LAKE MANITOBA LAKE ST. MARTIN

OUTLET CHANNELS PROJECT

MANITOBA INFRASTRUCTURE

Fish & Fish Habitat Offsetting Plan
Initial Concepts for Discussion

November 19, 2020

Submitted by:

North/South Consultants Inc.

Manitoba

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DISCLAIMER

This document was developed to support the Lake Manitoba and Lake St. Martin Outlet Channel Environmental Management and Monitoring Program. This document has been prepared by Manitoba Infrastructure as a way to share information and have discussion with Indigenous Communities and Groups and the public. This document has been prepared using existing environmental and preliminary engineering information, professional judgement as well as information from previous and ongoing public and Indigenous engagement and consultation. The contents of this document are based on conditions and information existing at the time the document was prepared and do not take into account any subsequent changes. The information, data, recommendations, and conclusions in this report are subject to change as the information has been presented as draft and will not be considered complete until further engagement and consultation is complete. The plan may be further revised based on information and direction received from provincial and federal environmental regulators. This draft report is to be read as a whole, and sections or parts should not be read out of context.

PREFACE

The Lake Manitoba and Lake St. Martin Permanent Outlet Channels Project (the “Project”) is proposed as a permanent flood control mitigation for Lake Manitoba and Lake St. Martin to alleviate flooding in the Lake St. Martin region of Manitoba. It will involve the construction and operation of two new diversion channels: the Lake Manitoba Outlet Channel (LMOC) will connect Lake Manitoba to Lake St. Martin and the Lake St. Martin Outlet Channel (LSMOC) will connect Lake St. Martin to Lake Winnipeg. Associated with these outlet channels are the development of bridges, control structures with power connections, a new realignment of PR 239, and other ancillary infrastructure.

Manitoba Infrastructure (MI) is the proponent for the proposed Project. After receipt of the required regulatory approvals, MI will develop, manage and operate the Project. This Offsetting Plan is one component of the overall Environmental Management Program (EMP) framework which describes the environmental management processes that will be followed during the construction and operation phases of the Project. The goal of the EMP is to ensure that the environmental protection measures committed to in the Environmental Impact Statement (EIS), conditions of the Environment Act Licence, Federal CEAA 2012 Decision Statement Conditions, and Fisheries Act Authorizations once received for the project are undertaken in a timely and effective manner. This includes the verification that environmental commitments are executed, monitored, evaluated for effectiveness, and that information is reported back in a timely manner to the Project management team for adjustment if required.

Manitoba Infrastructure remains committed to ongoing engagement and consultation with Indigenous groups and other stakeholders that are potentially impacted by the Project. EMP plan review discussions have been incorporated into community-specific consultation work plans and additional engagement opportunities will be provided prior to finalization of the EMP plans. Engagement opportunities include virtual open house events and EMP-specific questionnaires. EMP-specific questionnaires will be provided to Indigenous groups and stakeholders to obtain feedback and views on the draft plans, in addition to exploring opportunities for Indigenous participation in follow-up monitoring. Feedback and recommendations will be used to inform the completion of the plans.

The intent of this Offsetting Plan is to provide a preliminary estimate and discussion of the type and amount of habitat that will need to be offset in the Authorization for the Harmful Alteration, Disruption and Destruction of fish habitat as defined under the *Fisheries Act,* as well as several options for offsetting works, one or several of which will ultimately be included in the final Authorization.

GLOSSARY OF TERMS AND ACRONYMS

Acronyms

AEMP	Aquatic Effects Monitoring Plan
CEMP	Construction Environmental Management Program
DFO	Department of Fisheries and Oceans Canada
DO	Dissolved Oxygen
EIS	Environmental Impact Statement
EOC	Emergency Outlet Channel
EPP	Environmental Protection Plan
HADD	Harmful Alteration, Disruption or Destruction (of fish habitat)
km	Kilometre
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
MI	Manitoba Infrastructure
POC	Permanent Outlet Channel
TSS	Total Suspended Solids

Glossary of Terms

This list and definition of terms is to be developed as each Management Plan is written and reviewed. Following is an example of a glossary term:

This list and definition of terms is to be developed as each Management Plan is written and reviewed. Following is an example of a glossary term:

Aquatic habitat: The living and non-living components of a lake, river, wetland or other waters upon which aquatic life depends.

Aquatic life: Organisms temporarily or permanently living or found in water.

Aquatic vegetation: Submerged, floating-leaved and floating plants that only grow on or beneath the water surface. Submerged plants may be rooted in soils or free-floating.

Baseline: Initial environmental conditions, prior to construction.

Discharge: Rate of outflow; volume of water flowing down a river, from a lake outlet, or man-made structure.

Dissolved oxygen: Oxygen molecules (O_2) dissolved in water.

Fisheries Act Authorization: Under the federal Fisheries Act, if a Project is likely to cause the death of fish or the harmful alteration, disruption or destruction of fish habitat, then an authorization from the Minister of Fisheries, Oceans and the Canadian Coast Guard must be obtained.

Groundwater: Water that occurs beneath the land surface and fills the pore spaces of soil or rock below saturated zone.

HADD: Harmful alteration, disruption or destruction of fish habitat as defined under the *Fisheries Act*. The estimate of the HADD determines the amount of offsetting that is required.

Offsetting: Works or undertakings to replace lost fish production arising from the harmful alteration, disruption or destruction of fish habitat.

Suspended sediment: Particulate matter that is held in the water column due to movement of the water.

Turbidity: A measure of the relative clarity of water.

1.0 INTRODUCTION

1.1 Purpose and Scope

The Lake Manitoba and Lake St. Martin Outlet Channels Project EIS was submitted by Manitoba Infrastructure in March 2020. The project will require an Authorization for the Harmful Alteration, Disruption or Destruction (HADD) of habitat under the Fish and Fish Habitat provisions of the *Fisheries Act*. To fulfill DFO's objective of no net loss of productive fish habitat, works will be required to offset the unavoidable losses of habitat due to construction and operation of the Project. This document provides an estimate of the amount and quality of habitat that will require offsetting, and provides a conceptual description of potential offsetting measures. In addition, the Project may require an Authorization for the death of fish by means other than fishing; an approach to addressing these losses is also provided.

This Offsetting Plan will be refined during the regulatory review process, based on input from regulators, landowners and/or Indigenous Groups. At present, this document has been prepared to facilitate MI's consultations with stakeholders. The plan laid out is preliminary and will be updated once input from stakeholders is obtained.

It should be noted that a number of other environmental management and monitoring plans are being developed for the project that deal with water management, including an Aquatic Effects Monitoring Plan (AEMP), a Surface Water Management Plan (SWMP), Groundwater Management Plan (GWMP), and a Sediment Management Plan (SMP).

1.2 Objectives

The specific objectives of this Offsetting Plan are to:

- Provide an initial estimate of the HADD for the Project; and
- Provide a preliminary description of potential offsetting projects.

It should be noted that the Application for Authorization under the *Fisheries Act* will provide the information set out in Schedule 1 of the *Authorizations Concerning Fish and Fish Habitat Protection Regulations*, including a detailed description of Project works that will be in water, proposed mitigation measures and the selected offsetting works.

2.0 OVERALL APPROACH

The estimate of HADD presented in this document was developed based on an understanding of the existing environment and the anticipated changes that will occur as a result of the Project.

As a flood mitigation project, the primary drivers will be changes to surface water flow. Water flows from Lake Manitoba via the Fairford River to Lake St. Martin, which drains via the Dauphin River to Sturgeon Bay on Lake Winnipeg (Figure 1). The Fairford River Water Control Structure is used to maintain suitable levels on Lake Manitoba upstream of the dam and on the Fairford River, Lake St. Martin and Dauphin River downstream of the dam. The Lake St. Martin Emergency Outlet Channel (LSMEOC) was constructed from Lake St. Martin to the Dauphin River, via the Buffalo Creek system to reduce flooding and was operated to address flooding in both 2011 and 2014. The proposed Project will provide a permanent flood mitigation channel. The route differs from the emergency channel in that there are two separate channels, one routed from Lake Manitoba to Lake St. Martin and a second from Lake St. Martin to Lake Winnipeg without passing via the Dauphin River (Figure 1). The two outlet channels are intended to work together:

- The 24 km Lake Manitoba Outlet Channel (LMOC) will work in tandem with the existing Fairford River Water Control Structure to help regulate water levels and mitigate flooding on Lake Manitoba; and

- The 24 km Lake St. Martin Outlet Channel (LSMOC) will restore a more natural water regime to Lake St. Martin and will also provide flood protection by mitigating increased inflows from operation of the Fairford River Water Control Structure, as well as additional inflows from the planned outlet from Lake Manitoba.

Construction of these two channels will permanently intercept a portion of the watersheds for two streams:

- Birch Creek will lose approximately 27% of its watershed as a result of the LMOC; and
- Buffalo Creek will lose approximately 40% of its watershed as a result of the LSMOC.

This reduction in flows is the principle habitat alteration that will occur as a result of the Project. A description of the habitat effects associated with this alteration, as well as additional smaller scale changes due to other components of the Project, is provided in Section 4.

Offsetting works were selected based on guidance provided by DFO as summarized below. Potential offsetting projects are described in Section 5.

2.1 Principles of Offsetting

The *Fisheries Act* provides for the protection of fish and fish habitat. The two key provisions include:

34.4(1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

35(1) No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

The *Fisheries Act* allows the Authorization of the death of fish by means other than fishing and the harmful alteration, disruption or destruction (HADD) of fish habitat. Prior to issuing an Authorization however, DFO must be satisfied that adverse effects have been addressed through a hierarchical approach, of "avoid, mitigate and offset". The first priority is to prevent (measures to avoid) adverse effects. When avoidance is not possible, adverse effects should be minimized (measures to mitigate) the extent possible. Adverse effects that cannot be avoided must be compensated through positive contributions to the aquatic ecosystems (measures to offset).

DFO's proponent's guide to offsetting (Fisheries and Oceans Canada 2019) provides the following guiding principles:

Principle 1: Measures to offset should support fisheries management objectives (FMOs) and give priority to the restoration of degraded fish habitat.

The FMOs for Lake St. Martin are provided in Appendix 2. The priority is the subsistence fishery for more than 3000 local Indigenous residents, followed by a recreational fishery based primarily on the Fairford and Dauphin rivers and a commercial fishery targeting Lake St. Martin.

Fish habitats in the Project area have been affected by several anthropogenic activities. Fish habitat on Lake St. Martin and the Fairford and Dauphin rivers has been affected by discharge regulation at the Fairford Water Control Structure, as well as recent large scale floods in 2011 and 2014. Much of the drainage basin, including smaller streams flowing into Lake St. Martin, drain agricultural land, and are affected by channelization, sedimentation and water quality impacts from agricultural land use.

Principle 2: Benefits from offsetting measures to should balance the adverse effects resulting from the Project.

To address this principle, DFO gives preference to measures that target local fish populations and habitats that are affected by the Project. However, offsetting measures can be applied to other waterbodies or fish species if these measures support fisheries management objectives and regional restoration priorities.

The offsetting measures proposed in this plan all target either directly affected fish habitats or areas nearby, with emphasis on Walleye, Northern Pike and Lake Whitefish, all species important in local fisheries.

Principle 3: Measures to offset should provide additional benefits to the ecosystem.

Measures to offset must provide a greater benefit than if these measures were not implemented. Therefore, positive effects resulting from a project cannot be considered offsetting. Measures to address degraded habitat are not considered offsetting if the proponent or another party will remedy the damage independent of the requirement for offsetting.

Construction of the LMOC and the LSMOC will result in the creation of year-round fish habitat, but these are not being considered offsetting for the reasons listed above. The measures proposed in this plan will further enhance fish habitat above what would occur from the construction of the Project alone.

Principle 4: Measures to offset should generate self-sustaining benefits over the long term.

The habitat offsetting works proposed in this document are all designed to not require on-going intervention, i.e., they would function without continued maintenance in the long term.

2.2 Types of Offsetting

DFO classifies offsetting into four general types that are described briefly below.

Habitat Restoration and Enhancement

These measures involve physical changes to habitat to increase productivity. Examples include:

- increasing structure through the placement of coarse material or large woody debris to improve fish habitat components such as spawning beds, reefs, etc.;
- stabilizing river banks and re-vegetating of riparian areas;
- improving access to habitats;
- removal of anthropogenic barriers to fish movements;
- establishing or enhancing vegetated areas within waterbodies; and
- improving hydraulic conditions to increase suitability for fish use.

Habitat Creation

Habitat creation is the development or expansion of aquatic habitat into a terrestrial area, including stream channels or side channels, lakes or bays, and wetlands.

Chemical or Biological Manipulations

This category includes measures to address water quality issues, stocking of fish, and control of aquatic invasive species. These measures are only used when other offsetting measures are not available and when they would result in a clear benefit to the fishery.

Complementary Measures

Data collection and scientific research related to fish and fish habitat are complementary measures. These may be considered where there is limited opportunity for offsetting, and are limited to 10% of the required offset.

2.3 Offsetting Plan Overview

The complete application for authorization under the Fisheries Act will provide all of the components listed under the Regulations, including a description of:

- the works associated with the Project, including detailed design drawings of in water features (i.e., the LMOC, the LSMOC and all inlet, outlet and control structures)
- construction methods
- planned operation, including maintenance
- a summary of consultation with Indigenous groups and the public
- fish and fish habitat, including species at risk (if present)
- effects to fish and fish habitat
- mitigation measures
- monitoring to assess the effectiveness of mitigation
- contingency measures in the event that mitigation measures do not function as planned
- a quantitative description of the death of fish and the harmful alternation, disruption and destruction of fish habitat
- offsetting plan, including a detailed description of measures, how they will be constructed, and the effect that is expected

Appendix 1 provides a summary of effects to fish and fish habitat, mitigation measures, monitoring and effects that will require offsetting. As described in Appendix 1, the death of fish due to stranding in the channels is not expected due to mitigation measures; however, in the event that the death of fish does occur, this would be offset by augmenting Walleye populations in Lake St. Martin through stocking, using the methodology proposed by DFO to offset the death of fish by stranding during operation of the EOC. This approach is described in Section 3 of this document. Appendix 1 also identifies habitat alteration that will require offsetting, specifically the inlet and outlet of each of the constructed channels and the reduction in flow in the adjoining natural drainages, Birch Creek at the LMOC and Buffalo Creek at the LSMOC. Quantification of the habitat alteration (HADD) is described in Section 4. Proposed offsetting for habitat alteration is described in Section 5.

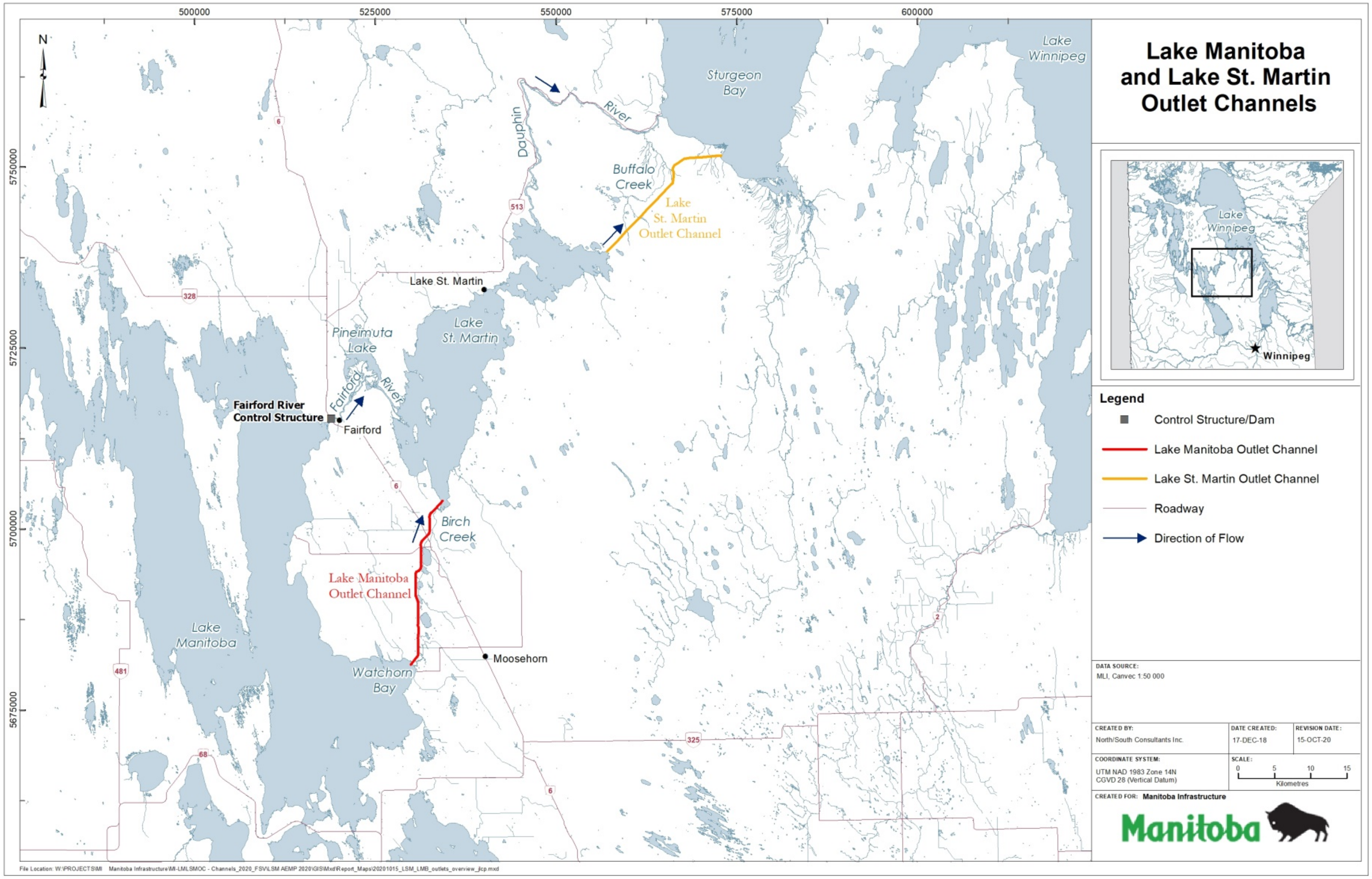

Figure 1: Location of Lake Manitoba and Lake St. Martin Outlet Channels. Arrows show direction of flow.

3.0 ESTIMATE OF DEATH OF FISH

Based on current mitigation measures, no death of fish due to stranding is predicted. This will be confirmed through monitoring described in the AEMP. In the unanticipated event that stranding does occur and cannot be mitigated through modification of the channel operating procedure (e.g., adjustment of ramping rates during channel shut down to provide fish with a cue to leave the channel), the death of fish will be offset through stocking.

The method used to determine the amount of stocking required to offset the loss of a given number of adult fish is provided in Appendix 3. This is the same methodology recommended by DFO to determine the stocking required to offset the death of fish following operation of the EOC in 2011/2012 and 2014/2015.

4.0 ESTIMATE OF HADD

4.1 Rationale

As summarized in Appendix 1, the following habitat alterations[1] that require offsetting will occur as a result of the Project:

- Excavation of 377,515 m^2 [2] of substrate at the inlet of the LMOC at Watchorn Bay.
- Diversion of 27% of the watershed of Birch Creek into a drainage ditch adjacent to the LMOC.
- Excavation of 433,887 m^2 of substrate at the outlet of the LMOC at Birch Bay on Lake St. Martin.
- Excavation of 521,217 m^2 of substrate at the inlet of the LSMOC at the southeast bay on Lake St. Martin.
- Diversion of 40% of the watershed of Buffalo Creek into a drainage ditch adjacent to the LSMOC.
- Excavation of 434,195 m^2 of substrate at the outlet of the LSMOC in Sturgeon Bay.

An estimate of the type fish habitat affected is provided below.

4.2 Approach

The following methods were used to quantify the habitat alteration:

- GIS analysis was used to overlay the project footprint (i.e., diverted channels, excavation at inlet and outlet) over known habitat to obtain an aerial estimate of change.
- In the absence of hydraulic modeling for Birch and Beaver creeks, it was assumed that the reduction in the watershed area would result in a proportional reduction of fish habitat in the stream.
- Fish use was based on the presence/absence of key species and the observation of important habitat (i.e., spawning) but no attempt was made to quantify usage by specific species.
- Conditions not conducive to fish survival, i.e., low dissolved oxygen, no flows or water depth less than 0.25 m, were considered indicative of marginal fish habitat.

4.3 Estimate

A summary of the HADD is provided in Table 1. Details are provided below.

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[1] Calculations are based on preliminary design and are subject to change based on final design and project construction.

[2] The area affected during construction may be up to 10% larger due to the placement of piers, jetties, and silt curtains or cofferdams.

Table 1: Summary of HADD estimate

Effect	Quantitative estimate	Fish use	Comments
Excavation of LMOC inlet at Watchorn Bay on Lake Manitoba	Temporary disruption of 377,515 m^2 of shallow sandy bay	Spawning does not occur in Watchorn Bay, affected area would provide feeding habitat, which is widespread	Habitat widespread, temporary loss of benthic invertebrate production
Diversion of 27% of flow from Birch Creek	Habitat is primarily confined to the 8.7 km long channel downstream of Goodison Lake. Channel is partly natural and partly channelized; average width is 9.7 m and average depth in spring is 1 m.	Spring spawning by a large number of sucker, fewer Walleye and Northern Pike. May provide summer foraging habitat in particular for small-bodied fish.	Presence of spawning runs in much smaller drainages suggests that Birch Creek will continue to provide spawning habitat. The area of spawning habitat is not known; therefore assume the reduction is proportional to the percentage of diverted flow.
Excavation of LMOC outlet at Birch Bay in Lake St. Martin	Excavation of 433,887 m^2 in shallow bay with gravel substrate.	Larval sucker and Walleye were captured during spring, but the actual spawning location is not known.	Habitat widespread, temporary loss of benthic invertebrate production. Potential use as spawning habitat.
Excavation of LSMOC inlet on Lake St. Martin	The bay is characterized by shallow water (< 1.0 m) that extends for approximately 1000 m offshore. Substrate within the area is loosely compacted sand and gravel interspersed with gravel and cobble deposits.	Larval Walleye, sucker species and Lake Whitefish are captured in the north basin of Lake St. Martin but the degree to which habitat at the outlet is used for spawning is not known.	Important Lake Whitefish spawning habitat is present in the Narrows. Use of the inlet area for spawning, if any, is not known although spawning may be restricted by the shallow depth (<1 m).

Effect	Quantitative estimate	Fish use	Comments
Diversion of 40% of flow from Buffalo Creek	Boggy drainage, subject to overwinter dissolved oxygen population.	Resident population of Yellow Perch and other forage fish. Diversion of flood flows through the creek during floods in 2011 and 2014 removed beaver dams that blocked access to the Dauphin River. These have not yet been re-established and use by large-bodied fish is not known.	Buffalo Creek watershed was largely isolated from the Dauphin River under typical conditions except during flood flows and thus did not usually contribute to a fishery prior to 2011. Beaver dams removed by flood flows in 2011 and 2014 have not yet been rebuilt so the creek is currently connected to the Dauphin River.
Excavation of LSMOC outlet in Sturgeon Bay	Excavation of 434,195 m^2 of medium hard sand and gravel at the outlet of the LSMOC in Sturgeon Bay	Spring neuston tows yielded larval Goldeye/Mooneye, suckers, minnows, Northern Pike, Lake Whitefish/Cisco, Troutperch, sticklebacks, White Bass and Walleye/Sauger/Yellow Perch indicating that fish spawn at or in the vicinity of the outlet.	Similar habitat is widespread in southern Sturgeon Bay.

4.3.1 LMOC Excavation at the Inlet in Watchorn Bay

The excavation of 377,515 m^2 of substrate at the inlet of the LMOC at Watchorn Bay would temporarily disrupt benthic invertebrates living in the surface sediments but ultimately provide a greater diversity of fish habitat.

Watchorn Bay in the vicinity of the LMOC inlet has a relatively uniform gently sloping bottom reaching a depth of 2.7 m approximately 750 m from shore (AAE Tech Services 2016). Substrate along the shoreline is primarily (>80%) gravel and cobble (Figure 2). Substrates at depths greater than 0.5 m and within one km of shore are comprised mostly of sand (90%) with areas of scattered boulders, particularly to the west of the LMOC inlet in proximity to Mercer Creek. Where depths exceed 1.5 m, substrates consist of gravel, sand, and silt. Pockets of coarser sand and gravel occur at depths greater than 2.0 m. Aquatic vegetation is sparse in Watchorn Bay and is restricted to localize areas near the mouths of Watchorn and Mercer Creeks and areas where water depth exceeds 2.0 m (AAE Tech Services 2016).

Large bodied fish captured during investigations in Watchorn Bay during fall 2015 included Northern Pike, Lake Whitefish and White Sucker. During spring sampling, White Sucker was the most abundant species, accounting for 87.6% of the total catch. Additional species captured included Northern Pike (7.1%), Walleye (2.7%), Common Carp (1.8%), and Freshwater Drum (0.9%). Spawning does not appear to occur in Watchorn Bay (AAE Tech Services 2016), likely because the shallow depths and wave action create conditions that mobilize sediments, which likely reduces the suitability of the area for spawning for most large bodied fish species (M. Forester Enterprises et. al. 2017).

Given that habitat similar to that in the excavated outlet is widespread in Watchorn Bay, no effect to fish production is anticipated.

Rather than offsetting the loss of invertebrate production, placement of substrates suitable for spawning in the lower section of Mercer Creek, which flows into Watchorn Bay is a may be considered to create higher value (i.e., less common) habitat. Invertebrates would also colonize the rock substrate, providing additional value as foraging habitat.

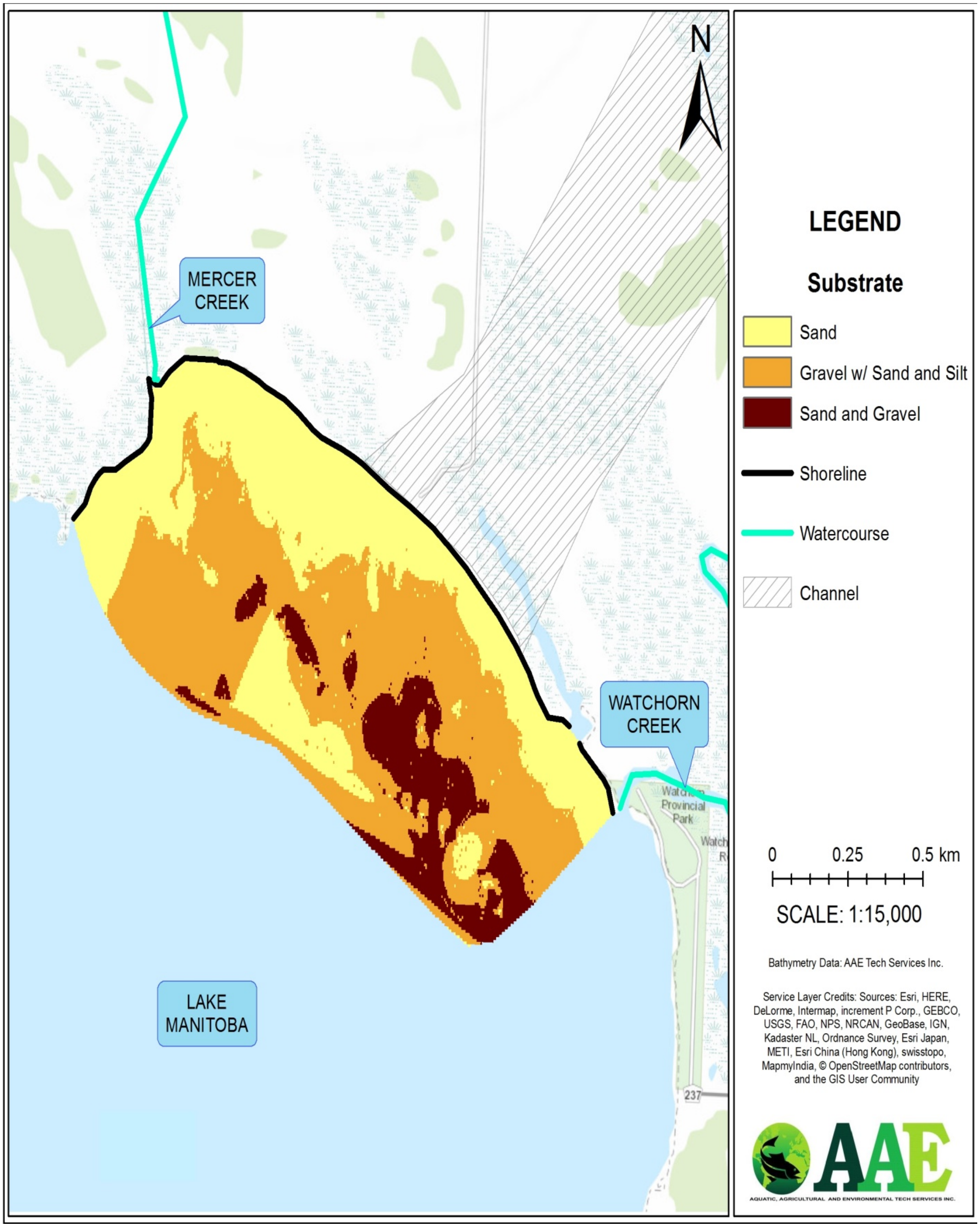

Figure 2: Substrate of Watchorn Bay

4.3.2 Birch Creek loss of flow

Birch Creek will experience the loss of approximately 27% of its watershed. Analysis of the locations and areas of sub-basins (Figure 3), indicates that the loss of watershed upstream of PR 279 is approximately 27%, as is the loss downstream. Apart from the reduction in inflow, there are no additional impacts to Birch Creek.

Construction of the drainage ditch parallel to the LMOC will divert from Birch Creek approximately 18,087 m of ditches that may support fish. Milani (2013) classified 7739 metres as Type B habitat (simple, support large-bodied fish) and 10,347 m as Type D (simple, support forage fish). Given that the drainage ditch will be constructed with stable banks to adequately carry the flow, no loss of the fish production potential of these ditches is anticipated and they will not be considered further.

A detailed description of fish and fish habitat in the Birch Creek watershed is provided in Appendix 4. The system is comprised of a lower reach of creek that is semi-channelized but provides sufficient flow and appropriate habitat characteristics to support spring spawning by large bodied fish including Northern Pike, White Sucker and Walleye (Figure 4). The creek is fed by drainage from headwater lakes and agricultural drains. As identified in the Groundwater Environmental Management Plan, there is no direct evidence that the small lakes and wetlands along Birch Creek, to the east of the LMOC, are fed by artesian springs. In general, the lakes are shallow and heavily vegetated (Figure 4). Passage of large-bodied fish from Lake St. Martin into these lakes would occur only during high flow events in Birch Creek, and these lakes likely become anoxic during winter due to their shallow depth and abundance of aquatic vegetation. Flow is in the agricultural drains is intermittent and likely only provides fish habitat only during high flow periods.

The effect of the reduction in discharge on fish use in Birch Creek is difficult to determine given that the current relationship between fish use and flow is not known. The most important function of Birch Creek to the local watershed appears to be the provision of spawning habitat to sucker species and, to a lesser extent Northern Pike and Walleye. AAE Tech Services (2016) reported observing thousands of suckers at the Highway 6 crossing during a spring survey. Sufficient sucker move up the stream to support a spring commercial trap net harvest. The observation of spawning migrations of sucker with a few Walleye in the much smaller Mercer and Watchorn creek drainages (AAE Tech Services 2016) suggests that these species will continue to use Birch Creek for spawning even if flows are reduced.

The extent to which Birch Creek is used as foraging habitat after the spring freshet is not known. Unlike many of the local drainages such as Mercer and Watchorn creeks, flow continues and dissolved oxygen concentrations remain suitable to support aquatic life. The largest effect of the diversion of 27% of the watershed may be a reduction in the suitability as foraging habitat.

Offsetting reductions in fish habitat in Birch Creek may be focused on improving habitat in streams affected by agricultural land use in the Lake Manitoba watershed, potentially including sites on Mercer Creek and Watchorn Creek (Section 5.2.5).

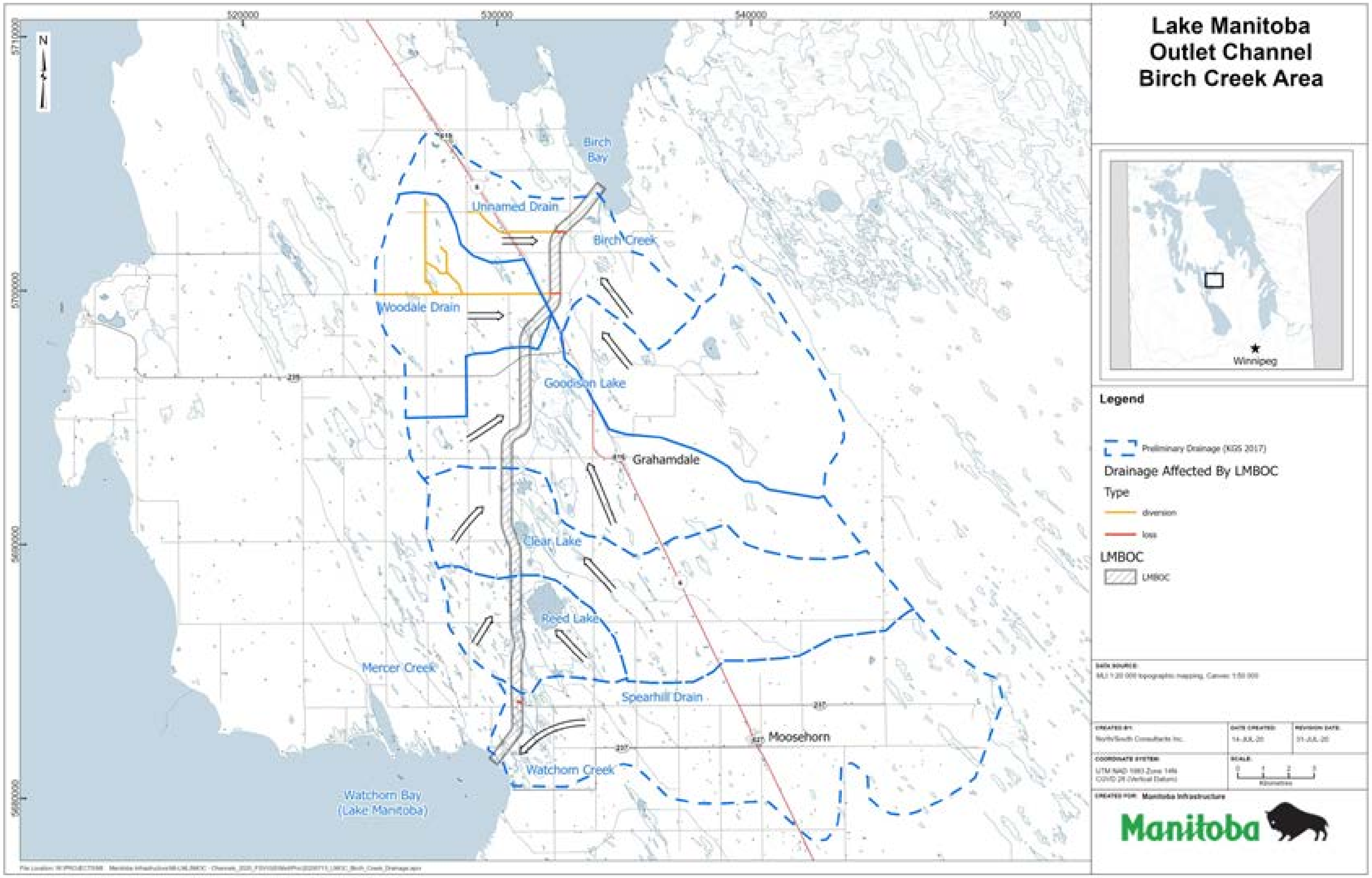

Figure 3: Location of creeks, lakes and drains along the LMOC corridor (figure reproduced from EIS)

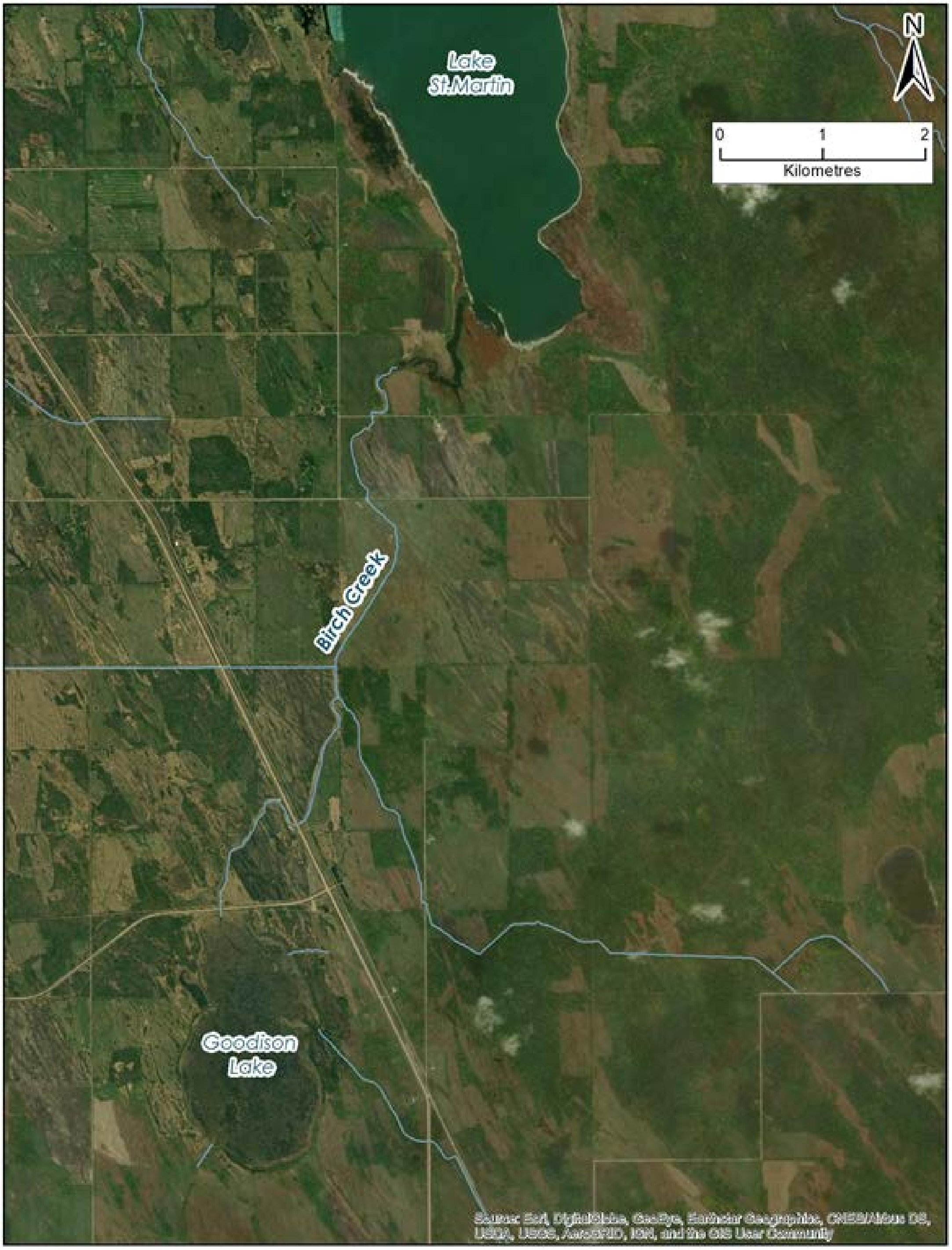

Figure 4: Aerial photo of Birch Creek (North/South Consultants Inc., 2020)

Figure 5: Birch Creek sites (North/South Consultants Inc., 2020). Upper photos show lower reaches of creek downstream of PTH 6; lower left photo a drain entering the creek and lower right channel into Goodison Lake upstream of PTH 6.

4.3.3 LMOC excavation at the Inlet in Lake St. Martin

Construction of the LMOC will require the excavation of 433,887 m^2 of substrate at the outlet of the LMOC at Birch Bay on Lake St. Martin. This will temporarily disrupt invertebrates present in the substrate and prevent fish access to the area while it is enclosed by a sediment curtain or coffer dam during instream construction.

Birch Bay in the vicinity of LMOC outlet has a relatively uniform gently sloping bottom reaching a depth of 3.0 m approximately 250 m from shore (AAE Tech Services 2016). Substrate along the shoreline is comprised of compacted gravel and cobble substrate interspersed with scattered boulders (Figure 6). Submerged boulder fields were visible within the shallow nearshore habitat, particularly within 20 m of the shoreline. Substrates in Birch Bay are comprised of gravel (70%) and sand (30%) to a depth <2.5 m (AAE Tech Services 2016). At depths >2.5 m, substrates transition to >90% sand although the occurrence of gravel increases at depths >3 m. Boulders occur intermittently at depths <1.0 m and within 20 m of shore. Aquatic vegetation is abundant and occurs almost exclusively at depths <2.0 m. High densities of aquatic vegetation occur along the east shore of southern Birch Bay and near the mouth of Birch Creek (AAE Tech Services 2016).

Fish collections conducted in Birch Bay during fall 2015 documented the occurrence of Northern Pike, Lake Whitefish, Cisco, and White Sucker (AAE Tech Services 2016). Lake Whitefish were most abundant, comprising 57.9% of the total catch. All whitefish captured were preparing to spawn during that fall. During spring sampling, 51 fish representing seven species were captured over a total set time of 126 minutes (AAE Tech services 2016). Northern Pike was the most abundant species captured, accounting for 37.3% of the total catch. White Sucker (27.5%), Shorthead Redhorse (19.6%), Cisco (7.8%). Yellow Perch (3.9%), and Lake Whitefish (2.0%) were also present (AAE Tech services 2016). Captured adult Walleye, Northern Pike, and White Sucker were reported to be in spawning condition. The locations of spawning areas in Birch Bay are not known, but the collection of larval White Sucker and Walleye in spring 2016 (AAE Tech Services 2016) suggests that these species had spawned nearby.

The habitat temporarily disrupted by excavation of the outlet is common within Birch Bay and as such the excavation is not expected to result in a loss of fish production.

Rather than offsetting the loss of invertebrate production, the placement of substrates suitable for spawning at a depth in Birch Bay where the substrates would remain clean (i.e., not be covered by fine sediments) may be considered to create higher value (i.e., less common) (Section 5.2.2). Invertebrates would also colonize the rock substrate, providing additional value as foraging habitat.

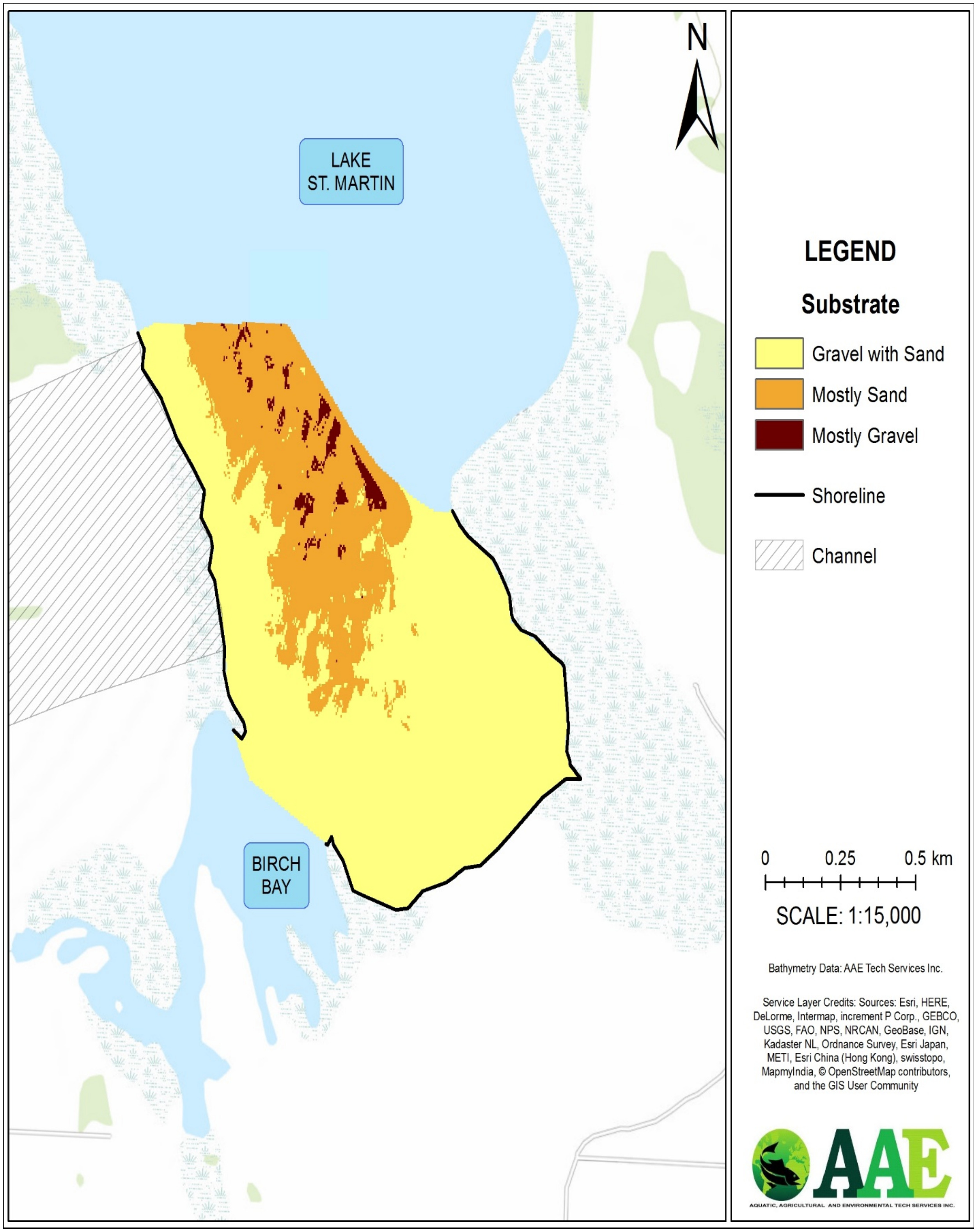

Figure 6: Birch Bay substrate (AAE Tech Services. 2016)

4.3.4 LSMOC excavation at the Inlet in Lake St. Martin

Excavation of 521,217 m^2 of substrate at the inlet of the LSMOC at the southeast bay on Lake St. Martin will temporarily disrupt invertebrate habitat.

The inlet to the LSMOC is located at the end of small bay in the north basin of Lake St. Martin. The bay is characterized by shallow water (< 1.0 m) that extends for approximately 1000 m offshore of the channel inlet. Substrate within the area is loosely compacted sand and gravel interspersed with gravel and cobble deposits (Figure 7). Sporadic boulder clusters occur throughout the area. Aquatic vegetation occurs along shoreline areas, particularly to the north and west of the channel inlet.

Index gillnetting was conducted during spring and fall 2018 in the immediate vicinity of the LSMOC inlet. During spring, White Sucker comprised 46.5% of the catch (NSC 2019b). Yellow Perch and Northern Pike were also frequently captured. During fall, Lake Whitefish were the most frequently captured species, comprising 75.8% of the total catch. White Sucker, Northern Pike and Yellow Perch were also common.

Spring neuston tows conducted annually in the north basin of Lake St. Martin from mid-April to early July in 2012 to 2018 captured larval fish which confirmed the successful spawning of sucker species (White and Longnose sucker and Shorthead Redhorse), percids (Yellow Perch, darters and Walleye), cyprinids, Lake Whitefish and Cisco), gasterosteids (stickleback) and Troutperch (NSC 2016b; NSC 2019b). Lake Whitefish and Cisco larvae were most abundant just after ice break up with increasing abundance of percids, catostomids and cyprinids as the season progressed (NSC 2016b; NSC 2019b). The extent to which fish may use habitat in the immediate vicinity of the LSMOC inlet for spawning is not known.

As with the outlet at Birch Bay, the temporary reduction in invertebrate production may be offset by the creation of spawning habitat in Birch Bay (Section 5.2.2).

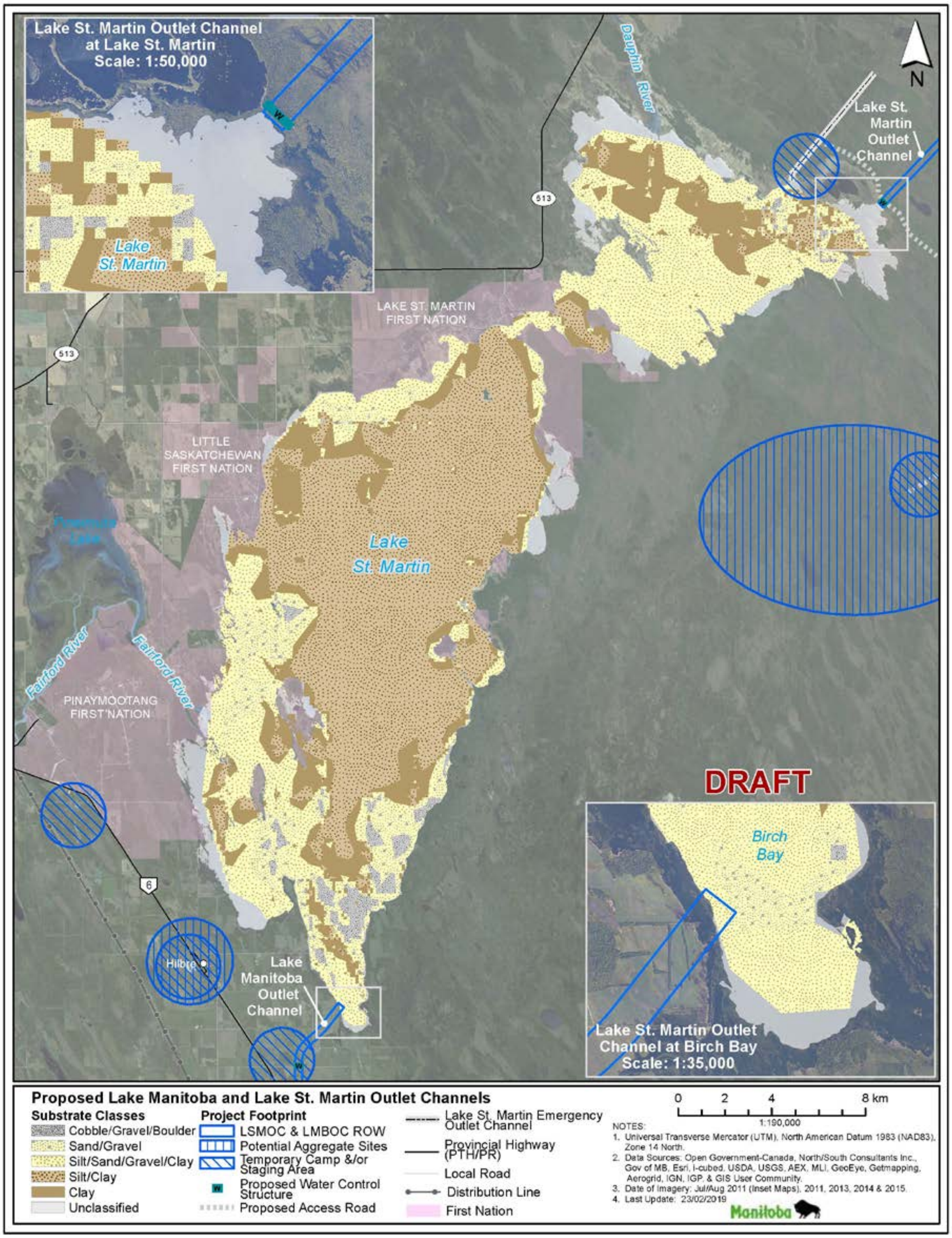

Figure 7: Substrate of the Lake St. Martin Outlet Channel at Lake St. Martin (map reproduced from EIS)

4.3.5 Buffalo Creek loss of flow

Buffalo Creek will lose approximately 40% of its watershed. Because the system is a bog, the effect of the diversion on water levels and flows cannot be readily estimated; however, it will be assumed that the habitat loss is proportional to the reduction in watershed area.

A detailed description of fish and fish habitat in Buffalo Creek before and after operation of the EOC is provided in Appendix 5. Buffalo Creek is the outflow of Big Buffalo Lake and the primary drainage in an extensive bog (Figure 8). Operation of the EOC resulted in large changes in the habitat within the creek (Figure 9). Prior to operation of the EOC, the system was an isolated bog drainage, supporting resident populations of yellow perch and small forage species. Access by large-bodied species from the Dauphin River was generally prevented by the presence of several well-established beaver dams. Operation of the EOC removed organic substrate and riparian vegetation, as well as the beaver dams from Buffalo Creek and allowed access by large-bodied species from the Dauphin River. Prior to operation of the EOC, overwintering habitat in the system was limited as low concentrations of dissolved oxygen under ice in Big Buffalo Lake periodically resulted in winterkill. During operation of the EOC, large numbers of large-bodied fish moved upstream through Buffalo Creek and Reach 1 into Lake St. Martin. Current fish use is not known but flows are small and a local fisher indicated that large-bodied fish are not entering the channel as they did during operation of the EOC. Measurements of DO in Buffalo Lake during winter 2013 when the EOC was not in operation recorded severe DO depletion, indicating that over-wintering habitat in the system is still limited. It is not known when beaver dams will be re-established such that Buffalo Creek again becomes an isolated watershed.

Prior to operation of the EOC, fish production in the Buffalo Creek system contributed little, if anything, to the fishery in the Dauphin River and Lake St. Martin because the system was largely isolated by beaver dams. Given that beaver dams are expected to become re-established at some point, offsetting measures will not be implemented within this system. Rather, offsetting may focus on improving habitat in streams affected by agricultural land use in the Lake Manitoba watershed, potentially including sites on Mercer Creek and Watchorn Creek (Section 5.2.5).

Figure 8: Aerial photo of Buffalo Creek. Reach 1 of the EOC appears in the lower left of the image.

A

B

Figure 9: Buffalo Creek before (A) and after (B) operation of the EOC

4.3.6 LSMOC excavation at Outlet on Sturgeon Bay

As with the other inlet/outlet structures, excavation of 434,195 m^2 of substrate at the outlet of the LSMOC in Sturgeon Bay will temporarily disrupt benthic invertebrates and prevent fish access to the area during construction.

Sturgeon Bay in the vicinity of LSMOC outlet has a uniform gently sloping bottom reaching a depth of 3.0 m approximately 1,200 m from shore (NSC 2016a). Substrate along the shoreline is comprised of a narrow band of compacted sand interspersed with boulders (Figure 10). Habitat mapping conducted as part of EOC monitoring showed that medium to hard compacted sand and gravel dominated nearshore, shallow habitat. Gravel, cobble, and boulder (i.e., hard substrates) were most common in a narrow, shallow offshore band beyond which substrates were finer (sand, silt and clay) (NSC 2016a). Aquatic vegetation occurs in nearshore areas to the north of the LSMOC inlet but generally occurs in low abundance throughout most of southern Sturgeon Bay.

During spring gillnetting conducted between 2012 and 2018, the most abundant fish species captured in southern Sturgeon Bay was Yellow Perch (up to 83% of the total catch in some years) with Northern Pike, Walleye, White Sucker and Shorthead Redhorse comprising most of the remaining catch (NSC 2016b; NSC 2019b). Lake Whitefish and Cisco were generally the most abundant species during fall index gillnetting, comprising between 34% and 62% of the total catch (NSC 2016b; NSC 2019a). Northern pike, white sucker, and shorthead redhorse were other species commonly captured in fall.

Numerous fish species spawn in southern Sturgeon Bay. Spring neuston tows yielded larval Goldeye/Mooneye, suckers, minnows, Northern Pike, Lake Whitefish/Cisco, Troutperch, sticklebacks, White Bass and Walleye/Sauger/Yellow Perch (NSC 2016b NSC 2019a). The presence of larvae of these species suggests that spawning occurs nearby, either in Sturgeon Bay itself or in local tributaries but whether spawning occurs at the outlet location is not known.

Effects of habitat alteration at the outlet of the LSMOC may be addressed through the creation of an offshore reef in Sturgeon Bay (Section 5.2.3).

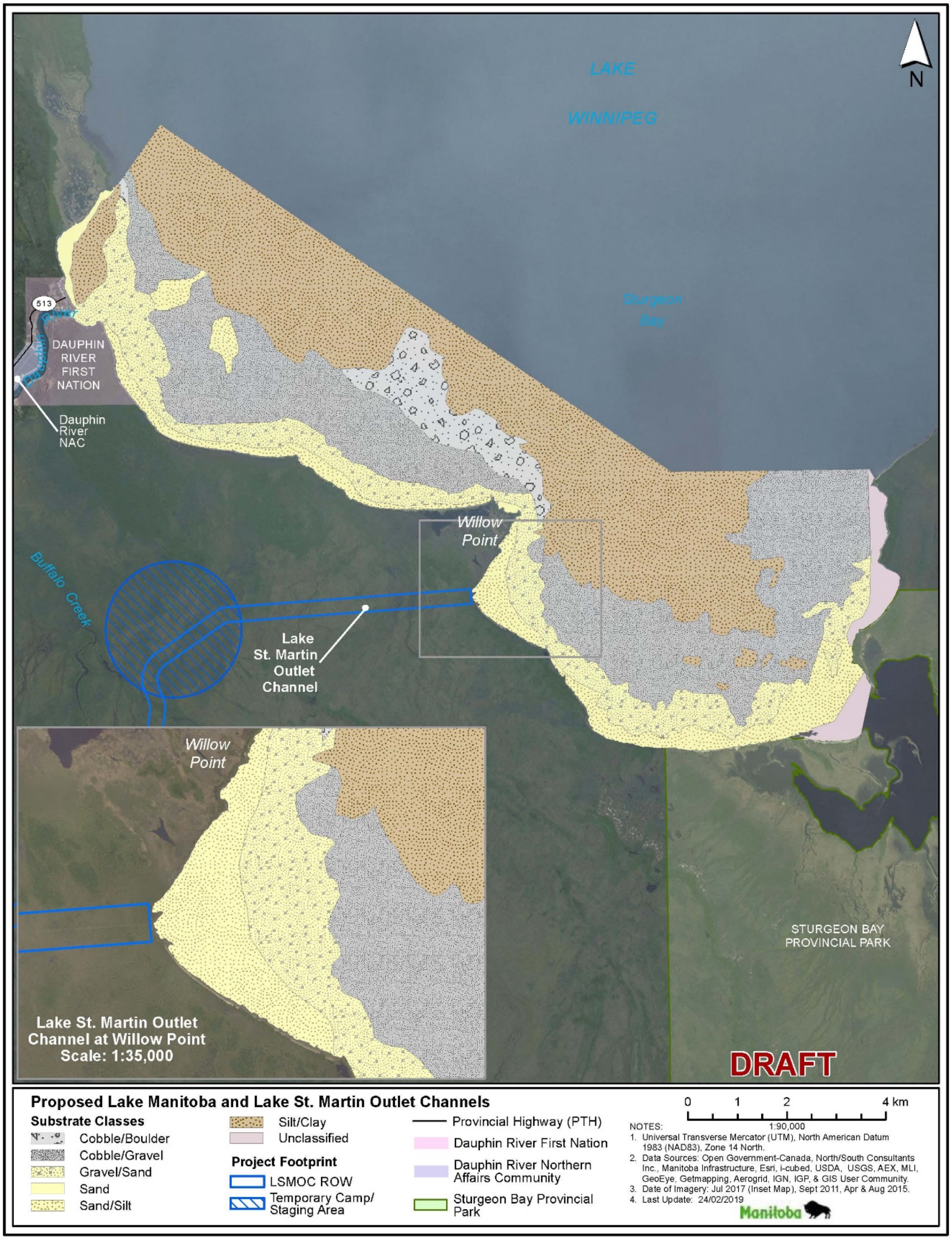

Figure 10: Sturgeon Bay substrate (map reproduced from EIS)

5.0 OFFSETTING WORKS

5.1 Rationale

The following section presents options for offsetting the residual effects identified in the preceding section. Development of the offsetting measures has considered the principles set out by DFO as described in Section 2.1 and the provincial FMOs provided in Appendix 2. The following were key considerations in selection of offsetting works:

- Creation of spawning habitat for key fish species (i.e., Lake Whitefish, Walleye, and sucker) where these are adversely affected by the Project and/or may be limiting in the existing environment.
- Support for enhancement of the local watershed, and thus water quality and fish habitat in streams in the Lake Manitoba watershed.

Table 2 provides a summary of the potential offsetting measures and the relation to DFO criteria and the FMOs. Additional information is provided in sections 5.2.1 to 5.2.5. As development of this plan proceeds and options for offsetting are selected, detailed descriptions of the design of the offsetting works will be prepared.

Table 2: Summary of potential offset measures, habitat benefits and relation to DFO offset criteria and FMOs.

Project	Habitat Benefit	DFO Offset criteria	Fisheries Management Objectives
Birch Bay spawning substrate	Create spawning habitat for Walleye and Lake Whitefish	Create habitat that may be limiting in this area of the lake for species important to fishery	Support production of Walleye and Lake Whitefish, two key species for the fishery
Sturgeon Bay offshore reef	Improve foraging habitat	Increase habitat diversity	Support production of Walleye, an important commercial species
Mercer Creek spawning substrate	Create spawning habitat for sucker species through the provision of substrate	Create habitat that may be limiting in this area for a species important to local fishery	Support production of sucker (targeted in fishery in stream)
Watershed improvements	Fence streams/improve riparian habitat/off-system watering	Restore degraded habitat	Improve conditions downstream for stream spawning species such as sucker and Walleye

5.2 Conceptual offsetting works and activities

5.2.1 Birch Bay spawning reef

AAE (2016) reported that much of the substrate in Birch Bay was sand or gravel (Figure 6), indicating that wave action is sufficient to prevent the deposition of finer materials and/or the load of fines is small. However, optimal spawning substrates for Lake Whitefish and Walleye contain coarser material in addition to gravels (Table 3); therefore an option is to construct a 1000 m^2 spawning shoal near the outlet of the LMOC but within an area where wave action would provide suitable conditions, even when the channel is not in operation.

Table 3: Biological design criteria for the construction of spawning shoals for Lake Whitefish and Walleye

Parameter	Design criteria	Additional consideration
Substrate	A mix of coarse materials as follows: 25% boulder (750-500 mm); 35% cobble (256-64 mm); 25% large gravel (64-32 mm); and 15% small gravel (32-8 mm).	Substrate layer should have minimum thickness of 0.75 m, and substrate material should be free of silt and clay. Important that there be ample interstitial space for egg incubation and larval development.
Velocity and/or Exposure	At sites with flowing water, the velocity should be between 0.2 and 1.0 m/s. If water velocity is less than 0.2 m/s, then location requires wave generated circulation (i.e., exposure to northeast - northwest winds).	
Depth	Crest of spawning shoal: Walleye = 0.3–0.8 m below low water mark; and Lake Whitefish = 2.0–2.5 m below low water mark.	Lake Whitefish eggs incubate over winter; eggs deposited at depths less than 1.5 m below minimum lake level will be vulnerable to freezing at maximum ice thickness.
Size of Spawning Area	Minimum crest area at preferred depth should not be less than 1000 m^2 in lakes.	Shape of shoal in lake should maximize surface area (long and rectangular as opposed to round or square).
Slope	Slope of spawning area should not exceed 10%.	
Location	Select areas where mineral soil is present, areas adjacent to bedrock, or where organic soil is thin (i.e., peat veneer).	At standing water sites, orient shoals to maximize exposure to wave action.
Critical Annual Period	Walleye – Early May to mid-June. Lake Whitefish – Late October to late-April.	

Note: Rocky shoal biological design criteria were based on spawning shoal development criteria described in Kerr et al. 1997 and Geiling et al. 1996 and a description of Lake Whitefish spawning habitat characteristics reported in the EIS.

5.2.2 Sturgeon Bay offshore reef

Sturgeon Bay is a relatively homogenous, shallow bay (Figure 11). An option is for a shoal to be constructed in offshore waters of Sturgeon Bay, at depths where the crest of the shoal would be at least 2 m below the water surface at minimum lake elevation to avoid interference with navigation. The shoal would provide cover and habitat diversity for fish, and may provide suitable spawning conditions for Lake Whitefish. This species may, however, prefer to spawn in the Lake St. Martin/Dauphin River area.

Figure 11: Sturgeon Bay near outlet of LSMOC.

5.2.3 Mercer Creek spawning substrate

Mercer Creek supports an upstream movement of sucker in early spring (AAE 2016); however, the location of spawning habitat is not known and surveys found that the substrate was predominantly silt (Figure 12). An option is to place substrate of the composition listed in Table 1 in the lower section of the creek to provide habitat for spring spawners such as sucker and Walleye.

5.2.4 Watershed improvements

The Birch Creek watershed and portions of other streams entering Lake St. Martin are affected by agricultural development, including land drainage, stream channelization, loss of riparian habitat and livestock grazing. The mandate of the West Interlake Watershed District (WIWD) is:

To assess the health of the watershed and address regional land and water issues in a cooperative, long-term planned approach in a sustainable manner.

The WIWD has several on-going initiatives related to improvement of aquatic habitat, including:

- With assistance from the Manitoba Fisheries Enhancement Fund, the WIWCD supported several studies to gain a better understanding of issues affecting water quality, in-stream habitat, and the riparian habitat.
- The Winter Off-Site Watering System Program is designed to assist landowners to relocate winter feeding sites of livestock away from streams.
- The Riparian Management Program is designed to assist landowners in the protection and restoration of riparian areas along streams to improve aquatic and wildlife habitat.

More information is available at the website: https://wiwd.ca.

Potential offsetting works that could be implemented in co-operation with the WIWD include measures to restore riparian habitat along Mercer and Watchorn creeks through measures to prevent livestock from accessing the streams (Figure 13). If this approach is selected, then the first step would be to select appropriate sites in consultation with the WIWD and Manitoba Fisheries Branch. It is anticipated that MI would then provide funding to the WIWD to implement the measures by working with the local landowner and conduct required monitoring and follow-up. Manitoba Fisheries Branch would be consulted with respect to the specifics of site selection and the type of work conducted.

Figure 12: Mercer Creek

Figure 13: Mercer Creek showing damaged streambanks from livestock (top) and off-stream water system (bottom)

5.3 Schedule

The timing of the construction of offsetting works and associated monitoring is provided in Table 4. Generally two years of post-construction monitoring are proposed to determine whether the work is functioning as intended.

No timing is given at present for work with the WIWD.

Table 4: Potential schedule for monitoring and construction activities related to offsetting concepts. M = monitoring; X = construction; TBD = to be determined based on monitoring results

Study	Construction		Operation					
	Year 1	Year 2	Non Operation	Operation 1		Non Operation	Operation 2	
				Operation	Post Operation		Operation	Post Operation
Death of Fish								
Stranding					M		M	
Stocking						TBD		TBD
Habitat works								
Mercer Creek spawning substrate		X	M	M[3]				
Birch Bay spawning shoal		X	M	M				
Sturgeon Bay habitat shoal		X	M	M[2]				
Support for WIWD watershed improvement								
Identification of potential projects								
Implementation of projects								

[3] Can be monitored for two consecutive years after construction as is not affected by operation of the Project

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6.1 Personal Communications

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APPENDIX 1

Summary of Effects, Mitigation, Monitoring, Residual Effects and Potential Offsetting

Potential Effect	Assessment	Mitigation	Monitoring	Residual Effect	Potential Offsetting
Alteration or Destruction of Fish Habitat					
Excavation of bottom substrates at inlet/outlets in Watchorn Bay, Birch Bay, north east basin of Lake St. Martin and Sturgeon Bay	Excavation of bottom substrates (gravel/sand or gravel/cobble) will increase depth and temporarily disrupt benthic invertebrate community until area re-colonized. Areas isolated by cofferdams or silt curtains will not be available to fish during construction. Similar habitats are widely distributed in the affected waterbodies and, following removal of cofferdams, substrate composition will be the same as prior to excavation and the greater depth will provide better cover for fish.	Excavations will be limited to minimum required area. Construction techniques will reduce release of TSS to water and be conducted outside of sensitive timing windows.	Fish habitat, benthic invertebrate and fish use monitoring will be conducted in conjunction with monitoring of the channels (see below).	Temporary loss of benthic invertebrate production and access to 194 ha of habitat.	Substrates suitable for spawning will be placed in the nearshore areas of Birch Bay where wave action is expected to maintain the substrate clear of fine sediments (Section 5.2.2). An offshore reef will be constructed in Sturgeon Bay to provide cover for fish and potentially spawning habitat for Lake Whitefish (Section 5.2.3).
Construction of channels will change groundwater inflows to Big Buffalo Lake bog) and Birch Bay on LSM	Reduction in groundwater flow to Birch Bay (extends up to 3-5 km during construction, 200 m during operation from the LMOC) will not affect watered area but may reduce suitability of spawning habitat to Lake Whitefish if they depend on groundwater inflows and spawning habitat is present. Construction of the LSMOC may reduce groundwater inflow to the Big Buffalo Lake system but effects are uncertain and expected to be small. Reduction in flow may have a small effect on suitability as overwintering habitat; however under existing conditions Big Buffalo Lake can be anoxic in winter.	Discharge of groundwater released during construction to appropriate surface waterbodies.	Pre-construction monitoring will determine whether Lake Whitefish spawn in areas of Birch Bay potentially subject to a reduction in groundwater inflow. If Lake Whitefish spawn in potentially affected areas, construction and operational monitoring will determine whether there is a loss of spawning habitat.	Potential effect to Lake Whitefish spawning habitat in Birch Bay is not anticipated. Negligible reduction in habitat in the Big Buffalo Lake bog.	Support for enhancement of streams adversely affected by agriculture in the local watershed, and thus water quality and fish habitat in streams in the Lake Manitoba watershed

Potential Effect	Assessment	Mitigation	Monitoring	Residual Effect	Potential Offsetting
Construction of the project may result in the introduction of aquatic invasive species to Lake Manitoba and Lake St. Martin	Spiny water flea and zebra mussels are present in Lake Winnipeg but not Lake Manitoba/Lake St. Martin. These species cannot move upstream but could move via natural means (e.g., adhered to waterfowl) or by equipment used in Lake Winnipeg and then further upstream. Rainbow smelt could move upstream if hydraulic conditions in the LMOC and LSMOC are more favorable than existing conditions.	Use of appropriate AIS control measures on construction equipment. Design of channels to prevent upstream movement of Rainbow Smelt.	None. Control measures are well established.	No residual effect is likely.	None required.
Change in habitat due to construction of LMOC and LSMOC and concurrent re-alignment, isolation or dewatering of drains and headwater streams.	Construction of the LMOC will isolate approximately 27% of the Birch Creek watershed and 4% of the Watchorn Creek watershed on the west side of the channel. Flow in these drains will be re-routed to Lake Manitoba or Lake St. Martin. Habitat for large-bodied fish in these drains is marginal due to shallow depth, intermittent flow and lack of diversity. Use by forage species is intermittent, depending on seasonal flows. However, flow enters Birch and Watchorn creeks, which are used by white sucker and Walleye for spawning in spring. Flow reduction in Birch Creek will be proportional to the amount of watershed lost, in addition to reduced groundwater inflows noted above. Water management at the LSMOC will include installation of culvert and gate systems on Creek C and two unnamed creeks, which will reduce inflow to Buffalo Creek. This reduction might reduce spawning and annual recruitment for resident populations of Yellow Perch, Northern Pike, sucker and forage species in the Big Buffalo Lake bog.	Route selected for LMOC limits extent of watersheds affected. Temporary diversions will be constructed to provide fish passage during construction of new channels. Instream work will be conducted in consideration of DFO timing windows. The LMOC and LSMOC channels will provide approximately 172 ha of fish habitat. The LMOC will be 24.1 km long with a wetted width of 30-60 m and depths of 4-8 m, with a substrate primarily of till although aquatic vegetation may become established. The LSMOC will be 23 km long and 44 m wide with drop structures and pools at higher gradient sections and a till substrate. During non-operational periods the channels will provide year-round habitat for forage fish and juveniles of large-bodied fish. During operation for flood control, higher velocities at the outlets may be suitable for spawning by Walleye and possibly other species.	Aquatic habitat (depth, substrate, presence of vegetation) and benthic invertebrates will be recorded in the LMOC and LSMOC two years post-construction to confirm that conditions are suitable for fish. No monitoring of habitat Birch Creek system or Big Buffalo Lake bog is planned as conditions in these systems vary widely depending on inter-annual and seasonal changes in run-off; both habitat and fish use vary and are intermittent, making baseline and post project conditions difficult to accurately quantify. However, dissolved oxygen will be monitored to determine if conditions become less suitable for fish.	Loss/reduction of habitat in drains leading to Birch Creek; some drains are only wetted in spring and, if water is present year round, low DO limits use to species such as fathead minnow. Reduction in flow volume of Birch Creek is not expected to affect spring use by large-bodied species as spring flows are high. Isolation of Creek C from the Big Buffalo Lake bog complex will not reduce fish populations in the bog complex as a whole as similar habitat is widespread and habitat in Creek C is marginal.	Support for enhancement of streams adversely affected by agriculture in the local watershed, and thus water quality and fish habitat in streams in the Lake Manitoba watershed

Potential Effect	Assessment	Mitigation	Monitoring	Residual Effect	Potential Offsetting
Change in habitat due to the deposition of sediment	During construction, sediment will be mobilized and deposited in Lake Manitoba, Lake St. Martin and Lake Winnipeg. Redirection of drains along the LMOC and LSMOC may also result in the mobilization of sediments during construction. During initial operation of the channels, sediment will be mobilized from the channels, as well as inlets and outlets and deposited in Birch Bay, the northeast basin of LSM and Sturgeon Bay. This may decrease the suitability of gavel and cobble nearshore substrates for fish. However, it should be noted that the amount of sediment mobilized during operation of the channels is expected to be less than the amount of sediment that would be mobilized if the channels were not in operation.	Standard methods for erosion and sediment control will be implemented, including working in the dry behind cofferdams or working during low or no flow periods. Channels will be constructed to minimize sediment mobilization by compacting bottom sediments within channels, and riprapping or vegetating the slopes.	Sediment monitoring will be conducted during instream construction. Turbidity and TSS monitoring will be conducted during the initial periods of channel operation to estimate the total loads of sediment deposited in Lake St. Martin and Sturgeon Bay.	Fine silts and clays conveyed from the LMOC may first be deposited in nearshore areas of Birch Bay but wave action is expected to remobilize fine sediments which will ultimately settle in the deeper areas of Lake St. Martin where there are similar substrates. Similarly inputs of sediments from the LSMOC may first settle on nearshore gravel and cobble substrate near the outlet in Sturgeon Bay but would eventually be transported to the deeper areas of Lake Winnipeg. Over the long term, the amount of sediment transported during flood events will be reduced due to the reduction in overland flooding. Therefore residual effects to fish habitat are negligible.	None required.
Change in riparian area inundation	Operation of the channels will reduce the duration and extent of flooding of riparian areas along Lake Manitoba and Lake St. Martin. Reduction in overland flooding may reduce inputs of nutrients and other substances to surface waters.	Use the channels only during high flood events.	None	None. Reduction of nutrient and sediment inputs during floods is not expected to adversely affect productivity in Lake St. Martin given the large concentrations of nutrients and sediments in the water during flood conditions.	None required.

Potential Effect	Assessment	Mitigation	Monitoring	Residual Effect	Potential Offsetting
Change in flow patterns in rivers and streams	During flood events, operation of the channels will create flows from Watchorn Bay to Birch Bay and the northeast basin of Lake St. Martin to Sturgeon Bay. This diversion will reduce peak flood flows in the Fairford and Dauphin rivers, which provide habitat to Walleye, Lake Whitefish, and Northern Pike. Flood operation of the channels will also create inflows or outflows at new locations on Watchorn Bay, Birch Bay, the northeast bay of Lake St. Martin, and Sturgeon Bay. During periods of non-operation, base flows will be passed from the northeast basin of Lake St. Martin to the outlet of the LSMOC at Sturgeon Bay.	Operate the LMOC and LSMOC channels within the operating rules to maintain suitable conditions in the Fairford and Dauphin rivers during spring and fall spawning periods, including during periods of base flow (non-operation). Design inlets and outlets to reduce scour of sediments and provide suitable habitat for egg hatch. Develop ramping rates for the opening and closing of water control structure gates to cue fish that a change in flow is occurring and enable them to move out of the channel. .	Monitoring of fish movements in the Fairford and Dauphin rivers will indicate whether fish continue to move up these rivers during spring and fall spawning periods. Monitoring of fish spawning at the outlet structures will confirm that fish attracted to these areas are able to spawn successfully.	Operation of the channels is not expected to affect fish use of the Dauphin and Fairford rivers during spring floods because the channels will only convey excess flow that the rivers cannot pass. Use of the channels during high water years in fall would result in hydraulic conditions closer to normal flows, and not adversely affect fish use. Fish may also relocate to spawn at the outlets of the channels. Conditions at the outlets are expected to be suitable for successful egg hatch. The volume of base flow in the LSMOC is not expected to reduce flow in the Dauphin River to the extent that fish use will be adversely affected during spring or fall spawning periods. No reduction in suitable fish habitat is expected, although some fish use may shift to other areas (e.g., spawning at channel outlets).	Substrates suitable for spawning will be placed in the nearshore areas of Birch Bay where wave action is expected to maintain the substrate clear of fine sediments (Section 5.2.2). An offshore reef will be constructed in Sturgeon Bay to provide cover for fish and potentially spawning habitat for Lake Whitefish (Section 5.2.3).

Potential Effect	Assessment	Mitigation	Monitoring	Residual Effect	Potential Offsetting
Change in Fish Passage					
Effects to fish passage due to installation/replacement of culverts	Stream crossings will be constructed to allow fish passage and not affect fish movements	Implementation of measures to provide fish passage, including use of clear span bridges, and embedding and appropriate sizing of culverts.	None, mitigation methods are well established	No adverse effect to passage is predicted	None required.
Change in fish movements between Lake Manitoba/Lake St. Martin/Lake Winnipeg	Operation of the LMOC and LSMOC will provide corridors for the active downstream movement for adult and juvenile fish, from Watchorn Bay to Lake St. Martin, and from the northeast basin of Lake St. Martin to Sturgeon Bay. Larval fish may drift passively in the same direction. Base flows in the LSMOC will also provide a corridor for downstream movement, but the volume of flow is much less than during flood operation. The design of the LMOC will not allow passage past the water control structure and LSMOC will prevent upstream fish movement at the outlet. Fish will be able to return from Lake Winnipeg to Lake St. Martin via the Dauphin River and from Lake St. Martin to Lake Manitoba via the Fairford Fishway (large-bodied species only).	Channel design to allow fish to move out of the channels during the open water season. Implementation of ramping rates when changing the flows in the channels to provide fish with cues that velocities are changing and enable fish to respond accordingly.	Monitoring of active and passive (larval drift) fish movements in the channels and rivers during flood operation.	Adult and juvenile fish may move from Lake Manitoba to Lake St. Martin and Lake St. Martin to Lake Winnipeg. A similar transfer of larval fish may occur. The number of fish moving is not expected to be sufficient to adversely affect fish populations in upstream lakes. Fish will encounter suitable habitat in downstream lakes; therefore there is no net loss of fish.	None required
Change in attraction flows to Fairford and Dauphin rivers	Flow reductions in the Fairford and Dauphin rivers, and the creation of attraction flows at the outlets of the LMOC and LSMOC, have the potential to divert spawning fish from the rivers to the outlets of the channels. In spring, species such as Walleye, Northern Pike, and suckers move up the Fairford and Dauphin rivers to spawning habitat. No Lake Whitefish are known to migrate up the Fairford River in fall, but there is a large migration up the Dauphin River from Lake Winnipeg. If fish are attracted to the outlets of the channels in spring or in fall, they may not successfully spawn.	Implementation of ramping rates to provide fish with cues the flows are changing. Maintain adequate flows in the Fairford Fishway to maintain upstream fish passage in spring. Design the outlet of the LSMOC to prevent fish from moving into the channel from Sturgeon Bay.	Monitoring of active and passive (larval drift) fish movements in the channels and at the outfalls during flood operation. Monitoring of Lake Whitefish spawning migrations in the Dauphin River during periods of flood operation and non-operation. Monitoring of the outlets to determine whether successful spawning occurs.	Decreased flows in the Fairford and Dauphin rivers during spring flood operation is not expected to affect the number of spring spawning species ascending to spawning habitat because flows in the rivers will be near maximum capacity and only excess flood flows will pass via the channels. Attraction of some fish to the outfalls in spring is not expected to adversely affect populations as fish will be able to spawn at these locations. Operation of the channels to convey flow through the summer	Substrates suitable for spawning will be placed in the nearshore areas of Birch Bay where wave action is expected to maintain the substrate clear of fine sediments (Section 5.2.2). An offshore reef will be constructed in Sturgeon Bay to provide cover for fish and potentially spawning habitat for Lake Whitefish (Section 5.2.3).

Potential Effect	Assessment	Mitigation	Monitoring	Residual Effect	Potential Offsetting
				and fall is not expected to adversely affect the fall migration of Lake Whitefish in the Dauphin River because flows will be similar to typical flows. Some Lake Whitefish may be attracted to the LSMOC outlet but it is expected that spawning will be successful in Sturgeon Bay.	
Change in Fish Health and Mortality					
Accidental release of deleterious substances	Construction near the waterways may result in the accidental release of hydrocarbons, with potential negative effects to aquatic life.	Standard environmental protection measures will be implemented.	Measures are well established and no monitoring is required.	None	None
Introduction of sediment	Instream construction and initial use of the channels for flood control will result in the release of sediment to the environment. Sediment may directly affect fish health through effects to respiration, as well as indirectly though effects to the food web (phytoplankton and invertebrates).	Standard methods for erosion and sediment control will be implemented, including working in the dry behind cofferdams or working during low or no flow periods. Channels will be constructed to minimize sediment mobilization by compacting bottom sediments within channels, and riprapping or vegetating the slopes.	Sediment monitoring will be conducted during instream construction. Turbidity and TSS monitoring will be conducted during the initial periods of channel operation to determine increases above background concentrations in relation to the guidelines for the protection of aquatic life.	No adverse effects to fish health are expected. .	None

Potential Effect	Assessment	Mitigation	Monitoring	Residual Effect	Potential Offsetting
Stranding of fish and fish eggs	Fish will be attracted into the channels during operation and eggs and larvae may originate from spawning within the channels or drift in passively during operation. When operation ceases fish may be trapped in the channels and eggs/larvae exposed to suboptimal conditions. Fish will be able to leave the LMOC because it will be connected directly to Lake Manitoba and Lake St. Martin, upstream and downstream of the control structure, respectively. The LSMOC is being designed to allow fish to move downstream out of the channel during base flows; fish will not be able to enter from Sturgeon Bay.	Design LMOC to maintain a wetted channel to Lake Manitoba and Lake St. Martin. Provide year-round base flow in the LSMOC, in conjunction with drop structures that allow fish to move downstream through the open water season. Design channels to contain pools that will provide over-wintering fish habitat. Design the LSMOC outlet to prevent upstream fish passage.	During operation, monitor for egg deposition at the outlets of the LMOC and LSMOC and, if present, develop a water management strategy that will support successful egg incubation. Monitor DO in summer and winter to ensure that sufficient to support fish that may be present. Inspect channels for fish kills in spring.	These measures are expected to successfully mitigate the risk of stranding of adults, juveniles or larvae/eggs.	None is expected to be required. In the event that unanticipated mortality of adult fish occurs in the channels, then losses will be offset through stocking as was conducted for operation of the emergency channel. See Section 3.0.
Increased fish mortality due to increased angling pressure	The presence of a large construction workforce and development of permanent access roads is expected to increase fishing pressure.	Recreational harvest is subject to provincial fisheries regulation.	None	No adverse effects to fish populations are expected, given fisheries management	None required
Bioaccumulation of methylmercury due to change in terrestrial habitat inundation	Mobilization of mercury in the food web is expected to be reduced in the long term due to the reduction in flooding on Lake Manitoba and Lake St. Martin.	None required	Mercury concentrations will be monitored in fish from Lake St. Martin to address concerns of resource users.	None expected	None required

APPENDIX 2

Lake St. Martin Fisheries Management Objectives

Klein 2015APR04

Lake St. Martin is the least studied among Central Region's large lakes, though it is third largest in area at more than 40,000 ha. Fisheries management objectives are therefore largely based on commercial fishery dependent data and written for what is achievable with the current status of the fish stocks, under current edaphic conditions. The FMOs will change with edaphic changes and as current fishery objectives are approached.

The commercial fishery on Lake St. Martin uses most of the resource. The size of the recreational fishery is unknown. Most of the recreational fishing on Lake St. Martin is done at the outflow to the Dauphin River in the north basin from Big Rock campground. A substantial amount of fishing is also done below the Highway 6 Fairford Dam on the Fairford River. The size of the subsistence fishery is also unknown. There are three reserves on Lake St. Martin with total on-reserve populations of 3100, and Lake St. Martin is within the Métis harvest area. Managing for subsistence harvest is Fisheries Branch's highest priority after conservation.

The societal goals for Lake St. Martin's fisheries are to provide: enough fish for 3500 subsistence users, enough fish to keep drawing recreational anglers to the locally owned and operated campgrounds at the north basin and at Fairford Dam, and enough fish to support a moderate commercial fishery. Commercial harvest reporting is the only data source available. The most important performance metric to monitor the fishery is total annual mortality because it rolls together subsistence, recreational, commercial and natural mortalities.

Lake Whitefish (*Coregonus clupeaformis*) is the most important species in the Lake St. Martin commercial fishery. Whitefish are resident in Lake St. Martin, but there is also a population that migrates up Dauphin River from Lake Winnipeg to spawn in Lake St. Martin. The management objectives for whitefish are an annual commercial harvest of 50,000 kg, and an annual total mortality of 40% or less. These objectives require a stock biomass of 150 to 200 tonnes of Lake Whitefish aged five years or more.

Northern Pike (*Esox lucius)* is the next most important commercial species. The management objective is an annual commercial harvest of 35,000 kg, and an annual total mortality of 60%, requiring a stock biomass of 71 tonnes of pike aged four years and older.

Walleye (*Sander vitreus*) have been underperforming in Lake St. Martin for decades; it is the most sensitive species in the lake to overfishing. Walleye is the biggest attraction for recreational anglers. The fisheries management objective is an annual commercial harvest of 25,000 kg, and an annual total mortality of 38% or less, requiring a stock biomass of 79 tonnes of Walleye aged five and older.

Limited fisheries occur for White Sucker (*Catastomus commersoni)* in spring and Common Carp (*Cyprinus carpio*) year round. Both fisheries can be profitable, but no fisheries management objectives exist. Carp is an invasive and nuisance species; any decrease in their numbers benefits desirable native species. Sucker numbers increase where Walleye stocks are collapsed and continued high densities of suckers contribute to depressed Walleye stocks. Diminished numbers of both species, carp and sucker, favour Lake St. Martin fisheries management objectives.

Obstacles to achieving fisheries management objectives on Lake St. Martin are overfishing, an excessively high quota, the Fairford Dam, and possibly the new channel through Buffalo Lake and Creek if it is the fish sink fishers are reporting. Achieving the fisheries management objectives will allow sustainable fishing certification of the Lake St. Martin fisheries.

APPENDIX 3

Method to calculate number of stocked fish to offset death of fish

In the event that fish mortality is observed due to the death of fish by stranding, losses will be offset by stocking. The calculated number of stocked fish required to offset losses would be the same as those provided by DFO to offset the death of fish during EOC operation (MI 2020). The approach is described below.

Step 1: Number of Fish Killed

The numbers of large-bodied fish killed would be estimated based on stranding surveys conducted during post-operation monitoring. Ageing structures and length data would be collected, to the extent feasible, to support calculation of losses in Step 2 below. The focus will be on species targeted in fisheries, i.e., Lake Whitefish, Walleye, Northern Pike and sucker species.

Step 2. Age-1 Equivalents and Biomass Calculations

Life history data for the large-bodied species would be based on Coker et al. 2001 and would be assumed to follow the von Bertalanffy function fitted to length data from Manitoba populations (or neighboring regions) where length, L, in cm, was:

- $L_t = L_\infty\left(1 - e^{-k(t-t_0)}\right)$

Where L∞ is the asymptotic age, k is the growth coefficient, t is age, and t0 is the age at 0 length.

Age-specific weight, W, in grams, would be estimated from length as:

- $W_t = a{L_t}^b$

Species-specific estimates of death of fish were converted to the standard age-1 equivalents, EA1, of each species. The number of age-1 equivalents for each age class was estimated as:

- $EA1_t = N_t \frac{1}{s_{1\to t}}$

Where $s_{1\to t} = \prod_{i=1}^{t} s_i$ is the cumulative survival rate from age 1 to age t and N_t is the number of fish death at age t.

Age-specific survival rate was estimated from a length-based mortality schedule that assumes mortality decreases as an inverse function of length (Lorenzen, 2000).

Assuming von Bertalanffy growth, survival at age t was estimated as:

- $s_t = \left(\frac{L_t}{L_{t+1}} e^{-k}\right)^{\frac{m_0}{kL\infty}}$
- where m_0 represents the mortality at a single unit of length and M represents the instantaneous annual mortality at maximum length
- $m_0 = ML_{Tmax}$

- M was unknown and was estimated from literature functions
- We used the relationship presented by Hoenig (1983) where mortality is a function of longevity:
- $M = 4.31 {T_{max}}^{-1.01}$

An alternative mortality function, presented by Pauly (1980), where M is a function of the von Bertalanffy growth function parameters and temperature:

- $M = 1.327 {L_{\infty}}^{-0.1912} k^{0.7485} T^{0.2391}$

The age-specific number of fish death, N_t, was estimated as:

- $N_t = N \frac{s_{1 \to t \cdot}}{\sum_{j=T_{mat}}^{T_{max}} s_{1 \to j}}$

Step 3 Discounting

Due to the time lag between the time of impact of and implementation of stocking, the principle of discounting would be implemented. Discounting devalues events that occur in the future relative to those that are in the present. Because the harm event occurred in the past and the implementation of the offset is yet to begin we factor in discounting by applying compounding to the initial harm and project forward (rather than projecting backward as discounting is generally done) to estimate the current value of the harm that will need to be offset. We use a rate of 3% compounded annual which is a value commonly applied in discounting (Clark and Bradford 2014). The current values of age-1 equivalents was estimated as:

- $EA1_y = EA1(1 - 0.03)^y$
- Where y is the years between harm incurred and stocking

Determination of the number of stocked fish

The number of stocked fish would be adjusted based on the age of stocking. If larval fish are stocked then the survival to age 1 (to correspond to the estimate generated in Step 3) would be applied.

References

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Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82: 898-903.

Pauly, D. 1980. On the interrelationship between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J. Conseil 39: 175-192.

APPENDIX 4

Fish and Fish Habitat in the Birch Creek Watershed

The Birch Creek watershed drains north into Lake St. Martin and encompasses an area of 29,477 ha (KGS Group 2017[4]). The lower portion of the watershed comprises Birch Creek proper, an 8.6 km reach of creek originating at Goodison Lake that is fed by Goodison and other headwater lakes and agricultural drains. The creek has a consistent U-shaped cross-sectional profile and has an average width of 9.5 m and a maximum depth of about 1.0 m (AAE Tech Services 2016, NSC 2019a). Substrate composition is variable and includes patches of silt, sand, gravel, and cobble with some boulders. Riparian habitat is comprised of grasses and cattails and adjacent land use is almost exclusively livestock grazing and hay land (AAE Tech Services 2016). The lower 1.8 km m or so of the creek flows through a dense, grass and cattail marsh before entering Birch Bay (AAE Tech Services 2016). A prominent gravel reef extends across Birch Bay at the mouth of Birch Creek, rising to a depth of <1.0 m (AAE Tech Services 2016). Depths in the marshy area near the mouth of Birch Creek are also <1 m (AAE Tech Services 2016).

Detailed fisheries investigations of Birch Creek have not beewatern conducted. However, local knowledge has indicated that Walleye spawn in the creek (NSC 2013) and preliminary investigations conducted in spring 2016 (AAE Tech services 2016) and 2018 (NSC 2019a) reported that White Sucker and, to a lesser extent, Northern Pike and Walleye move into the creek to spawn. AAE Tech Services (2016) reported a large number of White Sucker and a lesser number of Northern Pike entering the creek during spring 2016. The number of White Sucker moving into the creek is sufficient to support a commercial trapping operation (AAE Tech Services 2016). NSC (2019a) observed adult Walleye, White Sucker and Northern Pike in Birch Creek at Highway 6. In years where spring runoff is high, it is probable that these species could ascend to and possibly into Goodison Lake. The location of spawning areas within Birch Creek are not known but it is suspected that at least some spawning may occur in a pool just downstream of Highway 6, where adult Walleye, White Sucker and Northern Pike were observed. Suitable substrate conditions also occur in the creek just downstream of Goodison Lake. The extent to which juvenile and small bodied fish species use Birch Creek is not known.

Two major drains enter into Birch Creek from the west. These include an unnamed drain that enters the creek approximately 2.6 km upstream of Birch Bay and Woodale Drain which flows into Birch Creek approximately 3 km upstream from Birch Bay (Figure A4-1). Clarks Lake (25 ha) drains into Birch Creek from the east and enters the creek approximately 5.5 km upstream from Birch Bay via a series of constructed drains (Figure A4-1). Flow in the drains is intermittent and the drains likely provide fish habitat only during high flow periods. Riparian vegetation along the drains was comprised of terrestrial grasses (NSC 2019a).

The upper portion of the Birch Creek watershed is comprised of a series of shallow, intermittent lakes (Goodison Lake [260 ha], Water Lake [100 ha] and Clear Lake [25 ha]) that are connected by drains that ultimately allow water to enter Birch Creek at the outlet of Goodison Lake. The size and depth of the lakes varies annually and seasonally depending on local precipitation. In general, the lakes are shallow and heavily vegetated. Passage of large-bodied fish from Lake St. Martin into these lakes would occur only during high flow events in Birch Creek. Data collected in 2011 and 2015 suggest there is a low possibility for groundwater inflows to these lakes, although some seepage may occur (KGS 2017). Regardless of groundwater input, these lakes likely become anoxic during winter due to their shallow depth and abundance of aquatic vegetation.

Long Lake (30 ha) and Reed Lake (180 ha) also occur in the headwaters of the Birch Creek drainage and are connected to Birch Creek via the lakes farther downstream (i.e., Clear, Water, and Goodison lakes). They are also connected to Spearhill Drain to the south. Outflow direction from both lakes appears to be from dependent on water levels, with water draining north into Birch Creek during high water and south into the Spearhill Drain at all water levels. Both lakes likely support forage fish populations and possibly could support some large-bodied fish species periodically depending on their connectivity to the Spearhill Drain. Data collected in 2011 and 2015 suggest there is a low possibility for groundwater inflows to both lakes although some seepage may occur (KGS 2017). Regardless of groundwater input, it is likely both lakes become anoxic during some winters due to their shallow depth and abundant aquatic vegetation.

[4] All references in Appendix 3 may be found in the reference list for the main document.

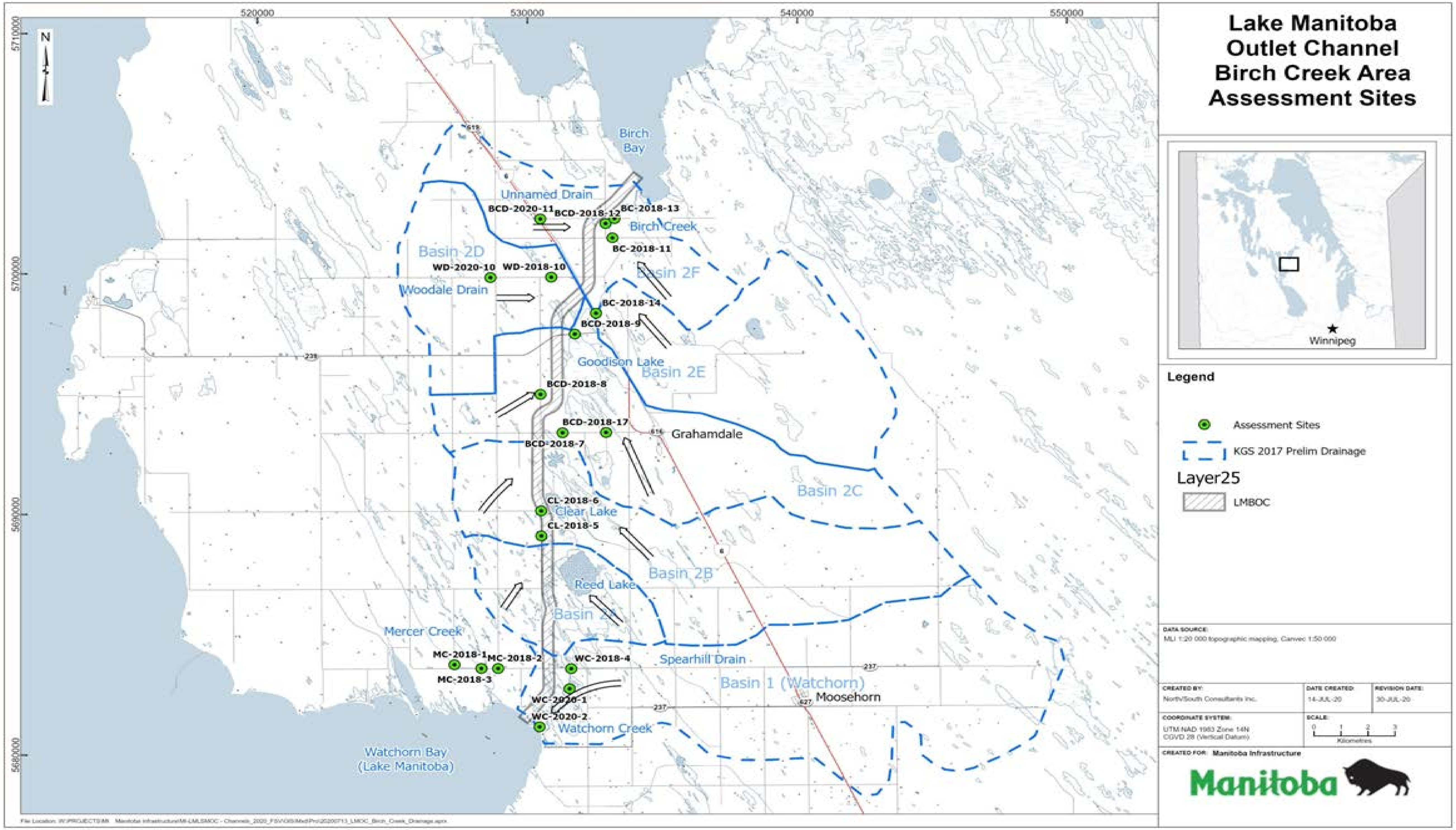

Figure A4-1. Birch Creek drainage basin showing the LMOC (figure reproduced from the EIS)

APPENDIX 5

Fish and Fish Habitat in the Buffalo Creek Watershed

The following information was taken from the final report for operation of the Emergency Outlet Channel (MI 2020).

The Buffalo Creek watershed is situated between Lake St. Martin to the south and the Dauphin River and Sturgeon Bay to the north. This watershed was used as a portion of the diversion route for emergency control of flood waters on Lake Manitoba and Lake St. Martin in 2011/2012 and 2014/2015. Fish and fish habitat studies were conducted in spring/summer 2011 prior to the first operation, and then during and after this operation. Fish salvage was conducted after both operation periods.

The EOC diversion route began with Reach 1, an excavated channel that extended from the northeast shore of the north basin of Lake St. Martin and extended approximately 6 km to a bog area adjacent to Big Buffalo Lake, which is the headwaters for Buffalo Creek. Buffalo Creek drains into the lower Dauphin River approximately 4 km upstream of Sturgeon Bay on Lake Winnipeg.

The Reach 1 channel was designed to have a bottom width of 60 m and 3:1 side slopes with a compacted clay and silt fines interspersed with gravels and cobbles comprise the substrate. Following closure, up to 30.5 ha of wetted habitat remained within Reach 1, but flows ceased and depths ranged from a few cm to more than 1.0 m. Habitat in Reach 1 became disconnected from other waterbodies during periods of closure.

Prior to operation of Reach 1, all flow in the Buffalo Creek system was due to local run off. The headwaters of the watershed are comprised of a bog complex including Big Buffalo Lake and several other ponds. Buffalo Creek originates at Big Buffalo Lake and flows for approximately 17 km to its confluence with the Dauphin River. For approximately the first 4 km downstream of Big Buffalo Lake, the creek flows through a sparsely treed wetland/bog complex before becoming a more defined creek channel with greater gradient and habitat diversity. HEC-RAS modeling estimates pre-operation 50th percentile discharge to have been approximately 4 m^3/s. The Buffalo Creek watershed has a drainage area of 38,700 ha.

Results from an August 2011 field investigation prior to operation of Reach 1 indicate that water depths in Big Buffalo Lake ranged from 1.2 to 2.1 m, with a mean depth of 1.7 m. Aquatic vegetation was abundant, and the lake substrate was comprised of soft, organic material. During summer 2011, standard index and small mesh gillnetting in Big Buffalo Lake captured Golden Shiner, Northern Pike, White Sucker and Yellow Perch. The Yellow Perch catch included large numbers of young, juvenile fish and fewer older juveniles and adults. The abundance of young juveniles suggests that Yellow Perch were successfully spawning in Big Buffalo Lake. The disproportionate number of young Yellow Perch may also be indicative of a lake subject to winter kill, that has just recently been re-colonized or where adults or other piscivorous fish were more susceptible to winter mortality.

The median wetted area of Buffalo Creek (also determined from orthometric imagery) was 20.09 ha prior to Project operation. Aquatic habitat information was collected during an August 2011 field campaign. Wetted width was generally between 7 and 15 m and water depths were almost always less than 1.0 m; exceptions included the occasional pool upstream of a beaver dam and the extreme downstream end of Buffalo Creek, where high water on the Dauphin River was having a backwater effect. As indicated by digital orthometric and satellite imagery, a wide variety of habitat types (run, pool, riffle) existed within the creek, and while substrate type varied from site to site, softer substrates were more frequently observed in pool habitat. Aquatic plants were present at all sites surveyed. At the downstream end of Buffalo Creek, water was slow and deep due to backwater effects from the Dauphin River. Sampling with a backpack electrofisher yielded Yellow Perch, Logperch, and Northern Pike. At the upstream end of the sampling reach, and upstream of back water effects from the Dauphin River, the creek became shallower and was characterized by riffle and glide sequences where Longnose Dace and Slimy Sculpin, species typically associated with faster flowing water, were more abundant.

The input of high flows due to operation of Reach 1 had the following effects to fish in Buffalo Creek:

- The overall abundance and diversity of fish (especially small-bodied species) was reduced during operation, but the pre-Project fish community started to re-establish within the two springs following the first closure;
- Large-bodied fish entered the watershed after the beaver dams were washed out but it is expected that beaver dams have become re-established and access by large-bodied fish from the Dauphin River is no longer possibly except under extreme high spring flows;
- There may be a short term reduction in riparian vegetation and abundance of large woody debris within Buffalo Creek affecting habitat for some forage species.

No fish and fish habitat surveys have been conducted in Buffalo Creek since closure of Reach 1 in 2015 and current fish use has not been documented.