Manitoba Infrastructure

Remote Road Operations
Project 6 - All Season Road Linking Manto Sipi Cree Nation, Bunibonibee Cree Nation and God's Lake First Nation

Aquatic Environment Report: **Effects Assessment**

March 2017

Manitoba

MANITOBA INFRASTRUCTURE – REMOTE ROADS OPERATIONS

PROJECT 6:

ALL SEASON ROAD LINKING MANTO SIPI CREE NATION, BUNIBONIBEE CREE NATION AND GOD'S LAKE FIRST NATION

Aquatic Environment Report

Effects Assessment

March 2017

Prepared for

Manitoba Infrastructure – Remote Roads Operations

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EXECUTIVE SUMMARY

The East Side Road Authority (ESRA), whose projects were assumed by Manitoba Infrastructure – Remote Road Operations (MI-RRO) in November 2016, is designing and constructing an all season road connecting Manto Sipi Cree Nation, Bunibonibee Cree Nation and God's Lake First Nation. Based on the preliminary alignment, 53 watercourse crossings will be constructed including culverts at 51 unnamed watercourses, a clear-span bridge at God's River and a two-span bridge at Magill Creek.

Effects Assessment

Potential project-related effects on aquatic habitat were evaluated using a Valued Component (VC) approach. Fish and fish habitat that are either part of or support a commercial, recreational or Aboriginal (CRA) fishery, and aquatic species-at-risk were selected as the aquatic VCs. Twenty four species of fish are documented to occur within streams and rivers crossed by the proposed project alignment including Lake Sturgeon which is designated as a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The primary potential effects of road development on fish and fish habitat include erosion and sedimentation of streams, introduction of deleterious substances and habitat loss and alteration (riparian and instream) at watercourse crossing sites. Potential effects to species-at-risk include: the disruption of Lake Sturgeon feeding habitat due to sediment introduction and deleterious substances.

Mitigation is expected to minimize the frequency, magnitude and extent of sediment introduction into the aquatic environment during the construction phase of the Project. However, in-water construction activities, particularly during the installation and removal of coffer dams and silt curtains, may result in temporary, localized increases in total suspended solids. Additional sediment releases from right-of-way (RoW) run-off may also occur during construction. Unavoidable destruction and alteration of fish habitat will occur within the footprint of crossings and crossing approaches. Habitat loss will include approximately 3,671.8 m^2 of instream and 864 m of riparian habitat. An additional 1,008 m of riparian habitat within the cleared RoW will be altered from riparian forest to low growing vegetation and 161.5 m^2 of instream habitat will be altered as a result of rip rap placed at the base of the pier of the proposed multi-span bridge at Magill Creek. No adverse residual effects to species-at-risk are anticipated with the implementation of mitigation.

Inspection and monitoring will be conducted at stream crossing sites to ensure that the mitigation measures are effective and to identify where adaptive management is required. Environmental site inspections will be conducted before and regularly during construction to ensure that

appropriate mitigation measures are in place, properly maintained, and effective. Post-construction inspections will ensure that crossing sites have been adequately stabilized and disturbed areas are restored. Monitoring programs will include water quality monitoring to measure potential increases in total suspended solids during instream construction activities.

ACKNOWLEDGEMENTS

Manitoba Infrastructure – Remote Road Operations is thanked for the opportunity to conduct this study. Ms. Leanne Shewchuk and Ms. Jaime Clarke provided technical support and direction during the course of this study.

Fisheries studies were conducted under Manitoba Sustainable Development Scientific Collection Permit 28-16.

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1.0 INTRODUCTION

The East Side Road Authority (ESRA), whose projects were assumed by Manitoba Infrastructure – Remote Road Operations (MI-RRO) in November 2016, is undertaking the design, and in the future, the construction of an all-season road (ASR) connecting the communities of Manto Sipi Cree Nation, Bunibonibee Cree Nation and God's Lake First Nation (the Project). The Project is part of a larger initiative to provide improved, safe, and more reliable transportation service between all the communities on the east side of Lake Winnipeg.

The ASR Project is currently in the preliminary design phase and based on the preliminary alignment, the proposed ASR will intersect both small and medium-sized streams and one large river. Detailed aquatic environmental studies were undertaken in June 2016 to identify and describe aquatic habitats potentially affected by the project and to assess the potential impacts of the Project on these habitats. Specific objectives included:

- To describe the existing aquatic habitat within the project study area;
- To assess the risk of the project to fish and fish habitat and aquatic species-at-risk at watercourse crossing sites;
- To identify watercourse crossings where ASR construction may cause "serious harm to fish[1]" pursuant to Section 35(1) of the federal *Fisheries Act*;
- To assess the potential effects of the project to the aquatic environment and propose measures to mitigate the effects;
- To assess the residual effects of the project on the aquatic environment; and
- To provide inspection and monitoring recommendations related to the aquatic environment for each phase of the ASR project.

The information provided in this report is intended to assist in project design and be used in support of an Environmental Impact Statement (EIS) to be submitted and reviewed under the Manitoba *Environment Act* and the *Canadian Environmental Assessment Act, 2012* (S.C. 2012, c. 19, s. 52; CEAA).

[1] Under the *Fisheries Act*, "serious harm to fish" applies to fish and fish habitat that are part of or support a commercial, recreational or Aboriginal fishery and includes the death of a fish or any permanent alteration to or destruction of fish habitat.

2.0 PROJECT OVERVIEW

The proposed ASR will extend from Bunibonibee Cree Nation to God's Lake First Nation (P6a) and from Manto Sipi Cree Nation to the P6a junction (P6b; figures 1 and 2) and will consist of an 8.5 m wide road top centered within a 60 m cleared right-of-way (RoW). The Project is currently in the preliminary planning stage and the road alignment and crossing design are yet to be finalized. Based on the preliminary route, the ASR project will require construction of 53 watercourse crossings. Although subject to change, the crossing designs are expected to include:

- a clear-span bridge at the God's River;
- a two-span bridge at Magill Creek; and
- culverts at 51 unnamed streams.

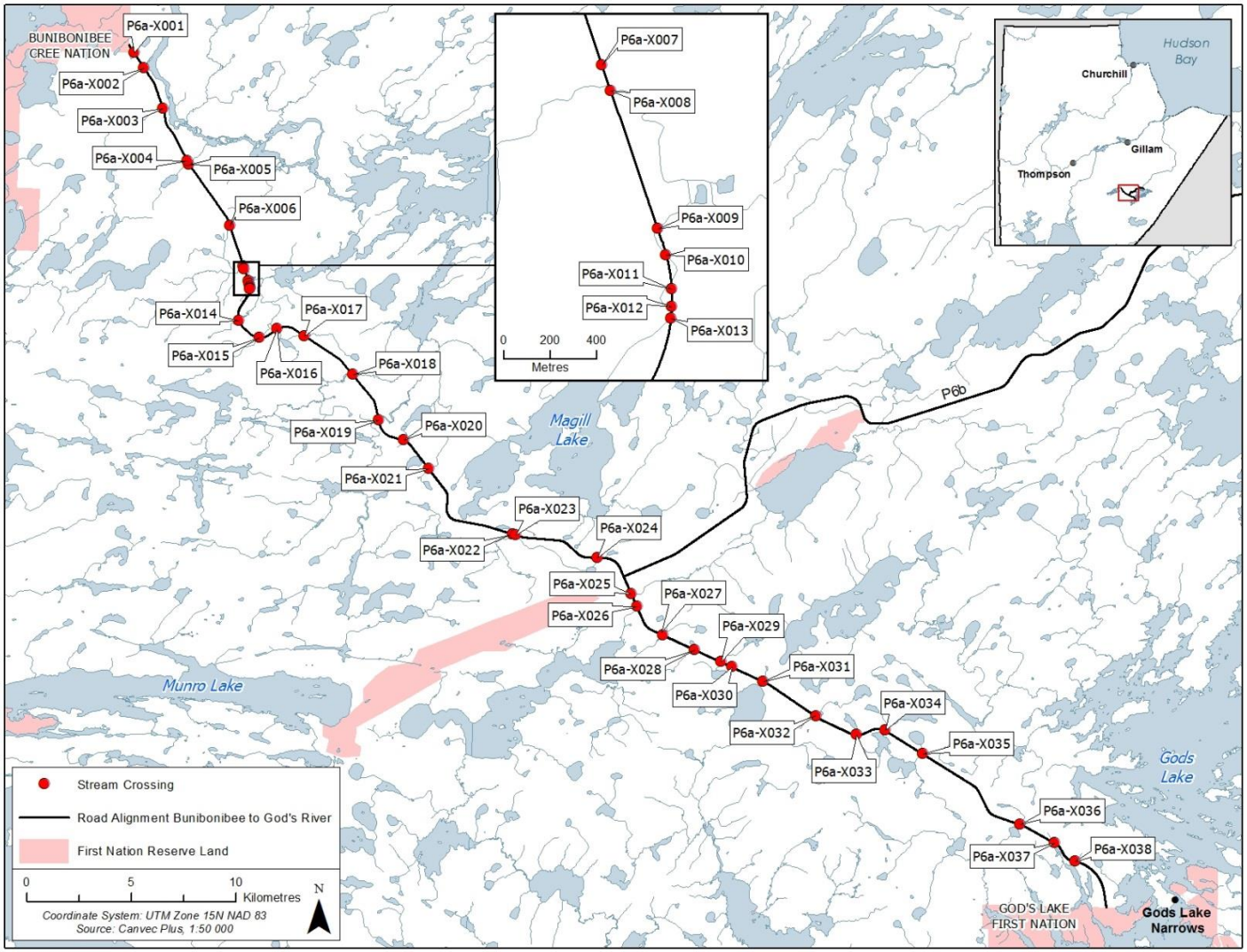

Figure 1. Project 6a – Bunibonibee Cree Nation to God's Lake Narrows First Nation All Season Road study area and watercourse crossing locations.

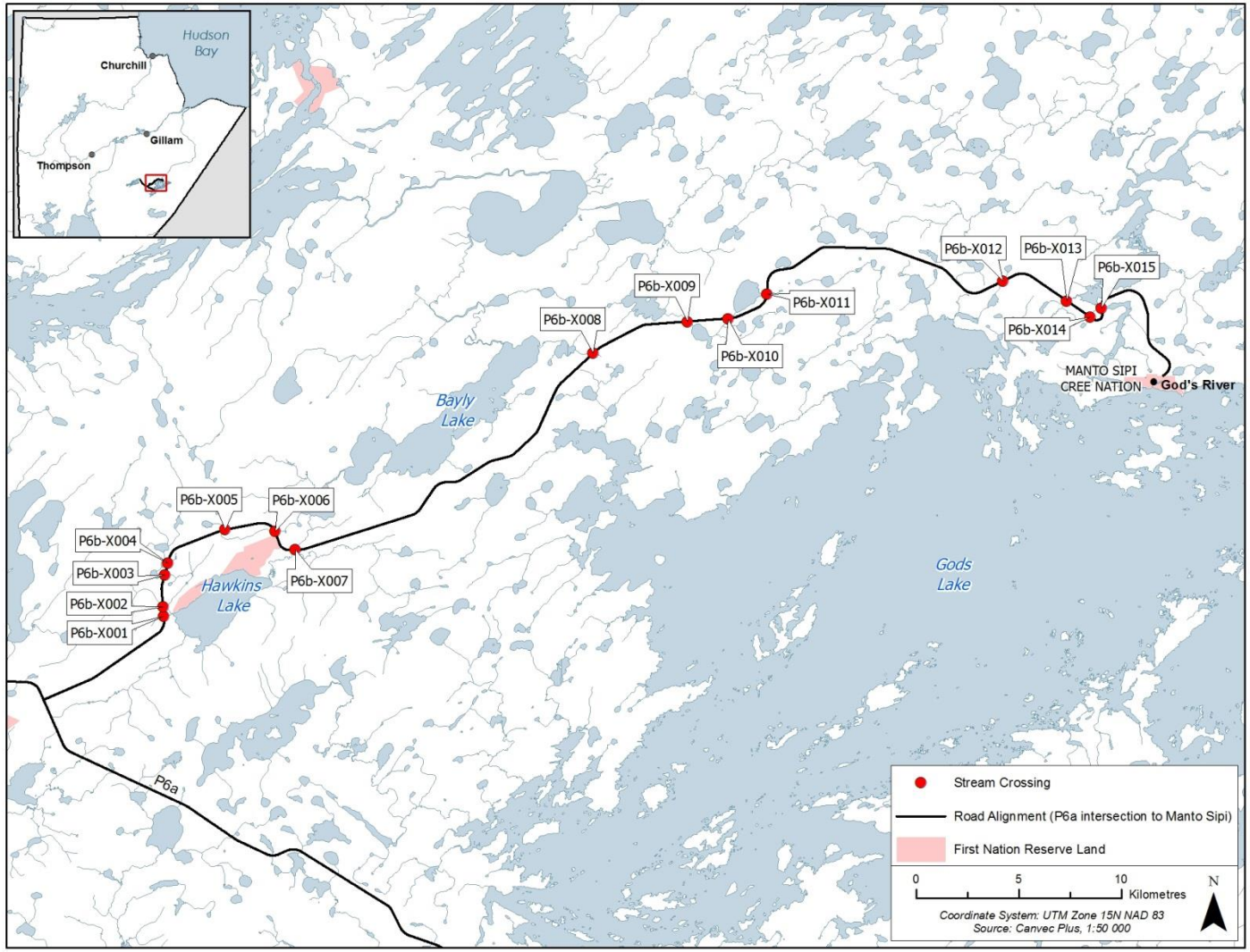

Figure 2. Project 6b – Manto Sipi Cree Nation to the P6a junction All Season Road study area and watercourse crossing locations.

3.0 EXISTING ENVIRONMENT

The Project is located on the east side of Lake Winnipeg, between the communities of God's Lake First Nation, Bunibonibee (Oxford House) Cree Nation, and Manto Sipi (God's River) Cree Nation.

The east side of Lake Winnipeg is located within the Boreal Shield ecozone and encompasses the Hayes River Upland ecoregion (Smith et al. 1998). Within the ecoregion, the Project traverses two ecodistricts: predominantly God's Lake and the northern-most portion intersecting Silsby Lake. Both the Silsby Lake and God's Lake ecodistricts are dominated by peatlands (i.e., bogs and fens) with poor drainage supporting black spruce, ericaceous shrubs and mosses in bogs, and sedges, brown mosses, shrubs and stunted tamarack in fens. However, unlike the Silsby ecodistrict, the God's Lake ecodistrict also supports mixed forests of white spruce, balsam fir, trembling aspen and balsam poplar bordering lakes and rivers. These two ecodistricts are characterized by short, cool summers, and long, very cold winters, with highest precipitation occurring during summer.

Waterbodies within the area are primarily comprised of small streams but include medium and large sized rivers, as well as small to very large lakes (the largest being God's and Oxford lakes). The smaller streams are often part of the numerous boreal wetlands such as bogs and fens that drain local areas into larger creeks, rivers or lakes, and are usually less than one metre in depth. Within the study area, these types of streams typically drain to major rivers, such as the God's and Hayes rivers which in turn drain to the northeast and ultimately Hudson's Bay. Discharges may be a number of cubic metres per second during spring, but become entirely dependent on precipitation during summer and can often reach zero during dry periods. Water temperatures in these streams may be near 0ºC at break-up in April or May, but can rise rapidly to the mid-twenties by June.

The smaller streams may be used as spawning and nursery areas by larger fish species (e.g., Northern Pike) in spring, while smaller forage species such as cyprinids (minnows) and stickleback may utilize the streams through the summer if water volume is adequate. Due to shallow depths and low winter flows, small streams generally provide little or no over-wintering habitat. Medium sized streams may provide spawning habitat for larger fish such as suckers and Northern Pike. For the remainder of the year, these streams may be utilized as a nursery for young fish, as well as providing habitat for various species of minnows, darters, sticklebacks and sculpins. Over-wintering of smaller fish in these types of streams will often occur when deeper pools are available. The one large river within the Project area, God's River, provides year-round habitat for several fish species. Due to perennial flows it supports both spring (e.g., Walleye, Northern Pike, suckers) and fall spawning species (e.g., Brook Trout and Cisco).

Small boreal wetlands also occur within the Project area. These habitats generally do not have clear connection to fish bearing waters and typically become anoxic during winter. A few species of small-bodied fish that are tolerant of low oxygen levels may persist in some, but most of these wetlands are typically devoid of fish populations.

Based on existing information, including traditional knowledge studies, thirty-two fish species occur within the major watercourses in the Project area (Table 1).

The proposed ASR alignment extends northwest from the God's Lake Narrows community to Oxford House and extends northeastward from the P6a junction to connect to the God's River community (figures 1 and 2). The landscape is relatively undeveloped; in addition to the Oxford House, God's Lake, and God's River communities other infrastructure developments include a winter road connecting the communities and an electrical transmission line.

3.1 STUDY AREA

The Project Footprint (PF) is the physical space or directly affected area on which the Project components or activities are located. The PF for the aquatic environment is the area of the watercourses directly affected by the road crossings, including the riparian zone (transition area between the aquatic and terrestrial environment) and the RoW associated with the watercourse crossing.

The Local Assessment Area (LAA) is the area within which project effects are measurable and extend beyond the PF. The LAA for the aquatic environment includes areas upstream or downstream of the alignment crossings that may be affected by the all-season road crossings, e.g., by changes in flow patterns. Project effects are expected to be restricted to a relatively short distance from the ASR alignment for small streams (1 km), but for larger streams (e.g., God's River) project effects may extend a greater distance from the ASR alignment and a 5 km buffer is applied.

The Regional Assessment Area (RAA) is the area beyond the LAA within which most indirect and cumulative effects would occur. The RAA would include areas upstream or downstream of the LAA that are connected to watercourses affected by the PF, e.g. the headwater areas of the affected streams, and downstream receiving waterbodies such as the Hayes River and God's Lake. P6a and P6b are located within the Hayes River Watershed Basin. This area would encompass most potential indirect and cumulative effects.

4.0 EFFECTS ASSESSMENT

This section outlines the approach used to assess the effects of the Project on the aquatic environment and identifies the potential effects, prescribed mitigation measures and residual effects resulting from ASR construction and operation.

4.1 APPROACH

The environmental effects assessment for the Project uses a Valued Component VC approach. The potential effects, mitigation measures, and residual effects are identified and assessed relative to the selected aquatic VCs, using the existing literature, available project information and habitat assessment results.

4.1.1 Valued Environmental Components

Fish and fish habitat and aquatic species-at-risk were selected as the VCs for the aquatic environment effects assessment as they are important environmental components that are potentially affected by the ASR.

4.1.1.1 Fish

Fish were selected as VCs because:

- they are important to people, communities and the ecosystem they inhabit in the area;
- they may be potentially affected by the Project; and
- they are protected under the federal *Fisheries Act*.

A diverse community of fish both harvested and non-harvested species occur within the Project area. Thirty-two fish species are known to occur within the study area, 24 of which occur within streams and rivers crossed by the proposed alignment (NSC 2017). The broad category of fish is consistent with protection afforded under the *Fisheries Act*, where the *Act* prohibits causing serious harm to fish or fish habitat that are part of or support a commercial, recreational or Aboriginal (CRA) fishery.

Species occurrence is the measurable parameter used to assess the potential effects of the Project on fish.

4.1.1.2 Fish Habitat

Fish habitat was defined as habitat that supports fish species that are part of or support a CRA fishery. Fish habitat was selected as a VC because:

- Section 35(1) of the federal *Fisheries Act* prohibits the permanent alteration or destruction of fish habitat that supports fish and habitat that are part of or support a CRA fishery;
- it encompasses a variety of biophysical parameters, including hydrology, channel and flow characteristics, substrate, cover, water and sediment quality, aquatic plants and benthic invertebrate communities; and
- it is often used as a surrogate for the productive capacity of aquatic habitats.

Measurable parameters to be used to assess the potential effects of the Project on fish habitat include:

- physical fish habitat (substrate composition; channel characteristics; cover for fish; habitat type);
- water quality (TSS);
- hydrology (velocity and water depth); and
- riparian vegetation (riparian vegetation composition).

4.1.1.3 Aquatic Species-at-Risk

Aquatic species-at-risk were selected as VCs because:

- they are known to occur in the area;
- they may be potentially affected by the Project; and
- they are protected under provincial (MBESEA) and federal (SARA) legislation.

Lake Sturgeon is the single aquatic species-at-risk VC identified. It is a species designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Currently, only Lake Sturgeon has been documented in God's River and God's Lake (NSC 2017). The Southern Hudson Bay-James Bay population is designated as Special Concern by COSEWIC (COSEWIC 2006) and is currently under consideration for protection under SARA. Consequently, sturgeon was included as a VC. Potential presence was assessed based on current and historical range, documented occurrences within the study area, and preferred habitats.

Measurable parameters used to assess the potential effects of the Project on aquatic species-at-risk include:

- important habitats (i.e., spawning, rearing, overwinter, migration);

- water quality (TSS); and
- species occurrence.

Lake Sturgeon critical habitat has not been identified by COSEWIC and therefore will not be included as a measurable parameter in the effects assessment.

4.1.2 Residual Effects Assessment

Residual effects are the effects remaining following the implementation of the technically and economically feasible mitigation measures.

The significance of the residual effects was determined by five key criteria as outlined in CEAA (2012): the duration of time the effect occurs, the magnitude, the geographic extent, frequency, and reversibility of the effect; and two additional criteria, the direction or nature of the effect, and the ecological and social context of the effect. With the exception of the direction and nature of the effect, three levels of significance were applied to each criterion, as described in Table 1.

Thresholds are included in Table 1 for the five criteria where available and applicable. Thresholds for the magnitude criteria would include those identified in the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG's; MWS 2011) and in particular the guideline for Total Suspended Solids (TSS) as it relates to fish and fish habitat. The threshold for magnitude to fish and fish habitat are set by the *Fisheries Act*, where the death of fish, and alteration or destruction of fish habitat are prohibited. Lake Sturgeon critical habitat has not been identified by COSEWIC and therefore will not be included as a measurable parameter threshold in the effects assessment.

An adverse residual effect associated with a selected Valued Component is deemed significant if there is a Level III rating result for Ecological and Social Context and if a Level II or III rating is given for each of the effect attributes of Duration, Magnitude, Extent, Frequency and Reversibility. In the event a significant adverse residual effect is expected, the level of confidence in the data and methods used in the framework of the environmental analysis of the significance determination as well as the likelihood of the significant effect occurring (i.e., very unlikely, unlikely, likely, very likely) is provided.

Table 1. Residual effects assessment criteria following the Reference Guide for the *Canadian Environmental Assessment Act* (2012).

Criterion	Level I	Level II	Level III
Direction or Nature[a] (of the effect)	• Positive	• Negligible (no measureable change)	• Negative
Duration (of the effect)	• Short Term • Time required to complete seasonal or annual construction/maintenance or rehabilitation activities (i.e., several months)	• Medium Term • Effect likely to persist until completion of construction and rehabilitation (i.e., 8 to 10 years)	• Long Term • Effect likely to persist into operations and maintenance (i.e., > 10 years)
Magnitude (of the effect)	• Negligible or Low: No definable or measureable effect; below established threshold of acceptable change (*i.e.*, TSS at or below background levels.)	• Moderate: Effect can be determined with well-designed monitoring program; below established threshold of acceptable change (*i.e.*, TSS higher than background levels, but below Manitoba water quality objectives).	• High: Effect is easily observable, measured; well beyond established thresholds of acceptable change (*i.e.*, TSS higher than Manitoba water quality objectives).
Geographic Extent (of the effect)	• Project Footprint: within the defined limits of the ASR RoW; effects are likely to be measurable	• Local Assessment Area (i.e., generally a 5 km band centered on the ASR alignment): area within which Project effects are measurable.	• Regional Assessment Area: area beyond the Local Study Area within which most potential indirect and cumulative effects would occur.
Frequency (of conditions causing the effect)	• Conditions or phenomena causing the effect occur infrequently.	• Conditions or phenomena causing the effect occur at sporadic or intermittent intervals.	• Conditions or phenomena causing the effect occur at regular intervals or is continuous.
Reversibility (of effect)	• Effect is reversible over a period of time less than or equal to the Project construction.	• Effect is reversible over many years into the Project operation.	• Effect is irreversible.
Ecological and Social Context (of effect)	• Low: VC is not rare or unique, is resilient to imposed change or is of minor importance to ecosystem function (i.e., White Sucker).	• Moderate: VC has some capacity to adapt, is moderately/seasonally fragile or is somewhat important to ecosystem function (i.e., Brook Trout)	• High: VC is protected/designated species or fragile with low resistance to imposed change or part of a fragile ecosystem (i.e., Lake Sturgeon).

a – levels I, II and III dot not apply for this criterion; VC = Valuable Component

4.2 POTENTIAL EFFECTS

4.2.1 Fish

The primary potential effects of ASR construction and operation to fish include erosion and sedimentation, introduction of deleterious substances, altered flow regimes and mortality from entrapment in cofferdams.

4.2.1.1 Erosion and Sedimentation of Streams

Increased suspended sediments can negatively impact fish by impairing water clarity and respiration. Short- and long-term increases in turbidity impair feeding success by visual feeders (Berg and Northcote 1985, Gardner 1981). Suspended sediment can also be harmful to fish by clogging gills, decreasing oxygen exchange and reducing growth rates (Wood and Armitage 1997).

4.2.1.2 Introduction of Deleterious Substances

Introduction of deleterious substances into watercourses can degrade water quality, resulting in toxic effects to aquatic organisms, including fish. Harmful substances may enter the watercourses from a variety of sources during construction of the ASR through accidental spills and leaks, and in run off.

Cast-in-Place Concrete Structures

Construction of cast-in-place concrete structures such as bridge abutments, footings and bridge decks may result in accidental releases of concrete or concrete wash water into the watercourse. Uncured or partly cured concrete and other lime containing materials (e.g., Portland cement, mortar and grout) have a high pH and are extremely toxic to many aquatic organisms, including fish. Accidental discharges into an aquatic environment may result in an increase in the pH of the water. Elevated pH can damage fish tissue and increase the toxicity of other substances in the water, such as ammonia. Concrete and concrete wash water can also contain sediments and spills can result in increased turbidity and sedimentation of the stream.

Construction Vehicles, Machinery and Equipment

Hydrocarbons, such as oil, fuel, gasoline, lubricants, or hydraulic fluids can enter watercourses during the operation, maintenance and fuelling of construction vehicles and machinery near watercourses. Hydrocarbons are considered deleterious substances, may kill fish or other aquatic biota directly, or may result in impaired health, vigor, or productive capacity. Polycyclic aromatic hydrocarbons (PAHs) can persist in stream sediments resulting in chronic exposure through direct contact or indirectly through food chain interaction (Collier et al. 2002). Effects of

PAHs to fish include fin erosion, liver abnormalities, cataracts, and compromised immune systems (Fabacher et al. 1991, Weeks and Warinner 1984, 1986, O'Conner and Huggett 1988). In benthic invertebrates, PAH exposure can inhibit reproduction, delay emergence, and cause sediment avoidance and mortality.

Explosives

Explosives used in blasting use oxidizing agents such as ammonium nitrate, calcium nitrate and sodium nitrate. Nitrates from these materials may enter the watercourse due to accidental spills, leaching from wet blastholes or in run off from undetonated explosives in blast rock. Increased nitrate levels can have toxic effects on aquatic organisms and cause eutrophication of surface waters. In addition, if ammonium nitrate is introduced into water, it dissociates to form ammonia which can have both lethal and sublethal effects on fish.

4.2.1.3 Disruption of Fish due to Blasting

The compressive shock wave resulting from the detonation of explosives near watercourses can cause serious harm to fish. Shock waves with overpressure levels greater than 100 kPa can rupture the swim bladder and vital organs such as the liver and kidney (Wright and Hopky 1998). The vibrations generated by a blast can also damage incubating eggs.

4.2.1.4 Temporary Crossings

The construction and use of temporary crossings can result in loss or damage to riparian vegetation (Section 4.2.2.3), and erosion and sedimentation of streams (Section 4.2.2.1). Temporary crossings, such as fords, can directly, or indirectly (through introduction of debris or sediment) disrupt sensitive fish life stages, such as spawning and incubation, resulting in decreased reproductive success.

4.2.1.5 Improved Access to Areas Where Fish are Sensitive or Vulnerable

ASR construction may result in improved access by both work crews and the public to habitats where fish may be sensitive or vulnerable to exploitation or disturbance.

4.2.2 Fish Habitat

The primary potential effects of ASR construction and operation to fish habitat are erosion and sedimentation of streams, introduction of deleterious substances and habitat loss. These and other potential effects of the Project on fish habitat are discussed below.

4.2.2.1 Erosion and Sedimentation of Streams

Vegetation removal and improper construction practices near watercourses can result in increased erosion leading to sedimentation of streams. Clearing streamside vegetation may result in decreased bank stability and exposure of bare soils that are susceptible to erosion. Heavy machinery and equipment working near the watercourse can damage vegetative cover and cause rutting and erosion of floodplains and channel banks.

There are multiple negative effects associated with increased levels of suspended and deposited sediment, including impacts to primary producers, invertebrates, and fish. A decrease in light penetration due to higher turbidity (suspended sediment) can lead to decreased photosynthesis by primary producers. Since primary producers form the base of the food chain, decreases in photosynthesis can impact higher trophic levels, such as invertebrates and fish. Large influxes of deposited sediment can bury aquatic invertebrates, an important food item for many fish species, resulting in reduced invertebrate species diversity and abundances. Fine sediment deposition over existing larger substrates may result in habitat loss for invertebrate species that anchor to coarse substrates.

Sedimentation may result in the loss of spawning habitats and/or decreased spawning success for some fish species. Infilling of existing coarse or rocky substrates with finer materials may create unsuitable spawning habitat for some fish species, smother deposited eggs or inhibit larval emergence from spawning substrates (Kondolf 2000).

4.2.2.2 Loss of Instream Habitat

A crossing design that includes the placement of permanent structures below the high watermark will have direct effects to fish habitat. Infilling of stream substrates due to the installation of bridge piers will result in the permanent loss of instream habitat. The armouring of channel banks below the high watermark may alter the quality and productivity of instream habitat; however, depending on design, certain types of armouring such as rip rap may increase habitat productivity by providing suitable substrates for insect production (i.e. fish diet items) and cover for fish.

4.2.2.3 Loss of Riparian Vegetation

Riparian vegetation contributes nutrients to streams and lakes through litter and terrestrial insect drop. The removal of riparian vegetation to accommodate temporary crossings, bridge approaches and line of sight requirements may reduce nutrient inputs into the aquatic food web. In many streams, terrestrial insects contribute to the diet of fish. Further, leaf litter and other organic matter are consumed by aquatic invertebrates, another important food source for many fish species (Allan et al. 2003).

4.2.2.4 Introduction of Deleterious Substances

Introduction of deleterious substances into watercourses can degrade water quality, resulting in toxic effects to aquatic organisms on which fish depend. Harmful substances may enter the watercourses from a variety of sources during construction of the ASR through accidental spills and leaks and in run off.

Stormwater Runoff

Stormwater runoff from impervious surfaces, such as bridge decks and approaches can contain a number of pollutants including suspended solids, hydrocarbons, metals, nutrients and road salts. During and after significant rainfall events, stormwater runoff into streams can cause short term changes in water quality. Stormwater runoff may also result in physical impacts to streams, including bank and channel erosion and/or sediment deposition due to increased runoff frequency, velocity and volume.

4.2.2.5 Disruption of Habitat due to Blasting

The compressive shock wave resulting from the detonation of explosives near watercourses can cause impacts to fish habitat. Impacts to habitat include physical alteration of habitat, sedimentation of streams (Sections 4.2.1.1 and 4.2.2.1) from particles generated by blasting and introduction of deleterious substances (Section 4.2.1.2).

4.2.2.6 Temporary Crossings

The construction and use of temporary crossings can result in loss or damage to riparian vegetation (Section 4.2.2.3), and erosion and sedimentation of streams (Section 4.2.2.1). Temporary crossings, such as fords, can disrupt spawning habitats and block migratory corridors..

4.2.2.7 Improved Access to Sensitive Habitats

ASR construction may result in improved access to sensitive habitats by both work crews and the public. Motorized vehicles, such as ATVs may disturb stream banks and riparian areas leading to erosion and sedimentation of streams.

4.2.3 Aquatic Species-at-Risk

The primary potential effects of ASR construction and operation to aquatic species-at risk are habitat degradation and disruption. These and other potential effects of the Project on aquatic species-at risk are discussed below.

4.2.3.1 Lake Sturgeon

The God's River crossing site provides moderate velocity run habitat with sand and rocky substrates (NSC 2017). The immediate crossing area provides foraging habitat for adult lake sturgeon and potential spawning habitat is found at a set of large rapids 4 km downstream of the crossing (NSC 2017). Potential impacts to Lake Sturgeon in the God's River are not expected as a clear-span bridge is proposed for the crossing site. Clear-span bridges do not require DFO review provided measures to avoid harm are implemented, as no temporary or permanent instream destruction or alteration is expected to occur.

4.3 MITIGATION

The following section describes measures to avoid or minimize the potential impacts of the Project to fish, fish habitat and aquatic species-at-risk. These include measures to be followed when working at or near watercourses that are fish habitat or are directly connected to fish bearing waters, as well as site specific-measures based on the fish habitat and species-at-risk information collected in the field. Mitigation measures are presented by project phase including: design; construction; and operation and maintenance.

4.3.1 Design

Many potential effects of road developments, including introduction of deleterious substances and channel erosion and sedimentation, can be minimized through proper design. The following measures will be incorporated into the project design to mitigate potential disruptions to fish habitat and species-at-risk:

- Where possible, roads will be located a minimum of 100 m from waterbodies except when crossing a watercourse. Where this is not feasible, a buffer of undisturbed vegetation equal to 10 m plus 1.5 times the slope gradient will be left between the road and adjacent waterbodies. These buffers will minimize runoff velocity and volume during rain events, encouraging the settling of sediment and contaminants and will preserve riparian functions such as allochthonous inputs into streams, shading, and bank stability;

- Culvert and bridge crossings will be designed to direct stormwater runoff into a vegetated area or small retention pond to decrease the velocity and volume of runoff and encourage the settling of sediment and removal of contaminants prior to discharge to the watercourse; and

- Crossings will be designed to maintain existing flow regimes and be passable by fish.

4.3.2 Construction

4.3.2.1 Deleterious Substances

To minimize the potential introduction of deleterious substance into watercourses:

- Construction crews will be adequately trained on the handling, storage, and disposal of deleterious substances;
- Spill clean-up kits will be available on site at all times; and
- Deleterious substances will be stored a minimum of 100 m from the high water mark.

Additional measures related to construction vehicles and equipment, concrete work and explosives are provided in sections 4.3.2.2, 4.3.2.7 and 4.3.2.8, respectively.

4.3.2.2 Construction Vehicles and Equipment

To mitigate the introduction of deleterious substances and erosion and sedimentation of streams from construction vehicles and equipment:

- Materials used to construct watercourse crossings will be clean and free of debris;
- Construction vehicles and equipment will arrive on site clean and free of leaks;
- Vehicle and equipment fueling and maintenance will be conducted a minimum of 100 m from the high water mark; and
- Machinery will remain above the high water mark except where temporary fording of a watercourse is required.

4.3.2.3 Erosion and Sediment Control

To protect stream banks and floodplains from erosion and minimize sediment introduction to watercourses:

- Appropriate erosion and sediment control (ESC) measures will be in place prior to the commencement of construction;
- ESC measures will be regularly inspected and maintained to ensure effectiveness throughout construction;
- Clearing and earthworks near watercourses will be conducted under favourable weather conditions and will be temporarily suspended during storm events;

- Whenever possible, construction work over soft floodplains will be conducted under frozen conditions to minimize rutting and erosion;
- Overburden will be adequately stabilized and stored well above the high water mark;
- Disturbed areas will be stabilized through re-vegetation with native plant species or other appropriate means (e.g., erosion control blankets) following completion of works;
- Riprap placed below the high water mark will be clean and free of debris; and
- ESC measures will remain in place until all disturbed areas are re-vegetated.

4.3.2.4 Vegetation Removal

To minimize erosion in riparian areas and prevent unnecessary clearing or alteration of riparian habitats:

- Vegetation will be retained as long as possible to minimize the exposure time of disturbed/bare soils to potential erosion;
- Clearing limits will be clearly marked prior to riparian vegetation removal to avoid any unnecessary damage to or removal of vegetation;
- Necessary ESC measures will be in place prior to the start of clearing; and
- Riparian vegetation clearing within the RoW will be limited to the removal of select vegetation that is required to maintain line of sight safety requirements (i.e., trees and tall shrubs). Low growing vegetation will be maintained.

4.3.2.5 Instream Work

The following measures will be implemented during works conducted below the high water mark:

- Instream construction activities conducted in a fish bearing watercourse will be timed to avoid fish spawning and incubation periods;
- Instream construction will be conducted in isolation of flowing water to mitigate downstream sediment transfer;
- A fish salvage will be conducted within the isolated work area prior to the commencement of instream work in fish bearing waters; and
- Construction vehicles and machinery will remain above the high water mark during instream construction activities.

4.3.2.6 Temporary Crossings

General

- Whenever possible, existing trails, roads and cut lines will be used as access to temporary crossings;
- Temporary crossings will be located within the 60 m cleared ASR RoW to avoid riparian impacts outside of the RoW;
- Placement and removal of temporary crossing structures will be timed to avoid high fish migration periods;
- Approaches will be stabilized as required to protect stream banks (e.g. swamp pads, logs); and
- Temporary crossing structures will be removed when no longer required and the crossing site will be restored to its original conditions.

Fords

If fording is required to transport materials during the construction of the ASR, the following measure will be implemented:

- Fording in flowing waters will avoid periods of fish spawning, incubation and migration.

Ice Bridges and Snow Fills

If temporary ices bridges or snow fills are required to cross watercourses during construction of the ASR, the following measures will be implemented:

- Ice bridges will be constructed of clean water, ice and snow only and will not block naturally occurring flows;
- The withdrawal of water used in the construction of ice bridges will not exceed 10% of the instantaneous flow;
- When an ice bridge is no longer required or the crossing season has ended, ice bridges will be notched at the centre to prevent the obstruction of fish movement. Notching will also encourage melting at the centre of the bridge, preventing channel erosion and flooding;
- Snow fills will be constructed of clean snow and will not restrict stream flows; and

- When a snow fill is no longer required or the crossing season has ended, compact snow will be removed prior to freshet.

4.3.2.7 Concrete Work

To avoid water quality impacts from accidental releases of uncured or partly cured concrete or concrete wash water:

- Uncured or partly cured concrete will be kept in isolation from watercourses;
- Water that has contacted uncured concrete will be isolated from watercourses until it has reached a neutral pH; and
- Equipment used in concrete work will be washed away from watercourses to prevent wash water from entering waterways.

4.3.2.8 Blasting

To mitigate the accidental release of explosive materials into watercourses, erosion and sedimentation of streams, and the potential lethal and sublethal effects to fish due to shockwaves:

- Explosive materials will be handled and stored in manner to minimize accidental spills or releases into watercourses;
- Explosive materials will be stored a minimum of 100 m from the high water mark;
- Storage and transport containers will be regularly inspected and maintained;
- Crew members working with explosives will be trained in spill containment and clean-up procedures;
- Ammonium nitrate-fuel oil mixtures will not be used in or near watercourses;
- Blasting will not be conducted in watercourses;
- Explosives will be detonated at sufficient distance from the watercourse to ensure that overpressure levels do not exceed 100 kPa at the land-water interface; and
- DFO's Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters will be adhered to (Wright & Hopky 1998).

4.3.2.9 Access to Watercourses and Sensitive Areas

To mitigate the disruption of sensitive areas due to increased access:

- Construction access roads and winter roads will be decommissioned and rehabilitated;

- Unnecessary access to sensitive areas by work crews will be prohibited;
- The ASR alignment and temporary crossings will avoid sensitive habitats; and
- Access to major watercourse crossings along the ASR will be restricted using measures such as slope treatment and fencing.

4.3.3 Post-Construction

Post-construction mitigation measures will be implemented to ensure long term stability of watercourse crossing areas:

- Stream crossings will be inspected following the first storm event and first freshet to ensure that there are no visible signs of bank and channel instability;
- Disturbed areas will be re-vegetated following completion of works; and
- Stream crossings will be inspected to ensure that adequate levels of vegetation has established in disturbed areas adjacent to watercourses.

4.3.4 Operation and Maintenance

Mitigation measures related to operation and maintenance activities are discussed in the following sections.

4.3.4.1 Bridge Maintenance

Debris Removal

- Unless considered an emergency work, debris removal will be timed to avoid periods of fish spawning, incubation and migration; and
- Debris removal will be conducted by machinery operating from shore (above the high water mark) or by hand.

Protective Coatings

- Removal and application of protective coatings will be conducted in a way that prevents deleterious substances (e.g., paint, paint flakes, blasting abrasives, solvents, etc.) from entering the watercourse (e.g. use of barges or shrouding);
- Paints, solvents and other deleterious substances will be stored and mixed on land (i.e., not on bridge decks) to prevent accidental releases into watercourses;
- Equipment will be cleaned where wash water will not enter the watercourse; and

- Waste materials (e.g., paint flakes, abrasives, etc.) will be properly contained and disposed.

Structural Repairs

- In water work will be timed to avoid periods of fish spawning, incubation and migration;
- Appropriate erosion and sediment control measures will be implemented prior to commencement of repair work and will be regularly inspected to ensure their effectiveness;
- Repairs and reinforcements will be conducted in a manner that prevents bridge materials from entering the watercourse;
- Waste materials will be stabilized and/or disposed of in an appropriate manner that prevents entry into the watercourse; and
- Disturbed areas will be restored and re-vegetated to mitigate erosion and sediment introduction into the watercourse.

4.3.4.2 Vegetation Management

- Vegetation management required to maintain line of sight safety requirements within the RoW will include the removal of trees and tall shrubs. Low growing vegetation will be retained; and
- Slash or debris piles should be stabilized and stored above the high water mark until disposal.

4.3.5 Site-Specific Mitigation

Of the 53 proposed stream crossings, 25 were assessed as having habitat supporting fish. Seven of these were designated as 'important' fish habitat supporting a range of life requisites for both large (i.e. Northern Pike, Walleye, sucker, trout) and small bodied fish species (i.e., forage fish). The remaining eighteen sites were assessed as 'marginal' fish habitat consisting of typically small boreal streams with limited flow and depth with soft substrates, habitat suited to small-bodied fish adapted to low oxygen environments (e.g. Brook Stickleback, Northern Pearl Dace). Although the habitat may also be suitable for Northern Pike in some cases, direct access to the habitat from larger waterbodies supporting relevant CRA fishery species tends to be restricted due to the presence of multiple ephemeral barriers.

Site-specific mitigation measures are presented in Table 2 and include the 18 sites at which fish habitat, defined as habitats that support fish that are part of or support a CRA fishery, is present. The remaining 7 sites are 'marginal' habitat supporting solely small-bodied fish and are not

expected to support a CRA fishery. A list of the proposed crossings summarizing the presence of fish, fish habitat and contribution to a CRA fishery is presented in Appendix 1. Detailed descriptions of the habitat at each crossing are available in the Existing Environment Report (NSC 2017).

Table 2. Site-specific mitigation for watercourse crossings with fish habitat, defined as habitats that support fish that are part of or support a CRA fishery, on the Manto Sipi, Bunibonibee and God's Lake All Season Road Project.

Crossing	Watercourse	Crossing Structure	Sensitivity/Concern	Mitigation
P6a-X002	Unnamed Tributary of Hayes River	Culvert	• Habitat for spring spawning fish species (i.e., Walleye, Northern Pike, suckers) and habitat supporting a range of life requisites for fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Floodplain prone to rutting and erosion by construction machinery and equipment.	• In water activity, including construction and removal of coffer dams or placement of rip rap below the high water mark will avoid spawning and incubation periods in spring (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6a-X008	Unnamed Tributary of Michikanes Lake	Culvert	• Spawning, rearing and feeding habitat for Northern Pike and fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment.	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6a-X018	Unnamed Tributary of Knee Lake	Culvert	• Spawning, rearing and feeding habitat for Northern Pike and fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment.	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.

Crossing	Watercourse	Crossing Structure	Sensitivity/Concern	Mitigation
P6a-X019	Magill Creek	Two-span Bridge	• Habitat for spawning and rearing of spring spawning fish species (i.e., Walleye, Northern Pike, suckers) and habitat supporting a range of life requisites for fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation.	• In water activity, including construction and removal of coffer dams or placement of rip rap below the high water mark will avoid spawning and incubation periods in spring (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats.
P6a-X023	Unnamed Tributary of Laird Lake	Culvert	• Suitable habitat for spawning and rearing of Northern Pike, feeding of White Sucker and habitat supporting a range of life requisites for fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6a-X031	Unnamed Tributary of Hignell Lake	Culvert	• Spawning, rearing and feeding habitat for Northern Pike and fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation.	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats.
P6a-X032	Unnamed Tributary of Hignell Lake	Culvert	• Potential Northern Pike spawning habitat and habitat supporting a range of life requisites for fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.

Crossing	Watercourse	Crossing Structure	Sensitivity/Concern	Mitigation
P6a-X033	Unnamed Tributary of an Unnamed Lake	Culvert	• Potential Northern Pike spawning habitat downstream of the crossing and habitat supporting a range of life requisites for fish which support a CRA fishery is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6a-X034	Unnamed Tributary of an Unnamed Lake	Culvert	• Habitat supporting a range of life requisites for fish which support a CRA fishery is present and potential Northern Pike spawning habitat downstream of the crossing; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation.	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats.
P6a-X037	Unnamed Tributary of an Unnamed Lake	Culvert	• Downstream habitat suitable for fish supporting a CRA fishery; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats
P6a-X038	Unnamed Tributary of an Unnamed Lake	Culvert	• Potential Northern Pike spawning habitat downstream of the crossing; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain

Crossing	Watercourse	Crossing Structure	Sensitivity/Concern	Mitigation
P6b-X002	Unnamed Tributary of Hawkins Lake	Culvert	• Habitat supporting a range of life requisites for fish which support a CRA fishery is present and potential Northern Pike spawning habitat downstream of the crossing; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6b-X003	Unnamed Tributary of Hawkins Lake	Culvert	• Habitat supporting a range of life requisites for fish which support a CRA fishery is present and potential Northern Pike spawning habitat downstream of the crossing; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6b-X006	Unnamed Tributary of Opaskaykow Lake	Culvert	• Habitat supporting a range of life requisites for fish which support a CRA fishery is present and potential Northern Pike spawning habitat downstream of the crossing; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6b-X007	Unnamed Tributary of Opaskaykow Lake	Culvert	• Potential Northern Pike spawning habitat. Walleye and sucker spawning habitat may also exist; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation.	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats.

Crossing	Watercourse	Crossing Structure	Sensitivity/Concern	Mitigation
			• Floodplain prone to rutting and erosion by construction machinery and equipment	• Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6b-X009	Unnamed Tributary of Tapper Lake	Culvert	• Habitat supporting a range of life requisites for fish which support a CRA fishery is present, Northern Pike spawning habitat is present upstream of the crossing site; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6b-X013	Unnamed Tributary of God's River	Culvert	• Habitat supporting a range of life requisites, including spawning for fish which support a CRA fishery and Northern Pike is present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Soft floodplain prone to rutting and erosion by construction machinery and equipment	• In water construction will avoid spawning and incubation periods for spring spawning fish (April 15-June 30) • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats. • Construction will be conducted under frozen conditions to avoid damage to floodplain.
P6b-X015	God's River	Clear-span Bridge	• Spring, summer and fall spawning fish species present; in water work could potentially disrupt fish during sensitive periods including spawning and egg incubation. • Potential Lake Sturgeon spawning habitat 4 km downstream. • Juvenile Brook Trout found in the area.	• In water activity, including construction and removal of coffer dams or placement of rip rap below the high water mark will avoid spawning and incubation periods in spring (April 15-June 30), summer (May 15-July 15), and fall (September 1 to May 15). • In water work will be conducted in isolation of flowing water to mitigate sediment transfer to downstream habitats.

4.4 RESIDUAL EFFECTS

Following the application of proven mitigation measures (Section 4.3), the adverse residual effects from the Project are limited to fish habitat and include: the introduction of sediments to streams; the alteration and destruction of riparian habitats and; and the alteration and destruction of instream habitat. A summary of the residual effects assessment is provided in Table 3. Based on the guidelines described in section 4.1.2, the effects to fish habitat are not significant.

Mitigation is expected to minimize the frequency, magnitude and extent of sediment introduction into the aquatic environment during the construction phase of the Project. However, in water construction activities, particularly during the installation and removal of coffer dams and silt curtains, may result in temporary, localized increases in total suspended solids. Additional sediment releases from RoW run-off may also occur during construction.

Unavoidable destruction and alteration of fish habitat will occur within the footprint of crossings and crossing approaches. Habitat loss will include approximately 3,671.8 m^2 of instream and 864 m of riparian habitat. An additional 1,008 m of riparian habitat within the cleared RoW will be altered from riparian forest to low growing vegetation. 161.5 m^2 of instream habitat will be altered as a result of rip rap placed at the base of the pier of the proposed multi-span bridge at Magill Creek. A description of the destruction and alteration of fish habitat at each crossing is provided in Appendix 2 and is explained in detail in the Existing Environment Report (NSC 2017).

Environment Canada (2013) has estimated that for a riparian zone to function sufficiently in its contribution to fish and fish habitat, the riparian zone for 75% of a stream length should be naturally vegetated. In consideration of the pristine nature of the project area, riparian habitat losses are well below this threshold.

Instream habitat losses will include the destruction of 3,665.96 m^2 of habitat at 22 culvert crossings and 5.84 m^2 of habitat in Magill Creek (Appendix 2). This destruction includes the loss of habitats typical of the watercourses in the Project area, consists of a relatively small area of habitat for each watercourse and does not include rare or critical habitats (NSC 2017).

No adverse residual effects to Lake Sturgeon resulting from the construction of the clear-span bridge at God's River are expected with the application of prescribed mitigation.

Table 3. Summary of adverse residual effects for watercourse crossings on the Manto Sipi, Bunibonibee and God's Lake All Season Road Project.

VC	Potential Effects	Project Phase	Evaluation (Before Mitigation)	Mitigation Measures	Residual Effect	Evaluation (After Mitigation)
Fish	Project will impair water quality as a result of sedimentation of streams from disturbed banks, right-of-way runoff, and instream works.	Construction	Direction or Nature: Negative Duration: II Magnitude: III Geographic Extent: II Frequency: II Reversibility: I Ecological and Social Context: II	• Erosion and sediment control (ESC) measures; • Instream work timed to avoid fish spawning and incubation periods • Instream construction conducted in an isolated area, and will include a fish salvage in fish bearing waters.	TSS is expected to temporarily exceed MWQSOGs thresholds (MWS 2011).	Direction or Nature: Negative Duration: I Magnitude: II Geographic Extent: II Frequency: I Reversibility: I Ecological and Social Context: II
Fish	Project will degrade water quality, and potentially have toxic effects on fish from accidental release of deleterious substances into a watercourse.	Construction Operation	Direction or Nature: Negative Duration: II Magnitude: III Geographic Extent: I Frequency: II Reversibility: II Ecological and Social Context: II	• Crews will be adequately trained on the handling, storage and disposal of deleterious substances; • An emergency response plan and spill clean-up kits will be available on site; • Deleterious substances will be stored a minimum of 100 m from the high water mark.	Minimal risk to fish	Direction or Nature: Negative Duration: I Magnitude: I Geographic Extent: I Frequency: I Reversibility: I Ecological and Social Context: II

VC	Potential Effects	Project Phase	Evaluation (Before Mitigation)	Mitigation Measures	Residual Effect	Evaluation (After Mitigation)
Fish	Compressive shock waves from blasting can seriously harm fish.	Construction	Direction or Nature: Negative Duration: I Magnitude: III Geographic Extent: I Frequency: I Reversibility: II Ecological and Social Context: II	• Blasting will not be conducted in watercourses; • DFO's Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters will be adhered to (Wright & Hopky 1998).	Minimal risk of fish mortality	Direction or Nature: Negative Duration: I Magnitude: I Geographic Extent: I Frequency: I Reversibility: I Ecological and Social Context: II
Fish	Temporary crossings will be built during construction that can directly or indirectly disrupt the sensitive life stages of fish such as spawning and incubation.	Construction	Direction or Nature: Negative Duration: I Magnitude: II Geographic Extent: I Frequency: I Reversibility: II Ecological and Social Context: II	• Movement of temporary crossing structures timed to avoid high fish migration periods; and • Approaches stabilized to protect stream banks.	Temporary increase in TSS that may exceed MWQSOGs thresholds (MWS 2011), and temporary loss of instream fish habitat.	Direction or Nature: Negative Duration: I Magnitude: I Geographic Extent: I Frequency: I Reversibility: I Ecological and Social Context: II
Fish	Project will result in increased access to fish resources during road construction and operation.	Construction Operation	Direction or Nature: Negative Duration: III Magnitude: III Geographic Extent: II Frequency: II Reversibility: III Ecological and Social Context: II	• Work crews access restricted; • ASR alignment and temporary crossings will avoid sensitive habitats; and • Major watercourse crossing access restricted using slope treatment and fencing.	Minimal loss of fish resources	Direction or Nature: Negative Duration: III Magnitude: I Geographic Extent: I Frequency: I Reversibility: II Ecological and Social Context: II

VC	Potential Effects	Project Phase	Evaluation (Before Mitigation)	Mitigation Measures	Residual Effect	Evaluation (After Mitigation)
Fish Habitat	Project will cause sedimentation of streams from disturbed banks, right-of-way runoff and instream works.	Construction	Direction or Nature: Negative Duration: II Magnitude: III Geographic Extent: II Frequency: I Reversibility: I Ecological and Social Context: II	• Erosion and sediment control (ESC); • Construction conducted under frozen and favourable weather conditions, when possible; • Disturbed areas stabilized	TSS is expected to temporarily exceed MWQSOGs thresholds (MWS 2011).	Direction or Nature: Negative Duration: I Magnitude: II Geographic Extent: II Frequency: I Reversibility: I Ecological and Social Context: II
Fish Habitat	Project will result in the alteration and destruction of riparian habitat	Construction Operation	Direction or Nature: Negative Duration: III Magnitude: II Geographic Extent: I Frequency: I Reversibility: II Ecological and Social Context: II	• Vegetation retained as long as possible to minimize erosion; • Clearing limits minimized and clearly marked; and Disturbed areas re-vegetated	Loss of riparian habitat and its contribution to fish habitat, but will not exceed Environment Canada threshold (Environment Canada 2013).	Direction or Nature: Negative Duration: II Magnitude: I Geographic Extent: I Frequency: I Reversibility: I Ecological and Social Context: II
Fish Habitat	Project will result in the alteration and destruction of instream habitat.	Construction Operation	Direction or Nature: Negative Duration: III Magnitude: III Geographic Extent: I Frequency: I Reversibility: II Ecological and Social Context: II	• Instream work timed to avoid fish spawning periods; • Instream construction conducted in an isolated area, and will include a fish salvage in fish bearing waters.	Loss of instream fish habitat.	Direction or Nature: Negative Duration: III Magnitude: II Geographic Extent: I Frequency: I Reversibility: II Ecological and Social Context: II

5.0 INSPECTION AND MONITORING

The following sections outline inspection and monitoring programs related to the aquatic environment. Inspection and monitoring is described for each stage of construction (pre-construction, construction and post-construction) for activities conducted at or near watercourses.

5.1 INSPECTION

Regular site inspections are conducted to ensure that appropriate construction best management practices and mitigation measures are implemented, adequately maintained, and effective. Site observations and conditions are documented using pre-determined checklists and photographs. Where non-compliance is observed or new issues arise, recommendations for corrective actions are provided by the inspector. The following inspection recommendations were developed based on anticipated construction activities and site conditions.

5.1.1 Pre-Construction

Where appropriate, environmental protection measures should be in place prior to the start of construction. Table 4 provides a list of pre-construction inspection requirements.

5.1.2 Construction

To be effective, environmental protection measures must be adequately maintained throughout the construction phase. Protection measures must be regularly inspected to confirm that they continue to function as intended as construction progresses and site conditions change. Table 5 provides a list of items to be inspected throughout the construction phase at sites at or near watercourses. Inspections should be conducted on a weekly basis, with additional inspections for erosion and sediment control conducted during and/or immediately after significant rain events.

Table 4. Pre-construction inspection requirements for construction sites located at or near watercourses.

PRE-CONSTRUCTION INSPECTION LIST
Deleterious Substances Storage and Spill Prevention
• Spill clean-up kits are present on site.
• Storage and waste containers, including fuel, are located a minimum of 100 m from the high water mark.
• Storage and waste containers are intact/sealed and clearly labelled.
• Waste containers are of sufficient volume for materials requiring disposal.
• Secondary containment is present where necessary.
Construction Equipment and Machinery
• Designated vehicle/equipment maintenance and wash down areas are located a minimum of 100 m from the high water mark.
• Designated vehicle/equipment fuelling areas are located a minimum of 100 m from the high water mark.
• Construction vehicles and equipment are clean and free of leaks.
Erosion and Sediment Control (ESC)
• Appropriate ESC measures are in place prior to construction.
• Extra ESC materials are on site and available for immediate use (e.g., silt fencing, polyethylene sheeting)
Sensitive Areas
• Construction limits and/or any sensitive areas are clearly marked prior to construction
• Clearing limits are clearly marked prior to vegetation removal near watercourses

Table 5. Inspection requirements for construction sites located at or near watercourses.

CONSTRUCTION INSPECTION LIST
Deleterious Substances Storage and Spill Prevention
• Spill clean-up kits are present on site.
• Hazardous waste is being removed from the site regularly.
• Required signage/labels on storage and waste containers are clear and intact.
• Waste containers are intact/sealed.
• Secondary containment is functioning as intended.
• No visible signs of spills/leaks in or near watercourses.
Construction Equipment and Machinery
• Construction vehicles and equipment are free of leaks.
• Equipment and vehicles are being maintained and refuelled a minimum of 100 m from the high water mark.
Erosion and Sediment Control (ESC)
• Visible inspection for erosion (e.g., washouts, rilling, slumping).
• Visual inspection of water quality (turbidity) (e.g., sediment plume visible in nearby watercourses; site run off is visibly turbid)
• Existing drainage is adequately managing site run off (e.g., runoff is directed away from surfaces that are susceptible to erosion)
• Stockpiled materials (e.g., overburden, soil piles) are stored away from watercourses and adequately protected.
• ESC measures have been properly installed.
• ESC measures have been adequately maintained and functioning as intended (e.g., no excessive sediment accumulation behind silt fencing and or check dams; Interceptor/diversion ditches are intact with no visible signs of channel erosion)
Sensitive Areas
• Construction limits and any sensitive areas have been identified and are clearly marked (e.g., soft floodplains, unstable banks).
• Clearing limits are clearly marked prior to vegetation removal.
• Riparian clearing has been conducted within the designated area. No vegetation damage or removal outside clearing limits.
Working In/Near Watercourses
• Heavy equipment remains above the high water mark.
• During instream works downstream flows are maintained at all times.
• Pump intakes used in fish bearing water courses are adequately screened.
• Pumps are discharged onto a non-erodible surface, such as geotextile or rock apron.

5.1.3 Post-Construction

Post-construction inspections are conducted to ensure that the site has been adequately restored and that the watercourse, including banks and approaches are physically stable. Table 6 provides a list of items to be inspected throughout the post-construction phase at sites at or near watercourses.

Table 6. Post-construction inspection requirements for sites located at or near watercourses.

POST CONSTRUCTION INSPECTION LIST
Deleterious Substances
• All waste (hazardous and non-hazardous) has been removed from site.
• No visible spills.
Construction vehicles, equipment and materials
• All construction equipment and materials have been removed
• All temporary stream crossings or diversions have been removed.
Remediation
• Disturbed areas and slopes have been adequately restored and stabilized (rip rap, seeding, plantings, etc.)
• Crossing sites are physically stable; no visible signs of channel or bank erosion, slumping, etc.[1]
• Vegetation growth/survival in seeded/planted areas

1 – physical stability assessments should be conducted following completion of site remediation, after first storm event, and after first spring freshet.

5.2 MONITORING

Monitoring will be conducted during each construction phase to ensure that environmental protection and mitigation measures are performing as intended and to identify where adaptive management is required.

5.2.1 Pre-construction

5.2.1.1 Water Quality

TSS and turbidity sampling will be conducted prior to construction to establish a TSS-turbidity relationship for the project area. This relationship will facilitate use of turbidity as a proxy for TSS allowing for rapid on-site assessment of potential water quality impacts during the construction phase of the Project.

5.2.2 Construction

A potential effect of ASR crossing construction is the degradation of water quality due to the introduction of sediment and other deleterious substances. Water quality will be monitored

during in water work that is conducted in streams that provide or are directly connected to fish habitat.

5.2.2.1 Turbidity Monitoring

The primary potential impacts from instream construction activities are sediment re-suspension and erosion in relation to the disturbance to the streambed and bank, and alterations to channel hydraulics. The primary indicator for these impacts is total suspended solids (TSS), with turbidity used as a surrogate for rapid on-site monitoring.

A turbidity monitoring program will be conducted during instream construction activities to document the spatial extent and magnitude of impacts to turbidity/TSS levels. Turbidity monitoring will use an upstream-downstream approach. Data collected at downstream sites will be compared to upstream reference sites (i.e., the background conditions) to quantify the effects of construction on TSS/turbidity and facilitate comparison of increases to MWQSOGs for the protection of aquatic life (MWS 2011).

Monitoring will consist of regular *in situ* turbidity measurements at transects and periodic measurements in the plume.

Transect Monitoring

Transect monitoring will be conducted before, during and after instream activities. A minimum of three transects will be established as follows:

- one transect upstream of the stream crossings (Transect 1), as close as feasible but distant enough so as to avoid any potential effects of construction (i.e., upstream of the cleared RoW);
- one transect downstream of the stream crossings (Transect 2), as close as practical considering safety and other considerations, such as construction activities (i.e., within the mixing zone to the extent possible); and
- one transect located at the end of the mixing zone (Transect 3), precise locations of transects will be subject to access and safety considerations.

Precise locations of transects will be determined based on site specific conditions at the time of instream construction (e.g., stream discharge, length of the mixing zone), but will cover a reach that is sufficiently large to determine the effects in the initial zone of dilution and downstream areas. Stream size may warrant establishment of additional transects located further downstream. Depending on site conditions, turbidity loggers may be deployed in the streams during construction to assist in data collection (e.g., at locations that are not readily accessible).

The numbers of sampling sites on each transect will depend upon the wetted width at the time of monitoring, but typically three sites are established per transect: left quarter channel, mid-channel, and right quarter channel. If turbidity data indicate that MWQSOGs for the protection of aquatic life are being exceeded, corrective actions will be undertaken and plume monitoring will be initiated.

The frequency of transect monitoring will be adapted to reflect the duration and nature of instream activities, and will target collection of data during both periods of peak TSS levels as well as more typical conditions.

Plume Monitoring

Plume monitoring will be conducted to estimate the downstream extent and magnitude of any sediment plume. Approximately three transects (or less, depending on conditions), will be established within the mixing zone. The number and location of transects will be determined at the time of monitoring. Laboratory TSS samples and turbidity measurements will be collected across each transect.

The frequency of plume monitoring will be determined based on the duration and intensity of the plume and nature of instream activities.

TSS-Turbidity Relationship

TSS will be measured in the laboratory and turbidity will also be measured *in situ*. A relationship between TSS and turbidity will be developed to facilitate the use of more frequent *in situ* measurements of turbidity to estimate TSS concentrations.

5.2.2.2 Cofferdam Dewatering Monitoring

Dewatering of coffer dams can result in discharges of water with excessively high TSS (e.g., at culvert placements) or pH values (at pier placements due to contact with concrete). Water pumped from coffer dams will be monitored to determine if it meets MWQSOGs. Should monitoring results indicate that guidelines were exceeded, appropriate mitigation measures will be implemented to treat the water before it re-enters the watercourse.

5.2.3 Post-Construction

Post-construction monitoring is not required.

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APPENDIX 1. LIST OF PROPOSED CROSSINGS ASSESSED FOR THE PROJECT 6 ALL SEASON ROAD

Table A.1. Summary of fish, fish habitat presence and contributions to a CRA fishery for watercourse crossings assessed on the Manto Sipi, Bunibonibee and God's Lake All Season Road, Project 6; adapted from NSC (2016).

		UTM 15				
Site	**Stream Name**	**Easting**	**Northing**	**Fish Habitat**	**Fish Species[1]**	**Supports a CRA[2] fishery**
Watercourse crossings with habitat supporting fish						
P6a-X002	Unnamed Tributary of Hayes River	355166	6086046	Yes	FF, LB	Yes
P6a-X005	Unnamed Tributary of Hayes River	357317	6081440	Yes	FF	No
P6a-X007	Unnamed Tributary of Michikanes Lake	359925	6076546	Yes	FF	No
P6a-X008	Unnamed Tributary of Michikanes Lake	359963	6076436	Yes	FF, LB	Yes
P6a-X018	Unnamed Tributary of Knee Lake	365150	6071363	Yes	FF, LB	Yes
P6a-X019	Magill Creek	366392	6069210	Yes	FF, LB	Yes
P6a-X020	Unnamed Tributary of Magill Creek	367584	6068240	Yes	FF	No
P6a-X022	Unnamed Tributary of Laird Lake	372798	6063748	Yes	FF	No
P6a-X023	Unnamed Tributary of Laird Lake	372935	6063705	Yes	FF, LB	Yes
P6a-X027	Unnamed Tributary of Wanless Lake	379995	6058916	Yes	FF	No
P6a-X028	Unnamed Tributary of Wanless Lake	381509	6058214	Yes	FF	No
P6a-X029	Unnamed Tributary of Hignell Lake	382770	6057629	Yes	FF	No
P6a-X031	Unnamed Tributary of Hignell Lake	384797	6056689	Yes	FF, LB	Yes
P6a-X032	Unnamed Tributary of Hignell Lake	387333	6055019	Yes	FF, LB	Yes
P6a-X033	Unnamed Tributary of an Unnamed Lake	389260	6054142	Yes	FF, LB	Yes
P6a-X034	Unnamed Tributary of an Unnamed Lake	390626	6054355	Yes	FF, LB	Yes
P6a-X037	Unnamed Tributary of an Unnamed Lake	398766	6048950	Yes	FF	Yes

Site	Stream Name	UTM 15 Easting	UTM 15 Northing	Fish Habitat	Fish Species[1]	Supports a CRA[2] fishery
P6a-X038	Unnamed Tributary of an Unnamed Lake	399735	6048087	Yes	FF, LB	Yes
P6b-X002	Unnamed Tributary of Hawkins Lake	383950	6066261	Yes	FF, LB	Yes
P6b-X003	Unnamed Tributary of Hawkins Lake	384030	6067799	Yes	FF, LB	Yes
P6b-X006	Unnamed Tributary of Opaskaykow Lake	389409	6069930	Yes	FF	Yes
P6b-X007	Unnamed Tributary of Opaskaykow Lake	390380	6069047	Yes	FF, LB	Yes
P6b-X009	Unnamed Tributary of Tapper Lake	409513	6080144	Yes	FF, LB	Yes
P6b-X013	Unnamed Tributary of God's River	428031	6081141	Yes	FF, LB	Yes
P6b-X015	God's River	429706	6080809	Yes	FF, LB	Yes
Watercourse crossings lacking habitat supporting fish						
P6a-X001	Unnamed Tributary of Hayes River	354680	6086782	No	N/A	N/A
P6a-X003	Unnamed Tributary of Hayes River	356066	6084096	No	N/A	N/A
P6a-X004	Unnamed Tributary of Hayes River	357220	6081611	No	N/A	N/A
P6a-X006	Unnamed Tributary of Michikanes Lake	359259	6078497	No	N/A	N/A
P6a-X009	Unnamed Tributary of Michikanes Lake	360165	6075841	No	N/A	N/A
P6a-X010	Unnamed Tributary of Michikanes Lake	360202	6075729	No	N/A	N/A
P6a-X011	Unnamed Tributary of Michikanes Lake	360225	6075583	No	N/A	N/A
P6a-X012	Unnamed Tributary of Michikanes Lake	360226	6075505	No	N/A	N/A
P6a-X013	Unnamed Tributary of Michikanes Lake	360222	6075456	No	N/A	N/A
P6a-X014	Unnamed Tributary of Michikanes Lake	359702	6073936	No	N/A	N/A
P6a-X015	Unnamed Tributary of Michikanes Lake	360702	6073154	No	N/A	N/A

Site	Stream Name	UTM 15 Easting	UTM 15 Northing	Fish Habitat	Fish Species[1]	Supports a CRA[2] fishery
P6a-X016	Unnamed Tributary of Michikanes Lake	361536	6073552	No	N/A	N/A
P6a-X017	Unnamed Tributary of Michikanes Lake	362851	6073221	No	N/A	N/A
P6a-X021	Unnamed Tributary of Magill Creek	368803	6066857	No	N/A	N/A
P6a-X024	Unnamed Tributary of Laird Lake	376856	6062609	No	N/A	N/A
P6a-X025	Unnamed Tributary of Hawkins Lake	378492	6060867	No	N/A	N/A
P6a-X026	Unnamed Tributary of Wanless Lake	378756	6060265	No	N/A	N/A
P6a-X030	Unnamed Tributary of Hignell Lake	383321	6057373	No	N/A	N/A
P6a-X035	Unnamed Tributary of an Unnamed Lake	392437	6053228	No	N/A	N/A
P6a-X036	Unnamed Tributary of an Unnamed Lake	397092	6049844	No	N/A	N/A
P6b-X001	Unnamed Tributary of Hawkins Lake	383989	6065801	No	N/A	N/A
P6b-X004	Unnamed Tributary of Hawkins Lake	384190	6068376	No	N/A	N/A
P6b-X005	Unnamed Tributary of Opaskaykow Lake	386967	6070020	No	N/A	N/A
P6b-X008	Unnamed Tributary of Bayley Lake	404927	6078620	No	N/A	N/A
P6b-X010	Unnamed Tributary of Tapper Lake	411494	6080295	No	N/A	N/A
P6b-X011	Unnamed Tributary of Tapper Lake	413389	6081483	No	N/A	N/A
P6b-X012	Unnamed Tributary of God's Lake	424907	6082134	No	N/A	N/A
P6b-X014	Unnamed Tributary of God's River	429148	6080372	No	N/A	N/A

1 – FF = Forage Fish (e.g., minnows, etc.), LB = Large Bodied (e.g., Northern Pike, Walleye, sucker spp., etc.).
2 – CRA = commercial, recreational or Aboriginal fishery

APPENDIX 2. NET HABITAT CHANGE RESULTING FROM THE PROJECT 6 ALL SEASON ROAD.

Table A.2. Net habitat change resulting from the Manto Sipi, Bunibonibee and God's Lake All Season Road, Project 6; adapted from NSC (2016).

Site	Watercourse	Instream Destruction (m^2)	Instream Alteration (m^2)[1]	Riparian Destruction (m)[2]	Riparian Alteration (m)[3]
P6a-X002	Unnamed Tributary of Hayes River	48.6	0	36	0[4]
P6a-X005	Unnamed Tributary of Hayes River	930.0	0	36	0[4]
P6a-X007	Unnamed Tributary of Michikanes Lake	162.0	0	36	0[4]
P6a-X008	Unnamed Tributary of Michikanes Lake	300.0	0	36	0[4]
P6a-X018	Unnamed Tributary of Knee Lake	270.0	0	36	0[4]
P6a-X019	Magill Creek	5.8	161.5	36	84
P6a-X020	Unnamed Tributary of Magill Creek	21.0	0	36	84
P6a-X022	Unnamed Tributary of Laird Lake	3.0	0	36	0[4]
P6a-X023	Unnamed Tributary of Laird Lake	300.0	0	36	0[4]
P6a-X027	Unnamed Tributary of Wanless Lake	60.0	0	36	0[4]
P6a-X028	Unnamed Tributary of Wanless Lake	234.0	0	36	84
P6a-X029	Unnamed Tributary of Hignell Lake	120.0	0	36	84
P6a-X031	Unnamed Tributary of Hignell Lake	66.0	0	36	84
P6a-X032	Unnamed Tributary of Hignell Lake	75.0	0	36	0[4]
P6a-X033	Unnamed Tributary of an Unnamed Lake	30.0	0	36	84
P6a-X034	Unnamed Tributary of an Unnamed Lake	90.0	0	36	84
P6a-X037	Unnamed Tributary of an Unnamed Lake	-[5]	0	36	84
P6a-X038	Unnamed Tributary of an Unnamed Lake	174.0	0	36	84
P6b-X002	Unnamed Tributary of Hawkins Lake	55.8	0	36	84
P6b-X003	Unnamed Tributary of Hawkins Lake	300.0	0	36	0[4]
P6b-X006	Unnamed Tributary of Opaskaykow Lake	18.6	0	36	0[4]

Site	Watercourse	Instream Destruction (m^2)	Instream Alteration (m^2)[1]	Riparian Destruction (m)[2]	Riparian Alteration (m)[3]
P6b-X007	Unnamed Tributary of Opaskaykow Lake	162.0	0	36	84
P6b-X009	Unnamed Tributary of Tapper Lake	36.0	0	36	84
P6b-X013	Unnamed Tributary of Gods River	210.0	0	36	0[4]
P6b-X015	Gods River	0	0	0[6]	0[6]
	TOTAL	3671.8	161.5	864.0	1008.0

1 – instream alteration consist of the addition of rip rap below the high water mark. Rip rap is expected to increase the diversity and productivity of the stream and is therefore not considered an adverse effect.
2 – calculated as the width of the road bed on each bank (18 m).
3 – calculated based on a 60 m cleared right-of-way on each bank. Does not include the length of riparian destruction.
4 – existing riparian consists of low growing vegetation. Alteration due to clearing for line of sight safety requirements is not expected.
5 – instream destruction was not calculated because a discernible stream channel was not present at the crossing.
6 - existing road and bridge at the God's River crossing has previously impacted riparian vegetation.