

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



Carcross/Tagish First Nation Community Report

2013

Prepared by the Yukon River Inter-Tribal Watershed Council



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# Acknowledgments

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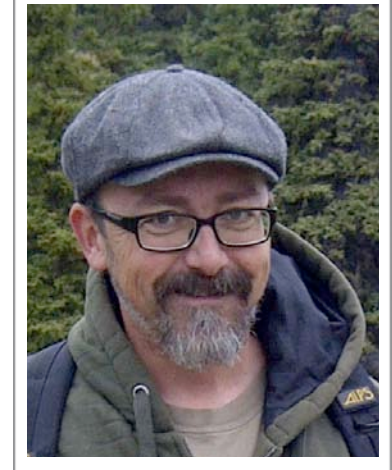
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# Introduction

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 Carcross/Tagish 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

**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.<sup>1</sup>

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).

**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 in Carcross/Tagish 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).

“Traditional knowledge, as defined by the C/TFN Government, is a way of life. This knowledge, which guides us through our lives, has been passed down from generation to generation through our Elders, by way of our stories and our language. The Elders teach the importance of sharing, preserving and respecting our traditional knowledge”(Carcross/Tagish First Nation 2009, 4).

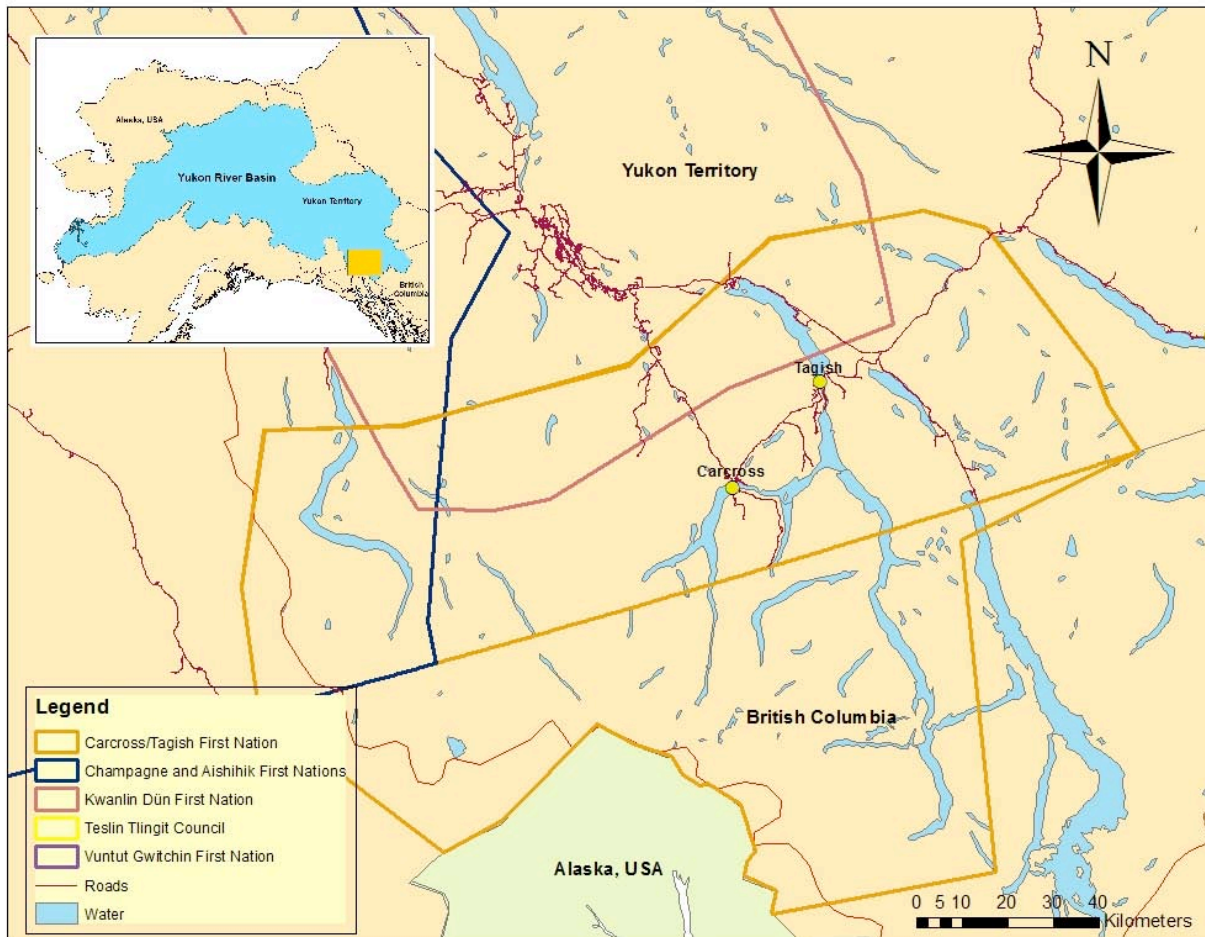
# Community Context

Carcross and Tagish are two communities within Carcross/Tagish First Nation (C/TFN) traditional territory. They have a combined population of approximately 553 (Government of Canada 2008). These communities are located in the Southern Lakes region of the Yukon (See Figure 2 – Map Carcross/Tagish Traditional Territory). C/TFN is comprised of both Tagish and Tlingit peoples. Tagish Athabaskan peoples were the original inhabitants of the area. This region later became home to Inland Tlingit peoples who traveled to the area for reasons of trade from Southeast Alaska, about 200 to 300 years before contact.<sup>1</sup> The members of C/TFN traded along the Chilkoot Trail long prior the arrival of Europeans. During the Klondike Gold Rush, the railroad was completed in the year 1900 and Carcross became a major transportation hub en route to Dawson City, Yukon (Government of Canada 2004).

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<sup>1</sup> <http://www.cyfn.ca/ournationsctfn>

**Figure 2 Map Carcross/Tagish First Nation Traditional Territory within Yukon Territory**



The members of C/TFN and their ancestors have relied on the lands and waters within their traditional territory as the basis for their subsistence way of life for millennia. Subsistence livelihoods continue to be of utmost importance to their people today. Consequently, C/TFN maintains many trails within their traditional territory to use for hunting, fishing, trapping, and for gathering traditional medicines and berries (Government of Canada 2004).

C/TFN became a Self-Governing First Nation in June 2006.<sup>2</sup> It has actively monitored water quality with the YRITWC at Bennett Lake and Tagish River within their traditional territory. This project was designed to build capacity and compliment the current monitoring that is being carried out by C/TFN.

## 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 C/TFN. 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. Seven interviews were conducted in total. Four out of seven community members were Elders. The remaining three were other adults from the community. Interview participants were asked to describe the importance of water to their community

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<sup>2</sup> <http://www.cyfn.ca/ournationsctfn>

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 C/TFN offices on August 16, 2012. Thirteen people participated in the focus group. Two of the focus group participants also completed interviews. Therefore, eighteen community members in total participated in this research project.

During the focus group, the YRITWC research team 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 C/TFN traditional territory was projected on 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 24 sites of concern were identified.

Although the YRITWC has funds available to sample at five sites, this total was increased to ten sites, when C/TFN offered to match this funding. 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 and the top ten were selected.

The next step of the research process was to collect water samples from each of the 10 prioritized sites. Water sampling was conducted between August and October of 2012. YRITWC environmental technicians conducted water sampling with help from the youth intern and staff from the C/TFN Heritage, Lands and Natural Resources Departments.

The research was designed in accordance with the Carcross/Tagish Traditional Knowledge Policy allowing us to provide research data to the C/TFN Archive for future use. Research data will not be released without the consent of the individuals involved. Copies of all interview data were returned to the C/TFN Heritage Department for this purpose. The YRITWC consider this an important step in the research process as it allows First Nations to maintain traditional knowledge for their own use. This community research report allows the YRITWC research team to return the results of this research to the community in a usable format.

### **Youth and First Nation 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. The youth interns' in depth knowledge about the community and surrounding area was invaluable to the project. Meagan Swanson was the C/TFN youth intern (See Project Team Biography).

The YRITWC trained five C/TFN environmental technicians in water quality sampling protocols on October 16, 2012. This training enables C/TFN to collect samples from the additional five sites.

# Results and Analysis

## “Water is Life”: The Importance of Water to C/TFN

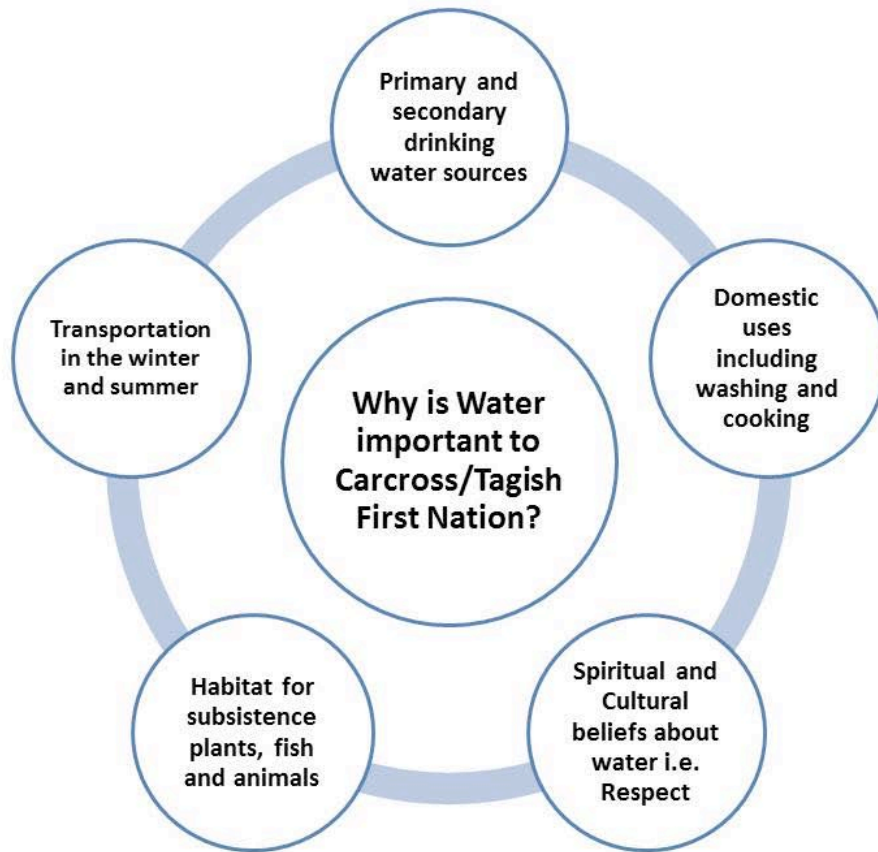
Water is important to the people of Carcross/Tagish for many reasons. Interview participants were asked to answer the question ‘*Why is Water Important to Your Community?*’ Their responses reveal that water is important to all aspects of life or as one interview participant put it, "Water is life. If you don't have water, you don't have life."

During the research project, many uses of water were identified (See Figure 3). Water from various sources is used for drinking. Participants explained that they use primary and secondary sources of water for consumption. Primary sources include delivered water from the water treatment centre and some private wells. Secondary drinking water sources

“So the laws that we have for water are in the clan houses. Those kinds of things are important because we need to respect water. We need to respect the fish that are in there and when you catch fish and you use it, you cook it up and then you put the fish bones back into the water. That's respecting the fish because those little things that you don't hardly see are in there using what's left of the bones and stuff like that.” (C/TFN Elder)

include water from creeks and springs. These secondary water sources are used by some C/TFN Elders as their preferred drinking water source. Other C/TFN community members said they use secondary sources when they are out on the land or at camp. Secondary sources were often preferred over treated drinking water because people tended not to like the taste of this chlorinated water. The lakes and rivers that make up the Southern Lakes region are also a major transportation corridor. Water also provides important habitat for a diversity of fish and other animals. The uses identified above makes it easy to see why water is integral to all aspects of subsistence livelihoods, which are central to First Nation culture.

**Figure 3 Why is Water Important to Carcross/Tagish First Nation?**



Interview participants discussed the need to respect water. In the words of one C/TFN community member, “water needs to be respected. The spirit of water needs to be respected. I don’t see that happening so much. Water should be celebrated, daily. It’s very, very important, more important than all the gold in the world, water is, but when it’s around you all the time, you take it for granted.” The notion of respecting water is similar to the First Nation beliefs about respecting fish and animals.

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 Concerns***

C/TFN community members described a number of water quality concerns during interviews and the focus group. These concerns covered several distinct issues including mining, sewage, landfills, agriculture, fuel spills, the White Pass Railroad and Yukon Energy's proposed project to raise the winter water levels on the Southern Lakes, on the waters within

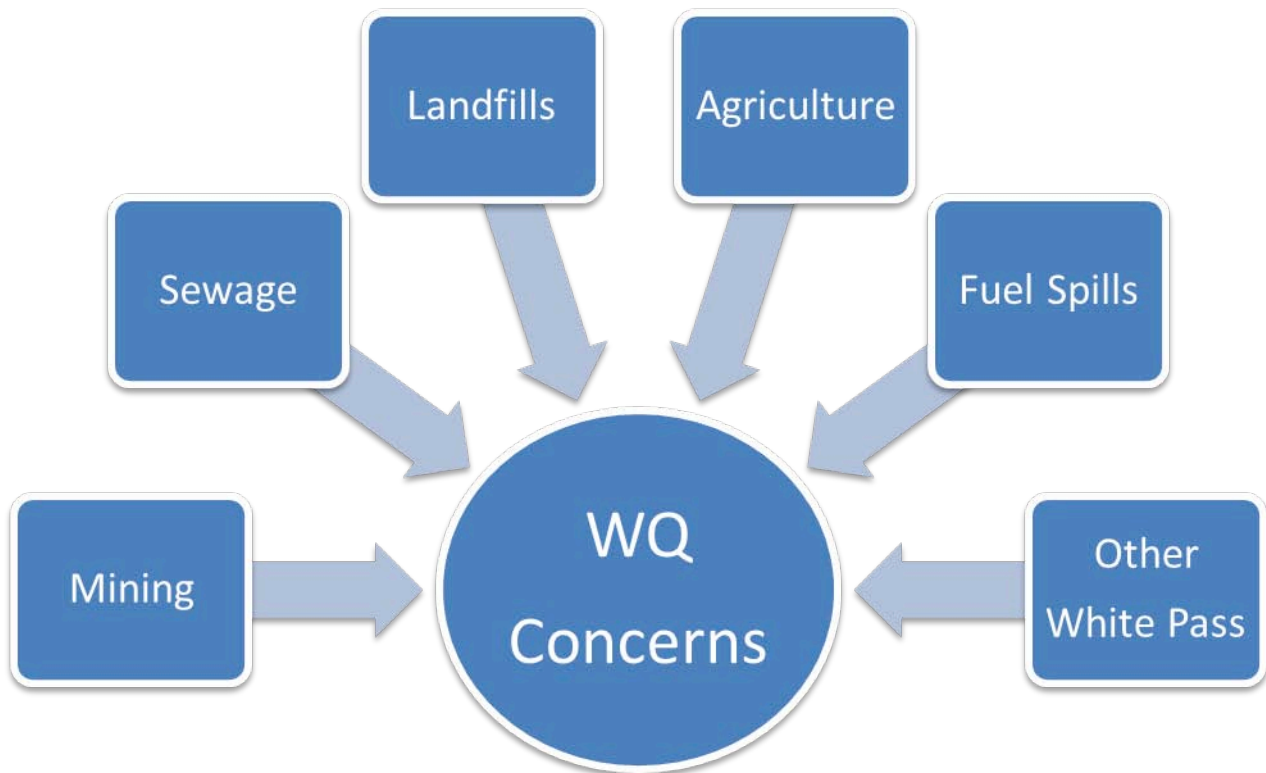
"The mining companies come in and they start placer mining. Well, we don't know what kind of contaminants they are digging-up [like arsenic] and letting it flow into the lake....what does it do to the fish?" (C/TFN Community Member)

"The old dumpsite is just on this hill and it was there since the community was established....there are batteries, old car batteries [there]. You name it, it's just buried in there." (C/TFN Community Member)

"White Pass Railroad is an environmental violator. They are known for that. They have a reputation for taking shortcuts when it comes to the environment and they got the lake right there. There are ties in the lake soaking with creosote. There are cars that, I don't know if anything has ever been done, but apparently there are train cars that have gone in there. They used to haul the lead zinc. They used to have this community full of lead zinc and ore cars. It went on for years and years and years and I don't think you would have to go very far to find lead zinc poisoning in this community, right by the railroad. By the railroad is a place that should be checked I think" (C/TFN Community Member)

their traditional territories (See Figure 4). The twenty-four 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. Detailed descriptions of these sites were recorded (See Appendix A).<sup>3</sup>

**Figure 4 Types of Land Uses Impacting Water Quality Identified by C/TFN**



<sup>3</sup> 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 C/TFN Traditional Territory

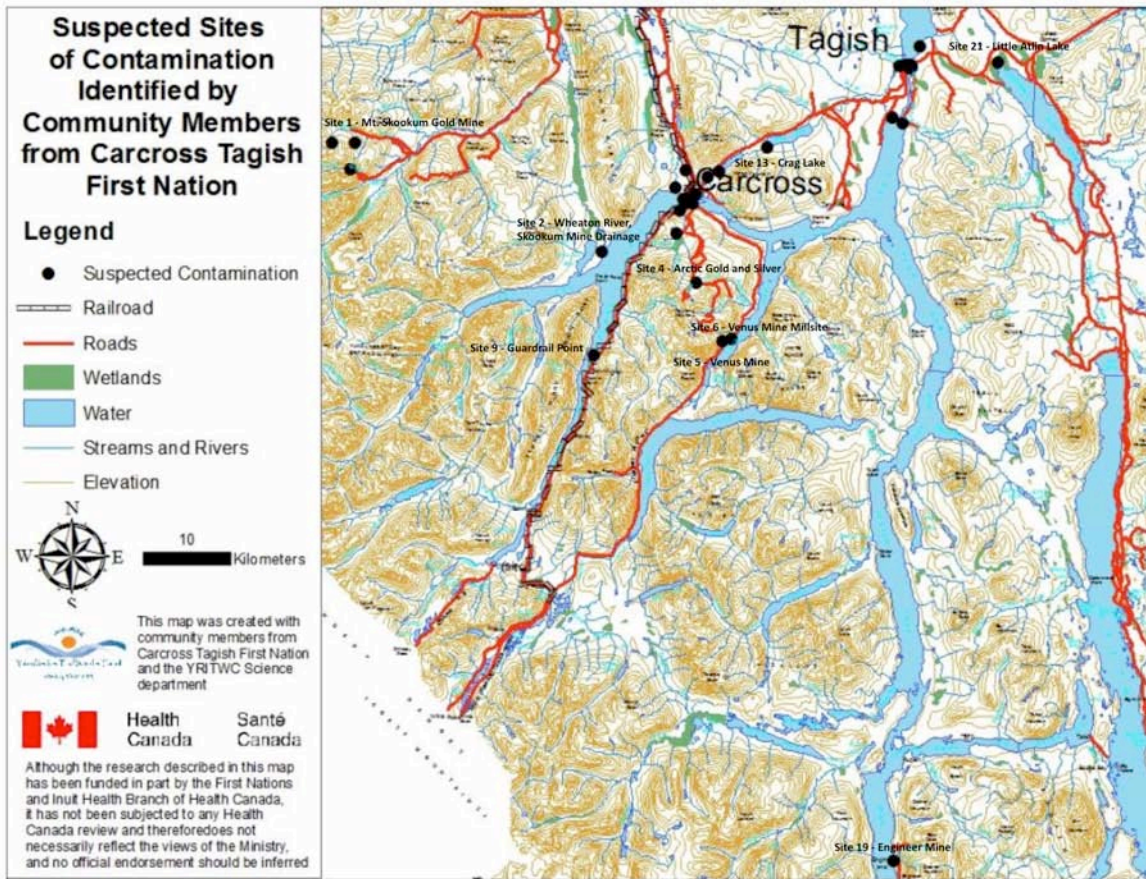


Figure 6 Water Quality Sites Identified near Tagish in C/TFN Traditional Territory

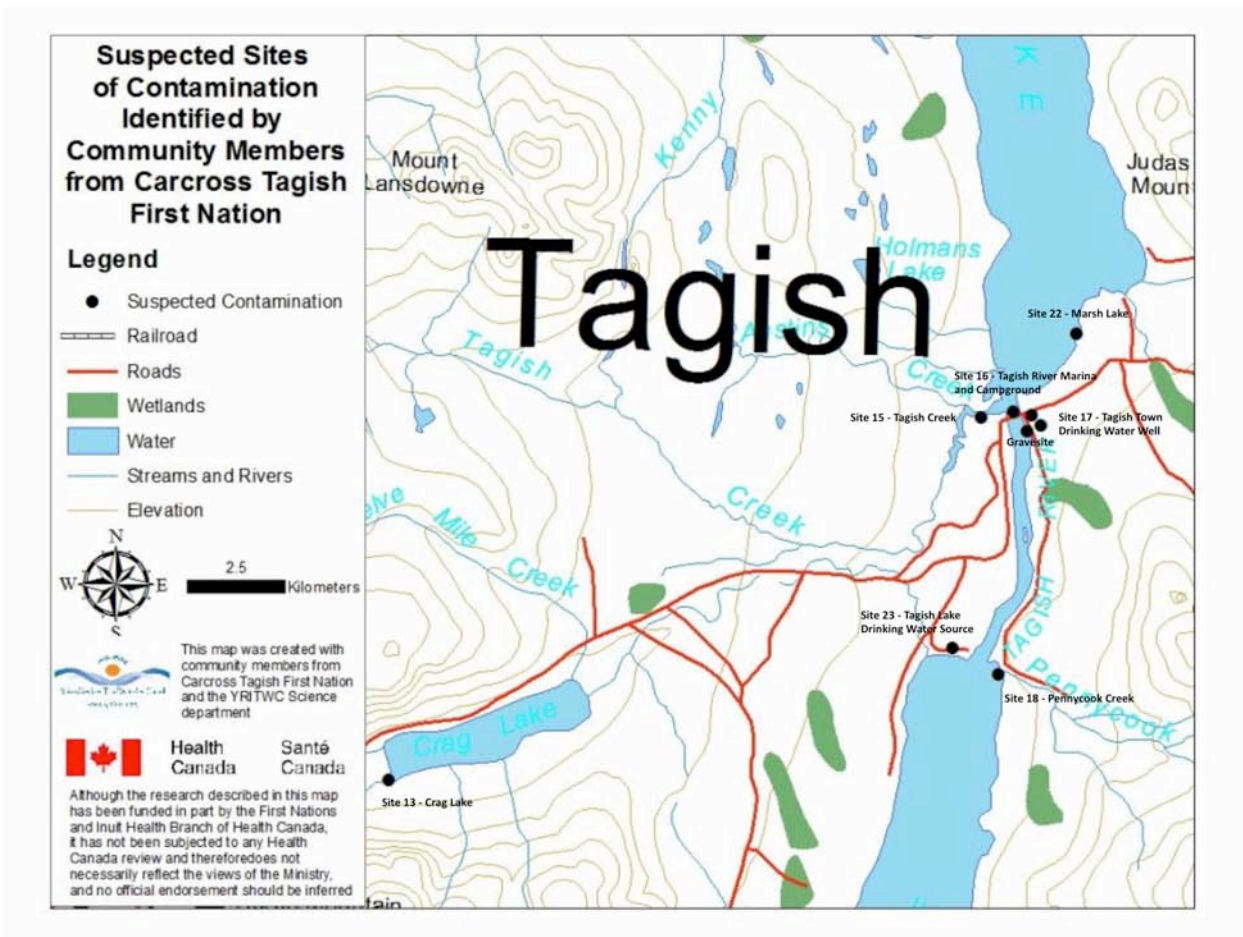
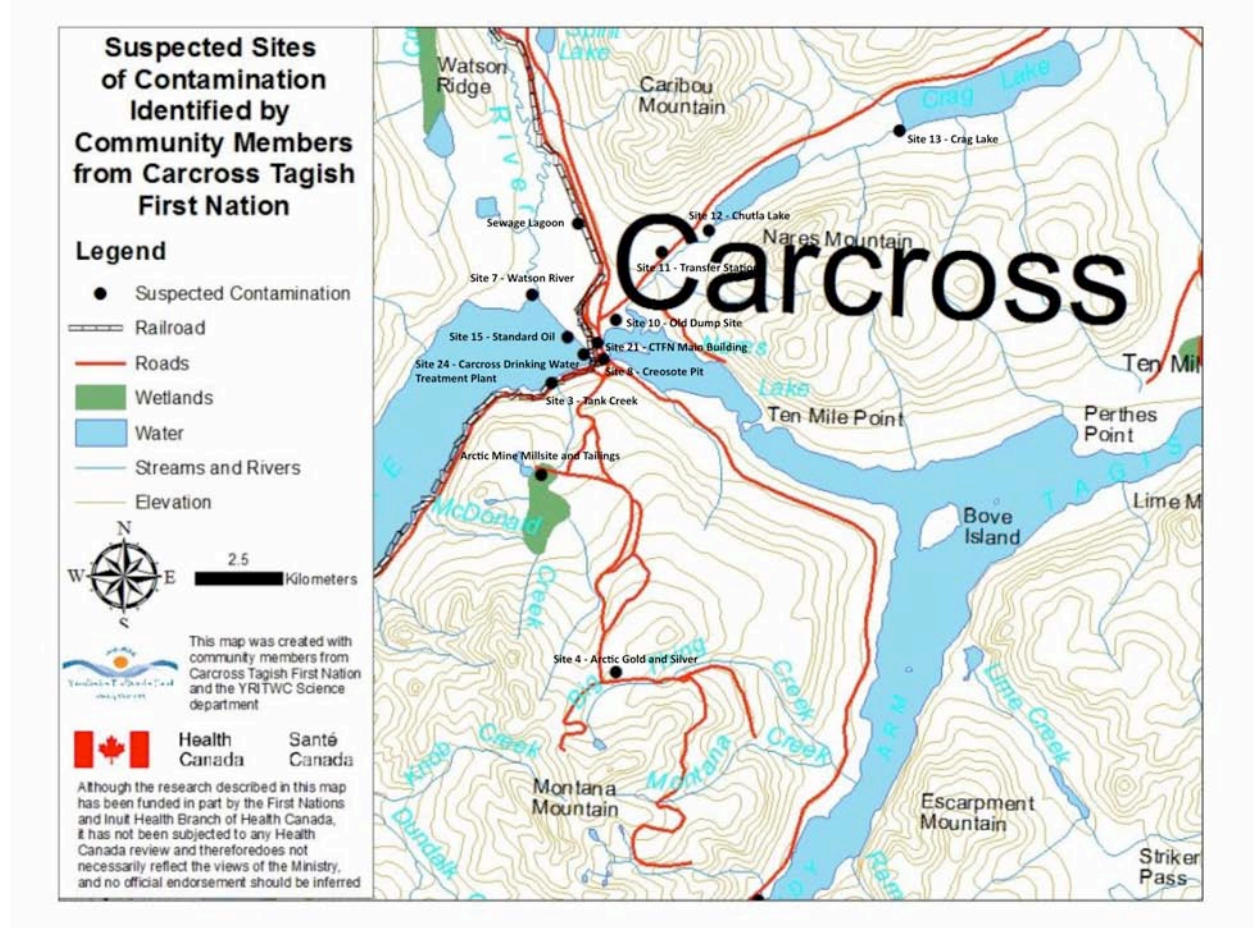


Figure 7 Water Quality Sites Identified near Carcross in C/TFN Traditional Territory



## 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<sub>4</sub>). 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 ( $\text{NO}_2 + \text{NO}_3$ ) because  $\text{NO}_2$  is poisonous to fish and is known to contribute to the overgrowth of algae. Nitrate ( $\text{NO}_3$ ) is a nutrient and too much can cause algae blooms and contribute to the depletion of available oxygen in water for aquatic life. Ammonium ( $\text{NH}_4$ ) 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 ( $\text{H}_2$ ) and oxygen-18 ( $\text{O}18$ ) 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 C/TFN government officials selected ten water quality sites throughout the C/TFN traditional territory. The YRITWC was responsible for sampling five of these sites.

"The biggest thing is that we do take it [water] for granted because it appears to be healthy and that was my question earlier, 'can we access data that might show us?', because we can't see it." (C/TFN Community Member)

Table 1 provides background information for these samples, including their location and the types of contaminants for which they were sampled.

Samples were collected from Wheaton River, Watson River, Tagish River, Tagish Creek, and Nares River. Several types of samples were sent to the ALS Environmental laboratory in Whitehorse, Yukon. Hydrocarbon samples were collected for petroleum contamination concerns in Tagish River and for creosote concerns in Nares River. Bacteriological and nutrient samples were collected for drinking, sewage, agricultural, and landfill concerns in Watson River and Tagish Creek. Metal samples were collected for mining effluent concerns in Wheaton River. Additional samples of the 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. YRITWC will need to follow-up with C/TFN with USGS data.

**Table 1 Carcross/Tagish First Nations Water Quality Sites Sampled**

Site Name	Site ID	GPS Coordinates (DD)	ALS Samples	Analysis	YRITWC Kits (Y/N)	Suspected Contaminants	Date
Wheaton River below Goddell Portal (Skukum Gold Mine)	CTFN01	60.20646, -135.28230	metals - dissolved, metals - total	Dissolved metals [DW], Total Metals in Water [DW]	Y	mining effluent	August 22, 2012 & Oct. 04, 2012
Wheaton River above Goddell Portal	CTFN02	60.19411, -135.31009	metals - dissolved, metals - total	Dissolved metals [DW], Total Metals in Water [DW]	N	mining effluent	August 22, 2012 & Oct. 04, 2012
Watson River at the mouth	CTFN03	60.18108, -134.73724	nutrients, metals - dissolved, <i>E. coli</i> , Total Coliform	Dissolved metals [DW]. Diss. Orthophosphate in water by colour., Total Metals in Water [DW], NO2, NO3, NO2+NO3, Total P in Water by Colour, E+TCOLI-COLI-HLTH	Y	sewage & mining	August 22, 2012, Oct. 04, 2012, Oct. 10, 2012
Tagish River above bridge	CTFN04	60.29266, -134.26198	nutrients, hydrocarbons, <i>E. coli</i> , Total Coliform	<i>E. coli</i> and total by Colilert (Health). NO2, NO3, NO2+NO3. Total P in water by colour. BTEX+VPH+MTBE+Styrene in water GCMS/FID. Diss. Orthophosphate in water by colour.	N	sewage & petroleum	Aug. 23, 2012, Sept. 20, 2012

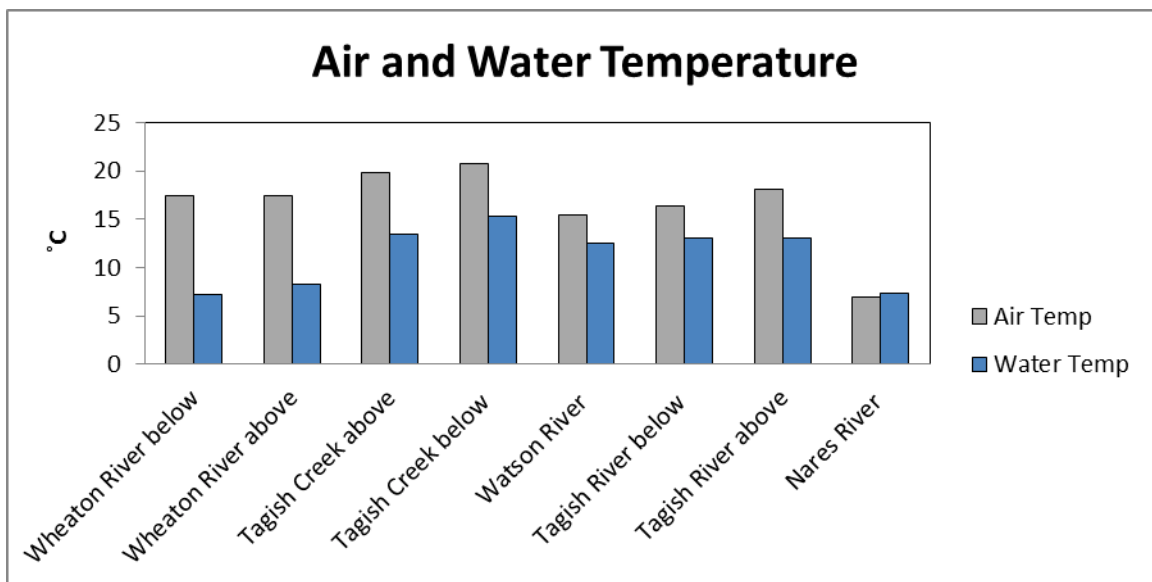
Tagish River below bridge	CTFN05	60.31774, -134.26797	nutrients, hydrocarbons, metals - dissolved, <i>E. coli</i> , Total Coliform	<i>E. coli</i> and total by Colilert (Health). NO2, NO3, NO2+NO3. Total P in water by colour. Dissolve metals. BTEX+VPH+MTBE+Styrene in water GCMS/FID. Diss. Orthophosphate in water by colour.	Y	sewage & petroleum	Aug. 23, 2012, Sept. 20, 2012
Tagish Creek above Tagish	CTFN06	60.30809, -134.29269	nutrients, <i>E. coli</i> , Total Coliform	<i>E. coli</i> and total by Colilert (Health). NO2, NO3, NO2+NO3. Total P in water by colour. Diss. Orthophosphate in water by colour.	N	septic, agriculture	Aug. 23, 2012, Sept. 20, 2012
Tagish Creek below at mouth	CTFN07	60.31765, -134.27350	nutrient, metals - dissolved, <i>E. coli</i> , Total Coliform	<i>E. coli</i> and total by Colilert (Health). NO2, NO3, NO2+NO3. Total P in water by colour. Total metals. Diss. Orthophosphate in water by colour.	Y	septic, agriculture	Aug. 23, 2012, Sept. 20, 2012
Creosote Pit at Nares River in Carcross, YT	CTFN08	60.16549, -134.70114	hydrocarbons, metals - total	BTEX+VPH+MTBE+Styrene in Water GCMS/FID, LEPH & HEPH CSR by SF, Total metals in Water [DW]	Y	Creosote	Oct. 04, 2012

## Analysis of Water Quality Samples

Generally, the YRITWC found the water quality to be within aquatic, recreational, and drinking water standards and guidelines. However, due to cost, not all parameters were analyzed at every site but only a synopsis of the suspected contaminants. A few samples indicated the presence of total coliform bacteria. One sample exceeded the aluminum guideline for aquatic life. Additional samples are needed to determine trends and to have a robust baseline to help identify physical and chemical changes.

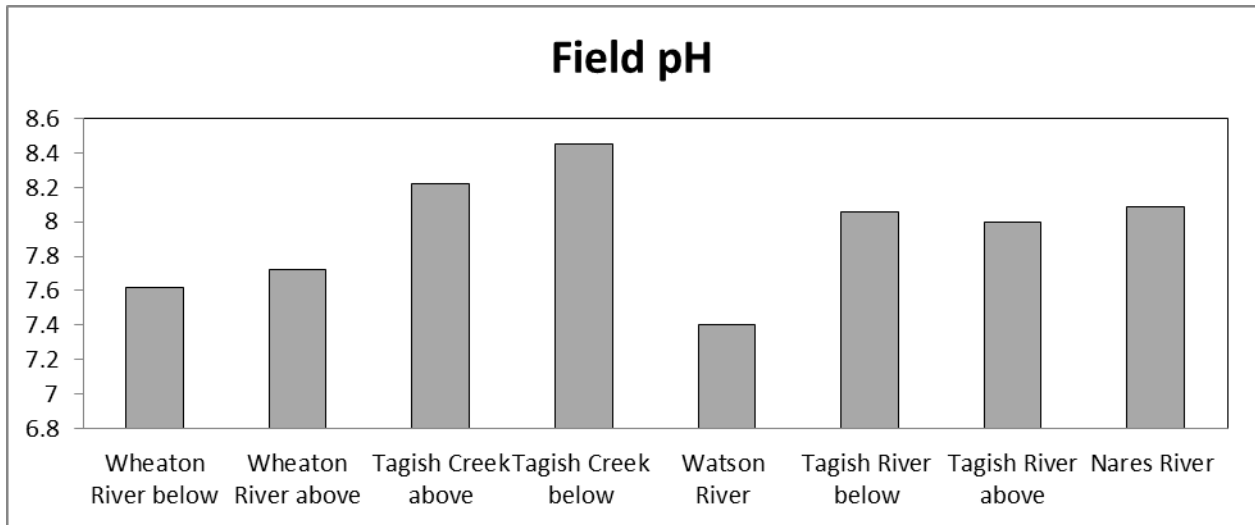
Field measurements of air and water temperatures are compared across all sites (See Figure 8).

**Figure 8 Air and Water Temperature**



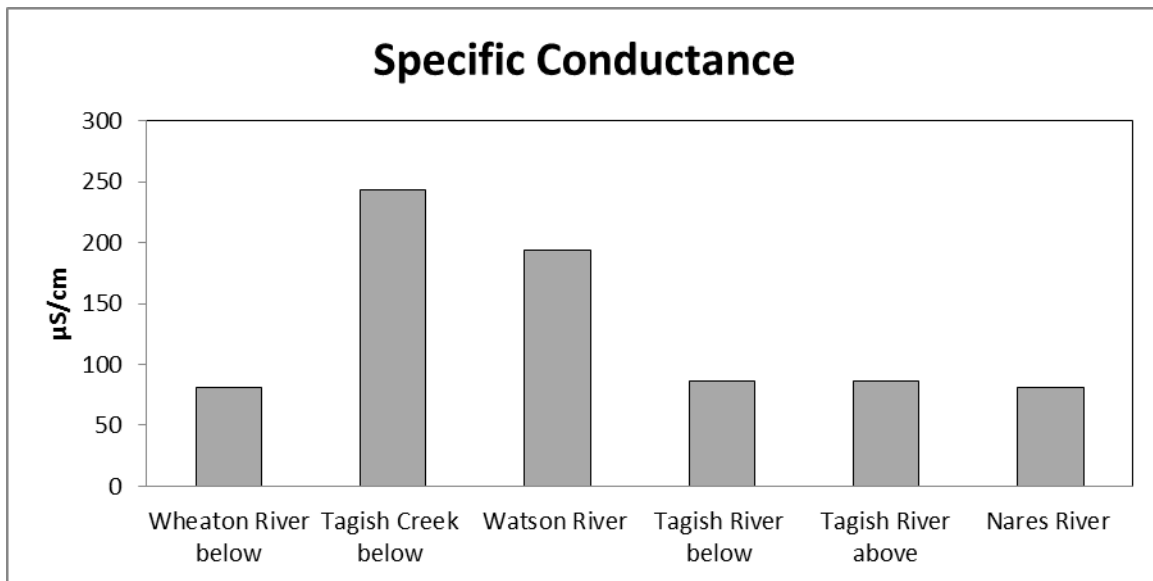
The pH field readings are in normal ranges for aquatic life, recreational water, and drinking water (See Figure 9). All of the samples collected were slightly basic (as opposed to acidic or neutral). Waters within the Yukon River watershed have similar pH values.

**Figure 9 Field pH**



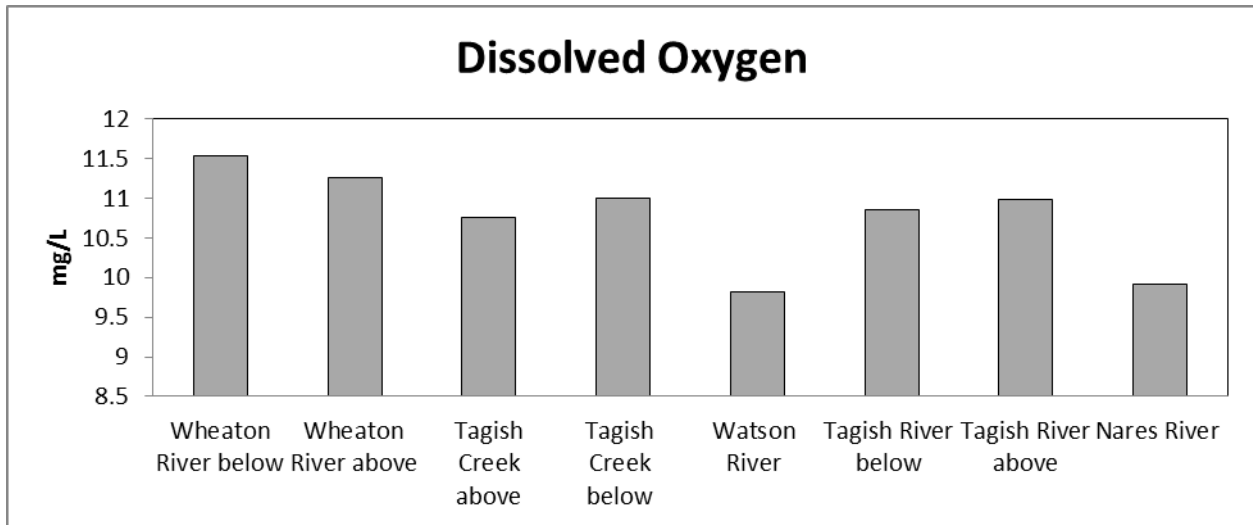
Specific conductance was analyzed at the USGS lab for all sites except for above samples at Wheaton and Tagish Creek (See Figure 10). This range of pH is consistent with most waters within the Yukon River watershed.

**Figure 10 Specific Conductance**



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

**Figure 11 Dissolved Oxygen**



Several water quality guidelines and standards were used 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. The guidelines and standards applied are Guidelines for Canadian Drinking Water Quality (CCME DW)<sup>4</sup>, Guidelines for Canadian Recreational Water Quality

<sup>4</sup> 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

(GCRWQ),<sup>5</sup> Canadian Environmental Quality Guidelines (CCME AW),<sup>6</sup> and Yukon Government Contaminated Sites Regulations (YCSR).<sup>7</sup> A committee of scientists, experts, and government establish standards and guidelines to help determine maximum acceptable concentrations of water contaminants.

A variety of means were used to collect water samples by wading, on-shore grab and boat. Wheaton River, Tagish Creek, and Tagish River, all had upstream (above) and downstream (below) sampling sites. The purpose was to capture samples above and below a point source or suspected contamination site. Due to time and access restrictions, Watson River was sampled at the mouth to capture suspected sewage contaminants from up river. Nares River was sampled near the buried creosote pit in Carcross. Wheaton River was sampled above and below the Goddell Portal for metals. Watson River at the mouth was sampled for bacteria, nutrients, and metals. Tagish River was sampled above and below the campground and boat dock for hydrocarbons, bacteria, nutrients, and dissolved metals. Tagish Creek was measured above and below Tagish for nutrients, bacteria, and dissolved metals.

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

<sup>5</sup> 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).

<sup>6</sup> 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).

<sup>7</sup> 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).

Table 2 identifies constituents that exceed drinking water and recreational standards and guidelines. Total coliform bacteria are present in Watson River, Tagish River and Tagish Creek.

**Table 2 Substances Exceeding Drinking and Recreational Guidelines and Standards**

Surface Water Body	Site	Water Quality Parameters that Exceed YCSR DW Standards	Water Quality Parameters that Exceed CCME DW	Water Quality Parameters that Exceed GCRWQ
Wheaton River Below	CTFN01	No	No	No
Wheaton River Above	CTFN02	No	No	No
Watson River at Mouth	CTFN03	No	Total Coliform Bacteria	No
Tagish River Above	CTFN04	No	Total Coliform Bacteria	No
Tagish River Below	CTFN05	No	Total Coliform Bacteria	No
Tagish Creek Above	CTFN06	No	Total Coliform Bacteria	No
Tagish Creek Below	CTFN07	No	Total Coliform Bacteria	No
Nares River	CTFN08	No	No	No

Table 3 summarizes the parameters exceeding aquatic life standards and indicates the presence of hydrocarbon contamination.

**Table 3 Substances Exceeding Aquatic Life Guidelines and Standards**

Surface Water Body	Site	Hydrocarbon, Volatile Organic Compounds, PAH	Water Quality Parameters that Exceed CSR AW Standards	Water Quality Parameters that Exceed CEQG
Wheaton River Below	CTFN01	-	No	No
Wheaton River Above	CTFN02	-	No	No
Watson River at Mouth	CTFN03	-	No	Al
Tagish River Above	CTFN04	No	No	No
Tagish River Below	CTFN05	No	No	No
Tagish Creek Above	CTFN06	-	No	No
Tagish Creek Below	CTFN07	-	No	No
Nares River	CTFN08	No	No	No

Table 4 summarizes the results of bacteriological tests. *E. coli* was not detected in the samples from Watson River, Tagish River, and Tagish Creek. Although, total coliform bacteria were detected at these sites and Tagish Creek had a count greater than 200 organisms in a 100 mL sample. This sample was collected below the community of Tagish and the creek itself is abundant in aquatic vegetation. Tagish Creek has been known as a source of raw drinking water for local residence. Health Canada’s (2012) does not use total coliforms as indicators of potential health effects from pathogenic microorganisms; they are used as an operational tool to determine how well the drinking water treatment system is operating. Health Canada (2012) recommends “the use of a multi-barrier approach that includes source water protection, adequate treatment, including disinfection, and a well-maintained distribution system can reduce microorganisms to levels that have not been associated with illness, as well as meet the guidelines”.

**Table 4 Bacteriological Tests**

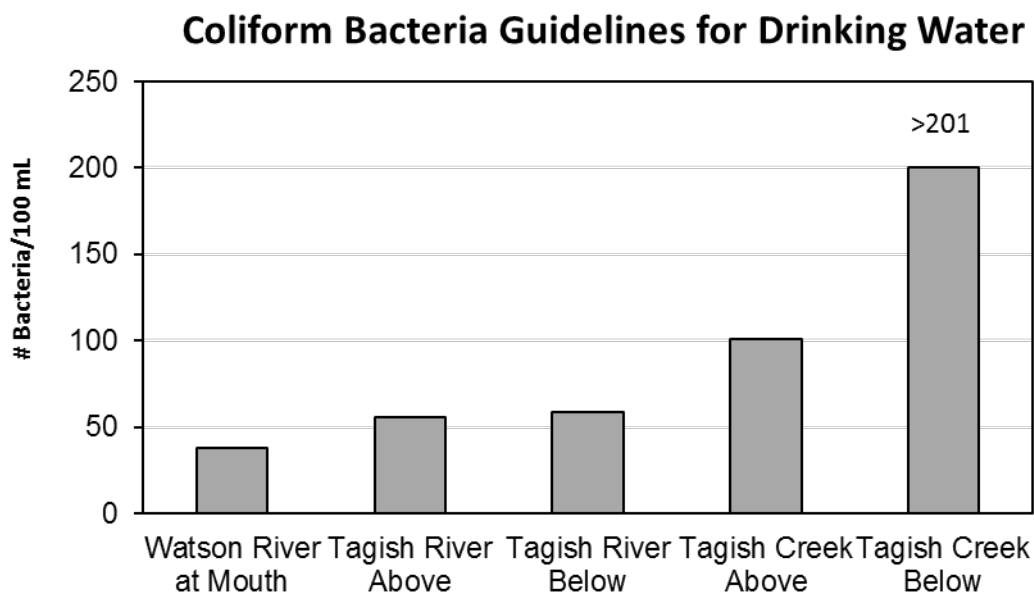
Site Name	Watson River at Mouth	Tagish River Above	Tagish River Below	Tagish Creek Above	Tagish Creek Below
<i>E. coli</i> *	<1	<1	<1	<1	<1
Coliform Bacteria - Total*	38	56	59	101	>201

\*# organisms/100 mL

The Guidelines for Canadian Drinking Water Quality are used for treated water and not intended for raw drinking water purposes. Water must first be treated in order for these guidelines to be applied; however, the guidelines are used here for the sole purpose of raw water consumption referencing. Health Canada requires all treated drinking water to have no presence of *E. coli* or coliform bacteria in a water sample of 100 mL. Samples from Watson River, Tagish River, and Tagish Creek all indicated natural occurring coliform bacteria (See Figure 12). The Yukon Contaminated Sites Regulations (2002) states “if the leading edge of a contaminated

groundwater is located within a 1.5 km radius (travel time of less than or equal to 100 years) of the closest existing or probable future drinking water source, the drinking water use standards are applicable to site due to the potential for the groundwater to pollute the receiving waters”. Sampling results are compared directly to the standards listed in YCSR for this water use and dilution factor is not assumed for this standard.

**Figure 12 Coliform Bacteria**



Nutrient levels do not exceed standards and most were not detected with the detection limits.

According to the Canadian Guidelines (2013) for aquatic life of total aluminum, which has a pH of 7.4, it exceeds the 0.10 mg/L guideline. The guidelines for total aluminum is 0.005 if pH < 6.5; 0.1 if pH ≥ 6.5 (See Figure 13).

**Figure 13 Total Aluminum Canadian Environmental Quality Guidelines**

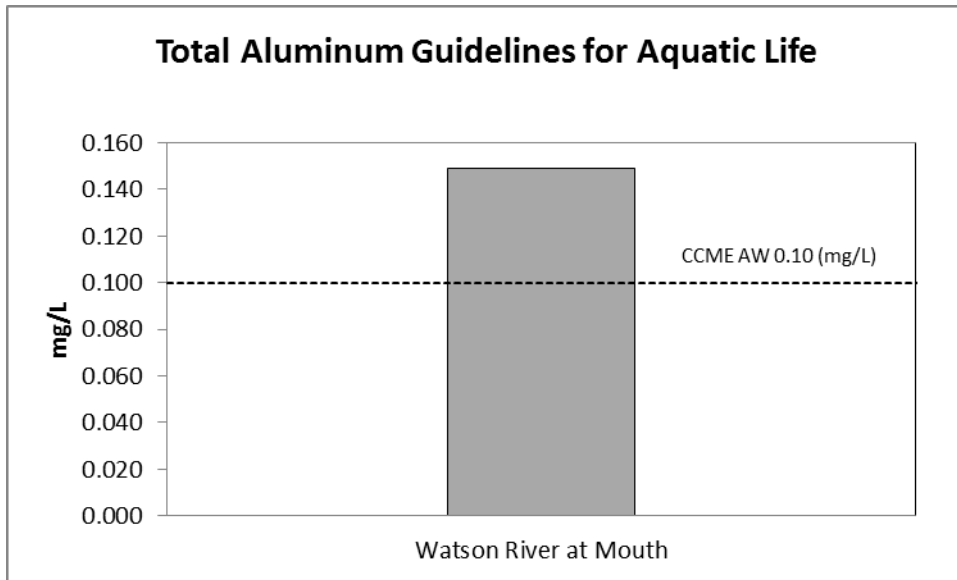


Table 6 indicates undetectable metals with the detection limits set.

There were no detectable volatile organic compounds found in Tagish River and Nares River (See Table 9 in Appendix D).

No hydrocarbons were detected in Nares River and Tagish River (See Table 10 in Appendix D).

Polycyclic Aromatic Hydrocarbons (PAH) were not detectable with the detection limits used in the analysis (See Table 11 in Appendix D).

***Interpretation of Results***

**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. Bacterial results (*E. coli* and total coliform) are just as likely to come from wildlife as they from humans. Within this study, we could not 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 C/TFN 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 C/TFN can continue to reference for many years in the future. At the very least, this data will allow C/TFN and the YRITWC to assess for changes over the years to come.

Take home points from the Water Quality Analyses:

1. *E. coli* was not found in any of the prioritized water bodies. Total coliform counts were relatively low for all samples; however, the concentration of coliform bacteria in Tagish creek was elevated relative to the other samples. While coliform bacteria themselves are not necessarily a reason for concern, more sampling should occur at this site to determine the validity of the data.

2. The aluminum concentration at the mouth of the Watson River exceeded the Canadian Guidelines for Aquatic Life. This result is most likely the natural background condition of the river; however, analysis was not conducted upstream of this site to allow comparison with a background value.
3. Much more sampling needs to occur to confirm or rule out any risk of contamination. The YRITWC and C/TFN 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, river and lake ice regimes, plants, fish and animals and others. These observations are summarized in Table 5 in the Carcross/Tagish Traditional Territory.

"There is quite a bit of rain alright and the rivers, well, you can see how high the rivers are" (C/TFN Community Member).

"You see birds that you have never seen before. Maybe one time you see a cougar. There are now deer. There never used to be when you were younger" (C/TFN Community Member).

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 information regarding the impacts that climate change is having on the environment and the people who call this region home. 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.

"This winter, it was a long winter and not as cold as it used to be. I remember as a little girl we used to really have to bundle-up even in October. And we just bundled up like that until about April, I guess. And then it got warm, the leaves started coming out the middle of June and then it was pretty warm until about August and then in September it started to get cold. Now [in mid-August] it's just like we've got September weather."  
(C/TFN Community Member).

**Table 5 Observations of Climate Change in the Carcross/Tagish Traditional Territory**

<b>Type of Change Observed</b>	<b>Examples of Change</b>
<b>Weather</b>	<ul style="list-style-type: none"> <li>• Warmer temperatures</li> <li>• Higher wind all year long</li> <li>• Freezing rain in the months of January and February</li> <li>• More rain in the summer leading to higher water levels</li> <li>• Freak snowstorms late in season</li> <li>• Elders are not able to predict the weather like they used to</li> </ul>
<b>River and Lake Ice</b>	<ul style="list-style-type: none"> <li>• Reduced ice thickness</li> <li>• Later freeze-up</li> <li>• Earlier break-up</li> <li>• Pressure cracks in lake ice used to be huge, now smaller</li> <li>• Increased snow depths</li> </ul>
<b>Plants</b>	<ul style="list-style-type: none"> <li>• Different plants that don't belong here</li> <li>• Decrease in fireweed</li> <li>• Berry crops have been poor - berries are small and have not ripened as soon (blueberries and cranberries)</li> <li>• It is now possible to put gardens in May when this did not used to be possible until June</li> </ul>
<b>Fish &amp; Animals</b>	<ul style="list-style-type: none"> <li>• Fewer fresh water herring, grayling and whitefish</li> <li>• Deer and cougars have migrated into the area</li> <li>• Moose are quieter during the rut</li> <li>• Different kinds of birds in area i.e., cormorants</li> </ul>
<b>Other</b>	<ul style="list-style-type: none"> <li>• Decrease in bees</li> <li>• Pests: Leaf miner outbreak and other invasive species are increasing because it is not cold enough to stop these outbreaks</li> </ul>

## 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 logistics of sampling over the large geographic area of the Yukon Territory further reduced the time available for fieldwork. Given the late start date of the project, 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 soil samples would also have been useful in identifying petroleum contamination.

# 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 C/TFN, 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 ten 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	Mt. Skukum Mine Sites	Mining	Heavy Metals, Mercury, Acid mine Drainage. Gold mine site: arsenic, cadmium, mercury, lead, zinc, acid mine drainage, metal mining affluent standards that water license needs to go through. They are not able to get water license because over standards because of discharge is too high. They are currently on maintenance. They are still releasing water but not going into tailings pond because there is no one maintaining water and they are on "care and maintenance".
2	Wheaton River	Mining	Mount Skukum Gold mine at Goddell Gully Deposit (Goddell Portal). Multiple Sites/Mt. Skukum Mine Drainage. The mine is active during the summer of 2012.
3	Tank Creek	Mining	Location of mill site and tailings pond from Arctic Gold and Silver Mine tailings pond/mill site. Site is located adjacent to Tank Creek.
4	Arctic Gold and Silver Mine Site	Mining	The mine is located on Montana Mountain. There are concerns about Arsenic, Cadmium, Lead, Zinc levels in water.
5	Venus Mine Site	Mining	Old quartz mine site. Has not been in operation since the 1970s.
6	Venus Mine Mill Site	Mining	Venus mine mill site. Runs right over top of creek. Actual mine is located 2 miles south of the tailings pond.
7	Watson River	Sewage Lagoon	Carcross Sewage Lagoon is located uphill from Watson River and there are concerns about its influence on the river. There may be groundwater monitoring pipes located here.
8	Creosote Pit	Hydrocarbon	White Pass Creosote Pit. Sample would be taken from Bennett lake/Nares River.
9	Guardrail Point	Hydrocarbon	Creosote ties, oil buckets, buried materials, gravel, and industrial waste. Influence on Bennett Lake
10	Old Dump Site	Heavy metals, hydrocarbons,	Impacts of leaching from old dump site. Used to dump sewage directly in there. Stopped dumping directly in there, because it started leaching into the lake.

11	New Transfer Station	Heavy metals, Sewage, Hydrocarbons	Drains into Choutla Creek. The creek provides important grayling habitat. Choutla creek and it has two dam sites.
12	Choutla Lake	Sewage	Choutla Creek at Outlet of Choutla Lake. There are no houses there. Influence of current transfer station for example vehicles.
13	Crag Lake	Agriculture	Nutrients, E. coli. There are houses with septic fields locate there.
14	Standard Oil	Hydrocarbon	Pump station, tank storage, groundwater, White Pass land (Private)
15	Tagish Creek	Sewage	Septic Fields upstream. People used to drink directly from this creek, but they no longer do because they started to get sick.
16	Tagish River	Sewage/Hydrocarbons	Boat marina and C/TFN campground in the area. Concerns about fuel spills. Potential sewage leakage from campground outhouses. Two of the six outhouses are below water level. YG may be doing some testing here as part of a special management unit.
17	Tagish Town Drinking Water Well	No current concern	Tested regularly.
18	Pennycook Creek	Mining	Mine site near Tagish. There is a road that goes all the way there. There was some activity here about twenty years ago. A CAT was used.
19	Engineer Mine	Mining	Concerns about influence of mine on Tagish Lake. C/TFN has samples from this mine site that are being tested right now.
20	Little Atlin Lake	Mining, Agriculture	There is mining and agriculture in area.
21	C/TFN Main Building Well	Drinking water, Arsenic	Have own well. Tested regularly. Did not pass the tests. Health & Safety is dealing with it.
22	Marsh Lake Mining Claims and Artesian Well	No current concern, future mining	Point of interest. Concerns that hydraulic fracking would be done if mining was done in the area. Artesian wells. Groundwater is very close to the surface.
23	Tagish Lake Drinking Water	No current concern	Drinking water source. Sampled regularly.
24	Carcross Drinking Water Treatment Centre	No current concern	Drinking water source. Built in 2012. Sampled regularly.

\*The sites identified in this table should not be considered an exhaustive list.

# Appendix B – Pictures of Water Quality Sites Sampled

**Figure 14 Wheaton River below Goddell Portal (Skukum Gold Mine)**



**Figure 15 Wheaton River above Goddell Portal (Skukum Gold Mine)**



**Figure 16** Watson River at mouth



**Figure 17** Tagish River below bridge



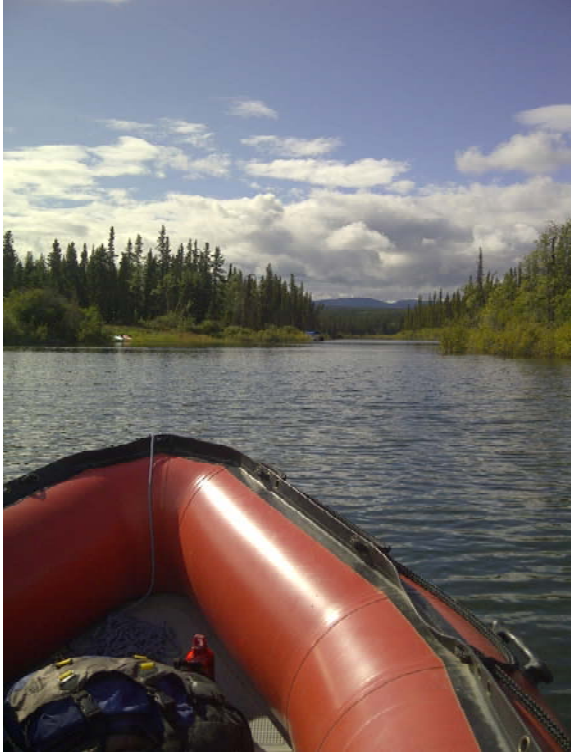
**Figure 18 Tagish River above Bridge**



**Figure 19 Tagish Creek above Tagish**



**Figure 20 Tagish Creek below at mouth**



**Figure 21 Nares River (Creosote Pit)**



# 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

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

## Groundwater

- [Yukon Wide Long-Term Groundwater Monitoring Program, Community of Whitehorse Wells, 2001-2010 Monitoring Data Analysis \(PDF 276 KB\)](#)

## Water Monitoring

1. [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](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](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](http://www.hss.gov.yk.ca/environmental_drinkingwater.php)-

9. The **Yukon Water Board** is an independent administrative tribunal established under the [Waters 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](http://www.geology.gov.yk.ca/pdf/MPERG_2007_2.pdf)

Yukon Water Resources Hydrometric Program Historical Summary 1975 – 2004.

<http://www.env.gov.yk.ca/pdf/hydrometricmanual2005.pdf>

# Appendix D – Water Quality Data

Site Name	Wheaton River Below	Wheaton River Above	Watson River at Mouth	Tagish River Above	Tagish River Below	Tagish Creek Above	Tagish Creek Below	Nares River
Site ID	CTFN01	CTFN02	CTFN03	CTFN04	CTFN05	CTFN06	CTFN07	CTFN08
Hardness (as CaCO <sub>3</sub> in mg/L)	40.9; 46.1	37.8	100; 109	-	44.3	-	104	39.0
Field pH	7.62	7.72	7.40	8.00	8.06	8.22	8.45	8.09
Air Temp. (°C)	17.5	17.4	15.4	18.1	16.4	19.8	20.8	7.0
Water Temp. (°C)	7.2	8.3	12.5	13.1	13.1	13.5	15.3	7.3
Dissolved Oxygen (mg/L)	11.54	11.26	9.81	10.99	10.85	10.76	11.0	9.92
Sample Type	open water	open water	open water	open water	open water	open water	open water	open water
<b>Total Metals (mg/L)</b>								
Aluminum (Al)	0.022	0.055	0.149	-	-	-	<0.010	0.027
Antimony (Sb)	<0.00050	<0.00050	<0.00050	-	-	-	<0.00050	<0.00050
Arsenic (As)	0.00015	0.00013	0.00097	-	-	-	0.00072	0.00039
Barium (Ba)	0.022	<0.020	0.041	-	-	-	0.036	<0.020
Boron (B)	<0.10	<0.10	<0.10	-	-	-	<0.10	<0.10
Cadmium (Cd)	<0.00020	<0.00020	<0.00020	-	-	-	<0.00020	<0.00020
Calcium (Ca)	16.3	13.5	34.6	-	-	-	31.3	12.8
Chromium (Cr)	<0.0020	<0.0020	<0.0020	-	-	-	<0.0020	<0.0020
Copper (Cu)	<0.0010	<0.0010	<0.0010	-	-	-	<0.0010	<0.0010
Iron (Fe)	<0.030	0.058	0.258	-	-	-	<0.030	0.055
Lead (Pb)	<0.00050	<0.00050	<0.00050	-	-	-	<0.00050	<0.00050
Magnesium (Mg)	1.33	0.96	5.42	-	-	-	6.21	1.70
Manganese (Mn)	<0.0020	0.0041	0.0179	-	-	-	<0.0020	0.0379
Mercury (Hg)	<0.00020	0.00020	<0.00020	-	-	-	<0.00020	<0.00020
Potassium (K)	0.43	0.61	1.05	-	-	-	0.77	0.52
Selenium (Se)	<0.0010	<0.0010	<0.0010	-	-	-	<0.0010	<0.0010
Sodium (Na)	<2.0	<2.0	3.2	-	-	-	2.7	<2.0
Uranium (U)	0.00143	0.00260	0.00128	-	-	-	0.00080	0.00106

Zinc (Zn)	<0.050	<0.050	<0.050	-	-	-	<0.050	<0.050
<b>Dissolved Metals</b> (mg/L)								
Aluminum (Al)	0.031	-	0.014	-	<0.010	-	-	-
Antimony (Sb)	<0.00050	-	<0.00050	-	<0.00050	-	-	-
Arsenic (As)	0.00018	-	0.00092	-	0.00038	-	-	-
Barium (Ba)	0.127	-	0.151	-	0.033	-	-	-
Boron (B)	<0.10	-	<0.10	-	<0.10	-	-	-
Cadmium (Cd)	<0.00020	-	<0.00020	-	<0.00020	-	-	-
Calcium (Ca)	14.6	-	32.5	-	14.0	-	-	-
Chromium (Cr)	<0.0020	-	<0.0020	-	<0.0020	-	-	-
Copper (Cu)	<0.0010	-	<0.0010	-	<0.0010	-	-	-
Iron (Fe)	<0.030	-	0.038	-	<0.030	-	-	-
Lead (Pb)	<0.00050	-	<0.00050	-	<0.00050	-	-	-
Magnesium (Mg)	1.11	-	4.70	-	2.25	-	-	-
Manganese (Mn)	<0.0020	-	0.0058	-	<0.0020	-	-	-
Mercury (Hg)	<0.00020	-	<0.00020	-	<0.00020	-	-	-
Potassium (K)	0.32	-	0.82	-	0.64	-	-	-
Selenium (Se)	<0.0010	-	<0.0010	-	<0.0010	-	-	-
Sodium (Na)	2.1	-	3.1	-	<2.0	-	-	-
Uranium (U)	0.00087	-	0.00112	-	0.00069	-	-	-
Zinc (Zn)	<0.050	-	<0.050	-	<0.050	-	-	-
<b>Volatile Organic Compounds</b> (mg/L)								
Benzene	-	-	-	<0.00050	<0.00050	-	-	<0.00050
Ethylbenzene	-	-	-	<0.00050	<0.00050	-	-	<0.00050
Methyl t-butyl ether (MTBE)	-	-	-	<0.00050	<0.00050	-	-	<0.00050
Styrene	-	-	-	<0.00050	<0.00050	-	-	<0.00050
Toluene	-	-	-	<0.00050	<0.00050	-	-	<0.00050
ortho-Xylene	-	-	-	<0.00050	<0.00050	-	-	<0.00050
meta- & para-Xylene	-	-	-	<0.00050	<0.00050	-	-	<0.00050
Xylenes	-	-	-	<0.00075	<0.00075	-	-	<0.00075
Surrogate: 4-Bromofluorobenzene (%)	-	-	-	96.5	96.0	-	-	83.1
Surrogate: 1,4-Difluorobenzene (%)	-	-	-	98.9	98.1	-	-	84.3
<b>Hydrocarbons</b> (mg/L)								
EPH10-19	-	-	-	-	-	-	-	<0.25

EPH19-32	-	-	-	-	-	-	-	<0.25
LEPH	-	-	-	-	-	-	-	<0.25
HEPH	-	-	-	-	-	-	-	<0.25
Volatile Hydrocarbons (VH6-10)	-	-	-	<0.10	<0.10	-	-	<0.10
VPH (C6-C10)	-	-	-	<0.10	<0.10	-	-	<0.10
Surrogate: 3,4-Dichlorotoluene (SS)	-	-	-	79.9 %	80.9 %	-	-	93.5 %
<b>Polycyclic Aromatic Hydrocarbons (mg/L)</b>								
Acenaphthene	-	-	-	-	-	-	-	<0.000050
Acenaphthylene	-	-	-	-	-	-	-	<0.000050
Acridine	-	-	-	-	-	-	-	<0.000050
Anthracene	-	-	-	-	-	-	-	<0.000050
Benz(a)anthracene	-	-	-	-	-	-	-	<0.000050
Benzo(a)pyrene	-	-	-	-	-	-	-	<0.000010
Benzo(b)fluoranthene	-	-	-	-	-	-	-	<0.000050
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	<0.000050
Benzo(k)fluoranthene	-	-	-	-	-	-	-	<0.000050
Chrysene	-	-	-	-	-	-	-	<0.000050
Dibenz(a,h)anthracene	-	-	-	-	-	-	-	<0.000050
Fluoranthene	-	-	-	-	-	-	-	<0.000050
Fluorene	-	-	-	-	-	-	-	<0.000050
Indeno(1,2,3-c,d)pyrene	-	-	-	-	-	-	-	<0.000050
Naphthalene	-	-	-	-	-	-	-	<0.000050
Phenanthrene	-	-	-	-	-	-	-	<0.000050
Pyrene	-	-	-	-	-	-	-	<0.000050
Quinoline	-	-	-	-	-	-	-	<0.000050
Surrogate: Acenaphthene d10	-	-	-	-	-	-	-	88.9 %
Surrogate: Acridine d9	-	-	-	-	-	-	-	96.8 %
Surrogate: Chrysene d12	-	-	-	-	-	-	-	92.2 %
Surrogate: Naphthalene d8	-	-	-	-	-	-	-	87.9 %
Surrogate: Phenanthrene d10	-	-	-	-	-	-	-	95.2 %
<b>Cation (ueq/L)</b>								
Al 396.153	16.432	-	10.142	4.837	4.451	-	2.605	3.601
Ba 455.403	26.802	-	33.154	56.746	38.884	-	25.423	28.586

Ca 317.933	12.481	-	27.769	11.836	11.425	-	22.985	12.759
Cu 224.700	2.419	-	1.764	0.381	-0.200	-	0.767	2.033
Fe 259.939	15.403	-	31.191	6.981	7.606	-	9.102	17.361
K-ax 766.490	0.250	-	0.600	0.325	0.353	-	0.482	0.369
Mg 279.077	1.094	-	4.729	2.244	2.098	-	5.356	1.775
Mn 257.310	1.381	-	5.369	0.359	0.380	-	0.517	46.981
Na 589.592 <50	1.344	-	2.395	1.008	0.844	-	1.931	1.188
Ni 231.604	-0.475	-	-1.185	0.117	0.132	-	-0.301	-2.335
S 180.669	4.361	-	8.288	2.658	2.537	-	2.400	3.112
SiO2 251.609	3.739	-	6.001	2.022	1.871	-	4.244	3.080
Sr 407.771	91.133	-	208.649	80.359	75.467	-	156.805	100.460
Zn 213.857	18.144	-	11.089	28.965	27.065	-	9.370	15.178
<b>Dissolved Organic Carbon</b>								
UV A@254nm (whole)	0.0190	-	0.0416	0.0189	0.0149	-	0.0588	0.0276
Avg DOC [ppm]	1.08	-	1.78	1.28	1.27	-	2.57	1.40
SUVA	1.75	-	2.34	1.47	1.17	-	2.28	1.97
Baseline High?	High	-	-	-	-	-	-	-
Alkalinity ueq/L	565.351	-	1532.639	654.969	706.959	-	1631.761	609.16
Conductivity	91.4	-	201	83.7	89	-	173.5	-
<b>Dissolved Oxygen</b>								
SC	81.2	-	194	85.8	86	-	243.7	81.2
DO mg/L	11.54	-	9.81	10.99	10.85	-	11	9.92
DO %	95.5	-	92	104.6	103.4	-	110.1	81.8

At or below instrument Detection Limit