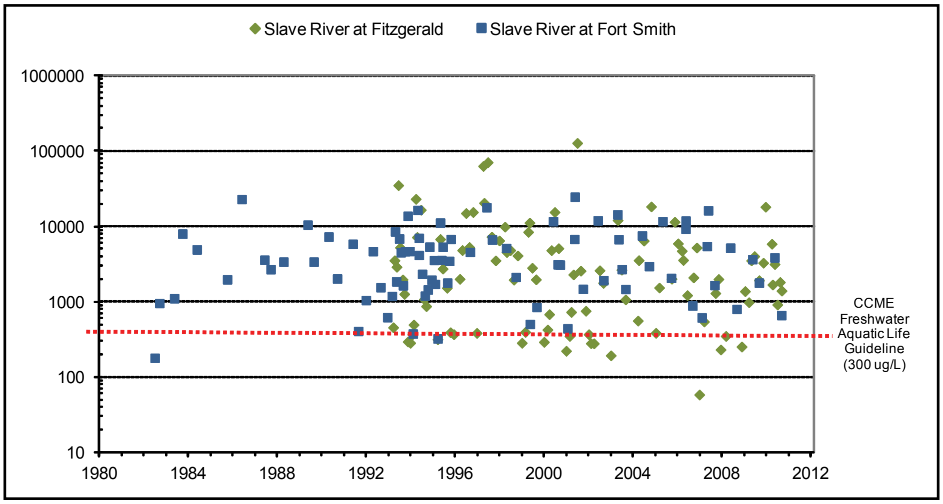


Figure 6: Total Iron Concentrations in the Slave River (1980-2010)

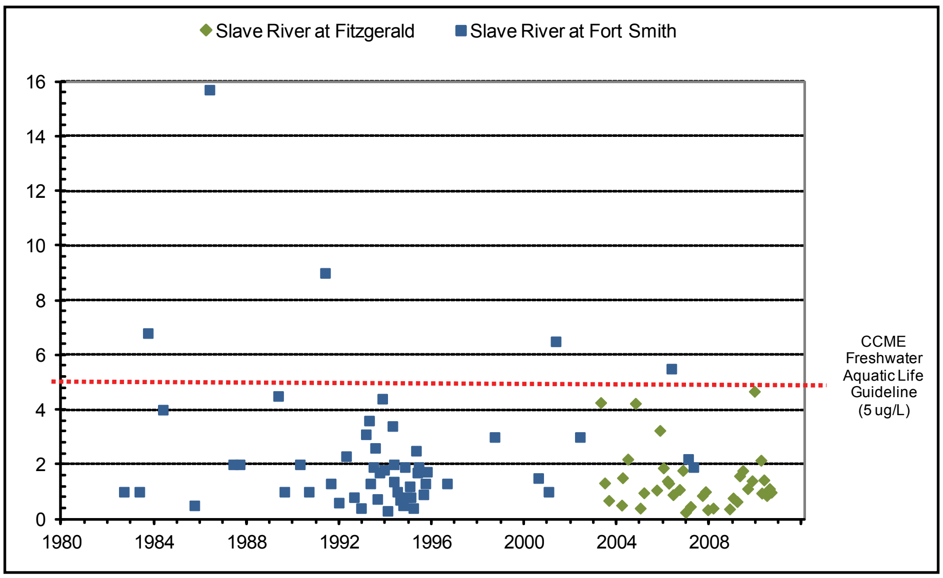


Figure 7: Total Arsenic Concentrations in the Slave River (1982-2010)

When generic guidelines are used, they can sometimes be either over-protective or under-protective. This is the reason why site-specific water quality objectives are needed. These objectives would allow for a better assessment of the substances in the Slave River and provide a relevant set of benchmarks against which future data can be compared. Also, where generic guidelines do not currently exist for certain substances of concern (e.g., phosphorus), the development of site-specific water quality objectives would help to fill these gaps.

normal and that a higher water quality objective may be more appropriate to assess iron levels in the Slave River.

However, metal levels in the Slave River are sometimes much lower than the generic guideline. This scenario is shown with total arsenic levels which range from 0.3 to 15 ug/L; with about 6% of the values exceeding the aquatic life guideline of 5 ug/L (Figure 7). In such instances, development of a lower site-specific water quality objective may be appropriate.

It is important to note that analysis of the data also identified a few instances where the dissolved concentration of a metal exceeded the total metal guideline (e.g., cadmium, chromium, copper and iron). It is important to keep monitoring and assessing these metals since it is the dissolved form which is generally more available to fish. To provide additional insight on this observation, trend analysis will be conducted once enough dissolved metals data becomes available.

Are there Persistent Organic Pollutants (POPs) in the Water or Suspended Sediments of the Slave River?

The Slave River monitoring programs at Fitzgerald and Fort Smith include the analysis of water and suspended sediment samples for human-made contaminants such as pesticides, chlorophenols, dioxins, furans and PCBs.

Where possible, results were compared to CCME guidelines for the protection of aquatic life. Guidelines do not exist for suspended sediment; therefore comparisons were made to bottom sediment guidelines. Suspended sediments collected from the Slave River are composed mainly of clay and silt (fine particles). As bottom sediments also contain coarse particles, there are limitations when comparing suspended sediment values to bottom sediment.

Of the 11 pesticides which were detected in water samples collected from Fitzgerald, nine were detected only once, and none have been detected since 1986. All values were below guidelines. Pesticides were not detected in the water or suspended sediment at Fort Smith, however, low detection limits were not always available; future monitoring with low detection limits will provide additional insight into sample results.

Some chlorophenol compounds were detected at low levels in both the water and suspended sediment samples collected from the Slave River at Fort Smith during the SREQMP (1990-1995). All chlorophenol values in water were below guidelines (Note: there are no sediment guidelines for chlorophenols). None of these compounds were detected in the Slave River at Fort Smith during the Follow-Up Study (2000-2010). This apparent decrease in chlorophenols could be due to the stricter limits for the pulp and paper industry, which were imposed by the Canadian Government in the 1990s. However, in some cases the very low detection limits obtained during the earlier study are not available today, so further monitoring is required to confirm these findings.

Slave River water and suspended sediment samples have been analyzed for contaminants that are known to be associated with upstream development. Overall, fewer organic compounds, and at lower levels, were found in the water and suspended sediment samples during the Follow-Up Study (2000-2010) than in the SREQMP (1990-1995). Monitoring will continue. Setting appropriate detection limits is important for future studies.

Pelicans below Rapids of the Drowned

It should be noted that for some organic parameters, detection limits were higher in the Follow-Up Study than the SREQMP. According to the laboratory used to analyze the organics in the river samples, the rules that govern laboratory reporting have changed. Laboratories must now report values with a much higher level of certainty than what was needed in the past. As such, the very low detection limits achieved during the SREQMP are not available today. In some cases, this makes comparison of results difficult, however, further monitoring will allow for trend analyses to be conducted which will help determine if trends are being observed.

A few dioxin compounds were found in the suspended sediment during both the SREQMP and Follow-Up Study at low levels and well below any available guidelines (Note: Dioxins are not measured in water). Levels were similar during both study periods. The presence of these compounds could indicate atmospheric or point sources. One compound which has been linked to pulp mill effluent (2,3,7,8 – TCDF) was detected at lower levels and less frequently (only one time) during the Follow-Up Study. This apparent decrease could also be linked to the regulation changes for pulp mills. Monitoring of these compounds will continue.

PCBs were not detected in any water samples using standard tests. On one occasion, when very low detection limits were used, PCBs were detected in the suspended sediment. The observed values were extremely low (800X less than the guideline).

Hydrocarbons

Hydrocarbons have both natural and human made sources. PAHs have been detected in both the water and suspended sediment samples collected from the Slave River.

All PAH compounds detected in water have been at levels which are lower than the aquatic life guidelines. Some PAH compounds in suspended sediment exceeded bottom sediment guidelines. However, in the Follow-Up Study, fewer PAH compounds were above guidelines and the ranges of values above detection were lower. A good example of this is naphthalene (Figure 8), with concentrations ranging from 10-580 nanograms per gram (ng/g) during the SREQMP and from 10-50 ng/g during the Follow-Up Study.

A ng/g is one billionth of a gram or part per billion (ppb). To think of it in a different way, a ppb is like 1 second of about 32 years.

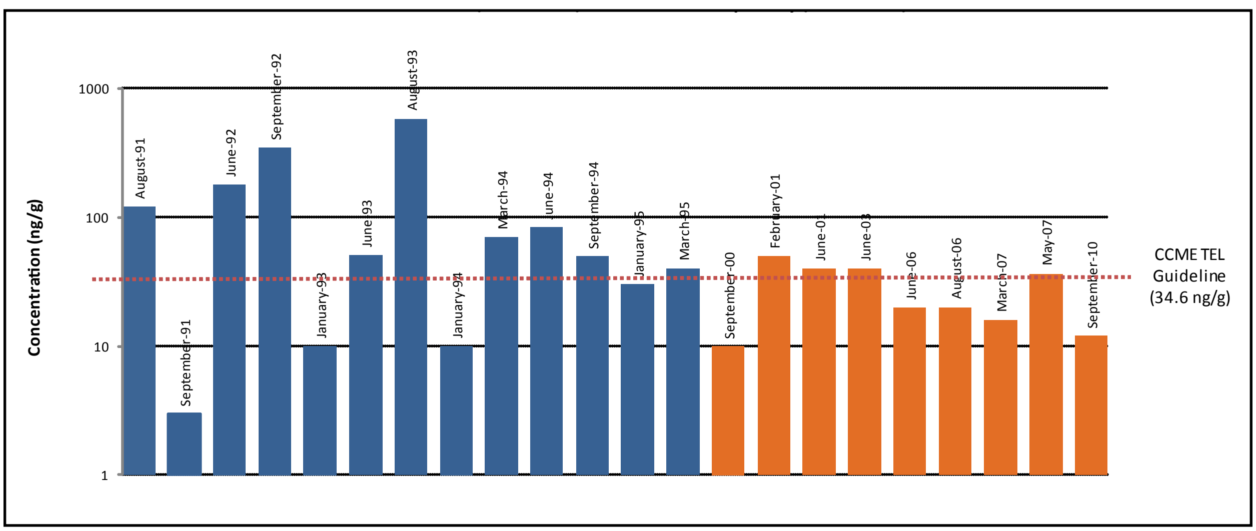


Figure 8: Comparing the Concentrations of Naphthalene in the Suspended Sediments of the Slave River between the SREQMP (1990-1995) and the Follow-Up (2000-2010)

Naphthalene is a hydrocarbon made from crude oil or coal tar. It is also produced when things burn and is found in cigarette smoke, car exhaust, and smoke from forest fires. It is used as an insecticide and can be found in mothballs. While it is important to continue to monitor for parameters such as naphthalene, which seem to be present in the river all the time, it is also important to ensure that monitoring efforts are focussed on emerging PAH compounds, such as alkylated PAHs, that have been specifically associated with upstream activities. These compounds were added to the monitoring program in 2007; and have been detected at low levels in the two samples collected. Although there are currently no Canadian guidelines for alkylated PAHs, the results from the samples were well below the United States Environmental Protection Agency (USEPA) benchmark established for the protection of bottom-dwelling organisms (bugs, worms, etc.).

Starting in 2001, suspended sediment samples were analyzed for an expanded list of PAH compounds, which allowed for comparison to total PAH guidelines[2] for bottom sediment. Total PAH levels in Slave River suspended sediments were found to be at least ten times lower than this guideline, which was established for the protection of bottom-dwelling organisms (Figure 9).

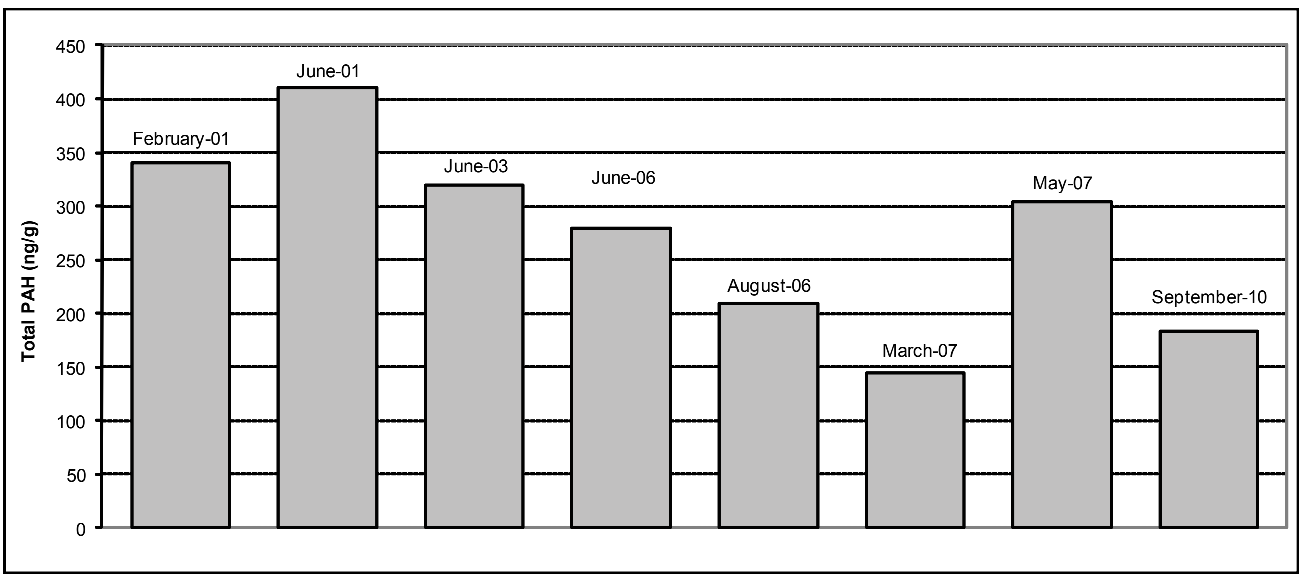


Figure 9: Total PAHs Concentrations in the Slave River Suspended Sediment Samples (2001-2010)

As there is no national guideline available for PAH, a comparison to the Ontario guideline is illustrated here. The levels in the Slave River suspended sediment samples are much lower than the Ontario total PAH bottom sediment guideline of 4000 ng/g established for the protection of bottom-dwelling organisms.

[2] In the absence of a national guideline for total PAHs in bottom sediments, the Ontario guideline was used.

Can I Drink the Water?

In Canada, the responsibility for making sure drinking water supplies are safe is shared between the provincial, territorial, federal and municipal governments. The day-to-day responsibility of providing safe drinking water to the public generally rests with the provinces and territories, while municipalities usually oversee the operations of the treatment facilities.

In conjunction with the provinces and territories, Health Canada developed the "*Guidelines for Canadian Drinking Water Quality*." These guidelines are used by every jurisdiction in Canada and are the basis for establishing drinking water quality requirements for all Canadians.

However, these guidelines are intended to be applied to treated tap water – not source water such as the Slave River. Since "Can I drink the water?" is a common and important question, the results of the Slave River surface water sampling were compared to Canadian drinking water guidelines as a general assessment of this water for drinking. As expected, due to the high sediment loads of the Slave River, total metals did not always meet the guidelines. However, when the metal concentrations in the filtered water sample (dissolved metals) were compared, the drinking water quality guidelines were always met.

Although waters in the Canadian outdoors are generally of excellent quality, people should always be prepared to boil or disinfect all drinking water.

It is very important to note that no surface water can be guaranteed to be safe for drinking without treatment. Health Canada and the Government of the Northwest Territories recommend heat as the oldest, safest and most effective method of purifying water. Bring the water to a rolling boil for at least one minute to remove bacteria. If the water is cloudy, like it is in the Slave River sometimes, it should be filtered before boiling. Filtration of source water prior to disinfection will provide additional protection.

The surface water of the Slave River is safe for drinking and swimming.*

** After filtering and boiling the water for at least one complete minute. Additional information on drinking water in the Canadian outdoors and/or information on drinking water sources in the NWT can be found at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/outdoor-plein_air-eng.php and http://www.maca.gov.nt.ca/operations/water/homepage.asp.*

Slave River Flows

Flow in the Slave River is greatly influenced by the Peace River, which contributes about 60% of the Slave River flow volume. Before the W.A.C. Bennett Dam was built, flows in the Slave River began to decrease in the fall, reached a minimum in the winter under ice and then peaked in the spring during and just after breakup (Figure 10). While this pattern is still observed, following construction of the dam, the hydrograph has been dampened, in that the winter flows are higher and peak flows are lower (Figure 10). In fact, since flow regulation, flows in the winter have been increased by 75%, and flows in the spring have been reduced by 20%. It is important to note that the total amount of water flowing into the Northwest Territories has not changed, just the timing of when the water arrives.

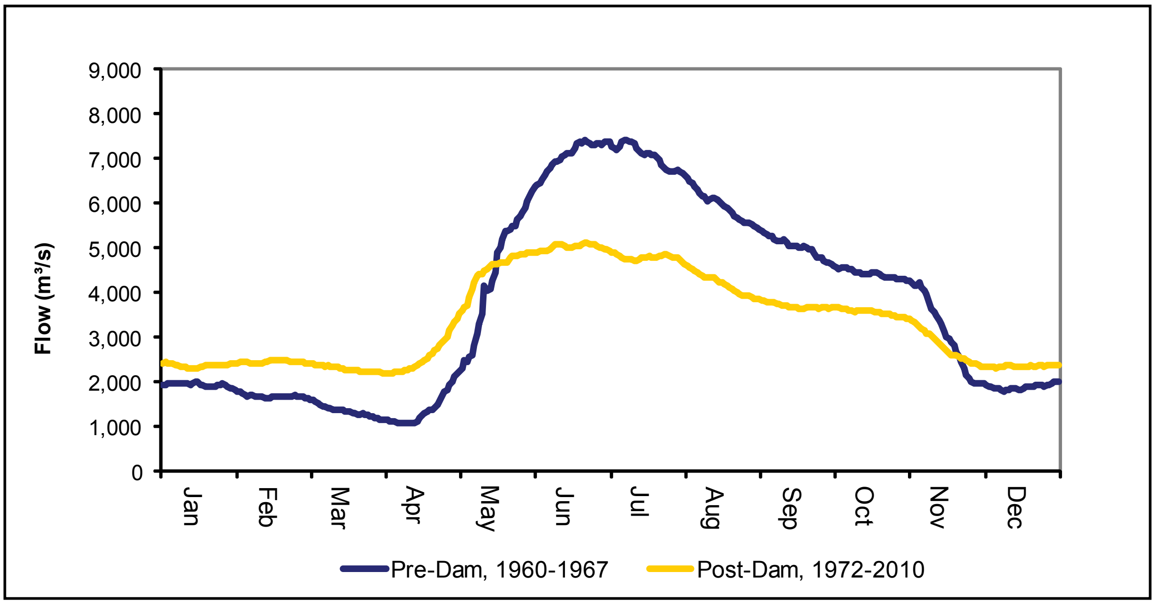


Figure 10: Mean annual hydrographs of the Slave River at Fitzgerald for pre-dam (1960-1967) and post-dam (1972-2010) years (Water Survey of Canada – 07NB001). Adapted from MRBB, 2003.

Other changes in the flow of the Slave River have been observed. For example, high freshet peaks were generally experienced in June before dam construction, but are now often in May (Figure 11). A trend toward more frequent peaks on the annual hydrographs has also been identified and secondary peaks now appear in some years during winter. These changes may be due to flow regulation, or an increase in climatic variability in the watershed.

In 2010, record low water levels were experienced on the Slave River, on Great Slave Lake and in the upper Mackenzie River. Many of the tributaries to the Williston Lake Reservoir behind the W.A.C. Bennett Dam also experienced record lows that year. This suggests that the low water levels in the NWT that year were likely due to low snowpack and rainfall in the upper portion of the Slave River watershed.

This report also examined long term trends in flow. In addition to looking at annual trends over time, each season was examined separately. No significant trends were found during the spring or over the entire year (Figure 12 a and b). However, significant decreasing trends were

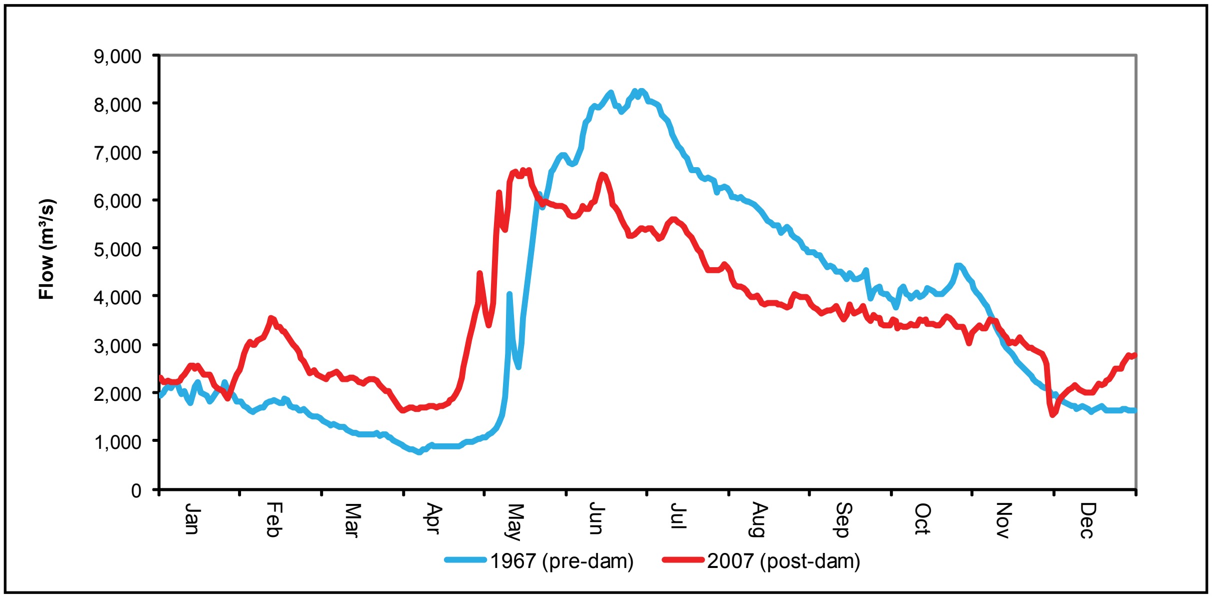


Figure 11: Examples of annual hydrographs of the Slave River at Fitzgerald for a pre-dam (1967) and a post-dam (2007) year (Water Survey of Canada – 07NB001).

found in the summer and fall flows, and a significant increasing trend was found in winter flows (Figure 12 c,d and e). In other words, it seems as though the amount of water during the summer and fall flows, and a significant increasing trend was found in winter flows (Figure 12). In other words, it seems as though the amount of water during the summer and fall are getting progressively lower each year. Additionally, the amount of water in the winter appears to be increasing each year. These trends may be due to flow regulation, but may also be due to climate change in the watershed. Further study is required to understand the ecological significance of these trends.

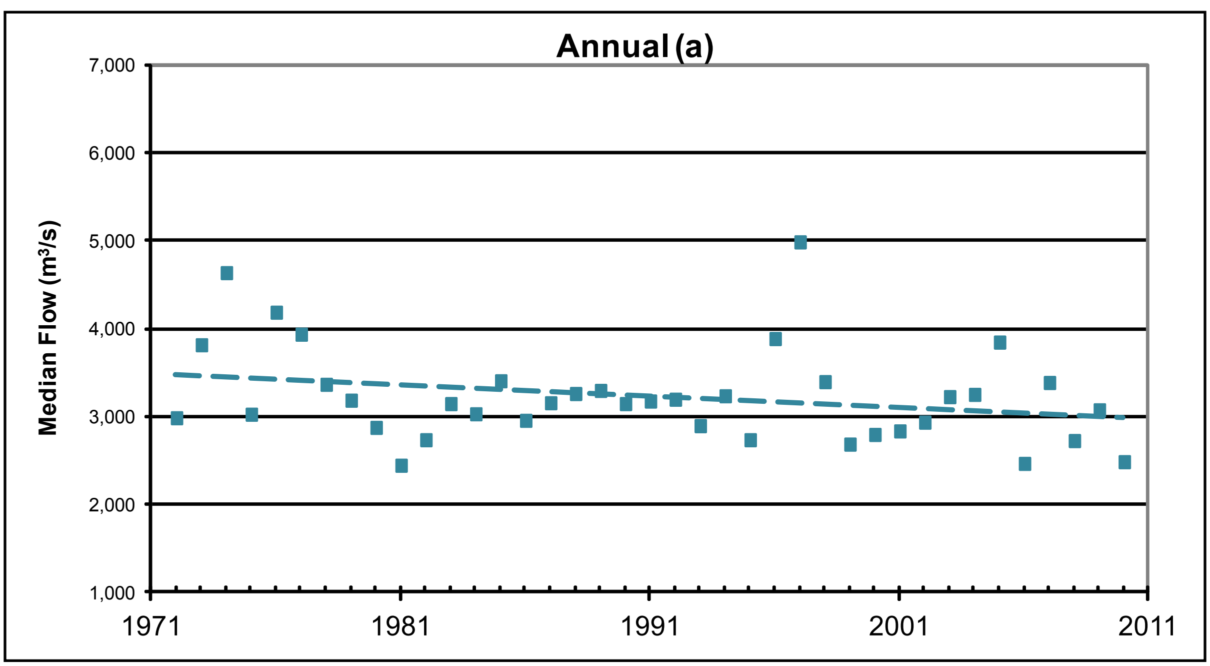


Figure 12a: Medians of 1972-2010 annual and seasonal Slave River daily flows at Fitzgerald (WSC Hydat, 2010). Solid lines indicate 95% confidence in the trend; dashed lines indicate trends with less than 95% confidence.

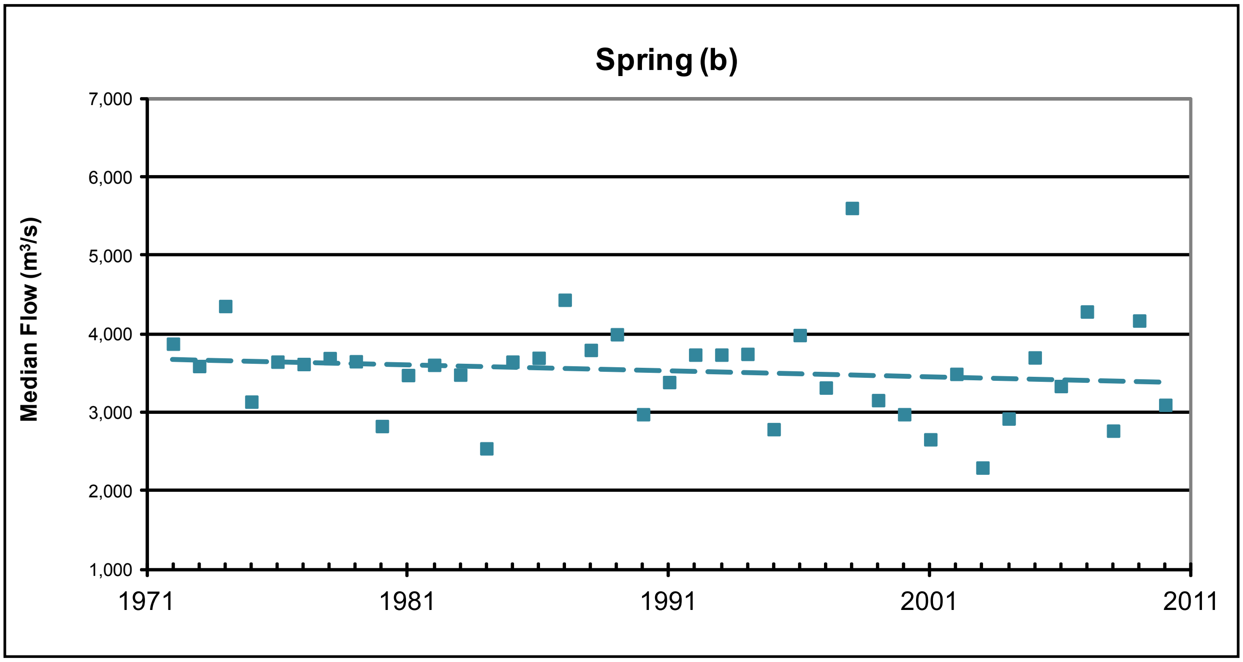


Figure 12b: Medians of 1972-2010 annual and seasonal Slave River daily flows at Fitzgerald (WSC Hydat, 2010). Solid lines indicate 95% confidence in the trend; dashed lines indicate trends with less than 95% confidence.

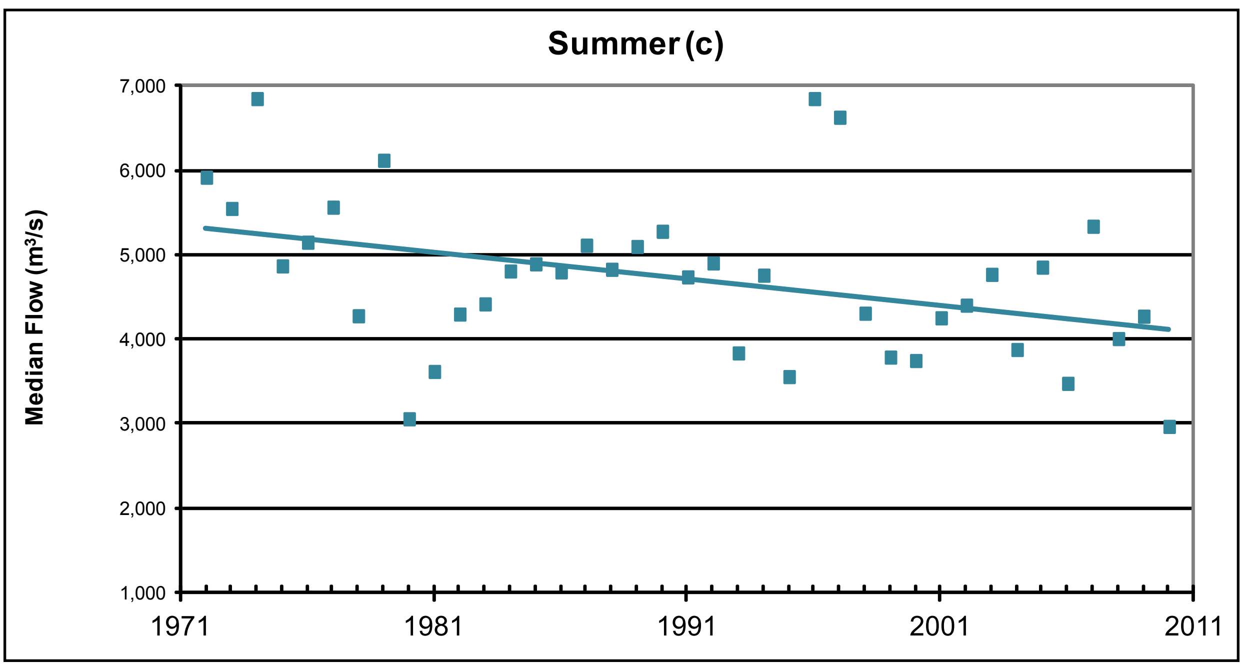


Figure 12c: Medians of 1972-2010 annual and seasonal Slave River daily flows at Fitzgerald (WSC Hydat, 2010). Solid lines indicate 95% confidence in the trend; dashed lines indicate trends with less than 95% confidence.

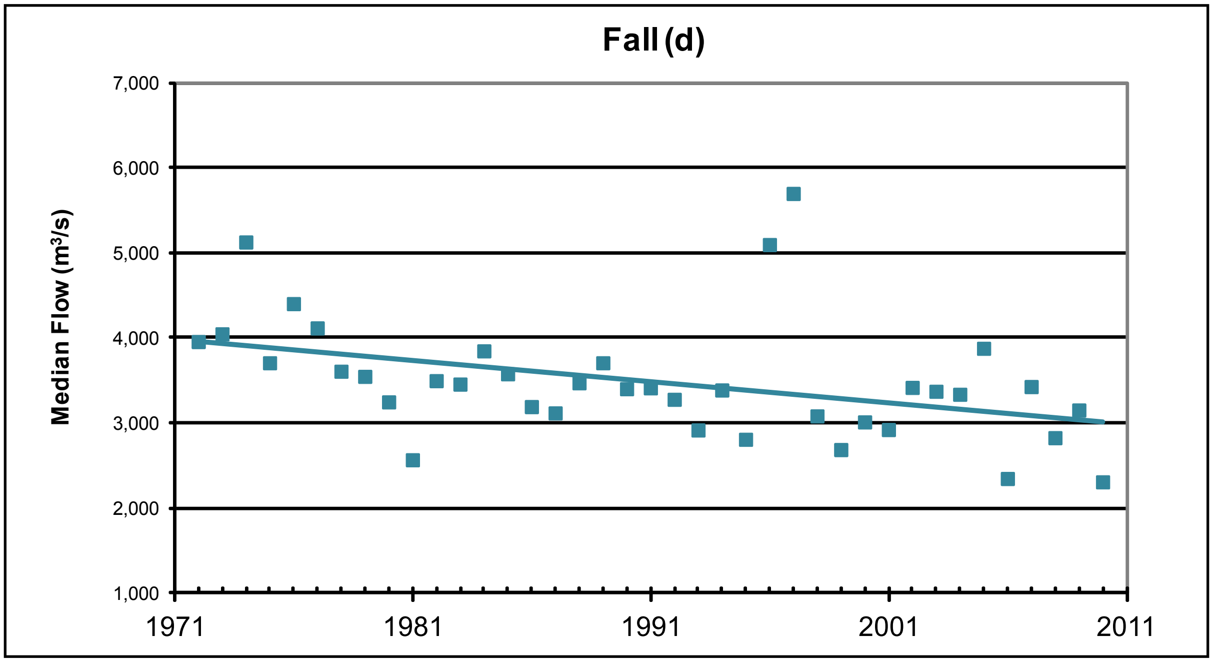


Figure 12d: Medians of 1972-2010 annual and seasonal Slave River daily flows at Fitzgerald (WSC Hydat, 2010). Solid lines indicate 95% confidence in the trend; dashed lines indicate trends with less than 95% confidence.

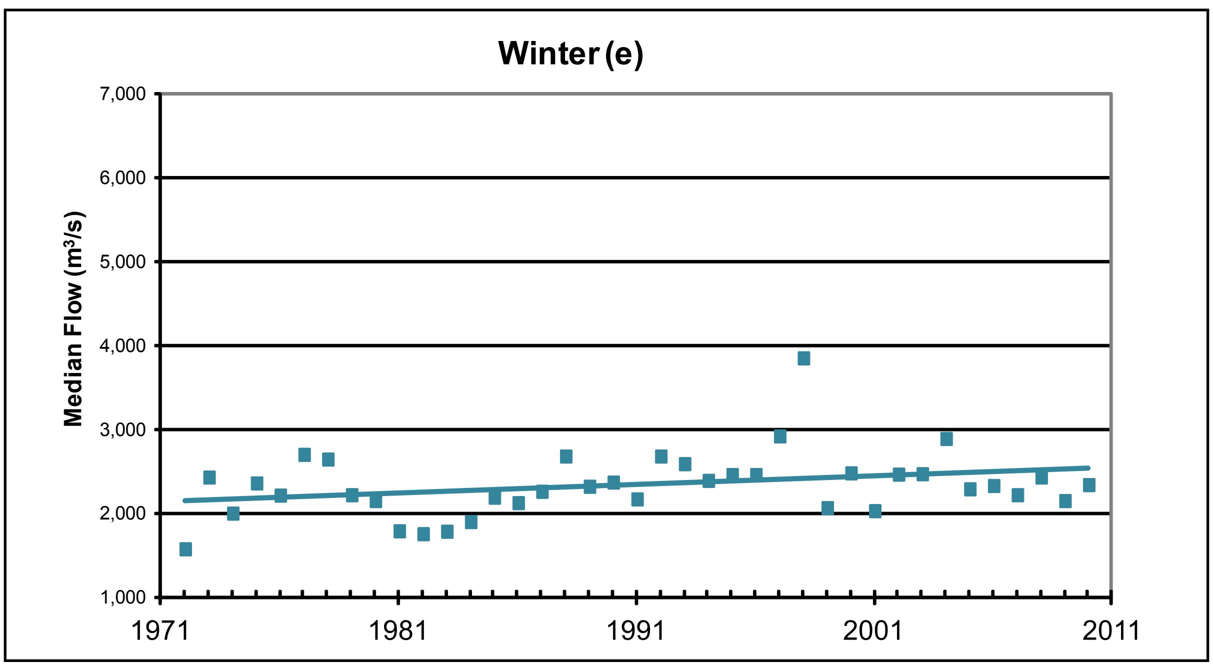


Figure 12e: Medians of 1972-2010 annual and seasonal Slave River daily flows at Fitzgerald (WSC Hydat, 2010). Solid lines indicate 95% confidence in the trend; dashed lines indicate trends with less than 95% confidence.

Changes in Water Quality due to Changes in Flow

Water quality and quantity are very closely linked. In natural unregulated rivers, dissolved substances are typically higher during the winter because a larger percentage of water comes from groundwater inflows. In the Slave River, however, this pattern is not observed. Many of the dissolved substances (total dissolved solids, potassium, sulphate, fluoride, dissolved organic carbon, phosphorus) have higher concentrations in the spring and summer, than in the winter. An example is shown in Figure 13. For other dissolved substances (specific conductance, alkalinity, calcium, magnesium, sodium, hardness, ammonia), concentrations in the Slave River were similar among seasons. An example is shown in Figure 14. These changes may be linked to the altered flow regime of the Slave River due to upstream flow regulation of the Peace River; higher observed winter flows, the mixing effects of Lake Athabasca and Williston Lake; and/or the potential influence of climate change.

For total dissolved solids, alkalinity and hardness, this seasonal pattern of higher levels in the spring and summer as compared to the winter appears to be occurring as far downstream as the mouth of the Slave River (i.e. just upstream of Great Slave Lake).

Further study is be required to determine if these seasonal changes in water quality, which can be linked to changes in quantity, are having any ecological effects on the Slave River aquatic ecosystem.

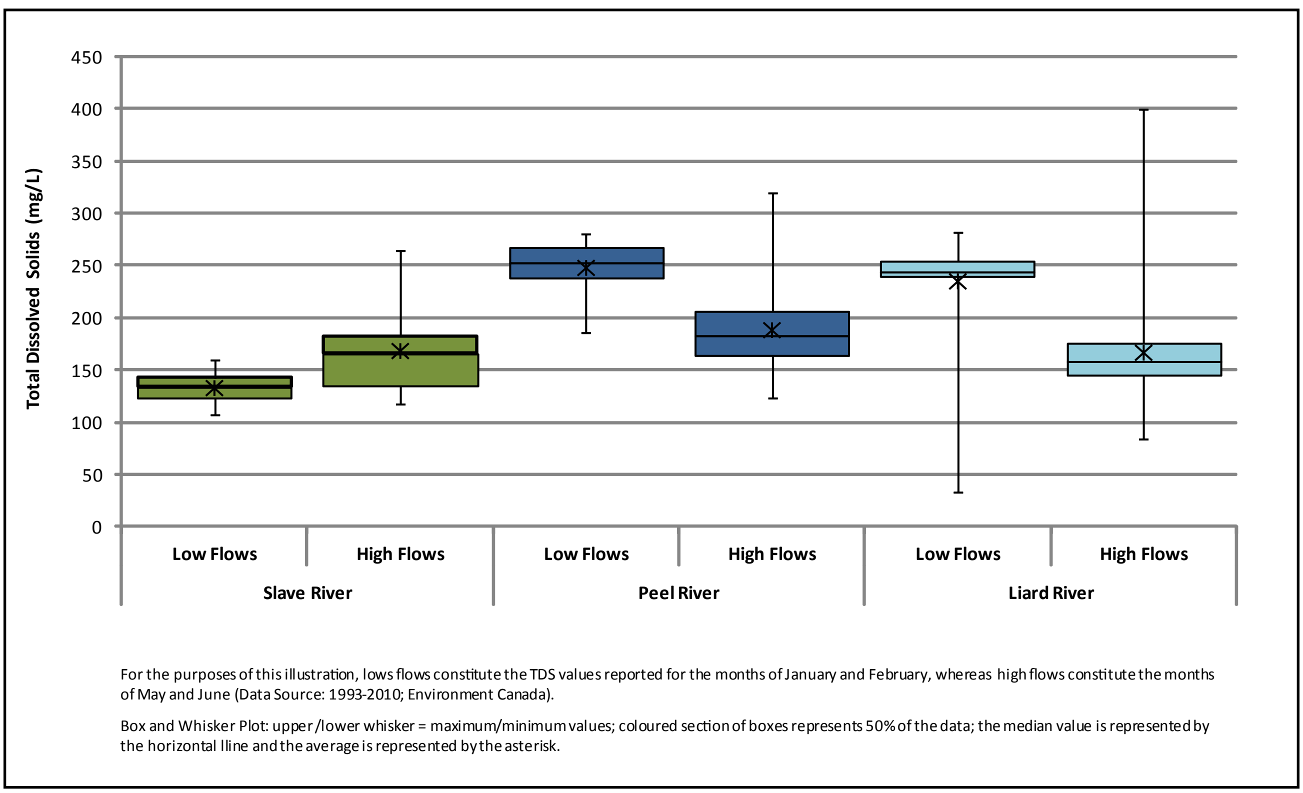
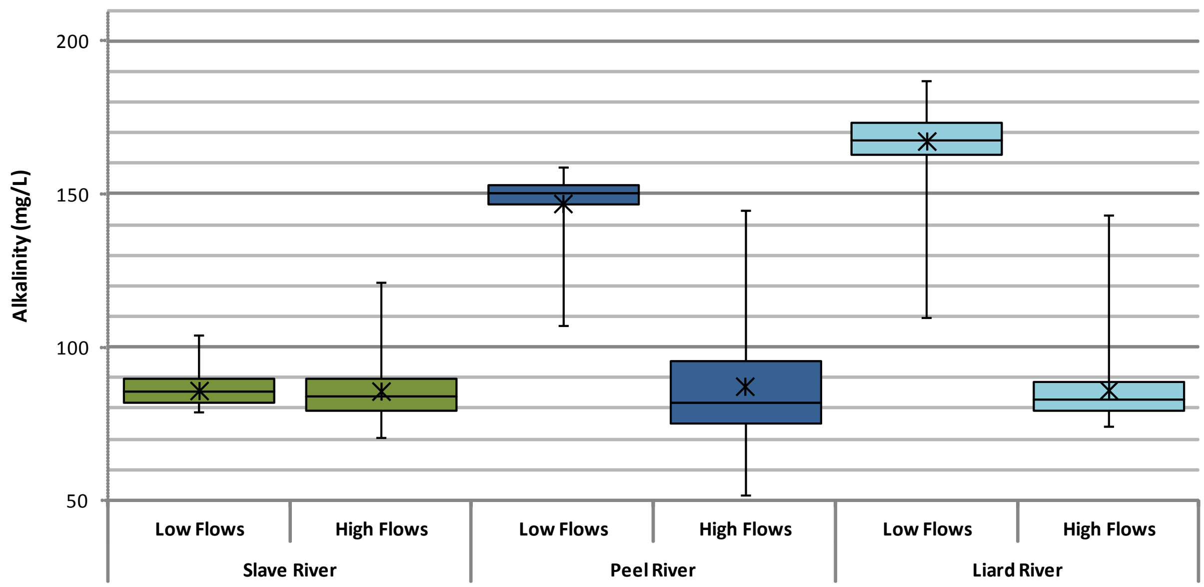


Figure 13: Comparing the Levels of Dissolving Solids during Periods of High Flow and Low Flow between the Slave, Peel and Liard Rivers



For the purposes of this illustration, lows flows constitute the alkalinity values reported for the months of January and February, w hereas high flows constitute the months of May and June (Data Source: 1980-2010; Environment Canada).

Box and Whisker Plot: upper /lower whisker = maximum/minimum values; coloured section of boxes represents 50% of the data; the median value is represented by the horizontal lline and the average is represented by the asterisk.

Figure 14: Comparing Alkalinity Levels during Periods of High Flow and Low Flow between the Slave, Peel and Liard Rivers

Slave River upstream of Fitzgerald

Fort Smith Community Workshop, March 2011

What happens next?

In conjunction with the Environment Canada monitoring programs at Fitzgerald, the AANDC monitoring program at Fort Smith provides a large amount of data from the Slave River. These programs are critical to better understand changes in the aquatic environment and form the basis of many different research and monitoring initiatives.

AANDC is continuing to carry out the Slave River monitoring program through the collection of water and suspended sediment samples. The Department will work with Environment Canada to assess Slave River water quality and quantity data when new data become available.

The Department will also continue to be active within other regional monitoring initiatives, such as the Slave River and Delta Partnership. This partnership, consisting of members from Aboriginal, federal and territorial governments, Aurora College and communities along the Slave River, has resulted in several initiatives. These include community-based monitoring workshops, Slave River Delta sediment sampling and the Slave River fish sampling program. Under this initiative, passive samplers have been recently deployed in the Slave, Athabasca and Peace Rivers. These samplers remain in the river for up to one month and will be analyzed for persistent organic pollutants and metals. In addition to these efforts, Environment

Canada has implemented an expanded oil sands monitoring program that includes the Slave River and Slave River Delta. Collaboratively, these research and monitoring initiatives will support each other to expand the knowledge and understanding of the Slave River aquatic ecosystem.

Overall, the Slave River report provides an overview of the data collected in past years. Monitoring will continue and, where possible, improvements to the monitoring program will be made. Incorporating additional data and information will help assess any environmental change in the Slave River over time. It is important that all monitoring programs attempt to collect data in a consistent manner. Consistent data collection and sharing, including across jurisdictions, can be extremely useful as it will allow for more thorough water quality assessments and provide a better understanding of change in the watershed.

Continued monitoring by water partners is important to ensure the health of the Slave River in the Northwest Territories.

For more information, please contact Juanetta Sanderson (867-669-2653) or Andrea Czarnecki (867-669-2509) with the Water Resources Division of Aboriginal Affairs and Northern Development Canada.

http://www.aandc.gc.ca/eng/1100100022930/1100100022931