Integrating Indigenous Knowledge into a Community Contaminant & Climate Change Monitoring Program

Selkirk First Nation Community Report

2013

Prepared by the Yukon River Inter-Tribal Watershed Council

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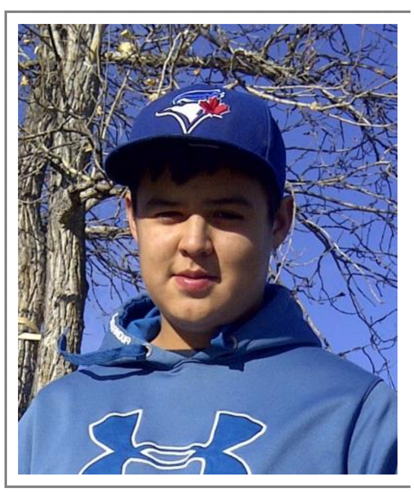
Project Team

Nick Wilson
Social Scientist
YRITWC
nwilson@yritwc.org

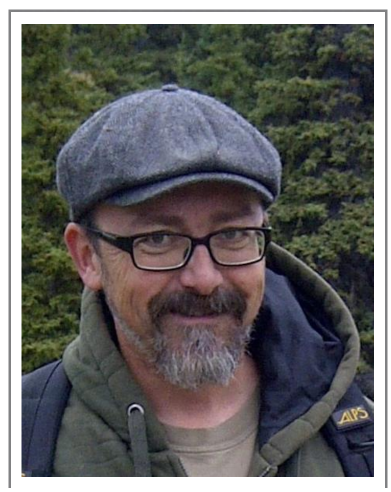
Jody Inkster
Environmental Technician, YRITWC
jinkster@yritwc.org

Ryan Toohey
Science Director, YRITWC
rtoohey@yritwc.org

Shannon Donovan
Assistant Professor of Environmental Studies, University of Alaska Anchorage
smdonovan@uaa.alaska.edu



Shaun Roberts
SFN Youth Intern



Sam Gallagher
Environmental Technician, YRITWC

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Introduction

This report details the results of the Yukon River Inter-Tribal Watershed Council's community-based research project, "Integrating Indigenous Knowledge and Public Health Concerns into a Community Contaminant and Climate Change Monitoring Program" conducted with Selkirk First Nation.

Climate change and environmental degradation pose significant threats to Arctic and Sub-Arctic freshwater systems and their Indigenous inhabitants. Scientific studies indicate that these regions are among the first to experience the impacts of climate change (Serreze et al. 2000; ACIA 2005; Hinzman 2005; IPCC 2007). Indigenous peoples whose subsistence livelihoods rely on the lands and waters within their traditional territories are closely connected to their local geography and consequently, they are among the first to feel the effects of climate change (Berkes, Folke, and Gadgil 1995; Nyong, Adesina, and Osman Elasha 2007; Turner and Clifton 2009). Furthermore, environmental degradation other than climate change also has significant implications for subsistence livelihoods. Contaminants transported from local and long-range sources are known to impact traditional food systems in the Arctic and Sub-Arctic (Kuhnlein and Chan 2003). The Indigenous inhabitants of the Yukon River Basin have identified the impacts of climate change and environmental degradation to the Yukon River and its tributaries as major threats to their lives and livelihoods.

During open floor discussions at the Yukon River Inter-Tribal Watershed Council's (YRITWC) Summit in August of 2011, First Nations discussed concerns about their health risks, unpredictable events of climate change, and exposure to contaminants. First Nations called on the YRITWC staff to assist them with conducting community-based research to assess and monitor climate change and contaminants within their traditional territories (See Figure 1).

Text Box 1. What is the Yukon River Inter-Tribal Watershed Council?

> The Yukon River Inter-Tribal Watershed Council is a treaty-based Indigenous grassroots organization consisting of 70 First Nations and Tribes, dedicated to the protection and preservation of the Yukon River Basin.[1]

Figure 1 Map of the Yukon River Basin

This project integrates Indigenous Knowledge of the environment into a community contaminant-monitoring program (i.e., heavy metals, hydrocarbons, nutrients, and bacteria) for five Yukon First Nations. The main question that this project aimed to answer was two-fold:

1. What concerns do First Nations have regarding climate change, public health, and contaminants?
2. What are the baseline levels of contaminants within these communities?

During this project, the YRITWC worked with the First Nations of Selkirk, Tr'ondëk Hwëch'in, Kluane, White River and Carcross/Tagish in developing their research project and increasing scientific capacity of First Nation members. This report details the results of the research conducted with Selkirk First Nation.

Text Box 2 What Is Indigenous Knowledge?

Indigenous knowledge of the environment, also referred to as Traditional Ecological Knowledge (TEK), is defined as "a cumulative body of knowledge and beliefs handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. Further, TEK is an attribute of societies with historical continuity in resource use practices; by and large these are non-industrial or less technologically advanced societies, many of them indigenous or tribal" (Berkes 2008: 7).

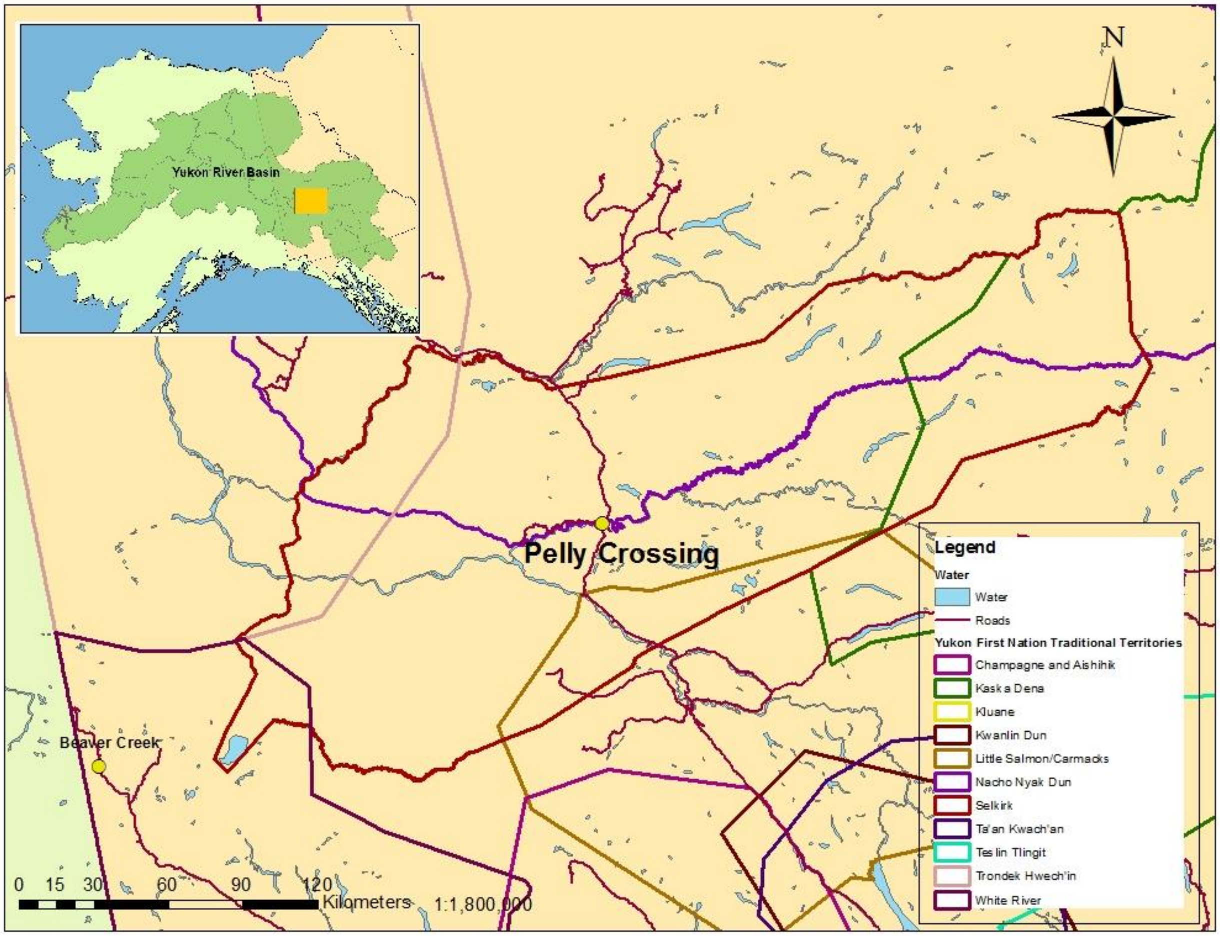
Community Context

Selkirk First Nation (SFN) is situated in the village of Pelly Crossing, which is located on the Klondike Highway in the central Yukon (See Figure 2 – Map of Selkirk First Nation Traditional Territory). SFN is a member of the Northern Tutchone cultural and language group, and belongs to the larger Athapaskan language group. They are closely related to their Northern Tuchone neighbours, the Na-cho Nyak Dun of Mayo and Little Salmon/Carmacks First Nation. Combined, these three First Nations form the Northern Tutchone Tribal Council. The people of SFN originally settled in Fort Selkirk, where the Yukon and Pelly Rivers meet.[1] The people of Selkirk First Nation have maintained subsistence livelihoods, including hunting, fishing and trapping, throughout their traditional territory for millennia (Government of Canada 2004). In the 1950s, the people of SFN relocated to the Village of Minto, on the Klondike Highway, when the riverboats stopped running from Whitehorse to Dawson City. They later relocated to their current location of Pelly Crossing.[2]

The current SFN citizenship is estimated at 500 and is increasing yearly. Approximately 40 percent of SFN's citizens reside in Pelly Crossing. The remaining 60 percent live elsewhere in the Yukon or in other locations across Canada.[3] Selkirk First Nation signed their land claims and self-governance agreements. They became a self-governing First Nation in 1997 (Government of Canada 2004).

[1] http://www.cyfn.ca/ournationssfn?noCache=970:1354315230
[2] http://www.cyfn.ca/ournationssfn?noCache=970:1354315230
[3] http://www.selkirkfn.com/CommunityInformation/History/tabid/64/Default.aspx

Figure 2 Map of Selkirk First Nation Traditional Territory



Research Design

This project is characterized by a community-based participatory approach. Community-Based Participatory Research (CBPR) is, first and foremost, designed to meet the needs of local communities: "In contrast to more traditional investigator-driven research, CBPR begins with an issue selected by, or of real importance to, the community, and involves community members and other stakeholders throughout the research process, including its culmination in education and action for social change" (Minkler and Wallerstein 2011, 1–2). This project also has a multidisciplinary research design, meaning that it uses methods from both the social and biophysical sciences to examine First Nation concerns related to the impacts of contaminants and climate change on water.

In the summer and fall of 2012, the YRITWC research team conducted interviews and a focus group with members of SFN. Semi-structured interviews were conducted with key stakeholders to gather in depth information on the importance of water for the community as well as concerns about changes in water resources as a consequence of either contamination or climate change. Twelve interviews were conducted in total. Seven out of fifteen community members were Elders. The remaining five participants were middle-aged community members. Three of the participants were SFN staff. Interview participants were asked to describe the importance of water to their community and any changes in water resources they observed within their traditional territory. Interview participant's observations of change contributed to the identification of water quality sites of concern.

A focus group was held at the Selkirk Community Support Centre on September 11th, 2012. Eighteen people attended the focus group. Five of the focus group participants also completed an interview. Therefore, a total of twenty-five individuals participated in this research.

During the focus group we used a participatory mapping exercise (Donovan et al. 2009) as a primary means for gathering data. Where possible, focus group participants identified, mapped and discussed sources of contamination and the associated impacts on water resources. Using ArcGIS, a map of the SFN traditional territory was projected a screen and focus group participants took turns identifying sites of concern on the map. A laser pointer was used to indicate the exact location. Sites of concern were recorded as points in ArcGIS 10, a spatial mapping program. A note taker recorded the site descriptions provided by participants including the suspected source of contamination. A total of 15 sites of concern were identified.

The YRITWC had funds available to sample at five sites. During the focus group, the YRITWC used a voting process to prioritize the top ten sites of concern. Each of the focus group participants was provided ten stickers and was directed to place the stickers on their areas of greatest concern. Participants could put more than one sticker next to a given site name. The names of all sites were written on a piece of paper and participants placed stickers next to the sites they felt should be prioritized for water sampling.

The next step of the research process was to collect water samples from each of the five prioritized sites. Water sampling was conducted from September 25th to 27th. YRITWC environmental technicians conducted water sampling with help from our Youth Intern and staff from the SFN Lands and Resources Department. This community research report allows the YRITWC research team to return the results of this research to the community in a usable format.

Youth Capacity Building

Youth capacity building is another important aspect of the project. In each community, the YRITWC worked with one Youth Intern, identified by the First Nation as between the ages of 16-25. The youth were an important addition to the research team. Each of the youth received training in water quality sampling and in some cases permafrost monitoring. The youth interns assisted with focus groups and helped the YRITWC environmental technicians with water sampling. Their in-depth knowledge about the community and surrounding area was invaluable to the project. Shaun Roberts was the SFN Youth Intern.

Results and Analysis

The Importance of Water to Selkirk First Nation

Water is important to the people of Selkirk First Nation for many reasons. Interview participants were asked to answer the question '*Why is Water Important to Your Community?*' Their responses reveal that water is essential to all aspects of life or as one interview participant put it, "It's pretty much the life of

> "A long time ago, people used to drink and pack water from the [Pelly] river. It was clear. And I remember when I was small, we used to drink from the river, even Minto too, till the mine come in and nobody touch water after that and then everybody used pump water." (SFN Elder)

everything. You can't sustain anything without the water and to live off the land and fish, they use, everyday activities, they use water. It's a big part and just to make sure everything is healthy and the way it should be."

"[The]Yukon water is affected, like this water run into Yukon. All the rivers run into Yukon. So our traditional ways they call it Tagé Cho, that mean 'big river.' So if it run into Yukon River, it's not only going to affect people in Yukon, why it's going to go right down to Alaska, all over the place. It will be affecting them too. That's why it's really important for us to have a good water, because today, I can't drink, I wouldn't even want to drink water from anywhere." (SFN Elder)

"I just worry about Faro Mine. I'm glad it shut down, otherwise it could have damaged more because that water at Faro, it come down to Pelly and there's another river go up that away is Macmillan. Macmillan comes down this way and those two water mix together. No wonder I barely see down the bottom." (SFN Elder)

During the research project, many uses of water were identified. Drinking water was one of the main uses of water discussed by participants. Primary and secondary sources of drinking water are used. Primary sources include water from the treatment plant, which arrives to people's houses by pipe or delivered by truck, and some private wells, mostly located in the Willow Creek Subdivision. Many SFN Community members stated that they do not like the taste of the water from the water treatment centre, due to the chlorine used in the treatment process. Some individuals stated that they would boil their tap water to get rid of the taste or got their drinking water from another source, such as a family member's private well. The members of Selkirk First Nation only use secondary sources, such as springs and creeks, occasionally. A number of secondary sources that are no longer used were identified including the Pelly River and Mica Creek. These water sources are not used for drinking water due to concerns about contamination from a variety of sources. For example, Pelly Crossing is located downstream from the Faro Mine on the Pelly River. Although one individual stated that they drink water from Willow Creek, it is believed that the majority of SFN Community members do not use this creek as a source of drinking water. Many people stated that they stopped using water directly out of the river when the mine became active. SFN members most often haul water from home when they are out on the land or at camp. The occasional secondary water source is also used. Water also provides SFN Community members important habitat for a diversity of fish and

Figure 3 Why is water important to Selkirk First Nation?

"I remember when we travel long time ago, with dog packs and things like that...we do have to travel with dogs. Dog was our big helpers. And wherever we camp, wherever we set our tent up, my dad used to tell us, 'don't throw away the poles anymore.' You know, the tent poles. 'Lean it against the trees' he said, 'next time we come back, we might use the same ones.' He said, 'anybody come around, they need tent poles, they can use it.' And whatever we use, we used to use brush from the ground and brush from the trees, that too. We just piled it up under the tree from inside the tent so those branches could try. So all the needles could fall off and turn into just branches. He said, 'people can use those to start fires maybe two or three years from now.' See that's how they look after the ground, those Elders. That's why I think about the mine. How our Elders used to respect the ground."(SFN Elder)

other wildlife. Rivers such as the Pelly and the Yukon are also used as a transportation corridor both in times of open water and when they are frozen-over in the winter. The uses identified above make it easy to see why water is integral to all aspects of subsistence livelihoods, which are central to Selkirk First Nation culture.

Documenting the importance of water is fundamental to establishing a community climate change and contaminants monitoring program for two reasons: 1) It allows us to understand how changes in water resources are impacting people 2) Cultural connections to water are also the inspiration for protecting water resources. The following section details the concerns that were raised about water quality and contaminants during the research process.

Observations of Changes in Water Resources

The purpose of this project was to understand the impacts of contaminants and climate change on water and public health for Yukon First Nations. The following sections detail community water quality concerns and the results of baseline contaminant monitoring completed during the project and describe community observations of climate impacts.

Community Water Quality and Quantity Concerns

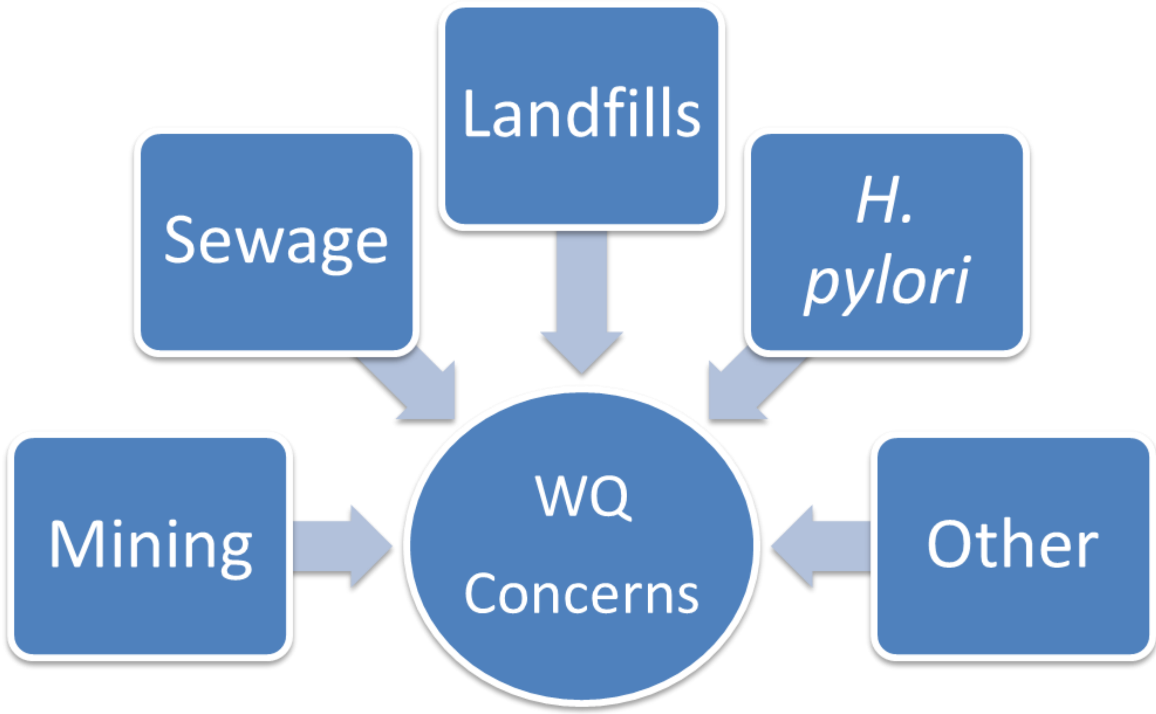
SFN community members described a number of concerns about water quality and quantity during interviews and the focus group. Their concerns included various sources of and types of contaminants: sewage, landfills, atmospheric contaminants, mining and mining exploration. Maintaining existing water quality was identified as a priority for subsistence fishing and hunting. Concerns about the impact of sewage and landfill on local water resources were raised by community members (See Figure 4). The majority of these concerns centered on the influence of the local landfill and sewage lagoon on the wetland where it is located and on Mica Creek, which flows past the landfill.

"Our health is more important than anything. That's why we got to do something about it and take care of our river, because there's not only us. When all those peoples [Elders] were alive, it was good. Now [with the] next generation, we notice everything is getting bad. Now when we pass on, next generation is going to say 'oh, we can't even go to fish camp, can't even go hunting. Everything is ruined.'"(SFN Community Member)

"Most of our territory has been staked and we don't have the proper people to do assessments, to keep track. Yukon Government is overwhelmed as well. They cannot inspect what they are approving. They do not have the manpower." (SFN Community Member)

Concerns about the impacts of mining and exploration were especially prominent in this community. Participants spoke most extensively about Faro Mine, located upstream from their traditional territory on the Pelly River, and Minto Mine, located within the SFN traditional territory on

Figure 4 Types of Land Uses Impacting Water Quality Identified by SFN



the Yukon River. Faro Mine was an active lead-zinc mine until 1997[4] and remediation is underway.[5] However, concerns about the impacts of contamination from the mine are ongoing in the community. Minto Mine is a copper mine and has been in operation since 2007. Regarding all mining and exploration, several participants expressed a concern related to the lack of potential to meet monitoring and assessment needs given the extent of the mining activity that is currently taking place in the territory. It was also

> "I think the water in the garbage dump all soak into that river. You see that creek up there, Micah Creek, by the garbage dump there, that's where you've got to check." (SFN Community Member)

> And a long time ago, people used to drink and pack water from the [Pelly] river. It was clear. And I remember when I was small, we used to drink from the river, even Minto too, till the mine come in and nobody touch water after that. And then everybody [started] using pump water. Not today, because some of [the creeks] are ruined, some of them are not, but it's far away from here." (SFN Elder)

[4] http://www.faroyukon.ca/about-faro/history-of-faro/history-of-faro.cfm
[5] http://faromine.ca/mine/general.html#vangorda

suggested that assessments should examine the cumulative effects of mining, rather than the individual mine in question.

Specific concerns related to drinking water were also raised. A number of participants talked about the high number of cases of *H. pylori*. *H. pylori* is a bacterium that causes chronic inflammation of the stomach.[6] Although the transmission of *H. pylori* occurs through other ways, it can be found in untreated water (Baker and Hegarty 2001). During the focus group it was thought that the majority of cases were concentrated in the Willow Creek Subdivision, where residents draw their drinking water from private wells. However, cases were also found elsewhere in the community where the water from the water treatment plant is the primary source of drinking water. Studying *H. pylori* requires expertise and in-depth study that goes beyond the scope of this study. This is an important health concern. It was recommended that SFN approach another organization that has an existing project on *H. pylori* in First Nation communities.

The specific sites associated with these concerns are identified on the contaminants map that was created during the focus group (See Figure 5 to 7). Sites identified during interviews were subsequently added to the map. 15 sites in total were identified. Sites identified during interviews were subsequently added to the map. Detailed descriptions of these sites were recorded (See Appendix A).[7]

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[6] http://www.mayoclinic.com/health/h-pylori/DS00958

[7] The sites of concern identified during the course of this research should not be considered an exhaustive list.

Figure 5 Participatory Contaminants Map in the Selkirk Traditional Territory

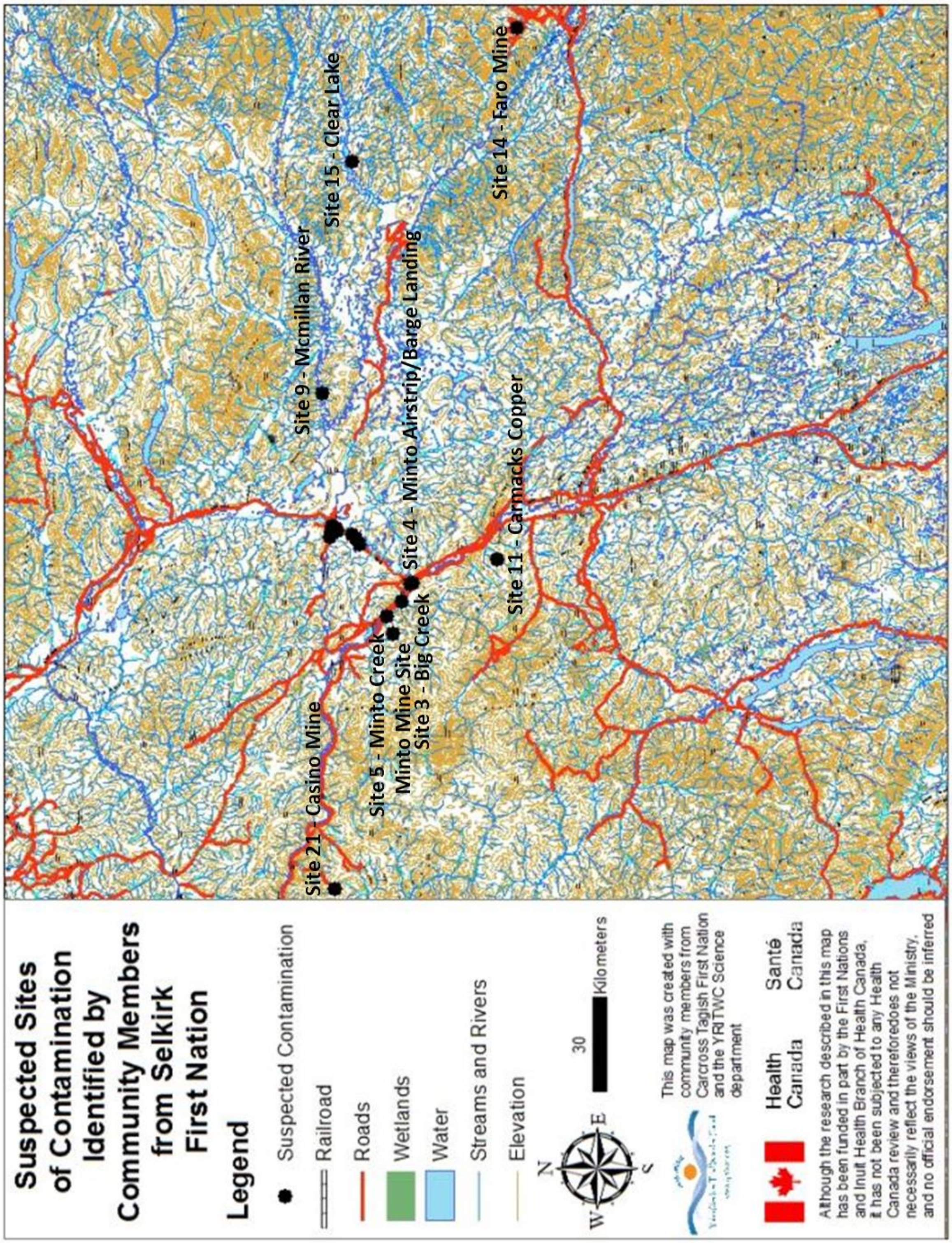


Figure 6 Water Quality Sites Identified on Yukon River

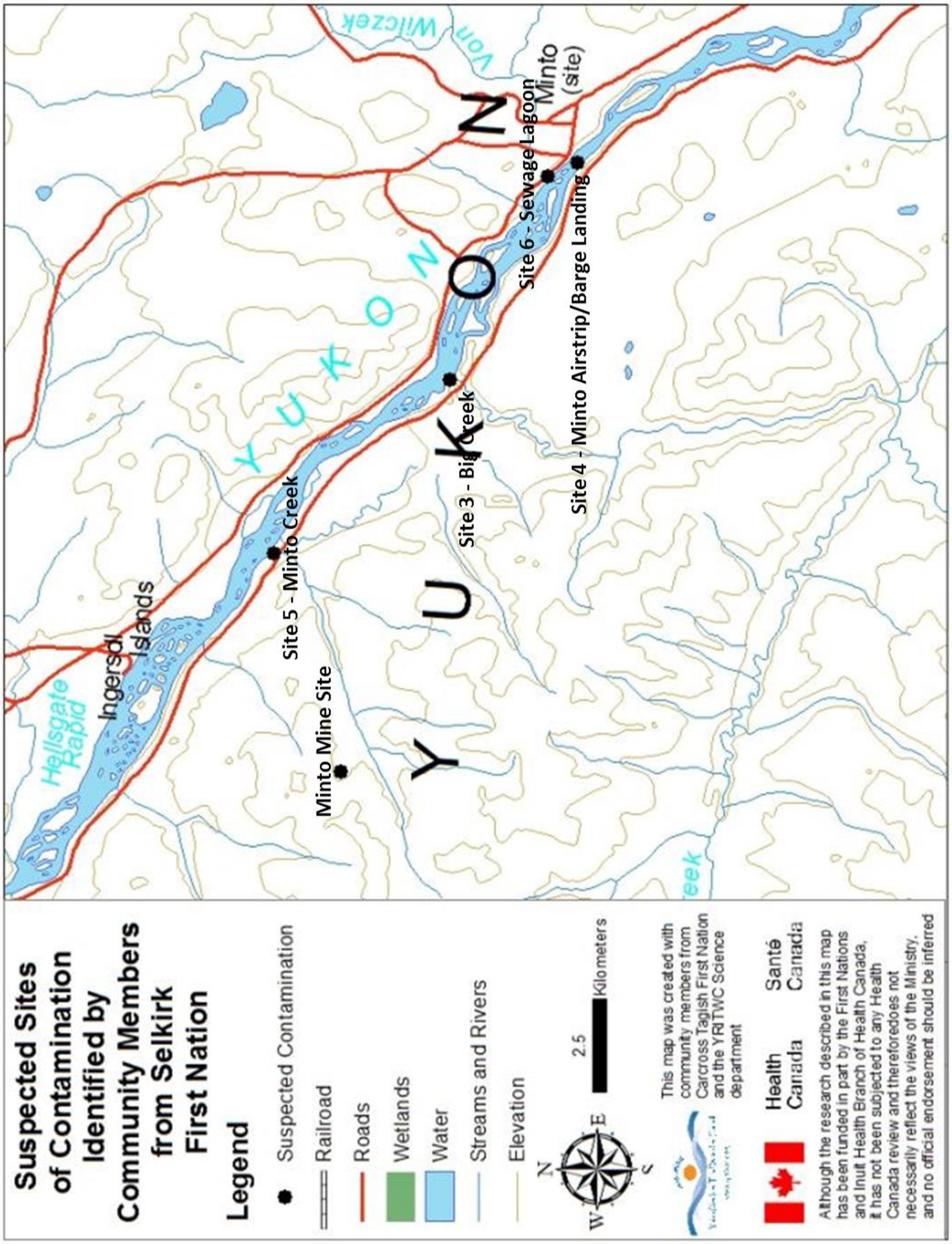
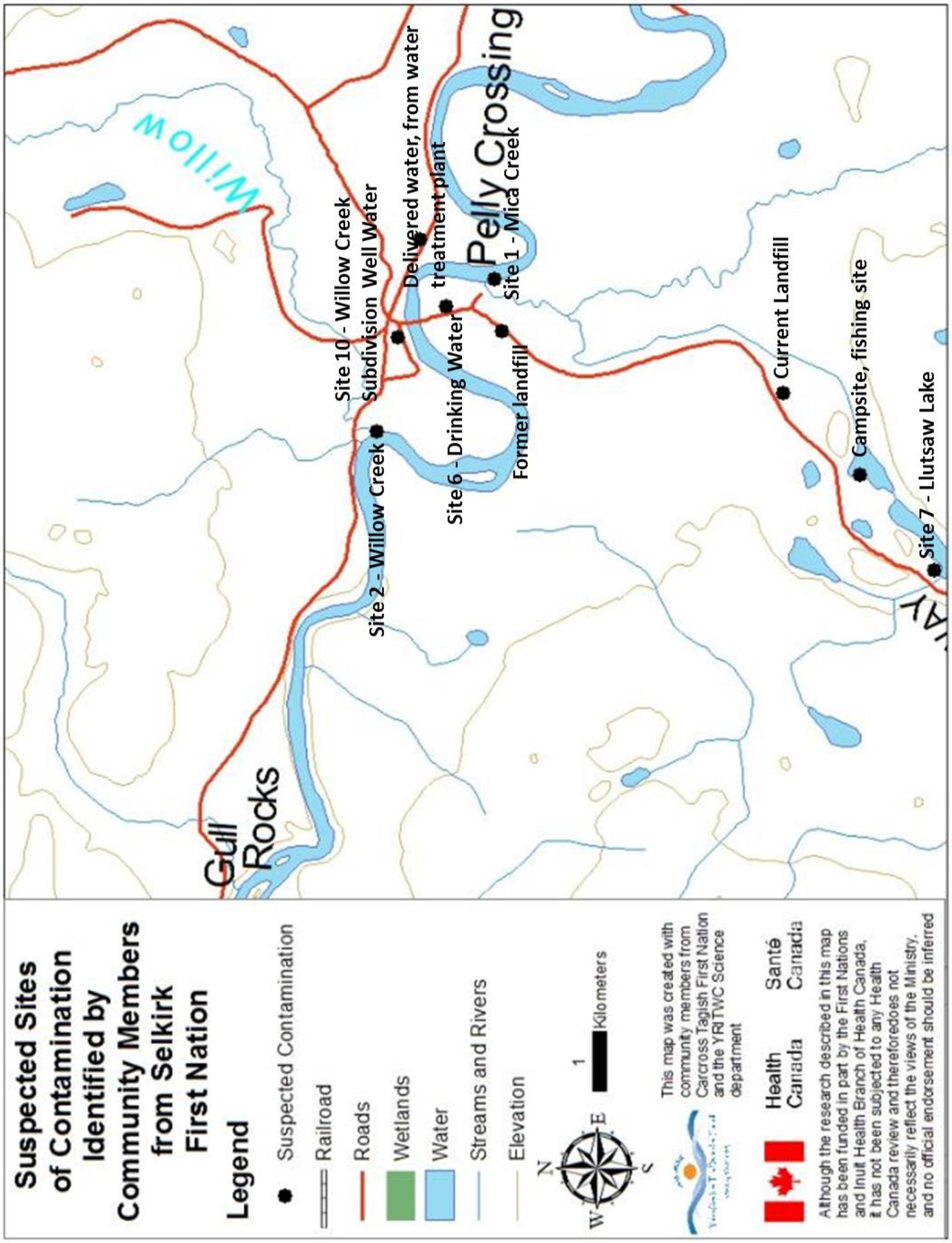


Figure 7 Water Quality Sites Identified Near Pelly Crossing



Results of Water Quality Contaminants Monitoring

Water Quality Parameters and Physical Tests

Water was tested for a variety of parameters. A suite of metals, nutrients, bacteria, and hydrocarbons were analyzed at ALS Environmental Laboratory. The Yukon River Inter-Tribal Watershed Council, Indigenous Observation Network (including C/TFN), and US Geological Survey's Water Quality Monitoring Program are working together to collect baseline water quality samples for each of the sites identified by this project. For each sample collected, analysis was performed for the following dissolved parameters: major ions (alkalinity, chloride, sulphate, calcium, magnesium, sodium and potassium), some trace metals, nutrients (ammonium and nitrate), dissolved organic carbon, and stable water isotopes (deuterium and oxygen-19). Temperature, pH, and dissolved oxygen were measured in the field at each site. The following section provides a description of the water quality parameters mentioned above.

Metals

A suite of 19 metals was analyzed for this project. These metals are often naturally occurring; however, the Canadian Guidelines for Drinking Water Health Canada (2012b) indicates that the concentration of dissolved metals can be elevated by sewage effluent, mining effluent, landfill run-off, soil erosion, weathering of rocks, industrial waste, leachates from plumbing materials, air emissions, and irrigation. There is no evidence that the metals aluminum, calcium, sodium, iron, magnesium, manganese, selenium, and zinc have adverse health effects (*Ibid.*). Guidelines have been developed to ensure treated drinking water with no offensive taste, as consumers may seek alternative sources that are less safe.

Major Ions (Anions and Cations)

Major anions include alkalinity, chloride (Cl), and sulphate (SO_4). Major cations include sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), and some trace metals. Major ions come mostly from natural (geologic) sources and make up most of what is dissolved in water.

Alkalinity is a measure of the water's ability to buffer or balance acid-producing substances. Carbonates, bicarbonates, hydroxides, borates, silicates, phosphates, and some organic substances are represented by alkalinity. It is affected by the bedrock, soils and vegetation (EMAN-North 2005, 3–14).

Chloride is a useful parameter because it behaves conservatively; that is, it tends not to participate in chemical reactions and so the amount going into a river is and the coming out tend to be equal. Chloride concentrations can be used to determine the origin of a water sample and to track long-term trends.

Sulphate is also a nutrient; and some bacteria known as sulphate-reducing bacteria thrive from sulphate consumption. These bacteria reduce sulphate to hydrogen sulphate and this also reduces available oxygen in water. These bacteria can change mercury's chemical form and render it toxic to birds, mammals, and fish (Schuster and Toohey 2012).

Potassium is important because it is a nutrient for aquatic life.

Bacteria

The bacteria samples were collected for total coliform and *Escherichia coli* (*E. coli*). Coliform bacteria are a group of rod-shaped bacteria commonly found in the environment. Fecal coliform bacteria are found in intestines of mammals and humans. Total coliform bacteria are not likely to cause illness, but their presence indicates that a water supply may be vulnerable to contamination by more harmful microorganisms. *E. coli* are the only member of the total coliform group of bacteria that is found only in the intestines of mammals and humans. The presence of *E. coli* in water indicates recent fecal contamination and may indicate the possible presence of disease-causing pathogens like bacteria, viruses, and parasites. Although most strains of *E. coli* bacteria are harmless, certain strains may cause illness. These bacteria are known to grow well in warm temperatures. Fecal coliform bacteria often cause bladder and kidney infection or intestinal inflammation. When *E. coli* bacteria move outside of the intestine they cause disease with symptoms that include stomach cramps, diarrhea, nausea, and vomiting. Boiling drinking water will kill microorganisms but not viruses (Health Canada 2012b).

Hydrocarbons

Hydrocarbons sampled included Volatile Organic Compound (VOC) (e.g. gasoline), Polycyclic Aromatic Hydrocarbons (PAH) (e.g. creosote), Light Extractable Petroleum Hydrocarbons (LEPH) and Heavy Extractable Petroleum Hydrocarbons (HEPH) (e.g. diesels, greases, waxes, lubricating oils, and hydraulic oils).

VOCs are organic compounds containing one or more carbon atoms that have high vapour pressures and evaporate quickly to the atmosphere. VOC emissions result from natural and man-made sources and examples would be from vegetation, forest fires, and animals. Man-made sources in Canada are from the transportation sector, the use of solvents and solvent containing products, and industrial sources (Environment Canada 2010).

PAHs are emitted into the environment from both natural and human sources. Examples would be from forest fires, aluminum smelters, creosote, metallurgical and coking plants, and deposition of atmospheric PAHS. PAHs are relatively non-volatile and of low solubility in water and are mostly absorbed to particulate matter and can be transported and degrade over time. PAHs degrade very slowly in sediments, an important environmental sink for PAHs (Health Canada 2007).

LEPHs are a group of hydrocarbons that contains petroleum hydrocarbons with a carbon range of C10-19 with the exception of some PAHs in the same weight range. The Contaminated Sites Regulations explain HEPH contain a carbon range of C19-32 (Yukon Government 2011).

Nutrients

Nutrients include, among other elements, nitrogen (N) and phosphorous (P). Both of these nutrients are important for aquatic life. In excess these nutrients can alter water quality by reducing oxygen in the water from the increase of algae growth. Sewage effluent and agriculture can increase nutrient levels. Most nutrients test will look for total oxidized nitrogen (NO2 + NO3) because NO2 is poisonous to fish and is known to contribute to the overgrowth of algae. Nitrate (NO_3) is a nutrient and too much can cause algae blooms and contribute to the depletion of available oxygen in water for aquatic life. Ammonium (NH4) is also measured because in high concentrations it can be toxic to fish and other animals (YRITWC 2012, 44).

Dissolved Organic Carbon

Dissolved Organic Carbon (DOC) is the first available nutrient in the food chain. This nutrient is not a health concern on its own; however, it can attract heavy metals such as mercury and cadmium. When these metals increase in concentration by moving up the food chain they become toxic for wildlife and humans. Arctic rivers are generally low in DOC but levels are higher with surrounding wetlands (YRITWC 2012, 44).

Stable Water Isotopes

The stable isotopes of water, deuterium or hydrogen-2 (H2) and oxygen-18 (O18) are measured to determine a water sample's "signature" or "fingerprint". They can be used to trace the origin and movement of a water sample. Groundwater has a different signature than rainwater. Lake water has a different signature than glacial melt water (YRITWC 2012, 44).

Field pH

The measure of pH is of the basic and acidic nature of a solution and varies with the amount of hydrogen ions present in water. Aquatic life tends to thrive in a particular range of pH values and this depends on their stage of life and environment. If their living environment fluctuates outside of that range they could die or become ill. A pH range of 6.0 to 9.0 provides a healthy environment for freshwater fish and invertebrates (YRITWC 2012, 43).

Dissolved Oxygen

Dissolved Oxygen (DO) is the amount of available oxygen in the water. Oxygen gets into water by aeration (rapid water movement), diffusions from the air, and as a product of photosynthesis. A high level of dissolved oxygen in drinking water is good because it makes the water taste better; however, high levels of dissolved oxygen can speed up corrosion of water pipes. If the concentration levels of total dissolved gas in water go over 110% it can be harmful to aquatic life. Fish and aquatic invertebrates can experience 'gas bubble disease' and die. The amount of DO that an aquatic organism needs is dependent on the species of the animal, the water temperatures, the animal's physical state, and the pollutants present in the water. At higher temperatures fish use more oxygen because their metabolic rate increases. Research suggests that 4 - 5 mg/L is the minimum amount of DO that can support a large and diverse fish population. Good fish habitat generally averages around 9 mg/L of DO. Fish die when DO levels fall below 3 mg/L (YRITWC 2012, 43).

Conductance

Conductance refers to the ability of a water sample to conduct electricity. Electrical current is transported by the ions that are present in the water. All of the dissolved solids in water are either negatively charged ions (anions, discussed above) or positively charged ions (cations, similarly discussed above). The total concentration of ions dissolved in water is commonly called total dissolved solids (TDS). The conductance of water generally increases as the number of ions increases; therefore a higher conductivity reading means that there are more anions and cations present in the water and therefore a higher TDS (YRITWC 2012, 43).

Total Dissolved Solids (TDS)

Total dissolved solids are not known to cause any human health problems, but are more likely to have aesthetic influences; they can contribute to the corrosion of water pipes. Elevated TDS can cause drinking water to taste unpleasant and look murky in appearance. Water becomes saline at extremely high levels of TDS; therefore, water is not recommended for drinking when the TDS reads above 500 mg/L or when specific conductance is above 750 uS/cm. Occasionally high levels of TDS cause gastrointestinal irritations.

Location of Water Quality Sampling

Community members and SFN government officials selected five water quality sites throughout the SFN traditional territory. The YRITWC was responsible for sampling these sites. Table 1 provides background information for these sites, including their location and the types of contaminants for which they were sampled.

Samples were collected from Mica Creek, Willow Creek, Yukon River (at the Minto barge landing), Big Creek and Minto Creek. Several types of samples were sent to the ALS Environmental laboratory in Whitehorse, Yukon. Hydrocarbon samples were collected for petroleum contamination concerns in Mica Creek and Yukon River (at the Minto barge landing). Bacterial and nutrient samples were collected for drinking, sewage and landfill concerns in Mica Creek and Willow Creek. A suite of heavy metal samples was collected for mining effluent concerns at four of the sites excluding the Yukon River site.

Additional samples (YRITWC kits) were sent to the United States Geological Survey (USGS) in Boulder, Colorado. These kits include: major ions, metals, nutrients, dissolved organic carbon, and stable water isotopes. The YRITWC will follow-up with SFN when additional USGS data is made available.

Table 1 Selkirk First Nation Water Quality Sites Sampled

Site Name	Site ID	GPS Coordinates (DD)	ALS Samples	Analysis	YRITWC Kit (Y/N)	Suspected Contaminants	Dates
Mica Creek	SFN01	62.81648, -136.56723	Hydrocarbons. VOC, PAH, Total metals. *E. coli*., Total Coliform, Nutrients.	BTEX+VPH+MTBE+ Styrene in water GCMS/FID. LEPH & HEPH CSR. Total Metals in water. *E. coli* and Total by Colilert (Health). N+N-VA. P-T-COL-VA. PO4-DO-COL-VA.	Y	Landfill.	Sept. 25, 2012. Sept. 27, 2012
Willow Creek	SFN02	62.83367, -136.62099	Total Metals. *E. coli*., Total Coliform, Nutrients.	Total Metals in water. *E. coli* and Total by Colilert (Health). N+N-VA. P-T-COL-VA. PO4-DO-COL-VA.	Y	General concerns because of use as a source of drinking water.	Sept. 25, 2012. Sept. 27, 2012
Minto Barge Landing, Yukon River	SFN03	62.59180, -136.87804	Hydrocarbons, VOC, PAH	BTEX+VPH+MTBE+ Styrene in water GCMS/FID. LEPH & HEPH CSR.	Y	Minto Barge Landing is active year round. Very active before freeze up, increased number of crossings.	Sept. 26, 2012
Big Creek	SFN04	62.61566, -136.99548	Total Metals	Total Metals in water.	Y	Mining activity.	Sept. 26, 2012
Minto Creek	SFN05	62.65643, -137.09502	Total Metals	Total Metals in water.	Y	Mining activity. Permafrost melting.	Sept. 26, 2012
				Total	**5**		

Analysis of Water Quality Samples

Generally, the YRITWC found the water quality to be within aquatic, recreational, and drinking water standards and guidelines. However, sampling at these sites occurred with respect to the suspected contaminants (i.e., if hydrocarbons were suspected, samples were analyzed for hydrocarbons not nutrients). Therefore, these sites may have other sources of contamination. Additional samples are needed to determine trends and to have a robust baseline to help identify physical and chemical changes.

Several water quality guidelines and standards were applied to determine a threat of contamination in drinking water, recreational water, and aquatic habitat. Caution is needed when applying guidelines and standards for water quality analyses as there may be additional factors to consider, such as dilution, pH, or water hardness. Drinking water standards are referenced for the sole purpose of consumption in its raw state. *There are no standards used for raw drinking water. They are designed for treated water to determine compliance and functionality of treatment systems.*

The guidelines and standards applied are Guidelines for Canadian Drinking Water Quality (GCDWQ/CCME DW)[8], Guidelines for Canadian Recreational Water

[8] Health Canada publishes the Guidelines for Canadian Drinking Water Quality and they are developed by a committee of Federal-Provincial-Territorial governments (Health Canada 2012). This guideline has set out Maximum Acceptable Concentrations (MAC) in drinking water for microbiological, chemical, and radiological contaminants. Also physical characteristics of drinking water, such as taste and odour have standards set to avoid consumers from seeking unreliable alternatives. Although Canadian drinking water supplies are generally of excellent quality, is it natural for water from these sources to contain elements of all of the substances they come in contact with. These can include minerals, silt, vegetation, fertilizers, and agricultural run-off. Most of these substances are not harmful to human health; some of them make be dangerous to vulnerable populations including children and the elderly. The Health Canada Drinking Water Guideless provide parameters that all drinking water

Quality (GCRWQ),[9] Canadian Environmental Quality Guidelines (CEQG/CCME AW),[10] and Yukon Government Contaminated Sites Regulations (YCSR).[11] A committee of scientists, experts, and government establish standards and guidelines to help determine maximum acceptable concentrations of water contaminants. From the sites tested, no samples exceeded recreational water guidelines.

YRITWC and ALS sampling protocols were used to collect surface water by a grab sample technique. In additional to the contaminant sampling, the YRITWC collected samples for major ions, metals, nutrients, dissolved organic carbon, and stable water isotopes for USGS analysis.

Mica Creek

Mica Creek was sampled at the mouth near the confluence of Pelly River for hydrocarbons, VOCs, PAHs, metals, bacteria, and nutrients (See Table 1). *E. coli* and total coliform bacteria exceeded YCSR standard and Canadian Guidelines for drinking water (See Table 2, Figure 13 and 14). No metal concentrations exceeded YCSR standards for aquatic life. VOCs, hydrocarbons, and PAHs were not detected at Mica Creek (See Table 2). Metal concentrations did not exceed the standards used in the analysis. Mica Creek had low nutrient levels during sampling.

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systems to seek to meet or exceed in order to provide safe drinking water (Health Canada 2012b).

[9] The objective of Health Canada's Guidelines for Canadian Recreational Water Quality is the protection of public health. These guidelines outline current scientific knowledge of health and safety issues related to the recreational use of water. These mainly include "the risk of infection from contact with pathogenic microorganisms, and illness or injury as a result of physical or chemical properties of the water" (Health Canada 2012a).

[10] The Canadian Environmental Quality Guidelines are nationally recognized science-based goals for environmental quality. They are defined as "numerical concentrations or narrative statements that are recommended as levels that should result in negligible risk to biota, their functions, or any interactions that are integral to sustaining the health of ecosystems and the designated resource uses they support" (CCME 2013).

[11] The Yukon Government's Contaminated Sites Regulations (CSR) establishes standards for drinking water, aquatic life, irrigation, and livestock. These standards ensure water is suitable for direct use and is clean enough to protect water uses on adjacent properties (Yukon Government 2012).

Willow Creek

Willow Creek was sampled for metals at the mouth near the confluence of Pelly River. Bacteria and nutrients were sampled at the bridge on the Pelly Farm Road. This sampling location was selected because some SFN members collect water at the bridge site. Concentrations for iron, manganese, and bacteria (i.e., E. coli and coliform) exceeded YCSR standard and Canadian Guidelines for drinking water (See Table 2). Iron concentrations exceeded Canadian Environmental Quality Guidelines for aquatic life (See Table 3). However, iron and manganese exceedances were likely due to high natural background concentrations (See Figure 15 and 16). The majority of metal concentrations were below the standards used in the analysis or they were undetectable. No hydrocarbon, VOCs, or PAHs were sampled at Willow Creek. The Creek had low nutrient levels at the time of sampling. *E. coli* and total coliform were present at the bridge sample site (See Figure 12 and 13).

Yukon River at Minto Barge

The Yukon River at Minto Barge Landing was sampled for hydrocarbons, VOCs, and PAHs (See Table 2). Minto Mine is the primary user of the barge; therefore, fuel and oil contamination are a concern for this area. At the time of sampling, VOCs, hydrocarbons, or PAHs were not detected at this site (See Tables 2).

Big Creek

Big Creek was sampled for metals at the mouth near the confluence of the Yukon River. No metal concentrations exceeded YCSR standard and Canadian Guidelines for drinking and recreational water. Concentrations of aluminum and copper exceeded the Canadian Guidelines for aquatic life (See Table 3, Figure 16 and 17). However, these exceedances were likely due to high natural background concentrations in the area. No hydrocarbons, VOCs, or PAHs were sampled at Big Creek.

Minto Creek

Minto Creek was sampled for metals at the mouth near the confluence of Yukon River. Concentrations of iron and manganese exceeded YCSR standard and Canadian Guidelines for drinking water (See Figure 14 and 15). Iron and aluminum concentrations exceeded Canadian Guidelines for aquatic life. No hydrocarbons, VOCs, or PAHs were sampled at Minto Creek.

Table 2 Parameters Exceeding Drinking and Recreational Water Standards and Guidelines

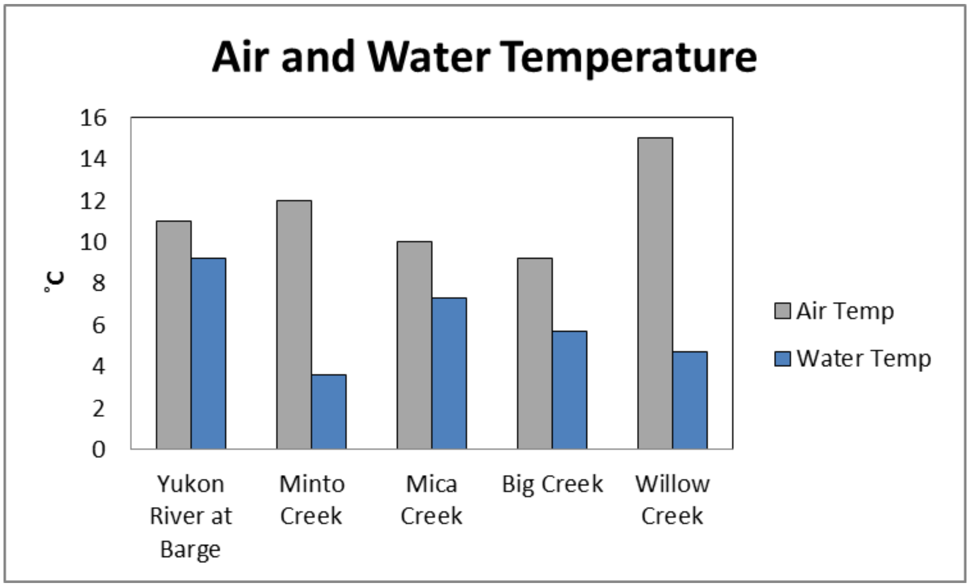
Surface Water Body	Site	Hydrocarbon, VOCs, PAHs	Water Quality Parameters that Exceed YCSR DW Standards	Water Quality Parameters that Exceed CCME DW	Water Quality Parameters that Exceed GCRWQ
Mica Creek	SFN01	No	Bacteria	Bacteria	No
Willow Creek	SFN02	-	Fe, Mn, Bacteria	Fe, Mn, Bacteria	No
Yukon River at Minto Barge	SFN03	No	-	-	No
Big Creek	SFN04	-	No	No	No
Minto Creek	SFN05	-	Fe, Mn	Fe, Mn	No

Table 3 Parameters Exceeding Aquatic Life Water Standards and Guidelines

	Site	Water Quality Parameters that Exceed YCSR AW Standards	Water Quality Parameters that Exceed CCME AW Guidelines
Mica Creek	SFN01	No	No
Willow Creek	SFN02	No	Fe
Yukon River at Minto Barge	SFN03	No	No
Big Creek	SFN04	No	Al, Cu
Minto Creek	SFN05	No	Fe, Al

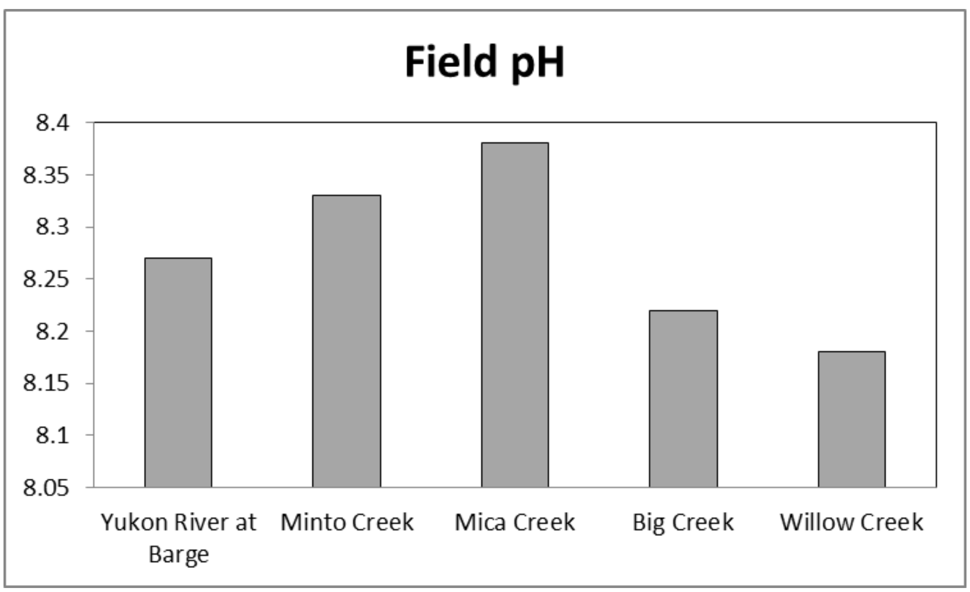
Field parameters of air and water temperatures are compared among all sites in Figure 8.

Figure 8 Air and Water Temperature



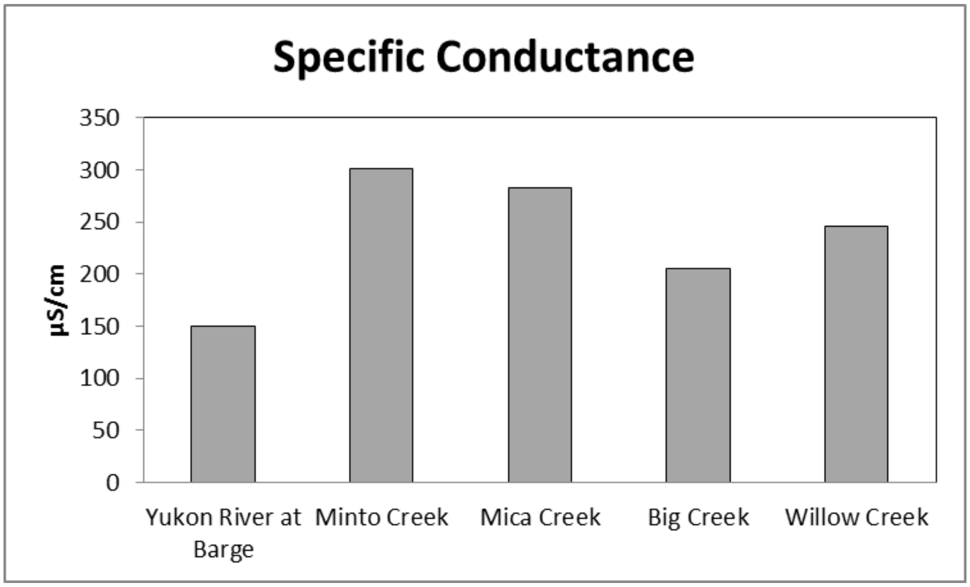
The pH field readings are in normal ranges for aquatic life, recreational water, and drinking water (See Figure 9). The pH of all the sites sampled indicates a slight basic reading. The underlying rocks and soils have an influence on pH.

Figure 9 Field pH



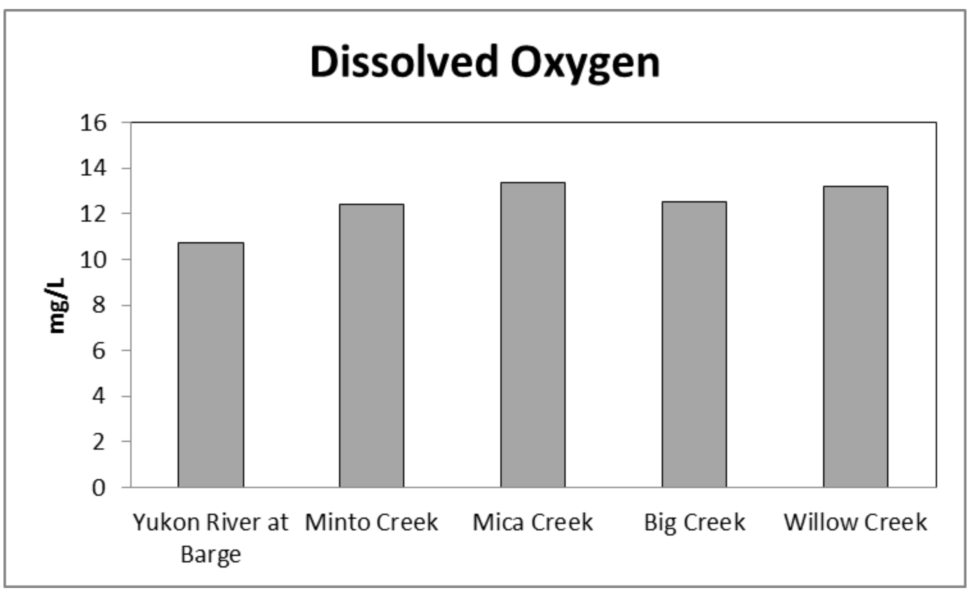
Specific conductance was analyzed at the USGS lab for all sites (See Figure 9).

Figure 10 Specific Conductance



Dissolved oxygen levels are all within aquatic life standards (See Figure 11). The Canadian water quality guideline for the protection of aquatic life recommends a minimum concentration of DO in fresh water of 5.5 mg/L.

Figure 11 Dissolved Oxygen



Not every site was tested for *E. coli* and total coliform bacteria. Only Mica Creek and Willow Creek were sampled for these parameters (See Figure 12).

Figure 12 *E. coli* Count in a Sample

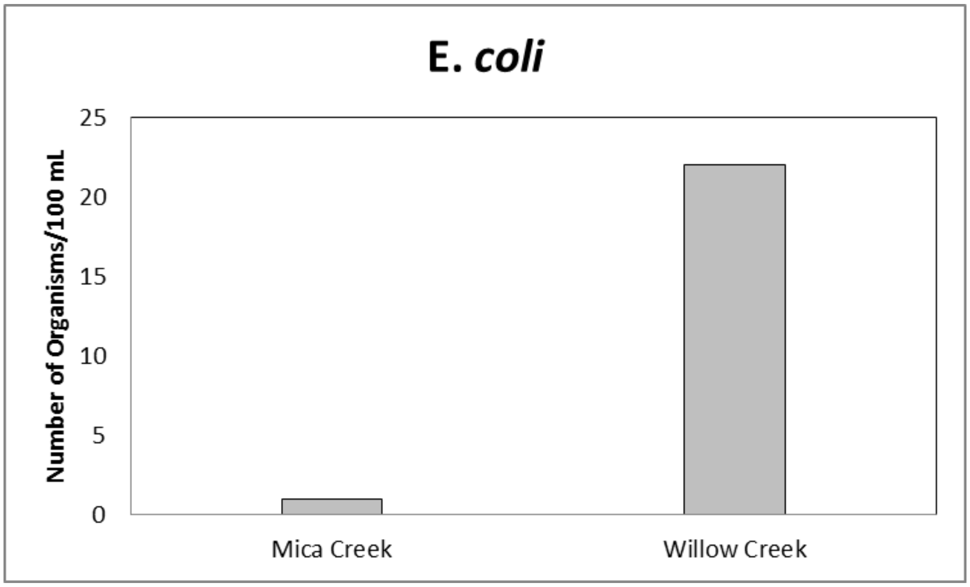


Figure 13 Total Coliform Count in a Sample

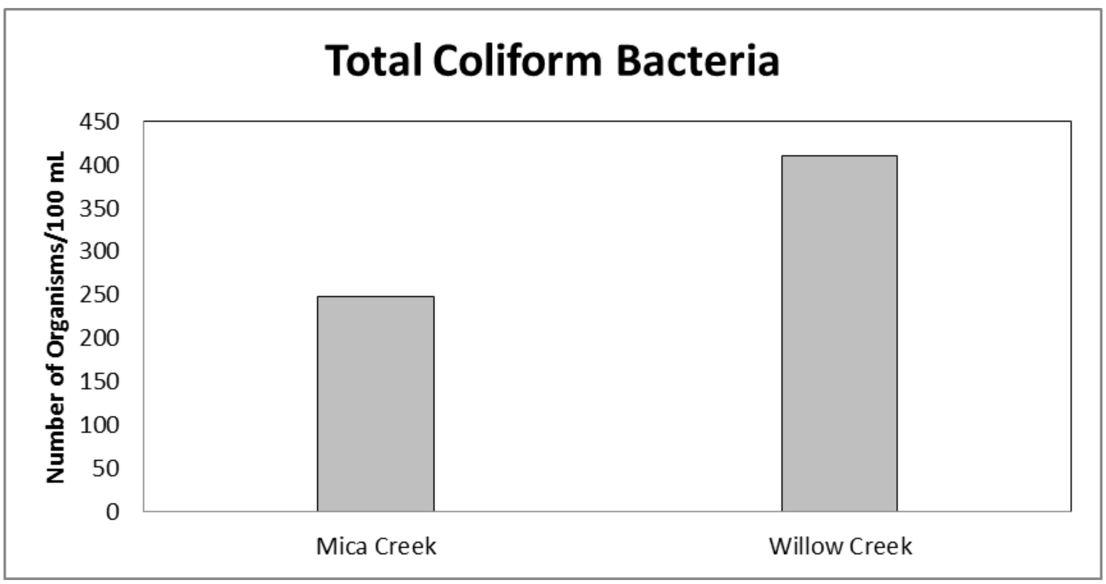


Figure 14 Iron Concentrations Exceeding Drinking Water Guidelines

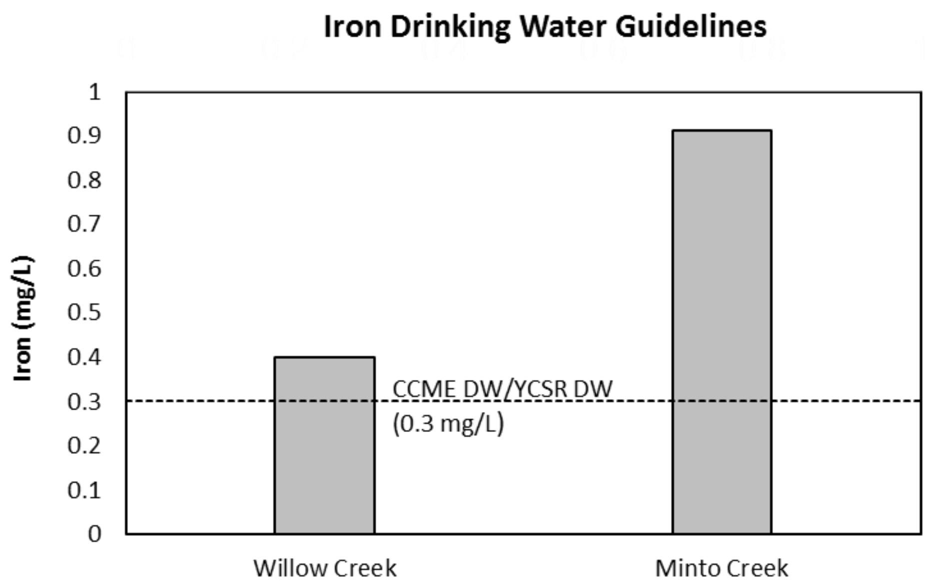


Figure 15 Manganese Concentrations Exceeding Drinking Water Guidelines

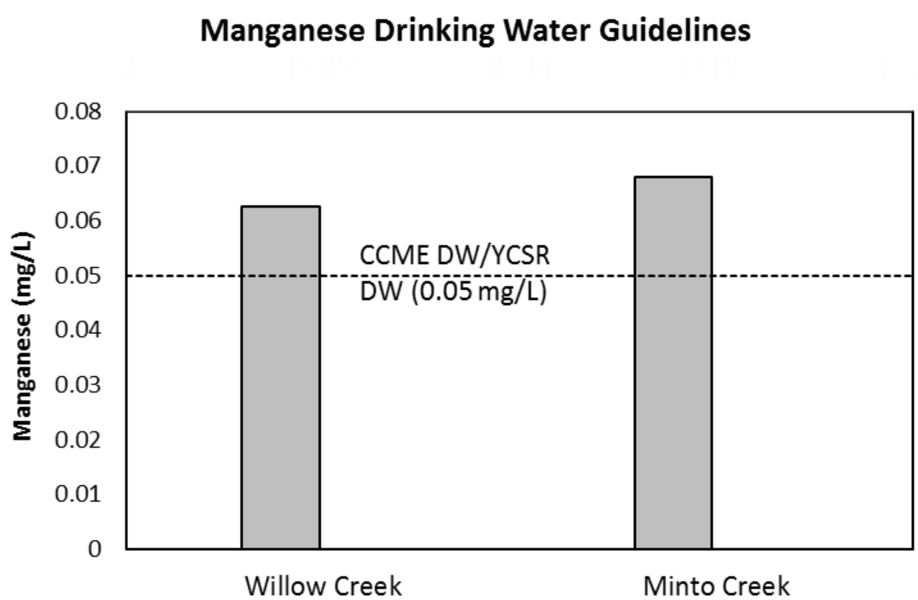


Figure 16 Aluminum Concentrations for Big Creek

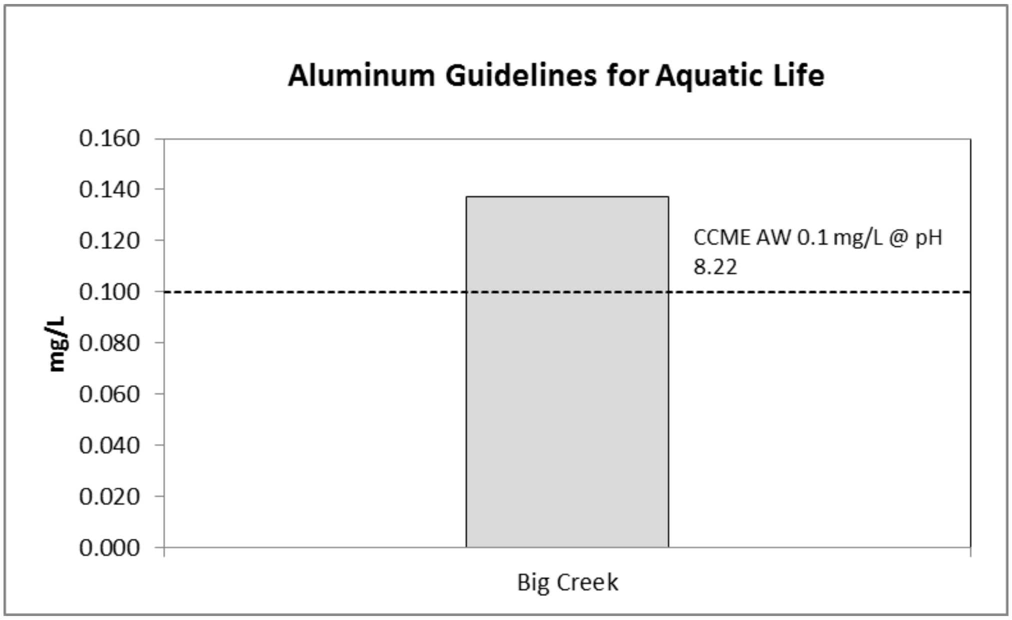
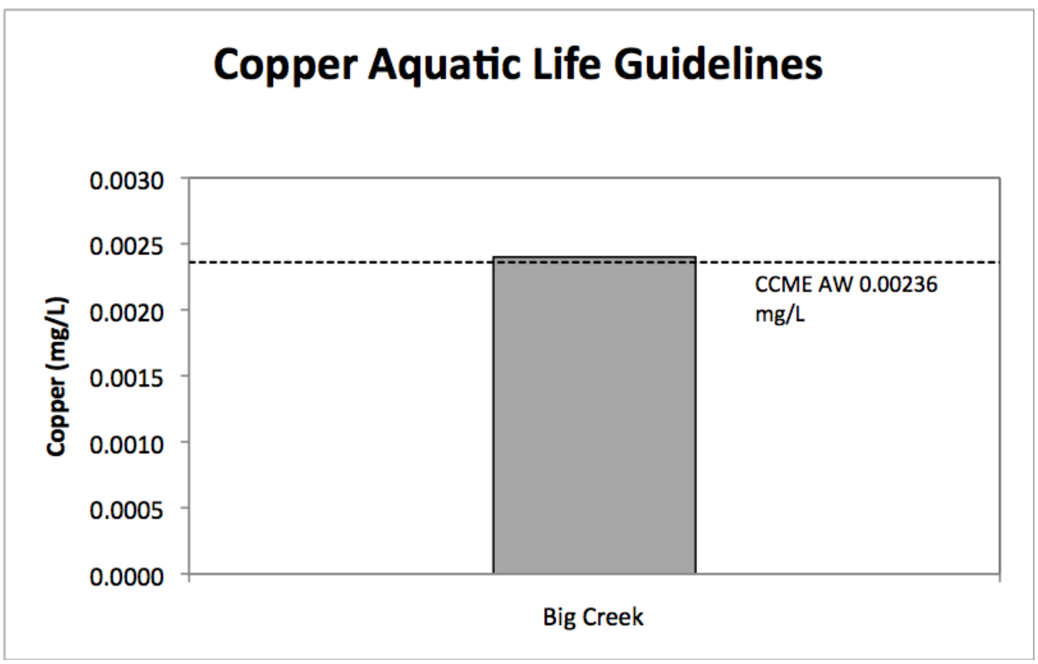


Figure 17 Copper Concentrations for Big Creek



What does it all mean?

While some of these samples showed elevated levels of specific metals and bacteria, this year's sampling did not suggest any major contamination occurring within the selected water bodies. Within this report, we compare results from the selected water bodies to four different sets of Canadian water quality standards: Drinking Water Quality, Recreational Water Quality, Environmental Quality and Contaminated Sites Regulations. Each of these standards was designed for different uses of water resources. The Drinking Water Quality standards are the strictest and only applied to treated water (i.e., filtered, chlorinated, etc.). However, we wanted to compare these untreated water bodies to Drinking Water standards because of their use as drinking water sources. Natural water bodies generally contain a wide variety of bacteria, nutrients, and metals that varies depending upon the geology, human and wildlife populations within the water body's watershed. Bacteria results (*E. coli* and Total Coliform) are just as likely to come from wildlife as they from humans. Within this study, we could determine the source (human vs. wildlife). Therefore, the results from this year's sampling do not show any significant results of contamination.

However, this year's results only provide a very small amount of data (one sample at one point in time) with respect to the selected water bodies. We hope that future funding will allow YRITWC and SFN to monitor these sites throughout the open water season for two more years. Sampling throughout the open water season will give a much clearer picture about any risk of contamination. If increased and continued sampling continues to support the results found in this report, then this data becomes a valuable set of baseline monitoring data which SFN can continue to reference for many years in the future. At the very least, this data will allow SFN and the YRITWC to assess changes over the years to come.

Take home points from the Water Quality Analyses:

1. Water from Mica and Willow creek should be treated before being used as drinking water because of elevated *E. coli*. Boiling, UV light, and portable water filters should all provide sufficient protection if properly used. Bacterial samples are also easily contaminated (i.e., from sample handling); therefore, more sampling should occur throughout the year to confirm results.
2. Much more sampling needs to occur to confirm or rule out any risk of contamination. The YRITWC and SFN have submitted proposals to fund water quality sampling for Year 2 of this project.

Observations of Climate Change

During interviews and focus groups, participants were asked if they had observed any changes in the environment that may be attributed to climate change. These observations included changes in the weather, water levels, permafrost, river and lake ice regimes, plants, fish and animals and others. These observations are summarized in Table 4 – Observations of Climate Change in the Selkirk First

"I notice that lately, we hardly have berries, even though lots of rain like that. We used to have, long time ago, we used to have lots of berries every summer when people pick their berries in August." (SFN Community Member)

"It's crazy. In summertime, in July month, it's supposed to be hot, but it was cold all through July. The winter is kind of warm sometime, right down to December, like that and then it gets cold after that." (SFN Community Member)

"Like the moose rutting time, it seems like for me, it seems like it's pretty late in starting. I went up on the tenth, I think. There were no hunters up there for the first three or four days, no hunter, no moose around the river. Then when they're ready to come back around 17 or something, all the moose come out and all the hunters come along the same time too. They usually start around 11, September 10, 11. They start rutting time, they start moving over the place. For some reason, this time, they didn't show up for a long time." (SFN Community Member)

"Along McMillan River there was a bit of landslide, that was the one they were talking about that almost pinched the river off. So people are getting pretty nervous because they are not used to seeing these landslides, like the whole side of a hill coming down." (SFN Community Member)

"The water is warmer. The fish, they feel softer, not just the salmon, but the grayling and stuff. So the warmer water, if feels like it's affected the fish somehow." (SFN Community Member)

Nation Traditional Territory. Observations are also illustrated by the quotes provided in the textboxes contained within this section. Many of these observations are consistent with observations of climate change elsewhere in the Arctic and Sub-Arctic (ACIA 2005; Environment Yukon 2011). Each of these observations provides important information regarding the impacts that climate change may be having on the environment in this region. In combination with concerns about the impacts of contaminants on water and results from water quality sampling, observations of climate change are important in understanding overall environmental change and the affects these changes may be having on community members. The documented observations of climate change provide a basis for further research on the interactions between contaminants and climate change in specific aspects of the environment. The observations documented in this report could also be useful to the community as they seek to respond to climate change. This could include the development of community-based adaptation and mitigation programs.

Table 4 Observations of Climate Change in the White River Traditional Territory

Type of Change Observed	Examples of Change
Weather	• Warmer temperatures in the winter • Colder temperatures in the summer • Increased rain in the summer
Water Levels	• Lower water levels in lakes, except this year • Some creeks have started to dry out during the summer
Permafrost	• Permafrost thaw • Increased erosion
River and Lake Ice	• Reduced Ice Thickness • Later Freeze-up
Plants	• Berry crops have been poor • Leaves are turning silver
Fish & Animals	• Reduced salmon runs • Moose are rutting later • Presence of new birds • Presence of new animals including cougars and deer
Other	• Presence of new insects i.e. A lot of moths were present in the community this spring

Study Limitations

This project was limited by several factors. Time limitations impacted the project in two major ways. First, in high latitude regions, water sampling must take place within a four month field season. The YRITWC was only able to take one water sample per site. The ability to take multiple samples throughout the season could have given us a more complete picture of what is occurring with water quality. Second, time limitations also impacted the ability to integrate interview data into decision-making about water sampling. The YRITWC spent one week in each community. In general, the focus group was conducted at the beginning of the week in order to allow time for sampling to be completed in the following two days. Interviews were conducted at the same time as sampling. Often new information came to light that should have been incorporated into the water quality sampling plan. In the future, it would be useful to conduct interviews before focus groups are conducted.

The contaminants monitoring conducted during this project was limited to water quality sampling. As contaminated sites were identified, it became apparent that surface water was not always the appropriate sampling medium. Soil samples also would have been useful in identifying contaminants. Bacteria and nutrient samples had a short holding time to reach the labs (30 hrs).

Conclusion and Next Steps

The purpose of this project was to initiate a community contaminant and climate change monitoring program. The preceding report documents the steps taken during the project to accomplish this task:

- **Documented the importance of water to SFN, which is a necessary first step for situating a community-based contaminants monitoring program.** Understanding the importance of water is fundamental to establishing a community climate change and contaminants monitoring program for two reasons: 1) It allows us to understand how changes in water resources are impacting people 2) Cultural connections to water are also the inspiration for protecting water resources;

- **Identified and mapped the sites of concern to community members.** The contaminant maps produced during this project document community concerns regarding the impact of contaminants on water resources in their traditional territory. While we were able to take water samples at ten of these sites, the maps can act as a resource for the community as they seek to further develop their water quality monitoring programs;

- **Conducted water quality sampling at five sites**. While some of these samples showed elevated levels of specific metals and bacteria, this year's sampling did not suggest any major contamination occurring within the selected water bodies. Further sampling is required. This year's results only provide a very small amount of data (one sample at one point in time) with respect to the selected water bodies.

  Next Step: Identify sources of funding to conduct water quality monitoring of these sites for at least two years. Sampling throughout the open water season will give a much clearer picture about any risk of contamination. Continued sampling would allow for the establishment of a valuable set of baseline monitoring data which could be used as a reference for many years to come and allow for the assessment of changes over the years to come;

- **Documented observations of climate change.** Observations of climate change provide a basis for further research on the interactions between contaminants and climate change in specific aspects of the environment.

  Next Step: The observations documented in this report could also be useful to the community as they seek to respond to the impacts of climate change in their traditional territory. This could include the development of community-based adaptation and mitigation programs.

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Appendix A - Description of Community Identified Water Quality Sites of Concern

Site #	Name	Suspected Contaminants	Description
1	Mica Creek	Leaching, hydrocarbons, metals and Bacteria.	Current landfill suspected source of contamination. Landfill is located in a wetland. This creek used to be a source of drinking water and was used heavily for fishing (whitefish). The landfill and other sources of contamination have stopped people from drinking this water.
2	Willow Creek	Bacteria/Habitat	The Willow Creek Subdivision is located near this creek. There are concerns about the influence of sewage on this creek. The houses in this area have wells. This is an important area for hunting and fishing. One individual indicated that this creek continues to be a source of drinking water.
3	Big Creek	Mining	There is extensive placer mining taking place up Big Creek. There is an interest in studying the cumulative effects of these mines on the creek.
4	Minto Airstrip/Barge Landing	Hydrocarbons	There have been several fuel spills on the airstrip. You would need to take soil rather than water samples here.
5	Minto Creek	Mining	Concerns were raised about the impact that Minto Mine may be having on Minto Creek. For example, it is uncertain how an emergency discharge that occurred in 2008 impacted the fish. A site visit was conducted in spring 2012 due to high levels of sediment. There is also a lot of permafrost degradation occurring in the area where the mine is located causing the ground to slump. There has been an increased amount of sediments and all metals in the creek. It is uncertain whether it is caused by the mine, climate change or both.

6	Drinking Water	*H. pylori*	*H. pylori* is a concern in the community and is believed to be transmitted by drinking water. There are two sources of drinking water for the community. Water from the treatment plant is piped to some homes and delivered to those in the John Ross Subdivision. The homes in Willow Creek Subdivision rely on well water. There is a concern that these wells are from shallow ground water. The majority *of* people contracting *H. pylori* reside in Willow Creek. This is an important health concern. It was recommended that SFN approach another organization that has an existing project on *H. pylori* in First Nation communities.
7	Llutsaw Lake	Hydrocarbons	Barrels in lake may be affecting fish habitat.
8	Barge Crossing at Minto Landing	Hydrocarbons	Barge crossing goes across the Yukon River to Minto mine road. Concerns about impacts on water quality and fish habitat.
9	Macmillan River	Permafrost degradation	Permafrost degradation is occurring and slumping, erosion and landslides have been observed. Participants also observed a lot of 'black muck.' They noted that these observations are associated with permafrost thaw. It is isolated country and it requires a boat or a plane to get up there. The river goes all the way up to NWT.
11	Carmacks Copper	Mining	Heap Leaching is used as this mine.
12	Casino Mine at Coffee Creek	Mining	Porphyry gold-copper-molybdenum deposit. If this goes ahead, it will be among the largest copper mines in the world.
13	White Gold Area	Mining	Gold mining exploration is currently taking place in this area and they getting positive results in drilling. Will only expand operations.
14	Faro Mine	Mining	Concerns regarding the extent to which the Faro Mine site continues to impact the Pelly River and surrounding area.
15	Clear Creek	Mining Exploration	Concerns about the impacts of exploration and future mining.

Appendix B – Pictures of Water Quality Sites Sampled

Figure 178 Mica Creek

Figure 18 Willow Creek

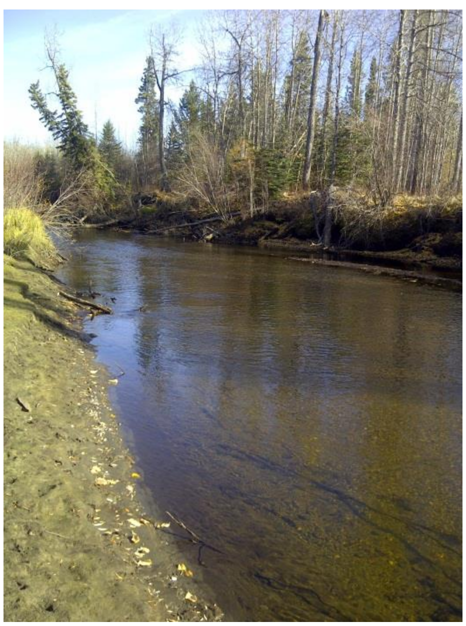
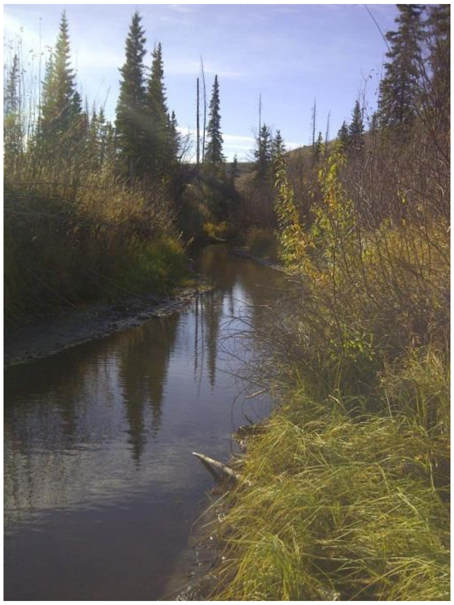


Figure 20 Yukon River at Minto Barge

Figure 191 Big Creek

Figure 202 Minto Creek



Appendix C – Useful Resources

1. Yukon Water: Here, you'll find information about Yukon's water resources. There is information about how water is used, managed and monitored (http://yukonwater.ca/-). The following is a listing of reference material from the yukonwater site:

Climate Change

- Mayo Region Climate Change Action Plan (PDF 2.3 MB)
- Climate Change Adaptation and Water Governance Report. (PDF 1.2 MB)
- Summary of: Compendium of Yukon Climate Change Science: 2003-2011 (PDF 4.1 MB)
- Compendium of Yukon Climate Change Science: 2003-2011 (PDF 2.3 MB)
- Hydrology of the Bennett Lake Watershed: Contemporary Conditions and Potential Impacts of Climate Change (PDF 4.01 MB)
- Yukon Water: An Assessment of Climate Change Vulnerabilities 2011 (PDF 10MB)
- Yukon Water: A Summary of Climate Change Vulnerabilities 2011 (PDF 3.1MB)
- Yukon Government Climate Change Action Plan (PDF 2.2 MB)
- Climate Change and Water Intergovernmental Panel on Climate Change Technical Paper VI (PDF 7.11 MB)
- Arctic Climate Impact Assessment (PDF, 1.62 MB)
- United States Environmental Protection Agency National Water Strategy: Response to Climate Change (PDF, 11.4 MB)

Groundwater

1. Yukon Wide Long-Term Groundwater Monitoring Program, Community of Whitehorse Wells, 2001-2010 Monitoring Data Analysis (PDF 276 KB)

Water Monitoring

- Yukon Snow Survey & Water Supply Forecast

The Yukon Snow Survey Bulletin and Water Supply Forecast is prepared and issued by Environment Yukon's Water Resources Branch three times annually after March 1, April 1, and May 1. The bulletin provides a summary of winter meteorological and stream flow conditions for Yukon, as well as current snow depth and snow water equivalent observations for 56 locations.

http://www.env.gov.yk.ca/monitoringenvironment/snow_survey.php-)

2. The Fresh Water Quality Monitoring & Surveillance Division focuses on regular monitoring, surveillance and reporting on fresh water quality, and aquatic ecosystem status and trends.

http://waterquality.ec.gc.ca/-

3. The Water Survey of Canada (WSC) is the national authority responsible for the collection, interpretation and dissemination of standardized water resource data and information in Canada. In partnership with the provinces, territories and other agencies, WSC operates over 2500 active hydrometric gauges across the country. http://www.ec.gc.ca/rhc-wsc/-

4. Environment impacts analysis; Contaminated sites monitoring; Assess and remediate Yukon Government contaminated sites.

http://www.env.gov.yk.ca/branches/environmental_programs.php-

5. Kwanlin Dun First Nation, Department of Heritage, Lands & Resources. Conduct continuous monthly seasonal water sampling at Michie Creek, southeast of Whitehorse.

http://www.kwanlindun.com/-

6. Ta'an Kwäch'än Council, Department of Lands, Resources and Heritage. Conduct seasonal continuous and continuous water chemistry sampling at sites within traditional TKC territory, on Takhini River, Flat Creek, Laurier Creek and Lake Laberge.

http://www.taan.ca/-

7. Water Resources Branch: Water-related strategic planning, policy development and implementation; Regional water quality/quantity monitoring and research; Provision of expert technical advice regionally and nationally; Enforcement and compliance of the *Waters Act* and water licences; Administration of water security deposits; Share responsibility for managing Yukon waters with five other Yukon Government departments including: **Health & Social Services** (drinking water & private sewage disposal), **Highways & Public Works** (water & sewage provision in unincorporated communities), **Energy, Mines & Resources** (regulate placer mining activities), **Executive Council Office, Water Board Secretariat** (water licensing process), **Community Services** (project management services for community infrastructure).

http://www.emr.gov.yk.ca/csi/index.html-

8. Health & Social Services monitors drinking water in town sites including Old Crow, Dawson City, Keno City, Mayo, Pelly Crossing (Selkirk First Nation), Carmacks (Little Salmon Carmacks First Nation), Faro, Ross River, Whitehorse, Haines Junction, Burwash (Kluane First Nation), Carcross Tagish, and Watson Lake. Sampling types include microbiological and water chemistry.

http://www.hss.gov.yk.ca/environmental_drinkingwater.php-

9. The **Yukon Water Board** is an independent administrative tribunal established under theWaters Act . The Board is responsible for the issuance of water use licences for the use of water and/or the deposit of waste into water.

http://www.yukonwaterboard.ca/-

10. YESAB was established under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA), which came into full force November 28, 2005. YESAB is committed to delivering an assessment process that works well for all Yukoners as well as all stakeholders. YESAB's goal is to ensure the assessment process under YESAA is the best possible arrangement for all interests. http://www.yesab.ca/index.html-

11. Summary of Yukon water wells. Most current report dating May 11, 2006.

http://www.env.gov.yk.ca/pdf/YukonWaterWellsSummary.pdf-

12. Reference Condition Approach Bioassessment of Yukon River Basin Placer Mining Streams Sampled in 2006. http://www.geology.gov.yk.ca/pdf/MPERG_2007_2.pdf

13. Yukon Water Resources Hydrometric Program Historical Summary 1975 – 2004. http://www.env.gov.yk.ca/pdf/hydrometricmanual2005.pdf

Appendix D – Water Quality Data

Sample ID	SFN01	SFN02	SFN03	SFN04	SFN05
Site Name	Mica Creek	Willow Creek	Yukon River at Barge	Big Creek	Minto Creek
Site Coordinates	62.81648, -136.56723	62.83367, -136.62099	62.59180, -136.87804	62.61566, -136.99548	62.65643, -137.09502
Date Sampled	25-SEP-12	25-SEP-12	26-SEP-12	26-SEP-12	26-SEP-12
	27-SEP-12	27-SEP-12			
Time Sampled	15:20	16:10	17:00	15:15	13:00
	09:45	10:30			
Matrix	Water	Water	Water	Water	Water
Physical Tests					
Hardness (as CaCO3 in mg/L)	160	145	-	100	172
pH	8.38	8.18	8.27	8.22	8.33
Air Temp. (˚C)	10	15	11	9.2	12
Water Temp. (˚C)	7.3	4.7	9.2	5.7	3.6
Dissolved Oxygen (mg/L)	13.36	13.24	10.72	12.51	12.43
Total Metals (mg/L)					
Aluminum (Al)	0.045	0.015	-	0.137	0.129
Antimony (Sb)	<0.00050	<0.00050	-	<0.00050	<0.00050
Arsenic (As)	0.00071	0.00190	-	0.00091	0.00092
Barium (Ba)	0.081	0.090	-	0.067	0.074
Boron (B)	<0.10	<0.10	-	<0.10	<0.10
Cadmium (Cd)	<0.00020	<0.00020	-	<0.00020	<0.00020
Calcium (Ca)	44.0	40.4	-	23.8	46.8
Chromium (Cr)	<0.0020	<0.0020	-	<0.0020	<0.0020
Copper (Cu)	<0.0010	<0.0010	-	0.0024	0.0019
Iron (Fe)	0.195	0.399	-	0.257	0.911

Lead (Pb)	<0.00050	<0.00050	-	<0.00050	<0.00050
Magnesium (Mg)	12.2	10.8	-	9.83	13.4
Manganese (Mn)	0.0240	0.0626	-	0.0229	0.0680
Mercury (Hg)	<0.00020	<0.00020	-	<0.00020	<0.00020
Potassium (K)	2.44	1.02	-	0.80	1.09
Selenium (Se)	<0.0010	<0.0010	-	<0.0010	<0.0010
Sodium (Na)	5.2	4.0	-	7.4	8.1
Uranium (U)	0.00069	0.00072	-	0.00200	0.00115
Zinc (Zn)	<0.050	<0.050	-	<0.050	<0.050
Volatile Organic Compounds (mg/L)					
Benzene	<0.00050	-	<0.00050	-	-
Ethylbenzene	<0.00050	-	<0.00050	-	-
Methyl t-butyl ether (MTBE)	<0.00050	-	<0.00050	-	-
Styrene	<0.00050	-	<0.00050	-	-
Toluene	<0.00050	-	<0.00050	-	-
ortho-Xylene	<0.00050	-	<0.00050	-	-
meta- & para-Xylene	<0.00050	-	<0.00050	-	-
Xylenes	<0.00075	-	<0.00075	-	-
Surrogate: 4-Bromofluorobenzene (SS) %	82.2	-	84.1	-	-
Surrogate: 1,4-Difluorobenzene (SS) %	84.7	-	85.0	-	-
Hydrocarbons (mg/L)					
EPH10-19	<0.25	-	<0.25	-	-
EPH19-32	<0.25	-	<0.25	-	-
LEPH	<0.25	-	<0.25	-	-
HEPH	<0.25	-	<0.25	-	-
Volatile Hydrocarbons (VH6-10)	<0.10	-	<0.10	-	-
VPH (C6-C10)	<0.10	-	<0.10	-	-
Surrogate: 3,4-Dichlorotoluene (SS) %	99.9	-	101.7	-	-
Polycyclic Aromatic Hydrocarbons (mg/L)					
Acenaphthene	<0.000050	-	<0.000050	-	-
Acenaphthylene	<0.000050	-	<0.000050	-	-
Acridine	<0.000050	-	<0.000050	-	-
Anthracene	<0.000050	-	<0.000050	-	-
Benz(a)anthracene	<0.000050	-	<0.000050	-	-

Benzo(a)pyrene	<0.000010	-	<0.000010	-	-
Benzo(b)fluoranthene	<0.000050	-	<0.000050	-	-
Benzo(g,h,i)perylene	<0.000050	-	<0.000050	-	-
Benzo(k)fluoranthene	<0.000050	-	<0.000050	-	-
Chrysene	<0.000050	-	<0.000050	-	-
Dibenz(a,h)anthracene	<0.000050	-	<0.000050	-	-
Fluoranthene	<0.000050	-	<0.000050	-	-
Fluorene	<0.000050	-	<0.000050	-	-
Indeno(1,2,3-c,d)pyrene	<0.000050	-	<0.000050	-	-
Naphthalene	<0.000050	-	<0.000050	-	-
Phenanthrene	<0.000050	-	<0.000050	-	-
Pyrene	<0.000050	-	<0.000050	-	-
Quinoline	<0.000050	-	<0.000050	-	-
Surrogate: Acenaphthene d10 %	76.3	-	87.2	-	-
Surrogate: Acridine d9 %	85.5	-	77.4	-	-
Surrogate: Chrysene d12 %	86.5	-	83.5	-	-
Surrogate: Naphthalene d8 %	77.7	-	82.8	-	-
Surrogate: Phenanthrene d10 %	90.2	-	77.5	-	-
Anions, Nutrients and Bacteriological Tests					
Nitrate and Nitrite (as N)	0.0346	<0.0051	-	-	-
Nitrate (as N)	0.0306	<0.0050	-	-	-
Nitrite (as N)	0.0040	<0.0010	-	-	-
Orthophosphate-Dissolved (as P)	0.0019	0.0134	-	-	-
Phosphorus (P)-Total	0.0206	0.0254	-	-	-
E. coli (#/100mL)	1	22	-	-	-
Coliform Bacteria (#/100mL)	248	411	-	-	-
Cation (ueq/L)					
Al 396.153	8.631322723	7.382870192	3.001	21.33848894	11.675
Ba 455.403	70.2171	75.61995	176.076	223.0711	66.151
Ca 317.933	40.56493	37.02775	21.787	24.3535	42.500
Cu 224.700	0.850137	-5.04762	1.083	0.448094	2.403
Fe 259.939	120.8198	279.3338	5.844	168.3399	163.829
K-ax 766.490	1.740837	0.724963	0.324	0.489958	0.874
Mg 279.077	12.20888	10.90264	5.575	10.20634	13.880

Mn 257.310	14.5218	54.12014	1.586	19.43924	64.974
Na 589.592 <50	2.966038	2.388644	2.374	4.902761	7.198
Ni 231.604	-3.33964	-1.57256	-1.001	1.281846	-1.280
S 180.669	8.756515	5.156024	4.187	4.923878	5.380
SiO2 251.609	6.922668	9.16179	4.480	10.72863	10.982
Sr 407.771	335.1606	250.8028	122.379	350.1301	398.890
Zn 213.857	22.42135	13.39614	51.068	47.1742	14.865
Dissolved Organic Carbon					
UV A@254nm (whole)	0.3068	0.2964	0.0587	0.2823	0.4527
Avg DOC [ppm]	12.33	10.20	2.46	9.52	14.69
SUVA	2.49	2.91	2.38	2.96	3.08
TIC High?	High TIC	-	-	-	High TIC
Avg TIC (if high)	593.503	-	-	-	720.399
Alkalinity ueq/L	2539.117	2454.028	1313.417	1871.194	3054.283
Dissolved Oxygen					
Specific Conductance ($\mu S/cm$)	282.8	245.4	149.8	205.4	300.7
DO mg/L	13.36	13.21	10.72	12.51	12.43
DO %	111	103	93.5	99.7	93.9

At or below instrument Detection Limit