Aquatic Effects Monitoring Plan and Surveillance Network Program: Construction of the Inuvik to Tuktoyaktuk Highway

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Northwest Territories Transportation

Inuvik Tuktoyaktuk
MACKENZIE VALLEY HIGHWAY


Northwest
Territories Transportation


Inuvik Tuktoyaktuk
MACKENZIE VALLEY HIGHWAY

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Abbreviations

AANDC. ..... Aboriginal Affairs and Northern Development Canada
AEMP..... Aquatic Effects Monitoring Program
CCME ..... Canadian Council of Ministers of the Environment
Cd ..... cadmium
Co ..... cobalt
Cr ..... chromium
Cu ..... copper
DFO. ..... Fisheries and Oceans Canada
DO ..... Dissolved oxygen
DOT. ..... Department of Transportation – Government of the Northwest Territories
Fe ..... iron
FJMC ..... Fisheries Joint Management Committee
Mn..... manganese
Ni ..... nickel
IWB. ..... Inuvialuit Water Board
Pb ..... lead
SNP ..... Surveillance Network Program
TSS..... Total suspended solids
Zn ..... zinc

1 BACKGROUND

1.1 Purpose

This document provides the Aquatic Effects Monitoring Plan (AEMP) and the Surveillance Network Program (SNP) consolidating all aquatic effects monitoring within one document for the Inuvik to Tuktoyaktuk Highway (ITH). The AEMP and SNP are both requirements under the Type A Water Licence N7L1-1835 issued by the Northwest Territories Water Board (NWTWB) on December 12, 2013.

The AEMP was developed in collaboration with Aboriginal Affairs and Northern Development Canada (AANDC), Fisheries and Oceans Canada (DFO), and the Fisheries Joint Management Committee (FJMC). Specific monitoring details such as site locations, sampling techniques and time frames are detailed in the AEMP.

The SNP was outlined within the Type A Water Licence and transcribed into this document. Both monitoring programs complement each other providing an overall set of robust monitoring initiatives. Quality assurance and quality control (QA/QC) are for aquatic monitoring are contained in the QA/QC plan (Appendix A).

Monitoring carried out under these plans will provide the necessary information required in determining when adaptive management actions are required.

1.2 The Receiving Environment

1.2.1 Hydrology

The alignment crosses through the Delta Hydrologic Region (IOL et al. 2004), which is characterized by very large numbers of shallow lakes and ponds that generally drain through small streams into either the Mackenzie River or Husky Lakes. The principal hydrologic processes are snowmelt, surface runoff, stream flow and development of a seasonal active layer. Surface runoff patterns are based on the annual freeze-thaw cycle, though summer rainstorms can also result in rapid rises in water levels. Lakes and ponds are recharged during spring freshet and surface flow connections between these lakes and ponds, however, many of these connections are only seasonal (Woo and Guan 2006).

1.2.2 Water Quality

The physical and chemical characteristics of lakes and ponds in the project area are known and expected to be highly variable, and may be dependent on the size, depth, interconnectivity, geomorphic/physiographic setting and thermokarst activity of each lake (Kokelj et al., 2005; 2009). Permafrost degradation and thaw slumping, which have been shown to be increasing in the project area, are expected to continue during project construction activities.

Historical activity in the project area has been minimal, and limited to recent geotechnical investigations associated with the ITH Project. Several historical drilling fluid containment sumps exist to the west of the project area. Generally, pre-construction conditions are expected to represent natural baseline conditions.

1.2.3 Sediment Chemistry

Borrow sources proposed to be used for construction consist of unconsolidated, ice-rich silt, sand and gravel. The chemical characteristics of sediments in the project area are highly variable, and dependent on geomorphic/physiographic setting, organic content and ice content. Samples of material excavated from the granular sources will be analyzed to further define the geochemical properties of the materials to be used in constructing the embankment. Recent studies in the project area show that natural releases of large quantities of sediment into small tundra lakes can cause significant alteration in lake chemistry, especially ionic concentrations and water clarity.

1.2.4 Fish Health and Habitat

The watercourses vary in size from ephemeral drainages, with only seasonal flow, to large permanent watercourses, which may flow year-round. The Husky Lakes provide important fish habitat, and is used for the subsistent harvesting of fish by residents of Inuvik and Tuktoyaktuk. The Highway crosses through the Fish Lakes and Rivers Management Area (704C), which also provides important fish habitat and subsistent harvesting of fish (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008). Common fish species which occur within the freshwater environments along the proposed Highway and Husky Lakes is provided in Table 1-1.

Table 1-1 Freshwater Fish Species Present and Estuarine Species Immediately Adjacent to the ITH Alignment

Common Name	Local name	Scientific name
Arctic cisco	herring	*Coregonus autumnalis*
Arctic flounder		*Liopsetta glacialis*
Arctic grayling	grayling	*Thymallus arcticus*
Broad whitefish	whitefish	*Coregonus nasus*
Burbot	loche	*Lota lota*
Fourhorn sculpin	devil fish	*Liopsetta glacialis*
Inconnu	coney	*Stenodus leucichthys*
Lake trout	trout	*Salvelinus namaycush*
Lake whitefish	crooked back	*Coregonus clupeaformis*
least cisco	big-eyed herring	*Coregonus sardinella*
Ninespine Stickleback		*Liopsetta glacialis*

Table 1-1 Freshwater Fish Species Present and Estuarine Species Immediately Adjacent to the ITH Alignment

Common Name	Local name	Scientific name
Northern pike	jackfish	*Esox lucius*
Pond smelt		*Hypomesus olidus*
Rainbow smelt	smelt	*Osmerus mordax mordax*
Saffron cod		*Eleginus gracilis*
Slimy sculpin		*Cottus cognatus*
Starry flounder		*Platichthys stellatus*

1.3 Issues and Concerns

DOT has conducted numerous consultations with community organizations, co-management bodies and regulators where concerns related to water quality and fish and fish habitat have been raised. The most common concern is over the potential of erosion and sedimentation affecting watercourses and waterbodies. Other concerns expressed include:

- Erosion and sedimentation at water crossings affecting water quality, fish habitat and fish health.
- Permafrost melting along embankment or water crossings potentially causing slumping and leading to sedimentation of watercourses and waterbodies.
- Water seepage or drainage from the embankment affecting water quality.
- Snow removal from embankment and bridges containing sediment entering watercourses or waterbodies.
- Erosion and sedimentation from pit development and potential effects on surface water quality and receiving aquatic systems.
- Flow velocities or low flows resulting from culvert crossings leading to potential blockage of migrating fish.
- Regular maintenance of water crossing structures, timing and procedures to prevent blockages to fish movement and water flows.
- Potential presence of acid rock drainage and/or metal leaching conditions and its effects on water quality.
- Potential effects of explosive charges affecting water quality and fish health.
- Effects on water quality from any unattended spills.
- Potential effects on water quality and fish health related to the storage of wastes and fuels and use of fuels.

1.4 Cumulative Effects

The Canadian Environmental Assessment Agency (2003) defines cumulative effects as changes to the environment that "are likely to result from the project in combination with other projects or activities that have been or will be carried out". Projects that have occurred in the past occurred mainly in the 1970's and 1980's with the construction of a power line (now abandoned) and oil and gas exploration which was also terminated in the late 1980s with no new start date at least for the foreseeable future. These past projects are identified and described by Kiggiak-EBA (2010). Current activities occurring within the ITH corridor are all related to community activities such as the use of local trails by snow machine and all-terrain vehicles, camps at select lakes especially Husky Lakes and use of portions of the corridor as a reindeer grazing range. The effects of climate change on watercourses and lakes, such as slumping and increased erosion, are being observed and reported by local residents and scientific researchers. The construction of the ITH, in conjunction with these natural physical changes related to climate change (e.g., land slumping, thermokarst lake drainage), may result in cumulative effects to watercourses, lakes and water quality in the project area. The magnitude of potential cumulative effect between ITH construction and climate change is difficult to predict. However, the use of best management practices in the construction and operation of the ITH will minimize the potential for cumulative effects related to the project.

2 CAUSES AND EFFECTS

2.1 Summary of Project Activities

The ITH project will construct a140 km all-season highway between the Town of Inuvik and the Hamlet of Tuktoyaktuk in the Inuvialuit Settlement Region (ISR). Construction will occur over a 4-5 year period starting in January 2014. Approximately 20 km of new embankment will be constructed each winter from both the southern and northern sections of the highway for a total of 40 km new embankment each year. Although most construction activities will occur during the winter period some summer activities will occur such as compacting and grading of previously constructed alignment. A Construction Atlas for the ITH is provided in Appendix B.

Winter Construction includes:

- Construction and maintenance of winter access roads along alignment ,to borrow pits and to water withdrawal lakes
- Water withdrawal
- Borrow pit operations including use of explosives
- Embankment construction
- Watercourse crossing construction
- Temporary camp use
- Fuel storage
- Transportation of fuel, waste, equipment and personnel

Summer activities include:

- Water withdrawal for dust control
- Pit management (i.e., stockpiling materials, ripping) – no explosive use
- Grading and compaction of constructed embankment
- Completing surface bridge structures but no instream work.
- Temporary camp use
- Fuel storage
- Assessing water course crossing mitigations

Winter and summer activities when the ITH becomes operational will include;

- Summer water withdrawal for dust control
- Grading and maintenance of highway surface summer and winter
- Culvert and bridge maintenance if required
- Snow removal

2.2 Mitigations

The project's construction practices to be employed, as well as the mitigation measures included in the Sedimentation and Erosion Control Plan, Fish and Fish Habitat Protection Plan, Waste Management Plan, Explosives Management Plan and Pit Development Plans, are intended to prevent any waste from entering the receiving environment. Mitigations are based on best management practices and proven mitigation procedures. Generally, the objectives of the mitigations in these plans are:

- To maintain water quality in the receiving environment at a level that allows for current and future water uses; and
- To ensure that waste is not deposited in the receiving environment.

2.3 Effects of Potential Concern

The effects identified within this plan are based on:

- Inadvertent discharges of waste to the environment
- Planned uses of water

The project does not have any "effluent" sources (planned points of discharge). Waste may be discharged *inadvertently* to the environment from a number of construction-related activities, including watercourse crossing construction, borrow source development or embankment construction.

2.3.1 Planned Discharges of Waste

There are no planned discharges of waste into the surrounding environment. The Sedimentation and Erosion Control Plan identifies measures to create positive drainage at borrow sources to prevent the formation of an end-pit lake. Melt water will be channeled away from proximal lakes and watercourses through the use of ditches, contouring and silt fencing if required. The planned discharge of meltwater to surrounding vegetation will have the effect of adding sediment to vegetation. However, no adverse effects to vegetation are expected from the planned redirection of melt water.

2.3.2 Inadvertent Discharges of Waste

Mitigations contained in the Sedimentation and Erosion Control Plan, Fish and Fish Habitat Protection Plan, Waste Management Plan and Explosives Management Plan are intended to *prevent* discharges of waste to the environment, primarily waterbodies and watercourses. Adverse effects may occur if mitigations are not applied properly or are not working effectively. Potential effects include:

- Inadvertent effects to water quality and fish habitat during watercourse crossing construction
- Inadvertent effects to water quality from borrow source development
- Inadvertent effects to water quality from camp operation
- Inadvertent effects to water quality from embankment construction
- Inadvertent effects to water quality from use of explosives

Should regular inspections of pits, constructed embankment and water course crossing structures, or from water analyses conducted under the AEMP and SNP, detect the entry of waste into water bodies approaching or above permitted guidelines and attributed to construction activities, the licencee and contractor will:

- Review all construction practices and enact the required improvements;
- Review and enhance all waste, fuel and explosives handling procedures;
- Review and enhance all sediment and erosion control measures; and
- Increase the frequency of monitoring to ensure that the enhanced mitigation measures are proving to be effective in mitigating waste entry

2.3.3 Planned Uses of Water

The Project will require use of water from over 30 different lakes during the 3 to 4 year construction period. Most lakes will be used as a water source for only one or two construction seasons. Selection of lakes for water withdrawal has been undertaken in accordance with DFO's *Protocol for Winter Water Withdrawal from Ice Covered Waterbodies in the Northwest Territories and Nunavut*. The protocol is intended to prevent adverse effects to fish and fish habitat for lakes where fish are expected to overwinter.

2.4 Standards and Criteria for Evaluating Effects

Following the methodology for developing standards and criteria (or "Action Levels") in INAC (2009), environmental quality objectives (EQOs) need to be developed for the receiving water body. The EQOs can be generic, such as Canadian Environmental Quality Guidelines (CCME 2013), site-adapted or site-specific. There is a lack of regional data to characterize appropriate baseline conditions in the lakes and watercourses along the ITH to develop site-adapted or site-specific EQOs. As such, criteria for lake water quality will follow Canadian Environmental Quality Guidelines, where appropriate. The Canadian Guidelines for the Protection of Aquatic Life (CCME PALs) are generally the most stringent guidelines

and are therefore considered to be protective of all water uses. For the EQOs that will be used for the indicators identified in Section 2.4 see Table 2-1. Parameters listed are those identified as required in the Water Licence for the SNP.

Table 2-1 Water Licence Effluent Standards and CCME Environmental Quality Guidelines for the Protection of Aquatic Life (PAL)

Parameter	Environmental Quality Objective	Source
Ammonia (total)	See Table 2-2	CCME 2013
Ammonia (un-ionized)	0.019 mg/L NH_3 (equivalent to 0.016 mg/L NH_3-N)	CCME 2013
Dissolved Oxygen	Lowest acceptable dissolved oxygen concentration: • for cold water biota: early life stages = 9.5 mg/L • for cold water biota: other life stages = 6.5 mg/L	CCME 2013
Total Mercury	0.026 µg/L	CCME 2013
Nitrate	Short-term (24 to 96 h) concentration not to exceed 550 mg/L NO_3^-/L (equivalent to 124 mg NO_3^--N/L)	CCME 2013
Nitrite	Long term 60 ug/L NO2-N	CCME 1987
Calcium/magnesium (hardness)	Used for determining hardness dependent criteria	
Sulphides	Used for determining acid rock drainage potential	
Oil and grease	Concentrations of oil and grease visible as film, sheen, discolouration or odour.	
pH	Acceptable between 6.0 to 9.0	WL
TSS	For watercourse crossings (during construction) an increase in Total Suspended Solids between the downstream and upstream sample of 100 mg/L. For surface runoff from pits (where flow may enter a water body), and other water discharges to the receiving environment, a maximum average concentration of 50 mg/L and a maximum concentration of any one grab sample of 100 mg/L.	WL
Turbidity	During clear flow: Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period). During high flow or turbid waters: Maximum increase of 5 NTUs from background levels at any one time when background levels are between 8 and 50 NTUs. Should not increase more than 10% of background levels when background is >50 NTUs.	BC Ministry of Environment Ambient Water Quality Guidelines (BCAWQG)
Total Petroleum Hydrocarbons	Maximum average concentration 3mg/L Maximum concentration of any one grab sample 5 mg/L	WL
Total iron	Long-term concentrations not to exceed 300 $\mu g \cdot L^{-1}$	CCME 2013

Table 2-1 Water Licence Effluent Standards and CCME Environmental Quality Guidelines for the Protection of Aquatic Life (PAL)

Parameter	Environmental Quality Objective	Source
Total Manganese	No environmental quality objective	
Total Zinc	Long-term concentrations not to exceed 30 µg·L^{-1}	CCME 2013
Hardness Dependent Metals: Total cadmium	The short-term benchmark concentration of 1.0 µg·L^{-1} is for waters of 50 mg $CaCO_3$·L^{-1} hardness. At other hardness values, the benchmark can be calculated with the equation Benchmark = $10^{\{1.016(\log[\text{hardness}]) - 1.71\}}$, valid for hardness between 5.3 and 360 mg $CaCO_3$·L^{-1}. The long-term CWQG of 0.09 µg·L^{-1} is for waters of 50 mg $CaCO_3$·L^{-1} hardness. At other hardness values, the CWQG can be calculated with the equation CWQG = $10^{\{0.83(\log[\text{hardness}]) - 2.46\}}$, valid for hardness between 17 and 280 mg $CaCO_3$·L^{-1}.	CCME 2014
Hardness Dependent Metals: Chromium	Cr(VI): Long-term concentrations not to exceed 1 µg·L^{-1} Cr(III): Long-term concentrations not to exceed 1 µg·L^{-1}	CCME 2013
Hardness Dependent Metals: Total copper	When the water hardness is 0 to < 82 mg/L not to exceed 2 µg/L At hardness ≥82 to ≤180 mg/L not to exceed the value calculated using the following equation: $= 0.2 * e^{\{0.8545[\ln(\underline{\text{hardness}})]-1.465\}}$ *(µg/L)* At hardness >180 mg/L, not to exceed 4 µg/L If the hardness is unknown, not to exceed 2 µg/L	CCME 2013
Hardness Dependent Metals: Total lead	When the hardness is 0 to ≤ 60 mg/L, not to exceed 1 µg/L At hardness >60 to ≤ 180 mg/L not to exceed the value calculated using the following equation: $= e^{\{1.273[\ln(\underline{\text{hardness}})]-4.705\}}$ *(µg/L)* At hardness >180 mg/L, not to exceed 7 µg/L If the hardness is unknown, not to exceed 1 µg/L	CCME 2013
Hardness Dependent Metals: Total nickel	When the water hardness is 0 to ≤ 60 mg/L, not to exceed 25 µg/L At hardness > 60 to ≤ 180 mg/L not to exceed the value calculated using the following equation: $= e^{\{0.76[\ln(\underline{\text{hardness}})]+1.06\}}$ *(µg/L)* At hardness >180 mg/L, not to exceed 150 µg/L If the hardness is unknown, not to exceed 25 µg/L	CCME 2013
Total arsenic	Long-term concentrations not to exceed 5 µg·L^{-1}	CCME 2013

Table 2-2 Water Quality Guideline for Total Ammonia for the Protection of Aquatic Life (mg/L NH_3) in Freshwater (CCME 2013)

		pH							
		6.0	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**10.0**
Temp (°C)	**0**	231	73.0	23.1	7.32	2.33	0.749	0.25	0.042
	5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
	10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
	15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
	20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
	25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
	30	23.7	7.50	2.39	0.767	0.256	0.094	0.043	0.021

3 AQUATIC EFFECTS MONITORING PROGRAM

The aims of the AEMP are to monitor potential effects of the project on the aquatic receiving environment, to determine if there are potential cumulative effects, and to assess the effectiveness of mitigations designed to prevent discharge of waste to the aquatic environment. The AEMP has been developed in accordance with AANDC, *Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories.* The results from water withdrawal monitoring and the monitoring requirements identified in the SNP will influence adaptive management considerations in the project mitigation plans and will be reported under the AEMP.

3.1 GRANULAR SOURCE PITS AND WATERCOURSE CROSSINGS

For lakes in the project area, water quality is expected to be naturally highly variable. Furthermore there are *no point discharges of waste* into any of the lakes in the project area and, as such, no pre-treatment will be applied. Any waste entries to water bodies, such as melt water from borrow sources, hydrocarbons or wastewater would be accidental and unplanned. Mitigation measures outlined in the Environmental Management Plan and Pit Development Plans are intended to prevent entry of waste into adjacent waters, as well as mitigate against any unplanned discharges. If an unplanned discharge occurred, follow-up sampling and analysis of the receiving environments would be conducted.

Most granular source pits will only be used for one to two construction seasons. During the winter construction period self-contained temporary camps will be established. No grey or black water waste will be deposited at the camp location but will be stored in tanks and transported to an approved waste facility in Tuktoyaktuk or Inuvik. Explosives using ammonium nitrate oil based mixtures will be used to loosen material and transported over ice road to the embankment construction sites. No use of explosives or transport of materials outside the borrow pit will occur during the summer period. During the summer when conditions permit, a small crew will be based at the borrow sources to stockpile materials in the pit and re-contour the pit where required. Work crews will be flown by helicopter in and out of the pit camp sites for crew changes.

Granular source material is mainly glacial- fluvial material with rock, clay and sand. No crushing of rock material will be conducted at the borrow sources for embankment construction.

3.1.1 Sampling

The AEMP sampling stations will coincide with the SNP monitoring stations as defined in the Water Licence and discussed below in Section 4. Granular sampling will occur during the winter construction period and water sampling will be conducted during the open water season when measuring effects to the aquatic receiving environment will be most effective, according to the sampling and analysis protocols in Appendix C.

Sampling will occur:

- In the granular sources which yield embankment construction material
- 50 m upstream and 100 m downstream of each watercourse crossing as identified in the SNP and 50 m downstream (temperature, turbidity, dissolved oxygen, pH and conductivity)
- At each borrow source where run off from the pit may flow into a water body or watercourse, at an upstream and downstream location within the receiving water body. Upstream locations will serve as reference stations, and therefore allow for quantifying potential effects in the downstream receiving environment. Sampling frequency and the parameters analysed will coincide with SNP monitoring (see Section 4). Depending upon the results, these may be modified following one-year of data collection.

3.2 Reporting

Within 30 days following the month being reported to the Board and Inspector, DOT will submit all data and information obtained through the AEMP. Reports will provide results of monitoring activities, identify potential issues and any corrective measures required. Community organizations in Inuvik and Tuktoyaktuk will also be provided with copies of the report. An annual report will be prepared summarizing the year's monitoring results and any effects of the project on the aquatic receiving environment.

3.3 Review

The AEMP will be reviewed annually during construction and for the first three years of operation. Review will be conducted in collaboration with the appropriate regulators. In the event circumstances indicate a review is required immediately, a review will be conducted in collaboration with the appropriate regulators. Any proposed modifications to the plan will be submitted to the IWB for approval before such changes are implemented.

4 SURVEILLANCE NETWORK PROGRAM

The terms and conditions of the surveillance network program (SNP) were established by the Northwest Territories Water Board (NWTWB) and detailed in their Type A Water Licence N7L1-1835, issued December 12, 2013, to the Government of the Northwest Territories, DOT.

4.1 Watercourse Crossings

Water quality sampling at all watercourse crossings for the SNP is divided into two separate components. The first component consists of water quality sampling on a monthly basis during the open water period immediately following the termination of winter construction activities. The second SNP component for watercourse crossings is to conduct sampling annually beginning the year after completion of the crossing. This sampling would be conducted once each year in early summer for a period of three years unless determined unnecessary by an Inspector.

Sampling locations for both water quality sampling components will be collected 50 m upstream of the watercourse crossing and 100 m downstream of the crossing. Monitoring locations will be located 50 m downstream of each crossing where temperature, turbidity, dissolved oxygen, pH, and conductivity will be monitored. Location of the watercourse to be sampled and the year in which sampling is anticipated to begin is provided in Table 4-1.

Table 4-1 Location of Stream Crossing Surveillance Stations and Start of Sample Collection

Station Number				Watercourse ID	Latitude	Longitude	Anticipated Monthly Sample Collection[1] (1 year only)	Anticipated Annual Sample Collection[1,2]
	50 m upstream of crossing	100 m downstream of crossing	50 m downstream of crossing					
1835-1	-a	-b	-c	0	68°25’11”	133°46’21”	2014	2015-TBD
1835-2	-a	-b	-c	1	68°25’56”	133°45’54”	2014	2015- TBD
1835-3	-a	-b	-c	2	68°26’6”	133°45’52”	2014	2015- TBD
1835-4	-a	-b	-c	3	68°26’23”	133°45’52”	2014	2015- TBD
1835-5	-a	-b	-c	4	68°26’51”	133°45’47”	2014	2015- TBD
1835-6	-a	-b	-c	5	68°27’17”	133°45’40”	2014	2015- TBD
1835-7	-a	-b	-c	6	68°28’19”	133°45’26”	2014	2015- TBD
1835-8	-a	-b	-c	7	68°28’45”	133°46’0”	2014	2015- TBD
1835-9	-a	-b	-c	8	68°29’22”	133°45’54”	2014	2015- TBD
1835-10	-a	-b	-c	9	68°29’33”	133°45’53”	2014	2015- TBD

Table 4-1 Location of Stream Crossing Surveillance Stations and Start of Sample Collection

Station Number				Watercourse ID	Latitude	Longitude	Anticipated Monthly Sample Collection[1] (1 year only)	Anticipated Annual Sample Collection[1,2]
	50 m upstream of crossing	100 m downstream of crossing	50 m downstream of crossing					
1835-11	-a	-b	-c	10	68°29'54"	133°46'1"	2014	2015- TBD
1835-12	-a	-b	-c	11	68°30'5"	133°45'56"	2014	2015- TBD
1835-13	-a	-b	-c	12	68°30'58"	133°46'14"	2014	2015- TBD
1835-14	-a	-b	-c	13	68°32'4"	133°45'56"	2014	2015- TBD
1835-15	-a	-b	-c	14	68°34'50"	133°43'14"	2014	2015- TBD
1835-16	-a	-b	-c	16	68°36'46"	133°41'29"	2015	2016-TBD
1835-17	-a	-b	-c	17	68°36'57"	133°41'16"	2015	2016-TBD
1835-18	-a	-b	-c	18	68°37'56"	133°38'7"	2015	2016-TBD
1835-19	-a	-b	-c	19	68°38'5"	133°38'11"	2015	2016-TBD
1835-20	-a	-b	-c	20	68°38'9	133°37'10"	2015	2016-TBD
1835-21	-a	-b	-c	21	68°38'21"	133°36'22"	2015	2016-TBD
1835-22	-a	-b	-c	25	68°46'3"	133°32'15"	2015	2016-TBD
1835-23	-a	-b	-c	26	68°46'48"	133°32'49"	2015	2016-TBD
1835-24	-a	-b	-c	31	68°52'6"	133°32'24"	2015	2016-TBD
1835-25	-a	-b	-c	12a	68°56'30"	133°24'55"	2015	2016-TBD
1835-26	-a	-b	-c	12b	68°31'29"	133°45'55"	2015	2016-TBD
1835-27	-a	-b	-c	13a	68°32'3"	133°45'57"	2015	2016-TBD
1835-28	-a	-b	-c	15a	68°34'0"	133°44'31"	2015	2016-TBD
1835-29	-a	-b	-c	15b	68°36'13"	133°41'33"	2015	2016-TBD
1835-30	-a	-b	-c	15c	68°36'14"	133°41'34"	2015	2016-TBD
1835-31	-a	-b	-c	17a	68°36'15"	133°41'34"	2015	2016-TBD
1835-32	-a	-b	-c	18a	68°37'25"	133°40'20"	2015	2016-TBD
1835-33	-a	-b	-c	20a	68°38'3"	133°38'31"	2015	2016-TBD
1835-34	-a	-b	-c	21a	68°38'13"	133°36'51"	2015	2016-TBD
1835-35	-a	-b	-c	22a	68°39'4"	133°34'49"	2015	2016-TBD
1835-36	-a	-b	-c	22b	68°40'11"	133°33'57"	2015	2016-TBD

Table 4-1 Location of Stream Crossing Surveillance Stations and Start of Sample Collection

Station Number				Watercourse ID	Latitude	Longitude	Anticipated Monthly Sample Collection[1] (1 year only)	Anticipated Annual Sample Collection[1,2]
	50 m upstream of crossing	100 m downstream of crossing	50 m downstream of crossing					
1835-37	-a	-b	-c	23a	68°42’35”	133°32’55”	2015	2016-TBD
1835-38	-a	-b	-c	24a	68°44’26”	133°32’10”	2016	2017-TBD
1835-39	-a	-b	-c	24b	68°45’32”	133°32’34”	2016	2017-TBD
1835-40	-a	-b	-c	27a	68°45’41”	133°32’27”	2016	2017-TBD
1835-41	-a	-b	-c	27b	68°47’38”	133°32’9”	2016	2017-TBD
1835-42	-a	-b	-c	27b2	68°48’17”	133°32’22”	2016	2017-TBD
1835-43	-a	-b	-c	27c	68°48’48”	133°33’9”	2016	2017-TBD
1835-44	-a	-b	-c	28a	68°49’10”	133°33’31”	2016	2017-TBD
1835-45	-a	-b	-c	29a	68°50’51”	133°32’58”	2016	2017-TBD
1835-46	-a	-b	-c	30a	68°51’47”	133°33’11”	2016	2017-TBD
1835-47	-a	-b	-c	33a	69°0’44”	133°18’48”	2015	2016-TBD
1835-48	-a	-b	-c	33b	69°0’44”	133°18’26”	2015	2016-TBD
1835-49	-a	-b	-c	34a	69°1’22”	133°15’28”	2015	2016-TBD
1835-50	-a	-b	-c	34a2	69°2’33”	133°12’31”	2015	2016-TBD
1835-51	-a	-b	-c	34b	69°2’44”	133°11’26”	2015	2016-TBD
1835-52	-a	-b	-c	34c	69°3’26”	133°9’39”	2015	2016-TBD
1835-53	-a	-b	-c	34e	69°3’58”	133°9’0”	2015	2016-TBD
1835-54	-a	-b	-c	35a	69°4’44”	133°6’26”	2015	2016-TBD
1835-55	-a	-b	-c	39a	69°13’13”	132°53’30”	2014	2015-TBD
1835-56	-a	-b	-c	39b	69°14’41”	132°54’18”	2014	2015-TBD
1835-57	-a	-b	-c	39c	69°15’2”	132°54’0”	2014	2015-TBD
1835-58	-a	-b	-c	39d	69°15’52”	132°55’0”	2014	2015-TBD
1835-59	-a	-b	-c	5a	68°27’21”	133°45’39”		
1835-60	-a	-b	-c	A10	69°6’58”	133°4’30”	2015	2016-TBD
1835-61	-a	-b	-c	A11	69°6’41”	133°4’49”	2015	2016-TBD
1835-62	-a	-b	-c	A12	69°6’29”	133°4’54”	2015	2016-TBD

Table 4-1 Location of Stream Crossing Surveillance Stations and Start of Sample Collection

Station Number				Watercourse ID	Latitude	Longitude	Anticipated Monthly Sample Collection[1] (1 year only)	Anticipated Annual Sample Collection[1,2]
	50 m upstream of crossing	100 m downstream of crossing	50 m downstream of crossing					
1835-63	-a	-b	-c	A13	69°4'54"	133°5'38"	2015	2016-TBD
1835-64	-a	-b	-c	A2	69°11'9"	133°0'26"	2014	2015-TBD
1835-65	-a	-b	-c	A2a	69°11'55"	133°55'46"	2014	2015-TBD
1835-66	-a	-b	-c	A3	69°10'4"	133°2'14"	2014	2015-TBD
1835-67	-a	-b	-c	A8	69°8'32"	133°2'17"	2014	2015-TBD
1835-68	-a	-b	-c	A9	69°7'35"	133°2'38"	2015	2016-TBD

NOTES:

[1] Sampling dates may vary depending on construction completion each year.

[2] TBD (to be determined). End dates for annual sampling will be reviewed and year of completion approved by an inspector

The water quality parameters to be sampled and analyzed for both components of the SNP for watercourse crossings are:

- Routine turbidity (Nephelometric Turbidity Units)
- Temperature
- Dissolved oxygen (DO)
- pH
- Conductivity
- Total suspended solids
- Calcium/magnesium/hardness
- Sulphate
- Alkalinity (total)
- Nutrients (ammonia, nitrate, nitrite)
- Total arsenic
- Basic metal scan (including total Cd, Cr, Cu, Co, Mn, Ni, Pb, Zn, Fe)
- Total mercury
- Total petroleum hydrocarbons

Turbidity, temperature, DO, pH and conductivity will be taken using a water quality multi-probe. All other parameters will be sent to an approved laboratory for analysis.

Monitoring will be conducted by NWT DOT personnel, construction operators and/or environmental contractors.

4.2 Granular Source Pits

Water quality sampling at all granular source pits for the SNP will occur on a monthly basis during the open water period immediately following the termination of each winter season of pit operations. The number of years required to be sampled will be determined by the results of the previous year, and may be modified by the Inspector. Station number, pit location and year to be sampled are provided in Table 4-2.

Granular source pits to be monitored in the SNP are identified in the Water Licence but the specific sampling locations are not defined specific sampling locations will be determined at the time of freshet based on the flow path of runoff and the location of operations within the pit. As the main concern related to the aquatic environment from pit operations is the potential contamination of waterbodies or watercourses adjacent to source pits, the sampling station for each granular source pit will be located where the water flows out of the pit.

Table 4-2 Location of Granular Source Pit Surveillance Stations

Station Number	Borrow Source ID	Latitude	Longitude	Years Sampled
1835-69	177	69°14’52”	132°56’32”	2014 - TBD
1835-70	170	69°9’36”	133°5’13”	2014 - TBD
1835-71	173/305 or 174	69°3’27” or 69°3’6”	133°15’38” or 133°21’26”	2015 - TBD
1835-72	309	68°58’26”	133°31’8”	2016 - TBD
1835-73	312 West	68°52’27”	133°34’15”	2016 - TBD
1835-74	PW19A	68°49’53”	133°34’30	2016 - TBD
1835-75	314/325	68°44’17”	133°25’38”	2014 - TBD
1835-76	PW18	68°44’35”	133°31’26”	2015 - TBD
1835-77	GSC3/GSC4	68°37’25” 68°39’10”	133°31’34” 133°29’32”	2015 - TBD
1835-78	PW10 (2.46) / PW11 (2.46)	68°32’3” 68°32’51”	133°40’57” 133°40’28”	2014 - TBD
1835-79	1401A	68°26’18”	133°43’41”	2014 - TBD

The water quality parameters to be sampled and analyzed for the SNP for granular source pits are:

- Routine turbidity (Nephelometric Turbidity Units)
- Temperature
- Dissolved oxygen (DO)
- pH
- Conductivity
- Total suspended solids
- Calcium/magnesium/hardness
- Sulphate
- Alkalinity (total)
- Nutrients (ammonia, nitrate, nitrite)
- Total arsenic
- Basic metal scan (including total Cd, Cr, Cu, Co, Mn, Ni, Pb, Zn, Fe)
- Total mercury
- Total petroleum hydrocarbons

Turbidity, temperature, DO, pH and conductivity will be taken using a water quality multi-probe. All other parameters will be sent to an approved laboratory for analysis.

4.3 Volume Measurements

The total volume of water extracted from each water source during the winter construction season will be recorded and reported.

4.4 Analysis

Standard lab testing criteria and quality assurance and quality control (QA/QC) plan will be established upon selection of a qualified analytical laboratory. QA/QC for both field and laboratory requirements are provided in Appendix A.

4.5 Reporting

Results of monthly and annual SNP monitoring results will be submitted to the NWTWB 30 days following the sampling activity for all SNP requirements in a given year.

5 REFERENCES

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APPENDIX A ITH Water Sampling QA/QC Plan

APPENDIX B ITH Construction Atlas

APPENDIX C

Granular and Water Sampling & Analysis Protocols