LAKE MANITOBA
LAKE ST. MARTIN

OUTLET CHANNELS PROJECT

MANITOBA INFRASTRUCTURE

Aquatic Effects Monitoring Plan

November 10, 2020

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 plans may be further revised based on information and direction received from provincial and federal environmental regulators. This draft report 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 Aquatic Effects Monitoring Plan (AEMP) 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 confirm that the environmental protection measures committed to in the Environmental Impact Statement (EIS) and the conditions of the Environment Act Licence and Federal Decision Statement Conditions 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.

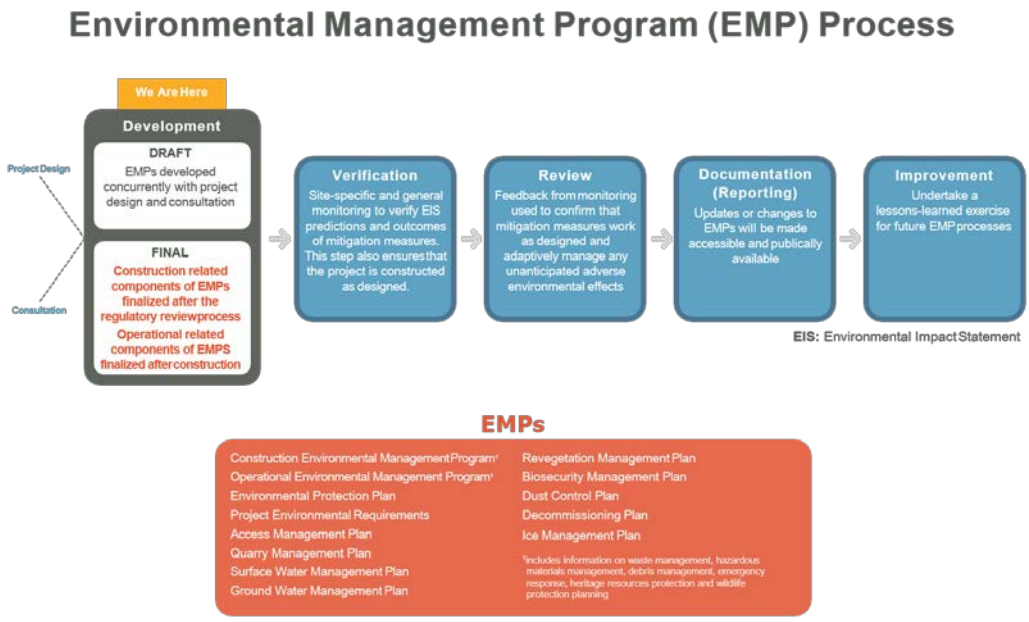
Manitoba Infrastructure remains committed to ongoing engagement and consultation with Indigenous groups and other stakeholders that are potentially impacted by the Project. Detailed EMP review discussions have been incorporated into community-specific consultation work plans and additional engagement opportunities will be provided prior to EMP finalization. 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 EMP provides the overarching framework for the Construction Environmental Management Program (CEMP) and an Operation Environmental Management Program (OEMP), which will be finalized as separate documents prior to Project construction and ideally operation, respectively. Their finalization will consider applicable conditions of the Environment Act Licence and associated approvals, any other pertinent findings through the design and regulatory review processes and key relevant outcomes of the ongoing Indigenous and public engagement and Consultation processes.

The purpose of the CEMP and OEMP is to guide how environmental issues will be addressed during construction and operation, respectively and how adverse effects of activities will be mitigated. The CEMP is supported by several specific or targeted management plans (e.g. surface water, groundwater, sediment, etc.), as shown in the Figure below, that will guide MI's development of the Project's contract documents and subsequently, the Contractor(s) activities, in constructing the Project in an environmentally responsible manner. The OEMP will likely include the same targeted plans developed to manage issues during

construction, but prior to construction completion they would be revised and adapted to suit the specific needs during the operation phase. The intent of this Aquatic Effects Monitoring Plan (AEMP) is to provide information on effects to the aquatic environment during Project operation, to support assessment of whether the management plans are functioning as intended. The AEMP will also meet monitoring requirements that will be set out in provincial and federal licences and permits with respect to the aquatic environment.

Environmental Management Program Process and Associated Environmental Management Plans



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Glossary of terms and acronyms

Acronyms

AEMP	Aquatic Effects Monitoring Plan
CAMP	Coordinated Aquatic Monitoring Program
CEMP	Construction Environmental Management Program
DFO	Department of Fisheries and Oceans Canada
DO	Dissolved Oxygen
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Statement
EOC	Emergency Outlet Channel
EPP	Environmental Protection Plan
FAA	Fisheries Act Authorization
FRWCS	Fairford River Water Control Structure
GWMP	Groundwater Management Plan
LAA	Local Assessment Area used in the EIS
LMOC	Lake Manitoba Outlet Channel
LSMEOC	Lake St. Martin Emergency Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
MI	Manitoba Infrastructure
PAL	Protection of Aquatic Life (in reference to water quality standards, objectives and guidelines)
PDA	Project Description Area used in the EIS
POC	Permanent Outlet Channel
SMP	Sediment Management Plan
SWMP	Surface Water Management Plan
TSS	Total Suspended Solids

Glossary of Terms

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 effects of the Project.

Construction Environment Management Program: MI's program to protect the environment during the construction of the POC.

Commissioning: After construction is complete, operation of the POCs may be tested to determine that they are functioning as planned.

Coordinated Aquatic Monitoring Program: An aquatic monitoring program being conducted at over 40 waterbodies in Manitoba conducted jointly by Manitoba and Manitoba Hydro.

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.

Offsetting: Measures such as habitat enhancement and restoration are required by DFO to provide additional fish production to replace the loss in production from natural habitats as a result of the construction of the Project.

Project Environmental Requirements: Measures to protect the environment included in contract documents.

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 Environmental Impact Statement (EIS) was submitted by Manitoba Infrastructure (MI) in March 2020. The EIS provided an overview of planned monitoring; this Aquatic Effects Monitoring Plan (AEMP) provides a detailed description of monitoring that will be conducted during and after the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project) is commissioned. Results of monitoring will be used to determine whether unanticipated effects are occurring and whether modifications to planned mitigation measures are required. This plan will also address the requirement for monitoring set out in provincial and federal licences and permits for the Project.

This AEMP does not include monitoring related to the management of the effects of construction activities; these are described within specific components of the Construction Environmental Management Program (CEMP). This AEMP also does not include monitoring specific to offsetting works that will be specified under the Fisheries Act Authorization for this project as these measures are currently being developed; monitoring for offsetting will be described in the offsetting plan but methods will be consistent with those set out in this AEMP.

This AEMP will be refined during the regulatory review process, based on input from rights holders, stakeholders, and regulators.

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 a Surface Water Management Plan (SWMP), Groundwater Management Plan (GWMP), and a Sediment Management Plan (SMP).

1.2 Objectives

The specific objectives of this AEMP are to:

- Verify the predicted effects presented in the surface water quality and fish and fish habitat sections of the EIS;
- Determine the effectiveness of mitigation measures;
- Assess the need for additional mitigation measures if initial measures are not adequate;
- Determine the effectiveness of any additional/adapted measure(s); and
- Confirm compliance with regulatory requirements relevant to surface water quality and fish and fish habitat set out in the Project approvals (e.g., Manitoba Environment Act License; Fisheries Act Authorization).

2.0 OVERALL APPROACH

Monitoring activities described in this AEMP were developed based on an understanding of the existing environment and the anticipated changes that will occur as a result of the Project. As a water control 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 (FRWCS) 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. Until 2011, the control structure was effective in managing the Lake Manitoba levels within the desirable range; however the 2011 flood resulted in extensive flooding on Lake Manitoba, Lake St. Martin and the Dauphin River.

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 in both 2011 and 2014. The proposed Project will provide a permanent flood mitigation channel. The route differs from the Emergency Outlet Channel (EOC) 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 FRWCS 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 FRWCS, as well as additional inflows from the planned outlet from Lake Manitoba.

Specific monitoring plans have been developed for the following aquatic components:

- water quality and sediment quality[1];
- aquatic habitat;
- fish, including fish movements; and
- mercury in fish flesh.

For each aquatic ecosystem component a rationale for the proposed monitoring activity is provided based on potential effects identified in the EIS. Monitoring is described in terms of individual studies, and for certain effects, several studies will contribute to assessing that effect. Where appropriate, management thresholds will be established against which post-Project conditions can be compared to determine whether follow-up actions are required. Monitoring study design is described in terms of the frequency of monitoring, field and

[1] Sediment quality will only be monitored if TSS sampling indicates the mobilization of large amounts of sediments.

laboratory methods, parameters to be measured, and data analysis. An overall schedule is provided in Section 8 and an overview of predicted effects and monitoring, including a reference to the specific studies presented in this AEMP is provided in Appendix 1.

For the purposes of the monitoring program, Project phases have been divided into supplemental data collection, monitoring during channel commissioning, and monitoring conducted post-construction (Table 1). The supplemental data studies will be conducted prior to channel commissioning where data review has found additional data are required to provide a basis for comparison to post-Project conditions (Table 2).

Monitoring of effects will begin during commissioning of the Permanent Outlet Channels (POCs). Due the unpredictable requirement for channel operations (i.e., it is not known when flood conditions will require use of the channels), it is not possible to schedule monitoring by year once commissioning is complete. Therefore, post-construction studies were assigned on the basis of channel usage as defined in Table 1. Monitoring is proposed to be repeated for at least two operational periods after the channels have been commissioned.

After the second round of operational monitoring, the need for further monitoring during operation periods will be assessed; if monitoring indicates that effects are greater than predicted in the EIS and that additional mitigation is required, then monitoring will be continued following periods of channel operation until mitigation is deemed effective. It should be noted that if the channels are not operated for several years (i.e., five or more), they will be inspected to determine whether they still provide habitat suitable for the survival of fish, as it is anticipated that changes in the channel, potential vegetation growth, and other factors might make the channels less suitable for the survival of fish if they are not operated regularly.

Table 1: Definition of Project phases used in the AEMP

Project phase	Phase definition
Supplemental Data Collection	The period prior to commissioning; construction activities that are occurring are not expected to affect the aquatic environment components being studied. Supplemental studies conducted to provide information to address additional data requirements identified during AEMP development.
Commissioning	Construction is complete and operation of channels is being tested during commissioning. Data collected during initial project effects, including when flow is passing through the channels and when the channels are watered but there is no flow.
Post-Construction	Construction and commissioning are complete, channels have been watered.
Non-operational	Channels are not being operated. Monitoring studies conducted to describe conditions for periods between use of channels.
Operational	Channels are being operated to alleviate flood conditions. Monitoring studies to describe effects related to operation of the channels.
Post-operation	The three year period following channel operation.

Table 2: Supplemental studies proposed for implementation in 2021 and 2022

Supplemental Studies proposed for 2021 and 2022	Study Objective
1. Fish Community Monitoring in Lake St. Martin	Fish community composition data will be collected from Lake St. Martin to provide additional data against which potential changes related to channel operation will be assessed. Methods will follow those as described in Study 5 of this AEMP.
2. Larval Fish Movements	Larval fish movements from Lake Manitoba to Lake St. Martin via the Fairford River and from Lake St. Martin to Sturgeon Bay via the Dauphin River will determine the species composition and numbers of larval fish currently drifting through the system. Subsequent studies will assess whether this changes during POC operation. Methods will follow those as described in Study 7 of this AEMP.
3. Lake Whitefish Egg Incubation	The abundance and distribution of larval Lake Whitefish in Lake St. Martin will be documented during early spring. Subsequent monitoring conducted following POC operation will determine whether changes to ground water inputs due to operation of the LMOC affects Lake Whitefish reproductive success within Lake St. Martin, particularly in Birch Bay. Methods will follow those as described in Study 10 of this AEMP.
4. Lake Whitefish Spawning	Lake Whitefish use of spawning habitat in the Dauphin River, Lake St. Martin, and the Fairford River will be examined by documenting the magnitude and timing of fall whitefish movements into the Dauphin and Fairford rivers, and the occurrence and density of Lake Whitefish larvae in the rivers and Lake St. Martin during the subsequent spring. Subsequent monitoring conducted during and following POC operation will help assess how POC operation may affect use of spawning habitats by whitefish. Methods will follow those as described in Study 12 of this AEMP.
5. Fish Use of Birch Creek and Buffalo Creek	Investigations will be conducted to determine the extent to which fish currently use habitat in the Birch Creek and Buffalo Creek drainages. Subsequent investigations will determine how fish use of the drainages may be affected following reductions in flow after construction of the channels. Methods will follow those as described in Study 13 of this AEMP.

2.1 Study Area

The study area for the AEMP overlaps with the Project Description Area (PDA) and Local Assessment Area (LAA) as defined for the Surface Water and Fish and Fish Habitat Assessments in the EIS. The study area for the AEMP (Figure 1) includes:

- the outlet channels (LMOC and LSMOC), including water control and drop structures and pools;
- inlets and outlets at both channels and immediate surrounding environment in Watchorn Bay and Sturgeon Bay;
- the Fairford River downstream of the FRWCS;
- the Dauphin River including its outlet into Sturgeon Bay;
- Lake St. Martin;
- the Birch Creek watershed draining into Lake St. Martin; and
- the Buffalo Creek complex, including Big Buffalo Lake.

2.2 Adaptive Management

The AEMP uses adaptive management to modify monitoring activities and mitigation measures, if and as required. Changes to these activities and measures will be considered if specific environmental indicators exceed a benchmark.

A two-staged approach is being used for adaptive management based on the development of two benchmarks: an early warning trigger, typically defined as a statistically significant change from baseline conditions; and a management threshold, the level of an indicator when the magnitude of an adverse effect is sufficient that it may result in long term adverse effects to a key fish species (i.e., Lake Whitefish, Walleye, and sucker where sucker support a fishery[2]). The early warning trigger is intended to highlight that a change has occurred. Detection of a change may require modifications to the monitoring program to acquire additional information, and subsequent evaluation of potential causes of the change to determine whether it is related to the Project. Management thresholds indicate that additional mitigation or management actions may need to be undertaken.

The approach to establishing benchmarks varies among components of the monitoring plan and is described in each section. As noted above, the early warning trigger is typically a comparison to baseline conditions. This AEMP presents some approaches to the identification of management thresholds including comparison to predictions in the EIS; it is anticipated that management thresholds will be developed prior to commissioning of the Project in discussion with rights holders, stakeholders and regulators.

Results of monitoring will be reviewed after each field program to determine:

[2] Monitoring and mitigation measures are focussed on these key species but measures to protect these species will also protect other species and components of the aquatic ecosystem.

- What is the magnitude of the effect in comparison to the predicted effect, i.e., has the result exceeded an early warning trigger for additional review? Generally, is there a statistically significant difference from pre-Project conditions?
- Are further investigations required to determine if the effect is related to the Project? Are modifications to the monitoring plan required?
- What are the potential implications to the aquatic ecosystem, in particular species valued in a fishery (i.e., Lake Whitefish, Walleye, and sucker)? In other words has a management threshold been reached and is additional mitigation required?
- If additional mitigation is required, what are potential methods and how could they be applied?
- What monitoring is required to determine whether the new mitigation measures are functioning as intended?

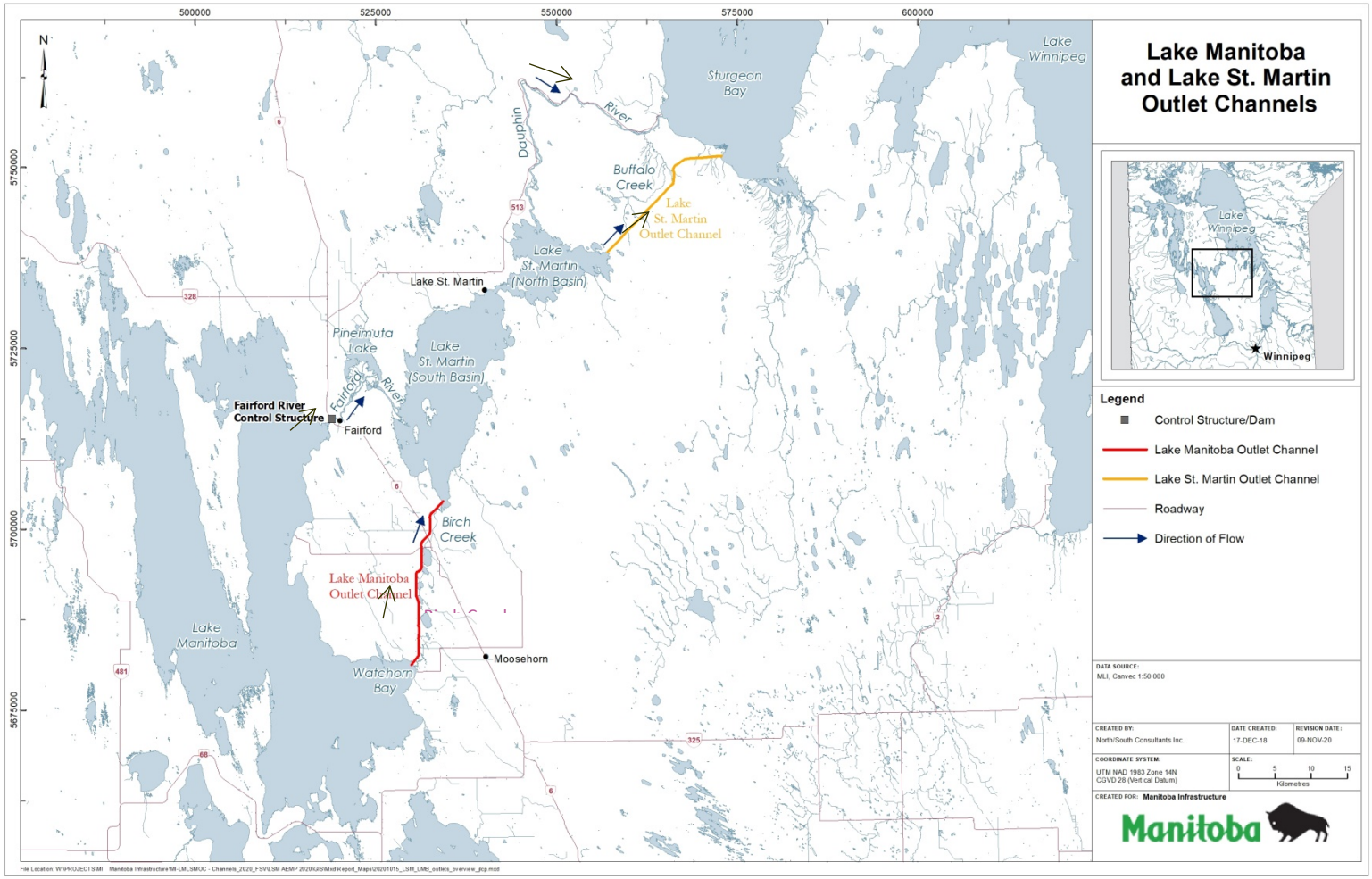

Figure 1: Location of Lake Manitoba and Lake St. Martin Outlet Channels and other waterbodies referenced in the AEMP. Arrows show direction of flow.

3.0 SURFACE WATER QUALITY

3.1 Rationale

Water quality is a key component of the aquatic environment, is critical for the maintenance of aquatic ecosystem health and, due to its importance to aquatic ecosystems, is required as part of effects monitoring. Monitoring of surface water quality conditions will help determine whether effects are as predicted in the EIS. Overall, changes in flow patterns due to operation of the channels are not expected to affect water quality. However, there may be some temporary increases in suspended sediment due to erosion and sediment re-suspension during channel operation. Dissolved oxygen (DO) was identified as a parameter of concern as concentrations can be depleted in natural channels and may also become depleted in the constructed channels during periods of non-operation.

Surface water quality monitoring to address Project effects related to these linkages includes the following components:

- Surface water quality monitoring at key locations throughout the study area.
- A specific effects program to monitor dissolved oxygen (DO) concentrations in the LMOC and LSMOC and selected sites in the Birch Creek and Buffalo Creek drainages to determine whether conditions are suitable to support fish during periods when the channels are not operated.
- A specific effects program to document spatial and temporal changes in total suspended solids (TSS) during channel operations to document sediment transport.

Sampling related to the management of construction-related effects (e.g., sampling of TSS conducted as part of the Surface Water Management Plan) is conducted under the Construction Environmental Management Program (CEMP).

3.2 Approach

3.2.1 Study Overview

Three studies are planned to monitor effects to water quality:

- **Study 1:** Surface water quality monitoring will be conducted in waterbodies in the study area to determine whether local water quality conditions change due to channel operations.
- **Study 2**: DO monitoring will addressed through a dedicated program focused on the LMOC and LSMOC once they have been constructed. Additional sites will be monitoring in the Birch Creek and Buffalo Creek drainages to determine whether reduced flows have exacerbated existing periods of low DO in summer and winter.
- **Study 3:** TSS monitoring will be conducted to monitor sediment transport during operation of the LMOC and LSMOC.

3.2.2 Baseline Information

Baseline data for the surface water quality program includes:

- data collected as part of LSMEOC monitoring program (2011-2015);
- data collected as part of POC baseline studies (2015-present);
- data collected by the Province of Manitoba (historic to present);
- data collected during late summer and fall 2020 as part of supplemental data collections for the POCs; and
- data to be collected during late winter 2020/2021 as part of supplemental data collections for the POCs.

3.2.3 Identification of Benchmarks

Benchmarks for the surface water quality monitoring program will be identified for key water quality parameters. These parameters will be those most likely to be affected by the Project, for which there is the greatest risk for direct effects on aquatic life, and for which there are objectives or guidelines for the Protection of Aquatic Life (PAL). The early warning triggers will be based on a change from baseline or background (i.e., upstream) conditions. Management thresholds will be based on the PAL and consider the magnitude, frequency, and duration of exceedance of PAL and the sensitivity of key aquatic species and life stages.

3.2.4 Adaptive Management

The following measures could be implemented as components of adaptive management:

- If changes to surface water quality are recorded, data will be examined to determine whether changes are attributable to the project and, if so, whether adverse effects to aquatic life are likely;
- If DO in channels declines to levels that are anticipated to have adverse effects to fish present, then the need for remedial measures will be considered;
- If DO declines in the natural streams occur to a greater magnitude or frequency then noted during baseline studies, then potential remedial measures will be considered; and
- If TSS monitoring indicates that sediment transport is greater than anticipated during channel operations, the need for remedial measures will considered. In addition, monitoring of sediment quality in areas of sediment accumulation may be implemented.

3.3 Study 1: Surface Water Quality Monitoring

3.3.1 Purpose

Surface water quality monitoring is planned to be conducted in waterbodies in the study area to determine whether water quality conditions change due to channel operations, specifically whether the change in flow patterns affects water quality.

3.3.2 Monitoring Frequency

Water quality monitoring is planned to be conducted once during POC commissioning and immediately prior to, during, and following the first two channel operation periods.

Samples are planned to be collected during four sampling sessions in each monitoring year to capture seasonal variability (i.e., once in spring, summer, fall and winter).

3.3.3 Field and Laboratory Methods

Sampling sites for the water quality monitoring program will be similar to sites sampled during previous studies. Sampling sites will be located at the following locations (Figure 2):

- Watchorn Bay in Lake Manitoba at the LMOC
- Fairford River at Lake Manitoba
- Birch Bay in Lake St. Martin at the LMOC
- South basin of Lake St. Martin
- Lake St Martin at the Narrows
- the north basin of Lake St. Martin at the LSMOC
- the north basin of Lake St. Martin at the Dauphin River
- Sturgeon Bay on Lake Winnipeg at the Dauphin River
- Sturgeon Bay on Lake Winnipeg at the LSMOC (minimum of two locations)
- Birch Creek immediately upstream of Lake St. Martin

3.3.4 Parameters

Laboratory analyses will include a suite of physical parameters, nutrients, and metals (including mercury) and major ions during both the construction and operation periods. These are listed in Table 3. *In situ* parameters will include temperature, pH, DO, turbidity and conductivity and Secchi disk depth (lake sites). Additional parameters including Biological Oxygen Demand, pesticides, hydrocarbons, cyanobacteria cell counts, microcystin, and *Escherichia coli* may be included during some seasons and at selected sampling sites, if required.

3.3.5 Data Analysis

Analysis will focus upon key indicators and comparison to benchmarks to identify the potential for adverse effects on aquatic biota. Benchmark exceedances will be assessed by comparing data collected upstream and downstream of the Project and by comparison to baseline data to determine if there are linkages to the Project.

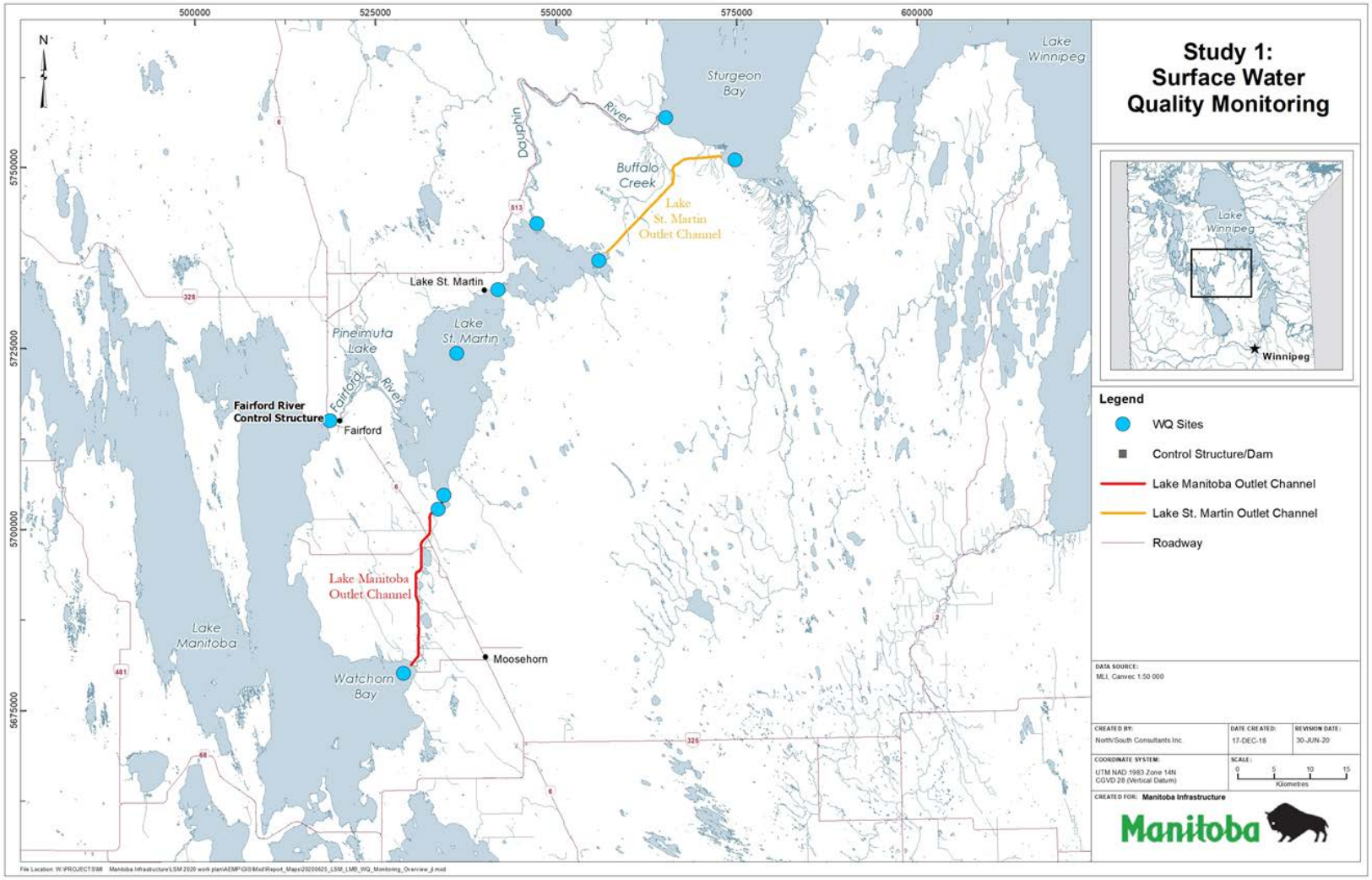

Figure 2: Location of surface water quality sampling sites for the AEMP

Table 3: Water quality parameters to be sampled for the AEMP

Parameter Groups		
Routine Parameters	**Metals (Total and Dissolved) and Major Ions**	
Alkalinity	Antimony (Sb)	Potassium (K)
Dissolved Organic Carbon	Arsenic (As)	Rubidium (Rb)
Total Inorganic Carbon	Barium (Ba)	Selenium (Se)
Total Organic Carbon	Beryllium (Be)	Silicon (Si)
Colour, True	Bismuth (Bi)	Silver (Ag)
Conductivity (at 25°C)	Boron (B)	Sodium (Na)
Hardness (Calculated from metals)	Cadmium (Cd)	Strontium (Sr)
Total Kjeldahl Nitrogen	Calcium (Ca)	Tellurium (Te)
Ammonia-N	Cesium (Cs)	Sulphate (dissolved)
Total Nitrogen (calculated)	Chromium (Cr)	Thallium (Tl)
Nitrite-N	Chloride (dissolved)	Thorium (Th)
Nitrate-N	Cobalt (Co)	Tin (Sn)
Phosphorus, Total	Copper (Cu)	Titanium (Ti)
Phosphorus, Total Dissolved	Fluoride (dissolved)	Tungsten (W)
Phosphorus Total Particulate (Calculated)	Iron (Fe)	Uranium (U)
pH	Lead (Pb)	Vanadium (V)
Total Dissolved Solids	Lithium (Li)	Zinc (Zn)
Total Suspended Solids	Magnesium (Mg)	Zirconium (Zr)
Turbidity	Manganese (Mn)	
	Molybdenum (Mo)	
Other Parameters	Mercury (Hg)	
Chlorophyll a	Nickel (Ni)	

3.4 Study 2: Dissolved Oxygen Monitoring

3.4.1 Purpose

Fish require DO in water to survive. Monitoring conducted for the POC baseline in both the Birch Creek and Buffalo Creek drainages has demonstrated that DO concentrations at sites within these systems may drop to critically low levels in winter under ice cover and be reduced during the open water season, in particular during mid-summer.

During periods of non-operation, DO levels within the LMOC and pools remaining in the LSMOC may become too low for fish to survive. Monitoring is planned to be conducted in the LMOC and LSMOC during periods of non-operation to determine whether DO levels are sufficient to support fish that are present.

Monitoring is planned to be conducted concurrently at representative sites in the Birch Creek and Buffalo Creek drainages to determine whether flow reductions due to the diversion of surface drainage have increased the magnitude and/or frequency of reduced DO.

3.4.2 Monitoring Frequency

Monitoring is planned to be conducted during periods of maximum DO depletion in late winter as well as during mid-summer. Monitoring is planned to be conducted according to the following schedule:

- during POC commissioning;
- during the first two years of non-operation following completion of the channels;
- during years subsequent to channel use for the first two operational periods; and
- additional monitoring may be required if the channels are not operated for an extended period of time (5 years or more). The timing of this monitoring will depend on observed conditions in the channels, in particular whether large quantities of organic material accumulate in the channels.

3.4.3 Field and Laboratory Methods

DO concentrations will be recorded by data loggers deployed during late winter and mid-summer. Four loggers will be installed in the LMOC at the following location (see Figure 3):

- one in the channel near Lake Manitoba
- one in the channel halfway between Lake Manitoba and the LMOC control structure
- one immediately upstream and one downstream of the LMOC control structure

Three loggers will be installed in a series of a series of representative pools in the LSMOC (Figure 3).

3.4.4 Parameters

Dissolved oxygen and water temperature will be recorded by the data loggers. It should be noted that DO will also be measured using a portable meter during the surface water quality program (Study 1).

3.4.5 Data Analysis

Data analysis will focus upon comparing DO concentration to the benchmark required to support fish.

Monitoring results will be used to assess the potential for fish mortality to occur within the LMOC and LSMOC during periods of non-operation under ice cover and in mid-summer.

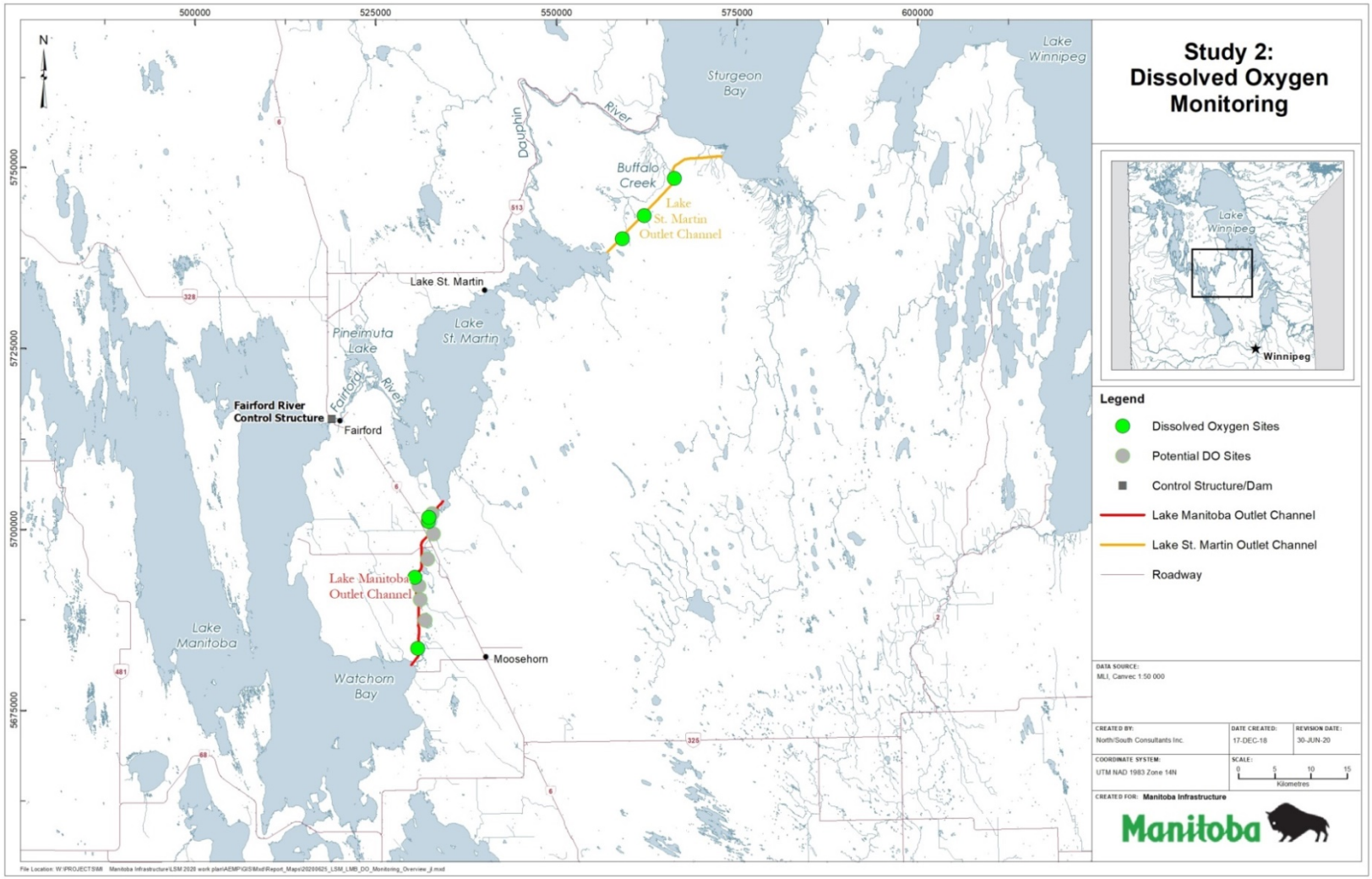

Figure 3: Location of continuous DO monitoring sites for the AEMP

3.5 Study 3: TSS Monitoring

3.5.1 Purpose

Sediments are naturally moved by flowing water. Operation of the LMOC and LSMOC during flood conditions may result in a change in the amount by which sediment is moved downstream from Lake Manitoba through the Fairford River, Lake St Martin and the Dauphin River to Sturgeon Bay. As well, operation of the channels will provide additional routes by which sediment is moved between those waterbodies.

3.5.2 Monitoring Frequency

Monitoring is planned to be conducted during POC commissioning and during and in years subsequent to the first two operational periods.

3.5.3 Field and Laboratory Methods

TSS monitoring will be conducted by deploying turbidity loggers at key locations to provide a continuous record of turbidity conditions during periods of operation. Water samples will be collected throughout the period of operation from each logger location and analyzed for turbidity and TSS concentration. This will allow for the development of site-specific turbidity/TSS relationships and allow the conversion of turbidity logger data to TSS and provide a continuous TSS record at each logger location.

Loggers will be deployed shortly before the onset of channel operation to establish initial turbidity/TSS conditions and will remain in place until after channel operation has ceased and TSS concentrations have returned to pre-operation baseline conditions.

Loggers will be deployed at the following locations (see Figure 4):

- the Fairford River at Lake Manitoba
- the Fairford River at Lake St. Martin
- Watchorn Bay on Lake Manitoba at the LMOC
- outlet of the LMOC at Birch Bay on Lake St. Martin
- the Dauphin River at Lake St. Martin
- the Dauphin River at Sturgeon Bay
- the LSMOC at Lake St. Martin
- the outlet of the LSMOC at Sturgeon Bay

3.5.4 Parameters

Key parameters to be monitored will include turbidity and TSS.

3.5.5 Data Analysis

Analysis will focus upon temporal changes to turbidity/TSS at each logger location. Comparison in trends of TSS between logger locations will provide insight into sediment transport throughout the system during periods of operation. Using TSS concentrations as inputs, an empirical model will be used calculate sediment loading into Lake St. Martin and Sturgeon Bay following each operation.

Comparison to predictions in the EIS and benchmarks will identify the potential for adverse effects on aquatic biota.

3.6 Reporting

Reports would be produced that document the methods and results of the surface water quality monitoring programs within one year of completion of the field studies (Studies 1-3).

Reports will provide comparison of results to predictions in the EIS and with established benchmarks, ascertain whether observed changes are Project-related and consider the possible requirement to implement adaptive management.

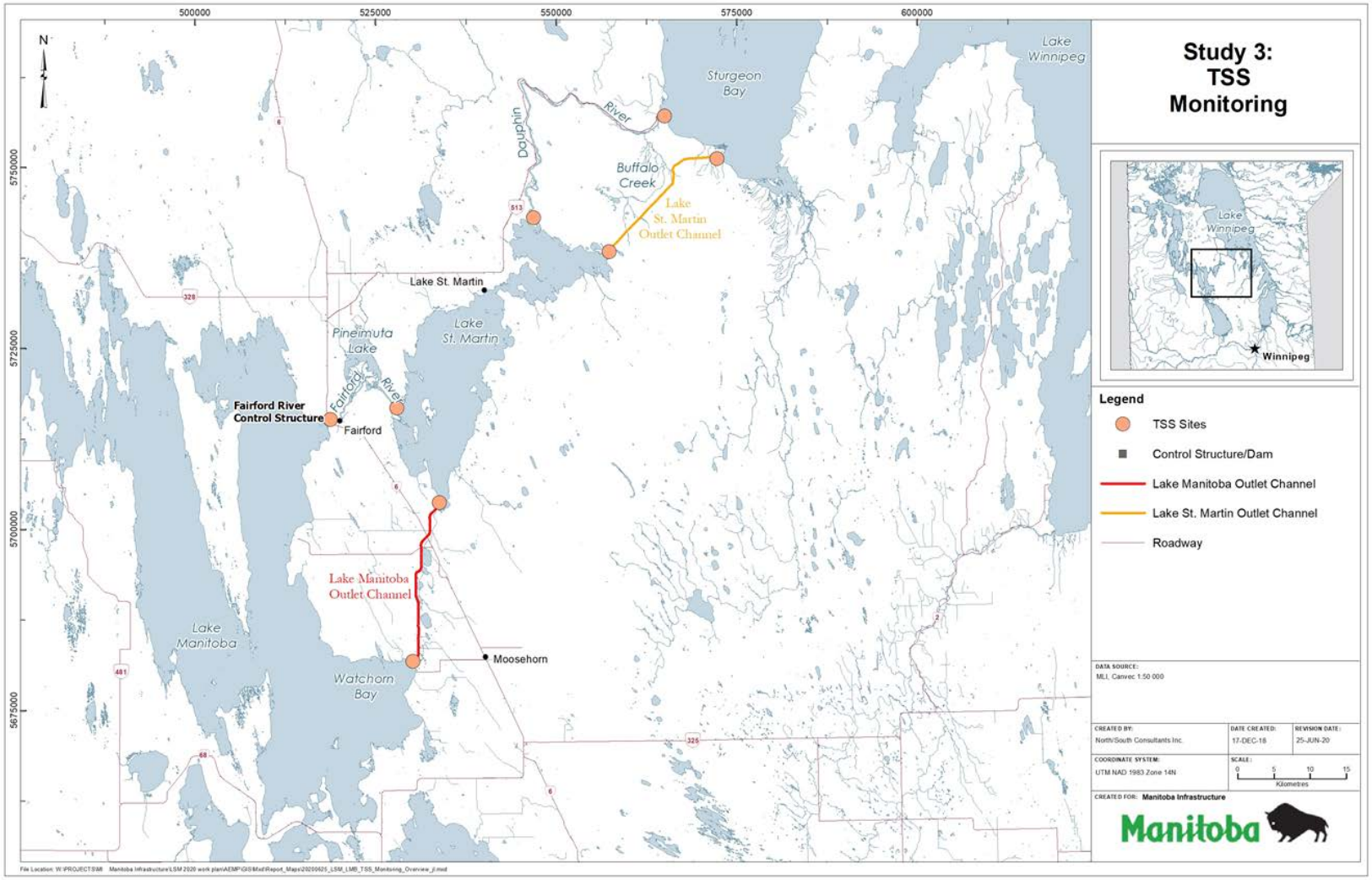

Figure 4: Location of turbidity logger and TSS sampling sites for the AEMP

4.0 AQUATIC HABITAT

4.1 Rationale

Aquatic habitat is the physical, chemical and biological environment in which aquatic organisms live. Consequently, changes to aquatic habitat can affect the organisms that live there. The Project could affect aquatic habitats in study area waterbodies and, as such, monitoring will be required to document where and to what extent changes may occur. The channel project will affect aquatic environments through the following linkages:

- construction of the LMOC and LSMOC will create new aquatic habitat that will be available to fish;
- construction of the inlet/outlet structures will modify existing habitat within the immediate footprint of the structures; and
- flow management will change existing aquatic habitat in the Birch Creek and Buffalo Creek systems.

Aquatic habitat monitoring is planned to document habitat conditions in the LMOC and LSMOC to provide the basis for determining their suitability to support fish that may use those areas prior to, during and following channel operations. Monitoring at the inlets and outlets of the POC will indicate whether these areas are stable or are experiencing erosion or sedimentation. Habitat will not be monitored in the Birch Creek and Buffalo Creek drainages as under existing conditions habitat varies widely depending on seasonal and inter-annual variations in flow. Instead, monitoring in these streams will focus on dissolved oxygen (Study 2) and the continued presence of fish (Study 13).

4.2 Approach

4.2.1 Study Overview

One study is planned to be conducted to address effects to aquatic habitat:

- **Study 4:** Channel Habitat - Information describing aquatic habitat will be collected at the inlets/outlets and from within the LMOC and LSMOC to describe post-construction habitat (i.e. at the end of the commissioning phase) and to document how those conditions might change following operation of the channels.

Monitoring will include water depth, channel width, substrate type and the presence of aquatic vegetation. Benthic invertebrates are an important food source for fish and, consequently, benthic invertebrate monitoring will also be conducted. Benthic invertebrates are also a useful indicator of habitat quality.

4.2.2 Baseline Information

Baseline information is available for existing habitat at the inlets and outlets of both channels, portions of the Fairford and Dauphin Rivers, Lake St. Martin, and the southern portion of Sturgeon Bay. Bathymetric and substrate classification maps are available for those locations.

Benthic invertebrate information has been collected from the inlet and outlet areas of both channels.

Additional information collected following the completion of the commissioning period will provide as-built habitat description of the channels and their inlets/outlets

4.2.3 Identification of Benchmarks

Post-construction and post-operation habitat conditions and benthic invertebrate data in the channels will be evaluated to determine whether they are suitable to support fish that are present based on comparisons to pre-Project benthic invertebrate composition and abundance and substrate types identified in the final design of the channels.

4.2.4 Adaptive Management

Adaptive management measures may include the following:

- if substrates at the inlets and outlets are unstable or experience extensive sediment deposition and do not support benthic invertebrates or other uses for fish species present, then the need for measures to stabilize the substrates will be considered; and
- if channels experience large changes following operation, then the need for channel stabilization/modifications will be considered.

4.3 Study 4: Aquatic Habitat Monitoring

4.3.1 Purpose

Aquatic habitat monitoring is planned to be conducted in the inlet/outlet areas and within the LMOC and LSMOC to determine the suitability of the habitat to support fish and other aquatic biota that may use those areas prior to, during and following channel operations.

4.3.2 Monitoring Frequency

Initial habitat and benthic invertebrate assessment is planned to occur two years after the channels have been commissioned. Waiting two years after construction will allow time for altered and newly created habitat to become established and stabilize.

Subsequent sampling is planned to be conducted following the first two operational periods to document how conditions in the channels may change due to operation.

Additional monitoring may be required if the channels are not operated for an extended period of time (five years or more). The timing of this monitoring will depend on observed conditions in the channels, in particular whether large quantities of organic material accumulate in the channels.

4.3.3 Field and Laboratory Methods

Habitat conditions in the LMOC and the inlets and outlets of both channels will be recorded using standard boat-based sonar to collect hydroacoustic information describing water depth and substrate classification. Substrate samples will be collected from survey areas to help interpret and validate substrate classifications derived from the hydroacoustic data.

Methods for habitat mapping/description in the LSMOC will be determined once the channel has been constructed and sampling conditions are known. It is anticipated that a combination of remote sensing (collection of aerial imagery) and field measurements of habitat parameters will be used.

Benthic invertebrates will be collected at the inlet and outlet of each channel as well as at several locations within each channel. Sampling locations within the channels will be determined once the channels are constructed and habitat conditions within the channels are better understood.

Benthic invertebrate samples will be collected using a ponar dredge. Replicate samples will be collected at each sampling location. Samples will be preserved at the collection site and delivered to a laboratory for analysis.

4.3.4 Parameters

Physical habitat parameters will include water depth, substrate and distribution of aquatic macrophytes.

Benthic invertebrate samples will be sorted and enumerated in a laboratory. Indices of species composition and diversity will be calculated.

Habitat information will be supplemented by the results of surface water quality sampling collected during Study 1 and DO measurements collected during Study 2.

4.3.5 Data Analysis

Physical habitat parameter analyses will include production of bathymetric and substrate classification maps for all survey areas and calculation of spatial area for different habitat classes. As additional years of data are acquired, comparison between years will be provided to describe changes in habitat within the channels.

Water quality conditions will be described based upon results from Study 1 and Study 2.

Benthic invertebrate species composition and density will be calculated. Changes in benthic invertebrate community and diversity indices will be compared between sampling years and to pre-Project data.

4.4 Reporting

Reports would be produced for each study year to describe the methods and results of the aquatic habitat monitoring program (Study 4). After the initial year of post-commissioning monitoring, subsequent monitoring will provide comparison of habitat conditions between monitoring periods years to describe how habitat in the channels evolves over time.

5.0 FISH

Fish are an important component of the aquatic ecosystem. Study area waterbodies support domestic, commercial and recreational fisheries. Monitoring of the fish community is planned to address whether effects are as predicted in the EIS and determine whether mitigation strategies to minimize effects to the fish community are effective. Five main potential pathways by which the Project could affect fish were identified in the EIS, as follows:

- transfer of adult and larval fish from Lake Manitoba to Lake St. Martin and from Lake St. Martin to Sturgeon Bay during operation of the outlet channels;
- possible stranding and subsequent mortality of fish in the outlet channels following operation;
- changes to groundwater inflow potentially affecting the success of Lake Whitefish egg incubation in Lake St. Martin;
- effects related to changes in flow, in particular reducing the attraction to the Dauphin and Fairford rivers and creating an alternate attraction to fish at the LMOC and LSMOC outlets; and
- effects of elevated TSS on the fish community in Lake St. Martin and Sturgeon Bay.

The EIS assessed these effects as not significant, based on planned mitigation. Monitoring is planned to confirm these predictions or, if effects are greater than predicted, determine whether additional mitigation is required. Studies planned to address the first four points are described in the following section; effects related to increased TSS are addressed in Study 3 (TSS monitoring).

5.1 Fish movements out of Lake Manitoba and Lake St. Martin

5.1.1 Rationale

Operation of the LMOC and LSMOC may result in increased movements of fish from Lake Manitoba to Lake St. Martin and from Lake St. Martin to Sturgeon Bay via the channels. The effects of these movements on fish populations are expected to be minimal, but monitoring will be required to determine the extent to which downstream fish movements occur during channel operation, and whether there is an effect on the fish community related to increased downstream movements.

5.1.2 Approach

Study Overview

Three studies are planned to assess effects to the fish community and movements of adult and larval fish:

- **Study 5:** Fish community composition in Lake St. Martin will be monitored to determine whether any changes occur that could be related to channel operation.

- **Study 6:** Downstream movements of fish through the LMOC and LSMOC will be monitored to document the number and species of fish that move downstream during periods of channel operation.
- **Study 7:** Larval fish movements from Lake Manitoba to Lake St. Martin and from Lake St. Martin to Sturgeon Bay will be monitored to determine the species composition and numbers of larval fish that may passively drift down Fairford and Dauphin rivers and the POCs during operation.

Baseline Information

Information pertinent to fish abundance and species composition includes:

- long-term commercial fish harvest data collected annually by the Province of Manitoba in Lake Manitoba, Lake St. Martin, and Sturgeon Bay;
- fish community data collected from Lake St. Martin and Sturgeon Bay as part of monitoring for the LSMEOC (2011-2015);
- fish community data collected from Lake St. Martin as part of baseline studies for the Project (2018);
- long-term fish community data collected annually from Sturgeon Bay as part of CAMP (2008-ongoing); and
- fish community data to be collected from Lake St. Martin as part of supplemental data collections scheduled for 2021 and 2022.

Larval fish movement data includes:

- data documenting downstream larval fish movements from Lake St. Martin to Sturgeon Bay collected during and between periods of operation of the LSMEOC (2012-2015); and
- larval fish movement data be collected from the Fairford and Dauphin rivers as part of supplemental data collections scheduled for 2021 and 2022.

Identification of Benchmarks

Benchmarks for fish community monitoring will be developed for key indicators. The early warning trigger will be based on detection of a statistically significant change from pre-commissioning conditions. Context for observed changes may be obtained from similar monitoring programs conducted on nearby waterbodies (e.g., sampling conducted by CAMP). Key indicators will likely include species relative abundance and fish abundance (e.g., CPUE) and population characteristics for key species (Lake Whitefish and Walleye) such as size distribution, growth and condition.

The EIS predicted that the fish community on Lake St. Martin would not experience a detectable change due to the Project. Management thresholds will be developed after supplemental data collection is complete and may be based on an analysis of the natural variation in fish community parameters observed pre-Project, with the objective of maintaining the fish community within this range during Project operation.

Benchmarks for downstream movements of larval, juvenile and adult fish via the POCs will be developed based on documented movements down the existing rivers and a review of the magnitude of loss that would occur before an adverse effect to the upstream fish community could occur.

Adaptive Management

Monitoring results would be reviewed to determine whether losses may result in impacts to upstream fish communities. Monitoring of fish communities will also indicate if effects are occurring. The degree of success of fish passage through channels (i.e., do they survive passage to the receiving water body) will also inform the need for adaptive management. If downstream losses could adversely affect the source population, then mitigation measures would be considered. These measures would need to be developed based on an understanding of the specific issue.

5.1.3 Study 5: Fish Community Monitoring

Purpose

Fish community composition in Lake St. Martin is planned to be monitored to determine whether any changes occur that could be related to channel operation. Commercial harvest records for Lake St. Martin, Lake Manitoba, and Sturgeon Bay will also be examined to determine whether there is a change in the commercial catch.

Monitoring Frequency

Supplemental fish community data are planned to be collected from Lake St. Martin during 2021 and 2022 to provide additional pre-impact data. Monitoring are planned to be conducted in the two years following the first and second operational periods.

Field and Laboratory Methods

Fish community sampling will be conducted using standard experimental gillnets comparable to those used during LSMEOC monitoring and Project baseline data collection (see Figure 5 for representative sampling locations). The fish community in Sturgeon Bay is monitored annually under CAMP (see Figure 6 for representative sampling locations).

Parameters

Fishing effort and biological parameters of captured fish (length, weight, state of sexual maturity, ageing structures) will be recorded during field programs in Lake St. Martin.

These are comparable to those collected during the CAMP program in Sturgeon Bay.

Data Analysis

Fish community and population metrics will be calculated as follows:

- Lake St. Martin: for each year in which sampling occurs; and
- Sturgeon Bay and commercial production data: for each year that sampling in Lake St. Martin occurs plus during intervening years.

Comparison of fish community and population metrics will be provided between sampling years.

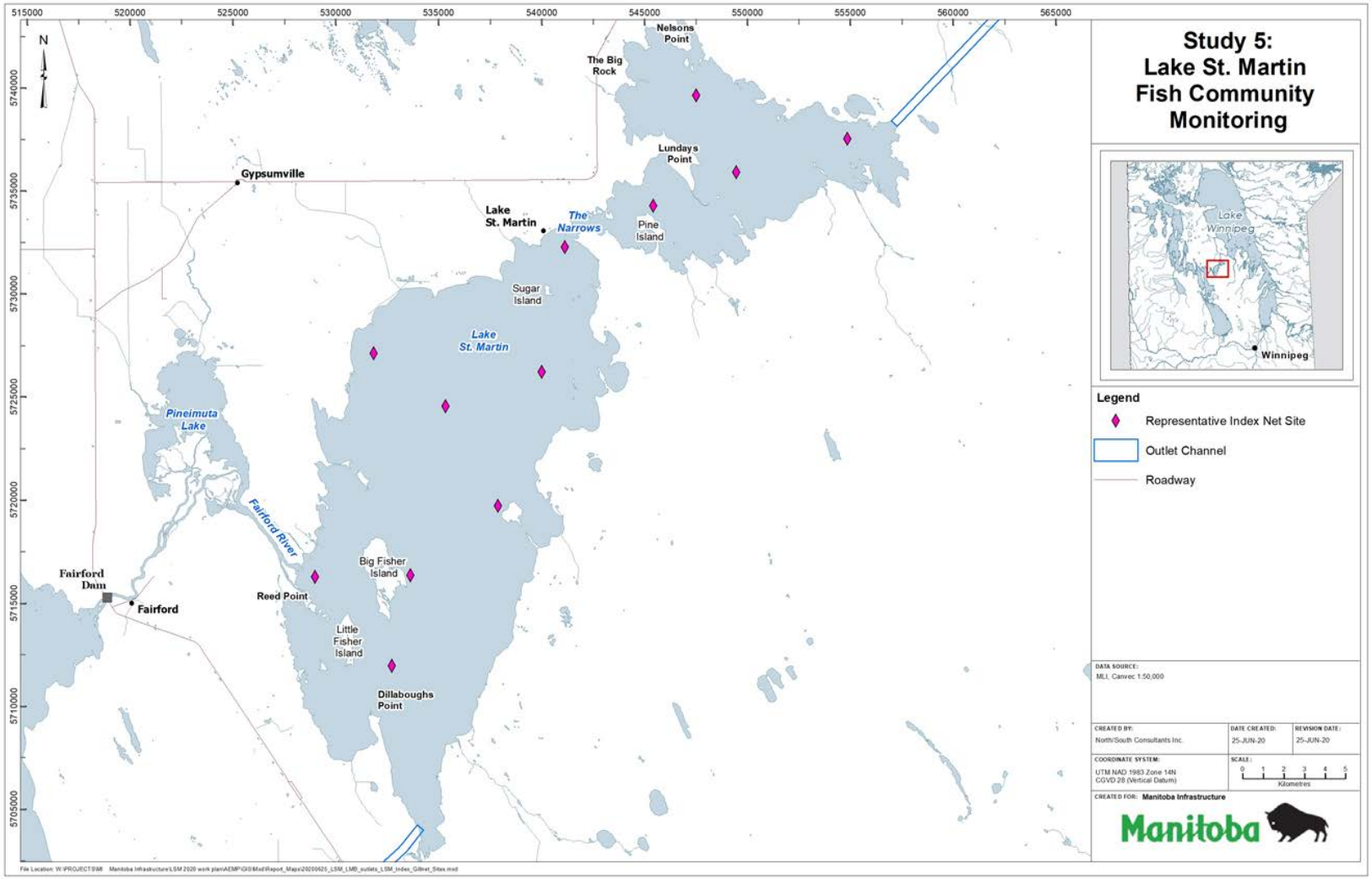

Figure 5: Representative index net sites for Lake St. Martin fish community sampling as part of the AEMP

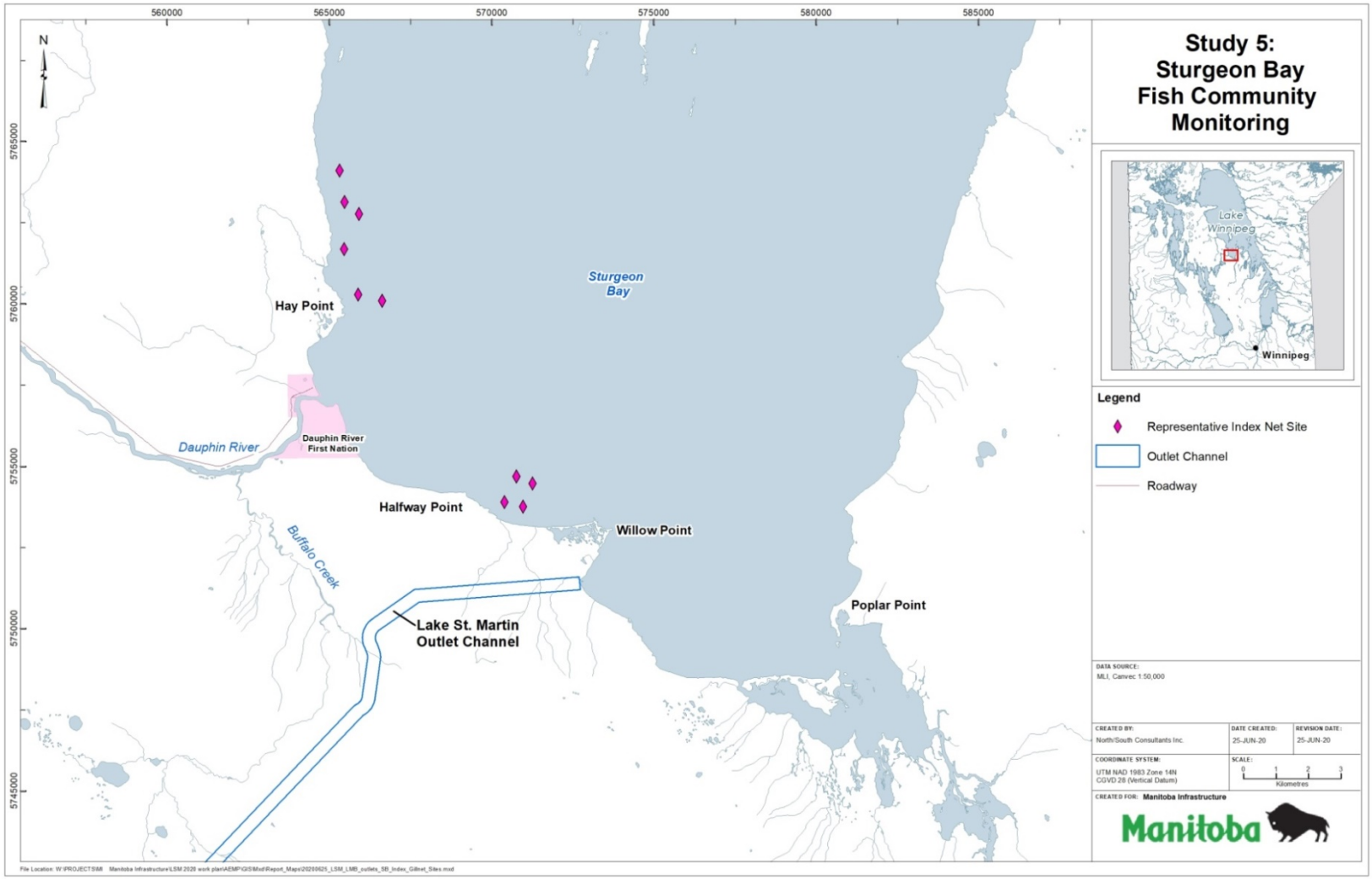

Figure 6: Representative index net sites for Sturgeon Bay fish community sampling as part of the CAMP

5.1.4 Study 6: Downstream Adult and Juvenile Fish Movements

Purpose

Downstream movements of adult and juvenile fish through the LMOC and LSMOC are planned to be monitored to document the number and species of fish that move downstream during periods of channel operation.

Monitoring Frequency

Downstream fish movements in the LMOC and LSMOC are planned to be monitored during commissioning and the first two years of channel operation.

Field and Laboratory Methods

Split-beam hydroacoustics will be used to enumerate fish moving downstream past the control structures in the LMOC and LSMOC (see Figure 7). “Receiver stations” will be installed in the channels immediately prior to the onset of operation and will remain in place for the period of operation. The use of split-beam hydroacoustic technology provides an enumeration of fish movement past the receiver station by direction and size, but does not identify fish to species.

Periodic fish sampling will be required to determine fish species moving through the channels and assist in analysis of hydroacoustic data. It is anticipated that a suite of fish capture techniques may be used, possibly including boat electrofishing, hoop nets, or gillnets.

Parameters

Data collected with the split-beam hydroacoustic program will include daily counts of fish moving upstream and downstream past the receiver station, and size estimates for each fish moving past the station.

Fish captures will provide species identification and additional size data.

Data Analysis

Hydroacoustic and fish capture data will be analyzed to provide daily counts of the number and size of fish and an estimate of the species composition of fish moving downstream within the channels.

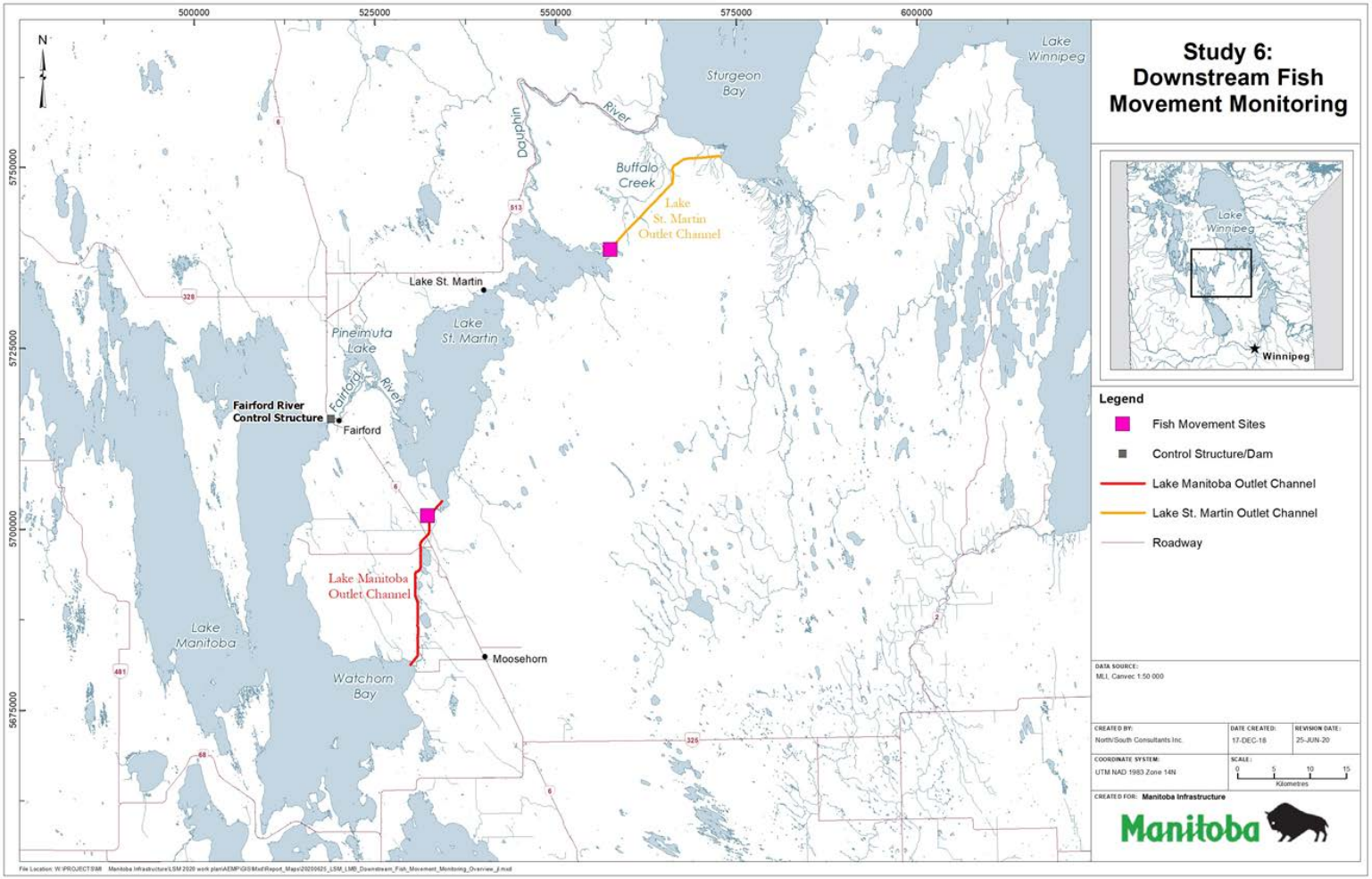

Figure 7: Location of hydroacoustic receiver stations to document downstream fish movements during POC operation

5.1.5 Study 7: Larval Fish Movements

Purpose

Larval fish movements from Lake Manitoba to Lake St. Martin and from Lake St. Martin to Sturgeon Bay are planned to be monitored to determine the species composition and numbers of larval fish that may passively drift down the Fairford and Dauphin rivers and the POCs during operation.

Monitoring Frequency

Supplemental studies are planned to be conducted in spring 2021 and 2022 to document the species composition and abundance of larval fish that drift down the Fairford and Dauphin rivers.

Monitoring studies are planned to be conducted during commissioning and the first two years of channel operation to determine the species composition and abundance of larval fish that drift down the Fairford and Dauphin rivers, as well as the POCs.

Field and Laboratory Methods

Larval fish drift will be monitored at the following locations (Figure 8):

- Fairford River at Lake Manitoba
- Dauphin River at Lake St. Martin
- inlet and outlet of the LMOC
- inlet and outlet of the LSMOC

Larval fish will be captured using larval drift traps comparable to those used during LSMEOC monitoring. Two traps will be set at each sampling location and will be left in to sample continuously. Flow meters will be used to estimate the portion of channel flow that is sampled.

It is anticipated that monitoring will be comprised of several sampling sessions per sampling year to maintain sampling effort at a reasonable level while providing coverage throughout spring. This is to account for differences in the timing of hatch and at which larvae of different species are vulnerable to passive movement with water flow. Specifically, larval Lake Whitefish drift immediately after ice off, while spring spawning species such as Walleye and sucker drift later in spring.

Traps will be emptied daily and contents preserved for sorting and enumeration by species in the laboratory.

Data Analysis

Data will be analyzed to provide an estimate of larval movements by species, location and date during each sampling year. Comparisons will be provided for the Dauphin and Fairford rivers for periods of varying discharge, as well as during periods of channel operation vs non-operation, and between drift in the POCs in comparison to the rivers.

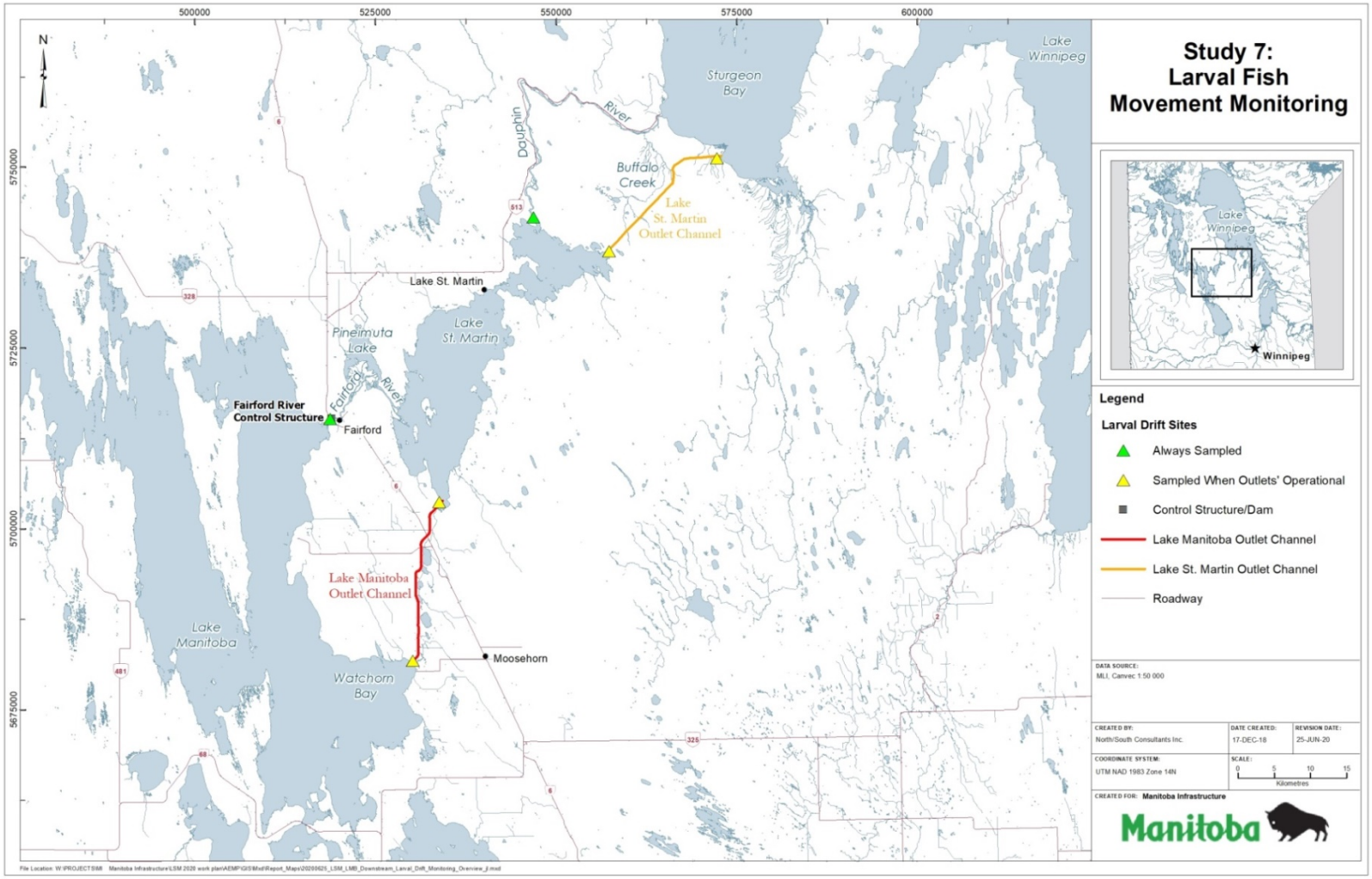

Figure 8: Location of spring larval fish movement sampling sites for the AEMP

5.1.6 Reporting

Reports would be produced for each study year that document the methods and results of the fish community and movement studies (Studies 5-7).

Analyses would include comparison of results with established benchmarks, as well as to predictions in the EIS.

5.2 Stranding of Fish

5.2.1 Rationale

It is anticipated that fish could be stranded within the POCs following closure, in particular if drawdown within the channels occurs rapidly. Within the LSMOC, some fish will remain in pools upstream of drop structures following closure of the channel gate; depending on the channel configuration, fish may also be stranded in isolated pools or beached on land. Channel closure is expected to have no effect on water levels upstream of the control structure in the LMOC, but rapid drawdown could strand or beach fish between the LMOC control structure and Lake St. Martin where water level would be expected to drop as flow through the channel is reduced.

Monitoring will be required to document whether fish stranding/beaching and subsequent fish mortality occurs in the POCs following closure.

Fish will be present in the POCs once they are commissioned, but may be susceptible to oxygen depletion during periods when the channels are not in operation. Results of the planned DO monitoring described in Study 2 (Section 2.4) would document DO conditions in the LMOC and LSMOC during periods of non-operation. Following periods when DO conditions are insufficient to support fish, monitoring may be required to document whether mortality of fish is occurring.

5.2.2 Approach

Study Overview

Two studies are planned to address the fate of stranded fish:

- **Study 8:** Surveys will be conducted to determine whether fish are stranded along the channel banks of the POCs immediately following drawdown after closure. Additional surveys will be conducted to document the occurrence and abundance of fish species remaining in the LSMOC following channel closure and again in fall and/or spring, depending on the timing of operation.
- **Study 9:** DO monitoring described in Study 2 will determine whether conditions are suitable to support fish in the POCs. Following periods when DO levels are low, monitoring will be conducted to document the distribution and abundance of fish mortalities along the shores of the channels.

Baseline Information

Data will be collected after the LMOC and LSMOC channel are constructed.

Identification of Benchmarks

The early warning trigger will be the observation of 50 dead large-bodied fish. This will indicate the need for a stranding survey based on a statistically rigorous design to obtain an estimate of fish mortality in the channels. Management thresholds will be developed in consideration of the incremental mortality that will not affect the sustainability of the fishery.

Adaptive Management

Management measures to cause fish to leave the channels prior to closure, including modifications to the closure procedure, may be implemented if large numbers of large-bodied fish are stranded.

5.2.3 Study 8: Fish Stranding

Purpose

Surveys are planned to be conducted to determine whether fish are beached along the shore or stranded in isolated pools following closure of the POCs.

Monitoring Frequency

Monitoring are planned to occur during commissioning and following closure after the first two periods of operation.

Additional monitoring may be required in the LSMOC if is not operated for an extended period of time (five years or more). The timing of this monitoring will depend on observed DO and habitat conditions.

Field and Laboratory Methods

Stranding surveys:

- Searches will be conducted along both banks of the POCs to look for stranded fish immediately following closure of the channel. Searches will focus on the portion of each channel that extends downstream from the control structure to the channel outlet.
- Stranded fish will be enumerated to species and locations where stranding occurs will be recorded. Fish size data will be collected from stranded fish.

Fish remaining in representative pools along the LSMOC following closure will be documented.

Fish will be sampled from the pools during fall subsequent to channel closure. It is anticipated that a suite of fish capture techniques will be used, including back pack electrofishing or gill nets.

Captured fish will be enumerated by species, location, and fish size will be recorded.

Parameters

Parameters include fish species and distribution, fish counts, and fish size data.

Data Analysis

Survey results will be analyzed to:

- Describe the occurrence, abundance, and distribution of stranded fish within the LSMOC following closure.
- Describe the occurrence, abundance, and distribution of fish remaining within the LSMOC during fall and the subsequent spring following closure.

5.2.4 Study 9: Fish Mortality due to Dissolved Oxygen Depletion

Purpose

Fish likely will utilize the LMOC once it is wetted, but may be susceptible to oxygen depletion during periods of ice cover when the channel is non-operational. Similarly, fish likely will remain in pools upstream of drop structures in the LSMOC after channel operations cease. Results of DO monitoring planned to be conducted in the LMOC and LSMOC (see Study 2) will be examined to determine whether oxygen levels are sufficient to support fish during winter when the channels are not being operated. If low oxygen conditions are observed during winter, monitoring is planned to be conducted to determine whether fish mortality is occurring and to document the number and species of fish that may vulnerable to mortality.

Monitoring Frequency

Monitoring frequency will be determined based upon results of DO monitoring planned to be conducted in Study 2. Planned monitoring frequency for Study 2 is as follows:

- during POC commissioning;
- during the first two years of non-operation following commissioning of the channels;
- during years subsequent to channel use for the first two operational periods; and
- additional monitoring may be required if the LSMOC is not operated for an extended period of time (five years or more). The timing of this monitoring will depend on observed DO and habitat conditions in the channels.

Field and Laboratory Methods

Shoreline searches for fish mortalities in LMOC will be conducted by boat immediately after ice break up if ice conditions permit. If ice cover precludes the use of a boat, searches will be conducted by foot. Searches will focus on areas within the LMOC where recorded DO conditions were lowest, but other representative areas along the channel will also be searched.

Fish surveys will also be conducted during spring and fall to document the numbers and species of fish potentially vulnerable to mortality. Fish will be captured using a combination of methods including boat electrofishing and gillnetting.

Shoreline searches in the LSMOC will be conducted by foot immediately after ice break up in spring. Searches will focus along the banks of representative pools where DO has been monitored (see Study 2) and are known to contain fish (see Study 8).

Fish surveys will also be conducted during spring to document the numbers and species of fish that overwintered within the pool. Fish will be captured using a combination of methods backpack electrofishing and gillnetting.

Parameters

The occurrence, distribution, abundance, and distribution of fish mortalities will be recorded. Fishing effort and biological parameters of captured fish (length, weight, state of sexual maturity, ageing structures) will be recorded.

Data Analysis

Counts of fish mortalities will be tabulated by species and location. Fish survey data will be tabulated by fish species and sampling location. Biological information for each species will be summarized.

5.2.5 Reporting

Reports would be produced for each study year that document the methods and results of fish stranding and mortality investigations conducted at the LMOC and LSMOC (Studies 8 and 9). DO data collected as part of Study 2 would be included in the interpretation of results.

Analyses would include comparison of results with established benchmarks and consider the possible requirement to implement adaptive management.

5.3 Change in groundwater inflows to Lake St. Martin

5.3.1 Rationale

Construction of the LMOC has the potential to affect local groundwater discharges within 3 km to 5 km of the channel. A reduction in groundwater discharge to Birch Bay on Lake St. Martin could reduce the suitability of the bay for Lake Whitefish spawning if groundwater upwellings are one of the factors influencing Lake Whitefish spawning habitat suitability, spawning success, and egg survival. Anecdotal information provided by local fishers suggests that Lake Whitefish do not spawn in Birch Bay, but baseline studies for the POC project have reported adult whitefish occurring in Birch bay during fall. Supplemental studies initiated during fall 2020 (Lake Whitefish telemetry) may provide further insight into whitefish use of Birch Bay. Although it is not known whether groundwater upwelling is linked to Lake Whitefish reproductive success in Lake St. Martin, monitoring is needed to document whether the success of Lake Whitefish reproduction is affected by construction of the LMOC. Although potential groundwater effects are expected to be limited to the southernmost portion Birch Bay, monitoring is planned to be conducted throughout Lake St. Martin to provide a reference for changes that might be observed in Birch Bay.

5.3.2 Approach

Study Overview

One study is planned to assess potential effects of changes to groundwater inflow in Birch Bay:

- **Study 10:** The success of Lake Whitefish reproduction in Lake St. Martin, including Birch Bay, will be determined by monitoring the distribution and abundance of larval whitefish within the lake. The occurrence of whitefish larvae will be considered an indicator of successful egg incubation.

Baseline Information

Information describing the abundance and distribution of larval fish in Lake St. Martin includes the following:

- data collected during spring 2012-2014 in the north basin as part of LSMEOC monitoring;
- data collected during spring 2016 in the south basin as part of LMBLSMOC baseline data collections; and
- data collected during supplemental studies proposed for 2021 and 2022.

Identification of Benchmarks

Benchmarks will be based on the presence/absence of larval Lake Whitefish, compared to pre-Project conditions and an index of abundance.

Adaptive Management

If the groundwater monitoring program indicates that groundwater discharge is not changed, then the larval monitoring program may be reduced. If a reduction in larval distribution is noted and no change to groundwater is recorded, then other possibly pathways of effect will be examined.

5.3.3 Study 10: Effects to Lake Whitefish Egg Incubation

Purpose

Monitoring is planned to be conducted to determine whether operation of the LMOC affects Lake Whitefish reproductive success within Birch Bay. Larval Lake Whitefish are planned to be sampled at several locations in Lake St. Martin to provide context for observed catches in Birch Bay.

Monitoring Frequency

Supplemental data collections are planned to occur during 2021 and 2022 to establish baseline conditions. If larval Lake Whitefish are found in Birch Bay, then additional monitoring will be conducted during the first two years of non-operation after channel commissioning to determine whether Lake Whitefish continue to spawn in Birch Bay.

Field and Laboratory Methods

Larval fish will be collected from the surface waters of Lake St. Martin using a neuston sampler. Volume of water filtered by the sampler will be measured to allow for the calculation of larval fish densities.

Sampling will occur immediately after ice break up, a period when larval whitefish have very recently hatched, are poor swimmers, and are generally associated with the surface of the water column.

Although the Birch Bay area of Lake St. Martin is the most likely area to be affected by changes to groundwater discharge, larval fish sampling will be conducted through the north and south basins to provide comparison of larval catches from Birch Bay area with other areas of the lake.

Samples will be preserved in the field. Fish larvae will be sorted and identified by species in the laboratory.

Data Analysis

Larval fish catches will enumerated by species, sample, and sampling location. Larval Lake Whitefish (and other species) densities will be calculated for each sample site and sampling area. Comparison between sampling areas and sampling years will be provided. Baseline data will be compared with post-construction data to determine whether a change in Lake Whitefish reproductive success has occurred.

5.3.4 Reporting

Reports would be produced for each study year that document the methods and results of the larval Lake Whitefish study (Study 10). Analyses would include comparison between pre and post commissioning periods.

5.4 Effects related to changes in flow

5.4.1 Rationale

Construction and operation of the LMOC and LSMOC will result in a change in flow patterns in the Fairford River, Dauphin River and local tributaries to Lake St. Martin (Birch Creek) and the Dauphin River (Buffalo Creek). Flow changes include the following:

- reduction of flows in the Fairford and Dauphin rivers during periods of channel operation;
- creation of a new inflow in Lake St. Martin due to operation of the LMOC;
- creation of a new inflow in Sturgeon Bay due to operation of the LSMOC; and
- reduction in flows in the Birch Creek and Buffalo Creek drainages.

Although fish are expected to be attracted to the LMOC and LSMOC outfalls, effects are expected to be negligible during spring when flows in the Fairford and Dauphin rivers will remain near naturally occurring spring flow conditions. Lake Whitefish are known to move up both the Dauphin and Fairford rivers in fall to spawn. Operation of the POCs during fall may reduce fall spawning movements of Lake Whitefish into these rivers due to reduced flows and possible attraction to the outfalls of the POCs.

The reduction in flows in the Buffalo Creek system is not expected to have a marked effect on species important to fisheries, as the creek provides only limited habitat for these species. Birch Creek provides spawning habitat to both Walleye and sucker, with a commercial sucker fishery occurring within the creek

itself. The extent to which spring fish use would be affected by a reduction in flow due to construction of the LMOC is not known.

Monitoring is needed to:

- determine the extent to which fish use habitat provided by the LMOC and LSMOC outlets in spring and fall during periods of operation;
- determine the extent to which, if any, operation of the channels reduces fall Lake Whitefish movements into the Dauphin and Fairford rivers; and
- determine the extent to which use of Birch and Buffalo creeks is affected by flow reductions in the respective drainages.

5.4.2 Approach

Study Overview

Three studies are planned to address the effects of changes in flow on fish use of habitats:

- **Study 11:** Investigations will be conducted to determine the extent to which fish are attracted to and utilize habitat in channel outflow areas during periods of channel operation. Emphasis will be placed upon use of those areas for spawning.
- **Study 12:** Investigations will be conducted to determine the extent to which, if any, operation of the channels reduces fall Lake Whitefish spawning movements into the Dauphin and Fairford rivers.
- **Study 13:** Investigations will be conducted to determine the extent to which, if any, reduction in flow affects fish use of Buffalo and Birch creeks.

Baseline Information

Data describing fish use of habitats in the LMOC and LSMOC are planned to be collected following channel construction.

Baseline data describing Lake Whitefish movements and spawning includes:

- data collected during LSMEOC monitoring to document the spring occurrence, abundance and distribution of larval fish in the north basin of Lake St. Martin (2012-2014);
- data collected during LSMEOC monitoring to document the location and the extent to which of Lake Whitefish spawned in the lower Dauphin River (2011-2014);
- data collected during LMBLSMOC baseline studies to document the spring occurrence, abundance and distribution of larval fish in Lake St. Martin (2016-2018);
- supplemental studies conducted in fall 2020 to document the timing and magnitude of whitefish movements through the Dauphin River (use of split-beam hydroacoustics to obtain fish counts and acoustic telemetry to track tagged whitefish), Lake St. Martin and the Fairford River (acoustic telemetry to track tagged whitefish);
- supplemental studies conducted during fall 2020 to document the species occurrence and abundance of fish in the Fairford and Dauphin Rivers; and

- additional supplemental data will be collected in 2021 and 2022 as described below.

Baseline data describing fish use of Birch Creek is limited:

- aquatic habitat survey conducted in fall 2015 and spring 2016;
- brief site visits conducted in spring 2018 and spring 2020;
- potential local knowledge from operator of a fish trap on Birch Creek; and
- additional data proposed to be collected in spring 2021, as described below.

Baseline data describing fish use of the Buffalo Creek drainage was collected prior to and during EOC operation and includes:

- spawning investigations conducted from fall 2011 to spring 2015, including collection of fish eggs, larval fish and spawning adults;
- fish utilization studies of Buffalo Creek prior to and following the 2011/2012 EOC operation (2011-2014);
- fish utilization studies of Buffalo Creek during EOC operations (2012-2015);
- fish utilization studies of Big Buffalo Lake prior, during, and following EOC operations (2011-2015; Big Buffalo Lake was not sampled following the 2014/2015 EOC operation);
- a brief site visit was conducted during fall 2020; and
- additional data, to describe fish use following changes in habitat (in particular the loss of beaver dams preventing access from the Dauphin River) as a result of the EOC operation, is planned to be collected in spring 2021, as described below.

Identification of Benchmarks

Early warning triggers (i.e., a statistical difference between pre and post Project) for the number of Lake Whitefish migrating up the Fairford and Dauphin rivers in fall will be developed based on work planned to be conducted in 2020-2022 and include comparison of fish counts and results of fish sampling (primarily boat electroshocking). Studies conducted during operation of the EOC will be used to supplement the recent data. Preliminary results of the 2020 field program suggest that fish movements in the Dauphin River may vary depending on discharge in the river, such that movements documented during flood conditions may be different from non-flood years.

Management thresholds with respect to fish attraction to the channel outlets will be developed based on an understanding of the proportion of fish affected in comparison to the total population, and the magnitude of change that can occur prior to the potential for an adverse effect. For example, a potential threshold could be based on the percentage of Lake Whitefish attracted to the LSMOC outlet in comparison to number migrating in the Dauphin River.

Early warning triggers for fish use of Birch and Buffalo creeks will be developed following the planned collection of supplemental information from the creeks during spring 2021. It is thought that triggers may be based largely on presence/absence as usage is expected to be highly variable depending on seasonal and inter-annual differences in flow.

Adaptive Management

The need for measures to reduce attraction into the channels will be determined in consultation with regulators, if monitoring suggests that adverse effects to fish populations may occur.

The need for measures to improve conditions in the creeks will be determined depending upon the extent of observed effects.

5.4.3 Study 11: Fish Utilization of the LMOC and LSMOC Outlets

Purpose

The extent to which fish will utilize habitat provided in the outflow from the LMOC and the LSMOC are planned to be monitored during periods of channel use.

Monitoring Frequency

Monitoring is planned be conducted during commissioning and during the first two periods of channel operation.

Field and Laboratory Methods

Sampling will be conducted downstream of the control structure at the LMOC and downstream of the final drop structure on the LSMOC.

A suite of sampling methods will be used to document fish occurrence and habitat use within the channel outflows. Fish capture methods will be based on site conditions (e.g., flow and water velocity) but it is expected that a combination of methods including boat electrofishing, gill nets or hoop nets will be used.

Habitat use will focus on spawning (i.e., are fish spawning in the outflows). The occurrence and success of spawning in outflow areas will be documented by the collection of fish eggs (egg mats) during spring and/or fall and larval fish (drift traps) during spring. Larval fish will also be collected from channel inlets to determine whether larval fish collected in outflow areas originated from upstream areas. Water velocity will be measured at drift trap mouths to estimate the volume of water filtered between sample collections.

The timing of the spawning-related activities to be documented will dictate the timing of studies. For example, during spring, larval Lake Whitefish hatch shortly after ice off, adult Walleye move to spawning areas and begin to spawn concurrently or shortly thereafter, and larval Walleye hatch about 2-3 weeks after spawning occurs. During fall, Lake Whitefish and Cisco begin to congregate prior to spawning as temperatures decrease below about 8°C, with actual spawning occurring at temperatures ranging from 0-5°C. Consequently, a series of short-duration field campaigns (2-4 days) will be conducted at two week intervals during spring and/or fall during each monitoring period to provide snapshots of biological activity over a broader time period, allow field investigations to target specific biological occurrences, and document general spring and fall fish activity and habitat use as the season progresses.

Fish eggs and captured larval fish will be preserved in the field for subsequent enumeration and identification in the laboratory.

Parameters

Adult and juvenile fish will be identified to species, measured and examined to determine sex and state of spawning condition.

Eggs and larval fish will be identified and enumerated by species and sampling location.

Data Analysis

Adult and juvenile fish data will analyzed by location (e.g., LMOC inlet) to describe the fish species, size of fish and spawning status of fish using outflow habitat during spring and fall.

Fish egg data will be used to provide descriptions of where spawning may have occurred at each location.

Larval fish occurrence and abundance data will be used to examine where spawning may have occurred (channel inlet vs outfall areas) and spawning success.

5.4.4 Study 12: Lake Whitefish Spawning

Purpose

Investigations are planned to be conducted to determine the extent to which, if any, operation of the channels affects Lake Whitefish spawning in the Dauphin River, Lake St. Martin, and Fairford River. Large numbers of Lake Whitefish have been shown to move into the Dauphin River to spawn and supplemental studies conducted during fall 2020 have shown that large numbers of Lake Whitefish in pre-spawn condition ascended the Fairford River to the Fairford River Control Structure (see Figure 1). Whether Lake Whitefish spawning occurred at that location will be determined during spring 2021.

The potential effects of channel operation on Lake Whitefish spawning are planned to be examined by:

- Monitoring the magnitude and timing of fall whitefish movements into the Dauphin and Fairford rivers during periods of non-operation and operation.
- Monitoring the occurrence and density of Lake Whitefish larvae in Lake St. Martin, and the Dauphin and Fairford rivers during the subsequent spring.

Monitoring Frequency

Supplemental studies are planned to be conducted during 2021 and 2022 to further establish baseline conditions.

Additional monitoring are planned to be conducted during and in years subsequent to the first two operational periods.

Field and Laboratory Methods

Magnitude and Timing of Adult Fall Movements

Fall Lake Whitefish movements into the Dauphin River will be monitored using split-beam hydroacoustic technology. A "receiver station" will be installed in the Dauphin River near Sturgeon Bay and will remain in place for the duration of the fall spawning run (September-October).

The use of split-beam hydroacoustic technology provides an enumeration of fish movement past the receiver station by direction and size, but does not identify fish to species. Periodic fish sampling will be required to determine fish species moving through the channels and assist in analysis of hydroacoustic data. Boat electrofishing will be used capture fish.

The method by which fall Lake Whitefish movements into the Fairford River will be enumerated has not yet been determined. Split-beam hydroacoustic technology may be used, but shallow water in the Fairford River may preclude the use of this technology. Alternate approaches may include the use of a fish counting fence or hoop nets to capture upstream migrants. Sampling in the Fairford River would occur over the same period as at the Dauphin River (September-October) and at a location just upstream of Lake St. Martin.

An alternate approach to the use of split beam hydroacoustics may be to use boat electrofishing to assess the timing and magnitude of fall whitefish movements as was done in the LMEOC studies in 201-2015 and Fairford River supplemental study in fall 2020. This method does not provide a total count of migrants but electrofishing catch-per-unit-effort provides a means for comparison of fish abundance between sampling sessions and years. Upon completion of initial split-beam hydroacoustic studies, consideration may be given to using boat electrofishing as a means of monitoring over the long term.

Larval Whitefish Occurrence and Density

Larval whitefish will be collected from the Fairford River, Lake St. Martin and the Dauphin River. Sampling will occur shortly after ice break up, a period when larval whitefish have very recently hatched, are poor swimmers, and are generally associated with the surface of the water column.

Larval whitefish fish will be collected from the Dauphin and Fairford rivers using drift traps comparable to those used during LSMEOC monitoring.

Larval whitefish will be collected from the surface waters of Lake St. Martin using a neuston sampler. Sampled areas will include the north and south basins of the lake. These data will also supplement larval whitefish information that are planned to be collected during Study 10.

Neuston and drift trap samples will be preserved in the field. Fish larvae will be sorted and identified by species in the laboratory.

Parameters

Data collected with the split-beam hydroacoustics will include daily counts of fish moving upstream and downstream past the receiver station and size estimates for fish moving past the station.

Fish captures using fish counting fences and hoop nets (if these methods are used) will provide species identification, additional size data, and information describing the spawning condition of migrating fish.

Fish captured by boat electrofishing will provide species identification, additional size data, and information describing the spawning condition of migrating fish that will be used to assist in interpretation of the split-beam hydroacoustics. In addition, electrofishing catch-per-unit-effort will provide another means of comparing fish abundance between locations and years.

Larval whitefish densities will be estimated based upon the catch and the volume of water sampled by the drift traps or the neuston sampler.

Data Analysis

Hydroacoustic and fish capture data will be analyzed to provide daily counts of the number and size of fish and an estimate of the species composition of moving into the Dauphin River during fall.

Numbers of Lake Whitefish in the Fairford River will be based on fish counting fence, hoop net or electrofishing surveys.

Larval whitefish data will be analyzed to provide an enumeration of larvae occurrence in Lake St. Martin and the Dauphin and Fairford rivers during each sampling year.

Adult fish movements and larval densities in subsequent year will be compared between periods of channel non-operation and operation.

5.4.5 Study 13: Fish utilization of Birch Creek drainage and Buffalo Creek drainage

Purpose

Investigations are planned to be conducted to determine the extent to which fish continue to use habitat in Birch and Buffalo creeks following reductions in flow after construction of the POCs.

Monitoring Frequency

Supplemental studies are planned to be conducted during 2021 and 2022 to establish baseline conditions.

Additional monitoring are planned to be conducted during the first two springs following commissioning.

Field and Laboratory Methods

Fish will be collected from selected representative locations in Birch and Buffalo creeks.

Sampling methods will be determined by site conditions. It is anticipated that a combination of sampling methods will be used, likely including back pack electrofishing and hoop nets.

It is anticipated that monitoring will be comprised of several short sampling sessions per sampling year to maintain effort at a reasonable level while providing sampling coverage throughout spring. This is to account for the timing of spawning-related movements of large bodied fish into the lower creek reaches during spring and to examine change in fish abundance as flow recedes following the spring freshet.

Parameters

At each sampling location, captured fish will be enumerated by species, measured for length and weight, and information describing their spawning condition will be noted.

Sampling effort will be recorded for each sampling location.

Data Analysis

Analyses will include the calculation of relative abundance and catch-per-unit-effort (CPUE) for each species and for each location.

Comparison of site-specific fish use metrics (relative abundance, CPUE) will be provided between baseline conditions and following flow reduction.

5.4.6 Reporting

Reports would be produced for each study year that document the methods and results of the fish use of channel study (Study 11), Lake Whitefish spawning investigations (Study 12), and fish use in the Birch and Buffalo Creek system study (Study 13).

Analyses would include comparison of results with established benchmarks, ascertain whether observed changes are project related and consider the possible requirement to implement adaptive management.

6.0 MERCURY IN FISH FLESH

6.1 Rationale

Inundation of organic materials can increase the activity of bacteria that convert inorganic to organic mercury (i.e., methyl mercury). Methylmercury can be taken up by aquatic organisms and passed up the food chain as smaller organisms are consumed by larger ones. Mercury bio-accumulates, i.e., becomes more concentrated in organisms higher up the food chain. Elevated concentrations of mercury in fish flesh can lead to human health concerns if fish is a large part of the diet. Although it is expected that the Project will not result in increased mercury concentrations in fish, this parameter is planned to be monitored to address community concerns.

6.2 Approach

6.2.1 Study Overview

Mercury in fish is planned to be addressed in one study:

- **Study 14:** Mercury concentrations in the flesh of fish from Lake Manitoba, Lake St. Martin and Sturgeon Bay will be monitored to determine if mercury concentrations increase and, if so, determine if it may be related to the Project.

6.2.2 Baseline Information

Total mercury concentration data was collected as part of LSMEOC monitoring and as part of baseline studies for the Project. Supplemental data were collected in fall 2020 and additional fish will be analyzed for mercury in 2021.

6.2.3 Benchmark

The benchmark for the fish mercury monitoring program will be the baseline total mercury concentration in Walleye, Northern Pike, and Lake Whitefish from Lake Manitoba, Lake St. Martin and Sturgeon Bay. If there is a statistically significant increase in mercury concentration then an appropriate management threshold would be identified in consultation with regulators.

6.2.4 Adaptive Management

If mercury concentrations significantly increase following operation of the channels, appropriate responses will be determined in consultation with regulators.

6.3 Study 14: Fish mercury concentration monitoring

6.3.1 Purpose

Mercury concentrations in the flesh of fish from Lake Manitoba, Lake St. Martin and Sturgeon Bay are planned to be monitored to determine if a change in mercury concentrations occur and, if so, determine if it is related to the Project.

6.3.2 Monitoring Frequency

Mercury monitoring is planned to be conducted following commissioning of the channels. Subsequent mercury monitoring may be conducted after channel operation, generally in conjunction with fish community sampling on Lake St. Martin (see Study 5).

The time frame over which mercury concentrations continue to increase in fish following changes to the aquatic environment can be up to five years (i.e., period before peak concentrations are reached). Consequently, additional sampling are planned to be conducted periodically during the five years following commissioning and the first two channel operations. Effort would be made to conduct these investigations as part of other ongoing studies or through the purchase of fish from the commercial fishery. A dedicated field program to collect mercury samples would be conducted if appropriate samples could not be obtained through other means.

During years mercury monitoring is planned to be conducted in Lake St. Martin, mercury samples will be collected from Sturgeon Bay as part of the CAMP program.

6.3.3 Field and Laboratory Methods

Tissue samples will be collected from a length-stratified sample of Walleye, Northern Pike, and Lake Whitefish for mercury analysis. The following biological variables will be collected at the time of muscle sampling for each fish: length, weight, sex, and maturity status, and ageing structures.

6.3.4 Parameters

Parameters measured will include fish length, weight, age and total mercury.

6.3.5 Data Analysis

To reduce the effect of fish size/age and to facilitate comparisons over time, mean mercury concentrations will be standardized to a common fish length. These standard means will be calculated from unique regression equations, by species and waterbody, based on the analysis of logarithmic transformations of muscle mercury concentration and fork length.

6.4 Reporting

Reports would be prepared in the year after sample collection. Results will be discussed in relation to fish species and waterbody and comparisons will be made to baseline mercury concentrations.

7.0 SCHEDULE

The frequency and timing at which each of the AEMP monitoring programs is planned to be conducted relative to Project commissioning and operation are presented in Table 4.

Annual work plans are planned to be developed prior to each open water season when monitoring is required or anticipated to be required based on flood projections, considering the results of the previous studies and status of operation/non-operation of the LMOC and LSMOC. If benchmarks were exceeded in preceding monitoring year and the need for adaptive management (including modifications to the monitoring program, development and implementation of additional mitigation) was identified, then monitoring activities would be adjusted accordingly.

Reporting of the results of each monitoring program would be completed prior to the start of the following field season such that results can inform activities to be implemented in that year.

An initial summary report describing water quality, habitat, and fish in the outlet channels and Birch Creek and Buffalo Creek after the channels have been commissioned and prior to the first operation for flood management (unless operation occurs immediately) will be prepared to document conditions in the channels and creeks and provide assurance that conditions are suitable for the survival of fish.

A summary report would be prepared after the first cycle of operation and three years of post-operation monitoring to document effects of operation and whether conditions in the channels are suitable for the survival of fish that may have moved into the channels during operation. This report would indicate whether unanticipated effects are occurring and modification of the mitigation measures is required.

Table 4: Schedule of monitoring planned to be conducted for the Aquatic Effects Monitoring Program

Study	Supplemental Data[4]		Commissioning[5]	Post-Construction				
	2021	2022		Non-Operation	First Operation		Second Operation	
					Operation	Post Operation	Operation	Post Operation
1. Surface Water Quality			x		x	x	x	x
2. Dissolved Oxygen			x	x		x		x
3. TSS			x		x	x	x	x
4. Aquatic Habitat			x			x		x
5. Fish Community Monitoring (Lake St. Martin)	x	x				x		x
5. Fish Community Monitoring (Sturgeon Bay) [1]	x	x	x	x	x	x	x	x
6. Adult and Juvenile Fish Movements in POC			x		x		x	
7. Larval Fish Movements	x	x	x		x		x	
8. Fish Stranding at the LSMOC			x			x		x
9. Fish Mortality in the LMOC [2]			x	x				
10. Lake Whitefish Egg Incubation [3]	x	x		x				
11. Fish Utilization of the LMOC and LSMOC			x		x		x	
12. Lake Whitefish Spawning	x	x	x		x	x	x	x
13. Fish Use of Birch Creek and Buffalo Creek	x	x	x					
14. Mercury in Fish Flesh			x			x		x

1. Sturgeon Bay fish populations will be monitored annually as part of CAMP
2. To be conducted if DO levels in LMOC are too low to support fish during periods of non-operation
3. Requirements for post-construction monitoring will be based upon results of ground water monitoring
4. Aquatic monitoring proposed for construction is discussed in the Surface Water Management Plan, Groundwater Monitoring Plan and Sediment Management Plan for the Project.
5. Studies conducted during commissioning may be adjusted depending on timing and flows.

APPENDIX 1

Summary of Effects and Monitoring

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
Water Quality			
Changes to local and regional flows	Construction of the LMOC and LSMOC will re-route a portion of the flood flows from the Fairford and Dauphin rivers. Given that flood waters currently pass from Lake Manitoba to Lake St. Martin to Sturgeon Bay, no changes in water quality are predicted. Similarly, redirection of some groundwater flows is not expected to affect overall water quality as groundwater currently discharges into Lake St. Martin and Lake Winnipeg.	Monitoring of water quality will occur at key points along the diversion route and in existing waterways during channel operation.	Study 1: Surface Water Quality Monitoring
Change in sediment concentrations	During construction, implementation of control measures is expected to minimize the amount of sediment that will be mobilized; however, additional suspended sediments may be present in the waterways. The channels are also being designed to minimize erosion; however, during initial operation of the channels, increased concentrations of TSS may occur at the outlets of the channels and receiving waterways (in Birch Bay and Sturgeon Bay). It should be noted that the amount of TSS in regional waterways is expected to be less than the amount of sediment that would be mobilized if natural flooding was occurring (i.e., the channels were not in operation).	Sediment monitoring will be conducted during instream construction and is discussed further in the Surface Water Management Plan. Turbidity and TSS monitoring will be conducted during commissioning and the two initial periods of channel operation to estimate the total loads of sediment deposited in Lake St. Martin and Sturgeon Bay.	Study 2: TSS Monitoring
Under low or no flow conditions, low	During periods when the channel is not in operation, dissolved oxygen concentrations in the channels may decrease.	Monitor DO in summer and winter to determine whether DO	Study 3: DO Monitoring

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
concentrations of dissolved oxygen in the constructed channels and a further reduction in dissolved oxygen in Birch and Buffalo creeks.	The reduction in flows in the Birch Creek and Buffalo Creek drainages may exacerbate existing low DO conditions during summer and winter.	concentrations are sufficient to support fish.	
Effects to Fish Habitat			
Excavation of bottom substrates at inlet/outlets in Watchorn Bay, Birch Bay, north east basin of Lake St. Martin and Sturgeon Bay	Temporary disruption of inlet/outlet areas will cause a short term decrease in benthic invertebrate community until area re-colonized. Water depth will be increased but substrate type is not expected to be altered.	Aquatic habitat and benthic invertebrate monitoring will be conducted in conjunction with the channel monitoring. Fish use will also be recorded during spawning periods (see below).	Study 4: Channel habitat

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
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) may reduce suitability of spawning habitat to Lake Whitefish if they depend on groundwater inflows and if 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.	Supplemental 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, monitoring during operation will determine whether there is a loss of spawning habitat. Effects of reduced groundwater inflow in the Buffalo Creek drainage would be cumulative with changes in surface water flow.	Study 10: Effects to Lake Whitefish egg incubation Study 13. Fish Use of Birch Creek and Buffalo Creek
Construction of the project may result in the introduction of aquatic invasive species to Lake Manitoba and Lake St. Martin	Spiny water flea, zebra mussels and Rainbow Smelt are present in Lake Winnipeg but not in Lake Manitoba/Lake St. Martin. Given project design and Aquatic Invasive Management measures, no upstream expansion is anticipated.	None though presence would be noted during habitat and fisheries programs.	N/A

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
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. Habitat for large-bodied fish in these drains is marginal. 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. Water management at the LSMOC will include installation of culvert and gate systems on Creek C and two unnamed creeks, which will isolate approximately 40% of the inflow to the lower reaches of 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. 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. 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, including outlets, two years post-construction to confirm that conditions are suitable for fish. Monitoring of use by fish is described below. No monitoring of habitat in the 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.	Study 4: Channel habitat

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
Change in habitat due to the deposition of sediment	During construction, implementation of control measures is expected to minimize the amount of sediment that will be mobilized; however, some additional sediment will be deposited in Lake Manitoba, Lake St. Martin and Lake Winnipeg. The channels are also being designed to minimize erosion; however, 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. 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.	Sediment monitoring will be conducted during instream construction as described in the Surface Water Management Plan and Project Environmental Requirements. Turbidity and TSS monitoring will be conducted during commissioning and the two initial periods of channel operation to estimate the total loads of sediment deposited in Lake St. Martin and Sturgeon Bay. Analysis of sediment particle size will be conducted if substantially greater than predicted amounts of sediment are mobilized.	Study 3: TSS monitoring
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.	None related to the fish and fish habitat. Reduction in flooding is the intent of the project.	N/A

Change in flow patterns in rivers and streams	Construction of the LMOC will isolate approximately 27% of the Birch Creek watershed on the west side of the channel. Similarly, water management at the LSMOC will isolate approximately 40% of the inflow to the lower reaches of Buffalo Creek. Flow reduction may affect fish use of the creeks. 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. However, operation of the channels will be conducted to maintain suitable conditions in these two rivers. 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. The inlets and outlets will be designed to support fish use that may occur, in particular if fish area attracted to spawn at the outlets during channel operation. Flow reduction at channel closure will be conducted such that fish are cued to leave the channels as flows are reduced at the end of operation periods.	Monitoring of fish use in Birch and Buffalo Creeks determine the extent to which fish continue to use habitat in those drainages following flow reductions. Monitoring of fish movements in the Fairford and Dauphin rivers will indicate whether fish continue to move up these rivers during fall spawning periods when the flow reduction could be greatest. Monitoring of fish spawning at the outlet structures will confirm that fish attracted to these areas are able to spawn successfully. Monitoring for stranded fish will determine whether flow reduction rates require adjustment such that additional fish emigrate as flows in the channels decrease or cease.	Study 13. Fish Use in Birch Creek and Buffalo Creek. Study 12. Lake Whitefish spawning Study 11: Fish use of the LMOC and LSMOC Study 8: Fish stranding in the LSMOC Study 9: Fish stranding in the LMOC
Change in Fish Passage			

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
Effects to fish passage due to installation/replacement of culverts	Stream crossings will be constructed to allow fish passage and not affect fish movements including use of clear span bridges, and embedding and appropriate sizing of culverts.	None, mitigation methods are well established	N/A
Change in fish movements between Lake Manitoba/Lake St. Martin/Lake Winnipeg due to creation of channels	Operation of the LMOC and LSMOC will provide corridors for the downstream movement of 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 and the design of the outlet for the base flow will reduce the number of fish entering the channel. The design of the LMOC will not allow passage past the water control structure during periods of non-operation 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). Managing the rate at which flows are changed in the channels will provide fish with cues that velocities are changing and enable fish to respond accordingly (i.e., move out of the channels).	Monitoring of active and passive (larval drift) fish movements in the channels and rivers during flood operation. Monitoring to determine whether there are overall changes in the fish community in Lake St. Martin. Monitoring to determine fish presence in the channels and whether they are able to leave safely.	Study 6: Downstream fish movements Study 7: Larval fish movements Study 5: Fish community Study 11: Fish use of the LMOC and LSMOC Study 8: Fish stranding in the LSMOC Study 9: Fish stranding in the LMOC

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
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. Large numbers of Lake Whitefish and Cisco migrated up the Dauphin and Fairford rivers in fall 2020. If fish are attracted to the outlets of the channels in spring or in fall, they may not successfully spawn. Effects mitigated by: • Changing flows in a specific manner to provide fish with cues the flows are decreasing so that they move out. • 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.	Study 6: Downstream fish movements Study 7: Larval fish movements Study 12: Lake Whitefish spawning Study 11: Fish use of the LMOC and LSMOC
Change in Fish Health and Mortality			

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
Accidental release of deleterious substances	Standard environmental protection measures will be implemented.	Measures are well established. If an accidental spill occurs, post clean-up monitoring will be conducted as per Project Environmental Requirements to confirm that the clean-up was successful.	N/A
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). The channels are also being designed to minimize erosion; however, 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. 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.	Turbidity and TSS monitoring will be conducted during instream construction as per the Surface Water Management Plan. Turbidity and TSS monitoring will be conducted during initial channel testing/commissioning immediately after construction and during the first two periods of operation to determine increases above background concentrations in relation to the guidelines for the protection of aquatic life.	Study 3: TSS monitoring

Project effect	Effect to aquatic environment, including mitigation and offsetting	Monitoring	Monitoring study reference
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 channels to contain pools that will provide over-wintering fish habitat.	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. Monitoring for stranded fish will determine whether the rate of flow reduction needs to be adjusted to allow additional fish to emigrate as flows in the channels decrease or cease. Inspect channels for fish kills in spring.	Study 11: Fish use of the LMOC and LSMOC Study 2: DO monitoring Study 8: Fish stranding in the LSMOC Study 9: Fish stranding in the LMOC
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. This increase will be managed via provincial fisheries regulations.	None	N/A
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.	Mercury concentrations will be monitored in fish from Lake St. Martin to address concerns of resource users.	Study 14: Mercury in fish flesh