LAKE MANITOBA LAKE ST. MARTIN

OUTLET CHANNELS PROJECT

MANITOBA INFRASTRUCTURE

Surface Water Management Plan

November 9, 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.

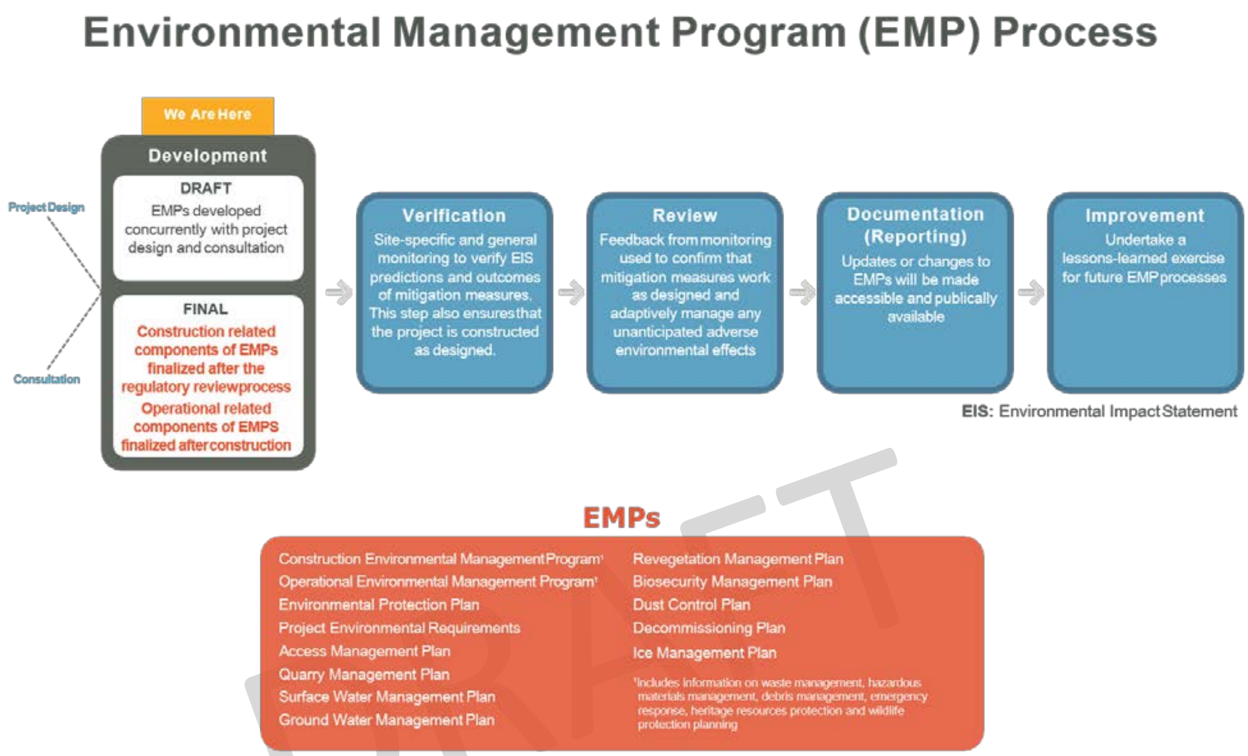
Manitoba Infrastructure (MI) is the proponent for the proposed Project. After receipt of the required regulatory approvals, MI will develop, manage and operate the Project. This Surface Water Management Plan is one component of the overall Environmental Management Program (EMP) framework which describes the environmental management processes that will be followed during the construction and operation phases of the Project. The goal of the EMP is to ensure that the environmental protection measures committed to in the Environmental Impact Statement (EIS) 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 the 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.

ENVIRONMENTAL MANAGEMENT PROGRAM PROCESS AND ASSOCIATED ENVIRONMENTAL MANAGEMENT PLANS



LAKE MANITOBA LAKE ST. MARTIN OUTLET CHANNELS PROJECT

GLOSSARY OF TERMS AND ACRONYMS

Acronyms

AEMP	Aquatic Effects Monitoring Plan
BMPs	Best Management Practices
CCME	Canadian Council of Ministers of the Environment
CEMP	Construction Environmental Management Program
DO	Dissolved Oxygen
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Program
EOC	Emergency Outlet Channel
GWMP	Groundwater Management Plan
ha	Hectares
IDF	Inflow Design Flood
LAA	Local Assessment Area
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
m	metre
m^3/s	cubic metres per second
mg/L	milligrams per litre
MI	Manitoba Infrastructure
MWQSOG	Manitoba Water Quality Standards, Objectives and Guidelines
OEMP	Operation Environmental Management Program
PAL	Protection of Freshwater Aquatic Life
Project	The Lake Manitoba and Lake St. Martin Permanent Outlet Channels Project
SMP	Sediment Management Plan
SWMP	Surface Water Management Plan
TSS	Total Suspended Solids

WCS Water Control Structure

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.

Aquifer: A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs.

Aquitard: A confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores groundwater.

Artesian: A body of rock or sediment containing groundwater that is under greater than hydrostatic pressure: that is a confined aquifer. When an artesian aquifer is penetrated by a well, the water level will rise above the top of the aquifer; a flowing artesian well is when the water level will rise above ground surface.

Baseline: Initial environmental conditions, prior to construction or anthropogenic actions.

Bedrock: The solid rock that lies beneath the soil and other loose material on the Earth's surface.

Carbonate aquifer: See Aquifer; see Carbonates. Refers to an aquifer comprised of a carbonate bedrock.

Carbonates: A rock made up primarily of carbonate minerals (minerals containing the CO3 anionic structure). Examples: limestone, dolostone, and marble (metamorphosed limestone or dolomite) are the most commonly encountered carbonate rocks.

Cofferdam: An enclosure, usually only partially obstructing a river, from which water is pumped to expose the bottom to permit construction.

Conductivity: A measure of the ability of a solution to conduct electrical flow; units are microSiemens per centimetre.

Confined aquifer: An aquifer that is bounded above and below by formations of distinctly lower permeability than that of the aquifer itself. An aquifer containing confined ground water. See artesian.

Depressurization: Action of decreasing hydrostatic pressure. Active depressurization involves the use of pumps. Passive depressurization does not involve the use of pump, but rather uses a relation between hydrostatic pressure elevation and topographic elevation.

Dewatering: Removal or draining groundwater or surface water from a riverbed, construction site, caisson, or mine shaft, by pumping or evaporation.

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.

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

Hydraulic profile: The graphical representation of the water level through the channel based on the water level of the receiving water, control points, and the head loss.

Hydrocarbon: A group of chemicals made up of carbon, hydrogen, and oxygen, including gasoline and oil.

Invert (channel): The stream bed or floor within a structure or channel.

Piezometric pressure: A measurement at a discrete location expressing the potentiometric surface which is an imaginary surface representing the pressure of groundwater in an aquifer that is defined by the level to which water will rise in a well.

Pool: A deep, slow-moving area of a stream; an artificially confined body of water above a dam or weir.

Recharge: Water added to an aquifer or the process of adding water to an aquifer.

Rip-rap: A lightweight stone covering used to protect soil or surface bedrock from erosion by water or the elements.

Runoff: The flow of flood waters out of a drainage basin.

Shoreline morphology: The outward appearance (shape, structure, color, pattern, size) of the narrow strip of land in immediate contact with the sea, lake or river.

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

Till: An unstratified, unconsolidated mass of boulders, pebbles, sand and mud deposited by the movement or melting of a glacier.

Turbidity: A measure of the relative clarity of water.

Water table: The upper surface of the zone of saturation in an unconfined aquifer.

Part 1: Introduction

1.0 PURPOSE AND SCOPE

The Surface Water Management Plan (SWMP) is a component of the overall Environmental Management Program (EMP) for the Lake Manitoba and Lake St. Martin Permanent Outlet Channel Project (the Project).

The purpose of the SWMP is to outline measures to be used to mitigate or avoid impacts to surface water during construction and operation of the Lake Manitoba Outlet Channel (LMOC) and the Lake St. Martin Outlet Channel (LSMOC). These include methods to manage local runoff, both inside and outside of construction areas, and the potential transport and deposition of sediments beyond construction areas and into off-site receiving water bodies. The SWMP also identifies preliminary monitoring requirements to confirm mitigations are effective and the process for identifying and implementing adaptive measures if they do not.

The SWMP is intended to be a living document that will be refined over the life of the Project and will be updated as preliminary and detailed design advances, incorporating applicable engagement feedback provided via regulatory review of the Environmental Impact Statement (EIS), landowners and/or Indigenous Groups.

At present, this document has been prepared to facilitate MI's consultations with stakeholders. The plan laid out is preliminary and will be updated once input from stakeholders is obtained.

Different surface water management strategies are required for the LMOC and the LSMOC as these distinct components of the Project are located in significantly different hydrologic settings. The LMOC, for example, is located in a well-developed agricultural area with an established drainage network, whereas the LSMOC is located in an undeveloped wetland and forested area. Furthermore, the strategies for handling local surface water drainage differ between the two channels as their specific designs impact on how surface water can be managed. Given these overarching site-specific differences, the SWMP is organized into three parts:

- Part 1 contains general information that is common to both the LMOC and LSMOC.
- Part 2 contains information that is specific to the LMOC.
- Part 3 contains information that is specific to the LSMOC.

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 Groundwater Management Plan (GWMP), Aquatic Effects Monitoring Plan (AEMP), a Sediment Management Plan (SMP) and an Ice Management Plan. Optimization of water quality monitoring objectives for the SWMP, considering those developed as part of the other environmental management and monitoring plans will be undertaken during detailed design with input from engagement processes and environment approvals, permits and licenses.

2.0 OBJECTIVES

The SWMP has been developed to address the following objectives:

- Control local surface water during and after construction of the LMOC and LSMOC.
- Reduce potential for erosion during and after construction of the LMOC and LSMOC and the transportation and deposition of sediments and pollutants beyond the project limits.
- Develop design details and identify Best Management Practices (BMPs) for control of water based on the current design status.
- Monitor surface water quality in the vicinity of the LMOC and LSMOC to verify that the measures implemented meet expectations and identify additional contingency measures in the event of emergency conditions or undesirable circumstances.

3.0 CRITERIA

The criteria for the SWMP is based on experience with other similar large-scale projects and will be reviewed prior to detailed design and updated, as required, considering project risks, costs and input from the environmental regulatory review process.

3.1 Water Quality Criteria

Water management controls will be designed to allow discharge into acceptable watercourses with the methods of containment, treatment and the discharge performed according to criteria outlined in the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) Regulation (Reg. 196/2011). Discharges from site will comply with applicable Canadian Council of Ministers of the Environment (CCME) and MWQSOG criteria and assessment process for the Protection of Freshwater Aquatic Life (PAL).

3.2 Design Criteria

3.2.1 Lake Manitoba Outlet Channel

For the construction phase, the water management controls related to the SWMP for the LMOC will be designed, constructed and maintained with sufficient capacity to manage precipitation and surface run-off without damage to the constructed works or delay to the project completion for a 1 in 10 year runoff event. This design event was selected to be similar to provincial standards typically applied for drainage in an agricultural setting. A larger, less frequent design event may be considered during detailed design to further reduce the construction risk, should it be cost effective. Additionally, to prevent soil erosion and discharge of sediment-bearing water runoff, erosion and sediment control measures will be designed, installed and maintained until construction is completed and vegetation has been established on disturbed areas. These measures are further described in the SMP.

For the operation phase, the permanent works related to the management of local surface water runoff for the LMOC will be designed as follows:

- The design discharge for the outside drain will be based on the 1 in 10-year runoff event from the contributing area west of the channel alignment. This event was selected to be similar to provincial drainage standards typically applied in an agricultural setting. These standards were originally developed to optimize the cost of construction with the long-term benefits of preventing agricultural damages in locations where the risk of flood damages to infrastructure (i.e. buildings) is negligible. A larger, less frequent design event may be considered during detailed design.
- The capacity of the outside drain may be augmented by incorporating overflow structures at a few locations to allow for excess water to overflow into the LMOC during large runoff events, thereby

further increasing the capacity of the drain and reducing the flood risk to the west of the LMOC. The design event to be considered for these structures will be determined during detailed design.

- Average velocities within the outside drain to be less than 1.0 m/s during the design runoff event, with appropriate erosion protection measures used in areas where hydraulic conditions exceed this criterion.
- The design of drainage crossing structures (i.e., culverts) will comply with MI Water Control & Structures' Structures Design Manual.

Since surface water in the vicinity of the LMOC is not being used for drinking, drinking water quality standards do not apply.

3.2.2 Lake St. Martin Outlet Channel

For the construction phase, the water management controls related to the SWMP for the LSMOC will be designed, constructed and maintained with sufficient capacity to manage precipitation, surface run-off, or wave action without damage to the constructed work or delay to the project completion for a runoff event or wind event with a return period of 10 years. The 10-year event falls within the range of what is typically adopted on other similar large-scale projects. Smaller, more frequent events may be considered at detailed design to reduce overall project costs if the resultant additional construction and environmental risks can be appropriately managed and mitigated. Additionally, to prevent soil erosion and discharge of sediment bearing water runoff, erosion and sediment control measures will be designed, installed and maintained until construction is completed and vegetation has been established on disturbed areas. This is further described in the SMP.

For the operation phase, the same criteria as that used for the construction phase will apply with the following variances:

- Within the channel, the LSMOC is designed to minimize the potential for bed erosion during operation at the discharge of 326 m^3/s. This is addressed in the preliminary design and therefore is not described in this SWMP.
- The design discharge for the outside drain is based on the 1 in 10-year runoff event from the contributing area east of the channel alignment. The design discharge was computed following MI's Transitional Method for determining design flows from small watersheds. Larger return periods will be considered at detailed design and the design criteria updated, as deemed necessary.
- Allowable shear stress within the outside drain will not exceed those adopted for the LSMOC, which is 10 Pa as determined during preliminary design.
- Flow from the outside drain will discharge into the LSMOC with drainage control structures. The structures will consist of one or multiple conduits sized to convey the 1 in 10-year runoff event without significantly increasing flood levels upstream of the structures. This event was selected to be similar to provincial standards typically applied in an agricultural setting. Those standards were originally developed to optimize cost of construction with the long-term benefits of preventing agricultural damages in locations where the risk of flood damages to infrastructure (i.e. buildings) is negligible. Since the LSMOC is located in an area with no pre-existing infrastructure, applying similar standards

were judged to be appropriate for this project. Flood volumes exceeding the capacity of the conduits will be allowed to temporarily "backwater" into the adjacent land without exceeding the top of the LSMOC dikes or damaging LSMOC infrastructure. An alternate option to discharge the outside drain directly into Lake Winnipeg instead of into the LSMOC will be considered during detailed design considering construction risks, costs and the environment.

- Allowing discharge across the LSMOC to maintain natural flow patterns from east to west towards Buffalo creek is not practical as it would require an aqueduct with pump station or a siphon and would be very costly to construct and maintain. As such, this is not a design requirement for this project and has been addressed separately as part of the EIS and the AEMP.
- Dissolved oxygen levels in the LSMOC should be maintained to minimum levels required to sustain fish habitat. This can be achieved by providing a base flow into the LSMOC through the water control structure. Minimum base flow requirements will be confirmed during detailed design with input from the environmental approval process.

Since surface and ground water in vicinity of the LSMOC is not being used for drinking, drinking water quality standards do not apply.

Part 2: Lake Manitoba Outlet Channel

4.0 PROJECT INFORMATION

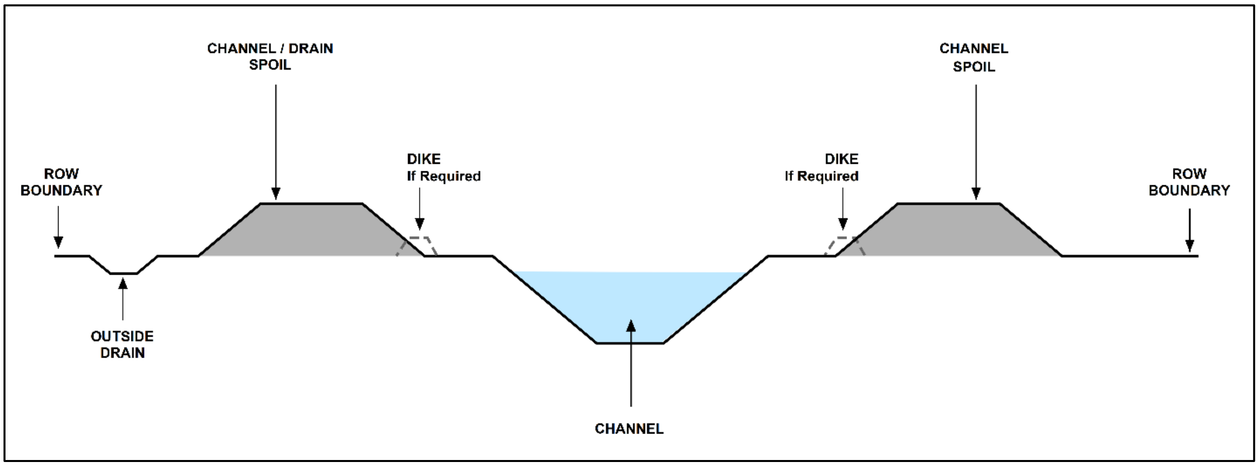
4.1 Project Description

The LMOC Project consists of an approximately 24 km long outlet channel, with the inlet positioned at Watchorn Bay on Lake Manitoba and the outlet on the west side of Birch Bay on Lake St. Martin, as shown in Figure 1. The LMOC is designed to convey a flow of 212 m^3/s (7,500 cfs) at a Lake Manitoba water level of 248.11 m (812.5 ft) and a Lake St. Martin water level of 244.14 m (801 ft).

Figure 1: LMOC Project Area

The proposed channel will have an invert elevation of about 242.1 m at Watchorn Bay and about 239.3 m at Birch Bay. The channel will have a trapezoidal shape with a flat base varying in width from 12 m to 22 m and side slopes varying between 4H:1V to 5H:1V. Embankment dikes will be constructed on both sides of the channel in areas where existing ground levels are low. Spoil berms will be located behind the dikes on either side of the channel which will also be used to gain access to the channel for maintenance. An outside drain will be constructed and located on the west side of the channel to collect surface water runoff originating from the west and convey it into Lake Manitoba and Lake St. Martin. Drainage overflow structures may also be incorporated to allow flows in the outside drain during high local runoff periods to discharge into the LMOC. A typical cross section of the channel is provided in Figure 2.

Figure 2: Typical Cross-Section of the Lake Manitoba Outlet Channel



Inlet and outlet works will be required to allow for a smooth transition of flow from Watchorn Bay into the channel and from the channel into Birch Bay. The hydraulic profile of the channel will require the lake bottom to be excavated at the channel inlet and outlet to match the proposed channel invert elevations. The excavations will be tapered over a short distance out from the shoreline to meet natural lakebed elevations.

A water control structure (WCS) will be constructed at Iverson Road (approximately 21 km downstream of the inlet) to control flows through the LMOC while ensuring that Lake Manitoba water levels remain within their normal operating range when use of the channel is not required. A bridge will be integrated into the WCS to provide access across the channel. The preliminary design of the WCS consists of three 5.4 m wide sluice bays with vertical lift gates, upstream and downstream stoplogs, and a stilling basin with chute blocks, baffle blocks and an end sill.

The LMOC will intersect provincial highways and municipal roads. Realignment of PR 239 is required in order to accommodate the LMOC while still allowing for safe, economically feasible, and hydraulically efficient structures across the channel. Various sections of municipal road will also be realigned or extended for the purposes of maintaining residential access and agricultural activities.

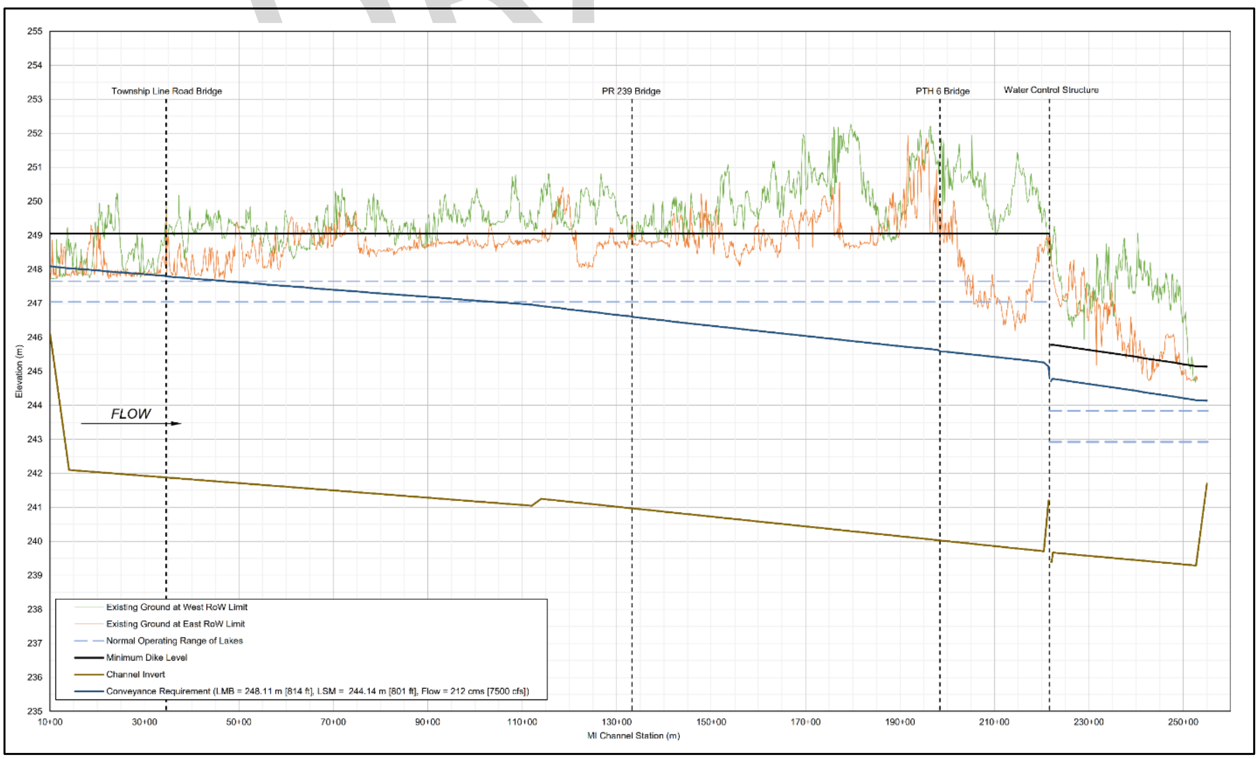
A total of four new bridges are planned to span the LMOC, of which one will be combined with the WCS as described above. The other three will be dedicated multispan bridges, constructed to maintain connectivity along the Township Line Road, realigned PR 239 (currently Carne Ridge Road) and PTH 6.

4.2 LMOC Operation

The LMOC will work in conjunction with the existing Fairford River WCS to regulate water levels on Lake Manitoba as established by the Operating Guidelines prepared for the Project. The LMOC will carry water directly into Lake St. Martin during periods when the water level on Lake Manitoba exceeds el. 247.65 m (812.5 ft), which is the top of its normal operating range.

The hydraulic profile for the LMOC is shown on Figure 3 for the normal operating range of the lakes (when the WCS gates are closed), as well as for the design conveyance condition of 212 m^3/s (7,500 cfs) in the channel with Lake Manitoba at el. 248.11 m (814 ft) and Lake St. Martin at el. 244.14 m (801 ft). Average velocities in the LMOC are expected to range between approximately 0.8 m/s and 1.0 m/s, with locally higher velocities occurring in the vicinity of the bridges and the WCS, during passage of the design conveyance condition.

Figure 3: LMOC Water Surface Profile



The LMOC is designed to be operated under both open water and ice covered conditions. The operation of the LMOC has been simulated by MI for a 103 year period from 1915-2017, based on historic lake levels and inflows. The simulation results indicate that the LMOC would have been used in 36 years over this period and been in operation for approximately 21% of the time on a daily basis.

4.3 Sequence of Construction

A preliminary construction sequencing plan is presently under development for the LMOC and will be provided in the preliminary engineering channel design report once it is complete. A brief high level overview of the general construction methodology is provided below.

4.3.1 Site Preparation

Site preparation will be the first activity to be undertaken, as it must be completed before construction can commence in all other work areas. This will include tree clearing, construction of drainage works, and establishment of bridge detours to facilitate bridge construction. Grubbing will not take place at the same time as tree clearing in order to minimize the risk of promoting the proliferation of invasive weed species, and thus will be part of individual construction contracts.

Tree clearing will be done in the winter months to avoid interference with the nesting window for migratory birds.

Permanent drainage to the west of the channel is needed in order to manage surface water runoff in the area and prevent it from flowing into the construction zones. Overland drainage from the west will be collected in a permanent outside drain located just to the west of the LMOC and routed to Lake Manitoba and Lake St. Martin. This drain will also be used to convey water from local construction dewatering and groundwater depressurization works along the LMOC.

Bridge detours would ideally be put in place during the construction season preceding bridge construction to avoid risk of delays.

4.3.2 Channel

The main consideration in the construction methodology and sequencing for the LMOC is managing the risks associated with basal heave and fracturing of the till aquitard, and/or slope instability, due to the high bedrock piezometric pressures that exist over the entire channel alignment. At present, it is anticipated that an active depressurization system will be used to lower the piezometric level in the vicinity of the LMOC to limit the risk of excavation basal heave during construction.

In order to reduce the required duration of active depressurization pumping, the construction methodology involves completing the channel excavation in several discrete segments that are separated from each other by a narrow natural land barrier (plug). Targeted depressurization pumping would then take place to lower the piezometric level within a particular segment and, once excavation of that segment is complete, that segment would be allowed to fill with water to restore weight to the till aquitard and thus no longer require active pumping to address basal heave risks.

Once excavation of each successive segment is complete, the plug that separates them would be removed. This will require flooding of the dry segment so as to equalize the water level on both sides of the plug, and thus prevent excessive erosive forces associated with the inrush of water that would otherwise occur into the dry segment when plug removal commences. Appropriate erosion and sedimentation controls, such as turbidity curtains, would be in place during the plug removal activities. A fish salvage will be required within the isolated area should fish be present.

Channel construction is envisioned to commence from each of the lakes and progress inland. This will allow each successively completed segment to then be opened to the lake, and thus use the lake water to restore weight to the till aquitard. At the upstream end, the work would be sequenced to allow construction activities for the inlet, Township Line Road bridge and the channel segment connecting them to be completed around the same time to allow this area to be opened to Lake Manitoba. Channel excavation segments would then be progressively advanced downstream towards the WCS, with the construction activities for the PR 239 bridge and PTH 6 bridge sequenced such that they are completed around the same time as the channel excavation segments at those locations. A similar strategy would be used at the downstream end of the LMOC where the channel excavation would be advanced from Lake St. Martin upstream towards the WCS. The channel segments around the WCS are likely to be the last sections to be excavated and these cannot be completed until construction of the WCS is complete.

Excavation activities within each segment are expected to advance in stages to further limit the duration of active depressurization pumping required, while managing the risks associated with basal heave and fracturing of the till aquitard. In general, initial excavation of a segment would be advanced to full width down to a level where the risk of basal heave is considered acceptable. This initial excavation would not require any depressurization pumping and thus could take place in either the winter or summer months. The remainder of the excavation within a segment would then be completed to the final geometry with active depressurization pumping in place, and ideally would be completed in the summer months so as to avoid the complications of having to pump and manage water in sub-freezing temperatures.

An alternate construction methodology is also under consideration that would involve limiting active depressurization to the bridges, water control structure, and potentially other discrete areas and accepting some risk of fracturing of the till aquitard. This would require a trench to be sub-cut into the base of the channel (below final grade) that would be backfilled with graded material to act as a filter. The trench would create a controlled path for groundwater seepage, as well as a location to divert and collect water that comes into excavation. This would greatly reduce the amount of depressurization pumping required and in turn, reduce the impacts to the regional groundwater system during construction.

4.3.3 Inlet and Outlet

It is presently assumed that construction of the inlet and outlet works will take place in the wet with the construction area isolated by a double turbidity curtain to prevent or minimize the migration of disturbed sediments into the lake. This work would take place in the summer, between July 1 and September 15, so as to be outside of the restricted spring (April 1 to June 15), summer (May 1 to June 30) and fall (September 15 to April 30) fish spawning windows. A fish salvage program will be required within the isolated area.

Alternate construction methods may also be considered, such as isolating the area with a cofferdam that would be constructed behind a turbidity curtain. In this case, only the construction and removal of the cofferdam would need to take place outside of the restricted spawning windows, however the overall construction time frame and impacted in-water area would be expected to be greater.

4.3.4 Bridges and Water Control Structure

Localized excavation and foundation preparation is required for the construction of the bridges and the WCS. It is expected that these work areas will be isolated from the rest of the channel with natural land plugs. These work areas would be kept small so as to limit the amount of pumping required to facilitate groundwater depressurization requirements and manage surface water runoff within the excavation. For the WCS, it is anticipated that pumping will need to continue for the full duration of its construction.

Detour roads will be established at each of the bridge locations and at the WCS to maintain traffic while those structures are being constructed.

5.0 SOURCES OF WATER

5.1 Surface Water

Surface water includes the runoff contribution from snowmelt and rainfall within the LMOC area (i.e., the excavated areas) as well as any additional runoff from outside of the LMOC area that naturally or artificially drains towards the LMOC.

Existing drainage in the region around the LMOC generally flows towards the lower lying area between Watchhorn Bay on Lake Manitoba and Birch Bay on Lake St. Martin. This low-lying area includes Watchhorn Creek, draining south to Lake Manitoba, with Reed Lake, Clear Lake, Water Lake, Goodison Lake and Birch Creek draining north to Lake St. Martin. The proposed LMOC will be located immediately to the west of this low-lying area and will block existing drainage paths flowing from the west.

Figure 4 shows the overall catchment area for the watershed (based on the latest LiDAR data), along with the delineation of the eight western sub-basins that will be blocked by the LMOC. The drainage areas and average slopes for these sub-basins are listed in Table 1. The total existing drainage area for Birch Creek is 295 km^2 and for Watchorn Creek is 93 km^2.

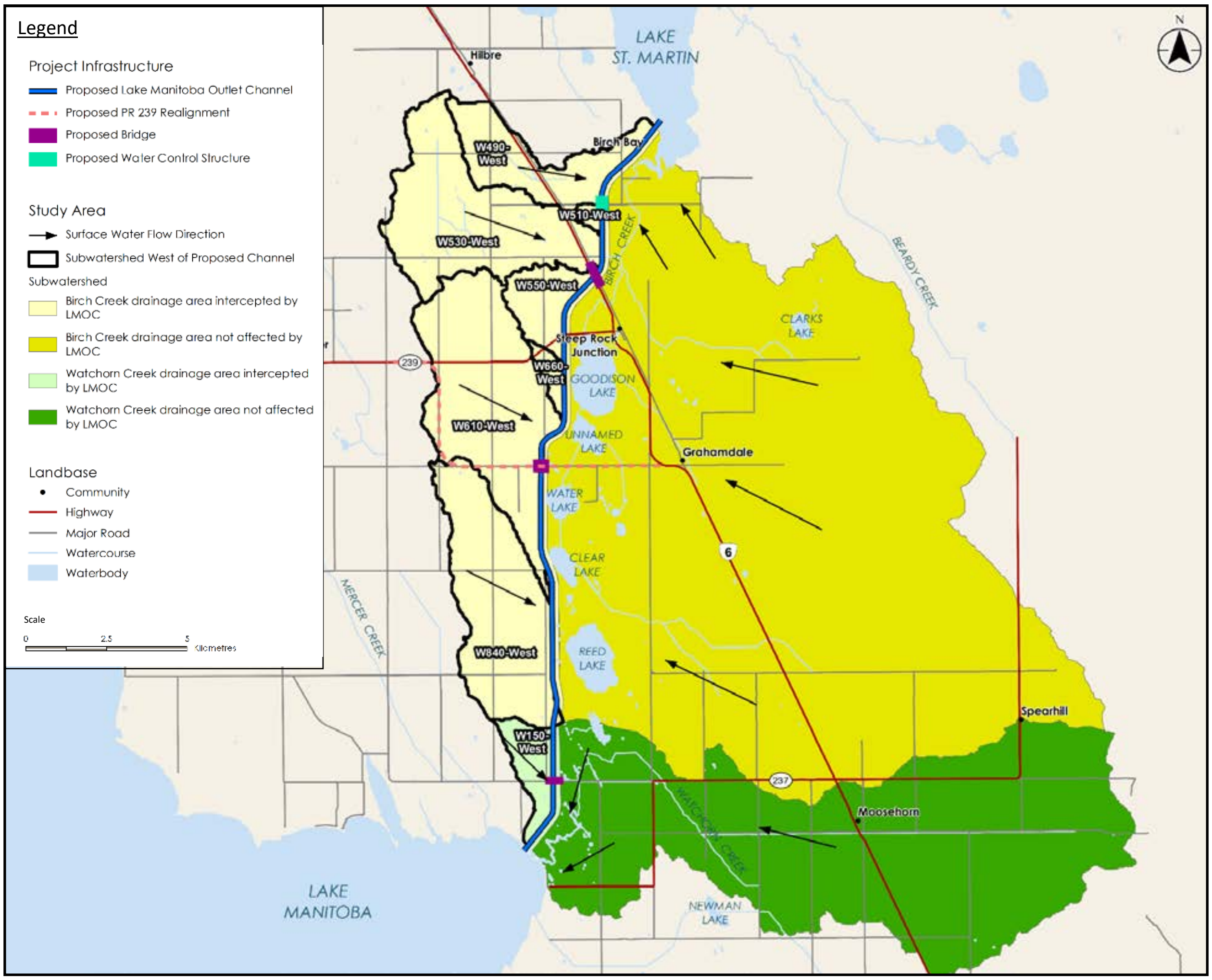
Table 1: Characteristics of Sub-Basins Blocked by the LMOC

Sub Basin Name	Drainage Area (km^2)	Average Sub-Basin Slope (%)
W150 - West	3.7	1.2
W490 - West	9.3	1.5
W510 - West	0.6	1.7
W530 - West	20.5	1.3
W550 - West	4.7	1.9
W610 - West	23.0	1.3
W660 - West	1.3	1.5
W840 - West	19.2	1.4

The blockage of surface water runoff by the LMOC will reduce the drainage area of Birch Creek and Watchorn Creek by 27% (to 217 km^2) and 4% (to 89 km^2), respectively. Quantification of the impacts to the reduction in drainage area will be undertaken in detailed design, as required, considering the other environmental management and monitoring plans that are being developed for the Project.

Surface water quality monitoring is currently underway to supplement existing datasets to further advance the understanding of surface water in the LMOC area. Water levels in the small lakes and wetlands along Birch Creek may also be monitored at select locations, which will be determined during the detailed design phase.

Figure 4: Surface Water Catchment Areas in Vicinity of the LMOC



5.2 Groundwater

The bedrock aquifers in the study area are composed of the Paleozoic rock sequence commonly referred to in Manitoba as the "Carbonate Aquifer System" and is considered to be the principal aquifer in the region. The primarily used aquifer in the LMOC region (referred to as the Upper Carbonate Aquifer) resides approximately in the highly fractured upper 30 m of bedrock. In areas where the bedrock aquifer pressures are elevated relative to the thickness of the confining till aquitard units, and in particular during channel excavation and unloading of the confining aquitard units, there is a risk of basal heave/hydraulic fracturing of the till.

During construction, active depressurization (pumping from wells) will be undertaken to lower the pressure head in the bedrock aquifer in the vicinity of the channel alignment. Depressurization wells will be placed along the LMOC construction perimeter with each well releasing groundwater from the confined aquifer (thereby reducing aquifer pressure) to the surface.

During operation, passive depressurization along the channel will take place via depressurization wells and reverse drains. Depressurization wells will passively release groundwater into the LMOC, while reverse drains will involve excavating to the bedrock and infilling with coarse material. The coarse material will act as a cover and provide the higher hydraulic conductivity required to allow water to flow upward from the bedrock aquifer into the LMOC.

More information on groundwater is available in the GWMP.

5.3 Processed Water

Processed water consists of any water considered to be a direct product of the construction activities only and, as such, may require the implementation of mitigation measures, such as settling ponds and/or chemical remedies to meet regulatory requirements. Potential sources of processed water for the LMOC will be defined during detailed design and may include, but are not limited to:

- Dewatering of excavation areas.
- Accidental spills and releases.
- Leachate from rock stockpiles and structures containing rock exposed to surface waters and/or drainage.
- Control and treatment of sewage water from any construction camps that may be established.

6.0 SURFACE WATER MANAGEMENT

6.1 Construction Phase (Temporary Measures)

Temporary measures will be required during construction to manage surface water to improve constructability, control the potential for erosion, and manage sediments. The specific measures will depend on construction staging and sequencing until the permanent works are completed. Construction methods for temporary drainage works will consider the erosion and sediment control measures described in the SMP.

6.1.1 Channel Works

Channel works include all construction activities related to the LMOC, excluding the inlet and outlet works, water control structure and road bridges.

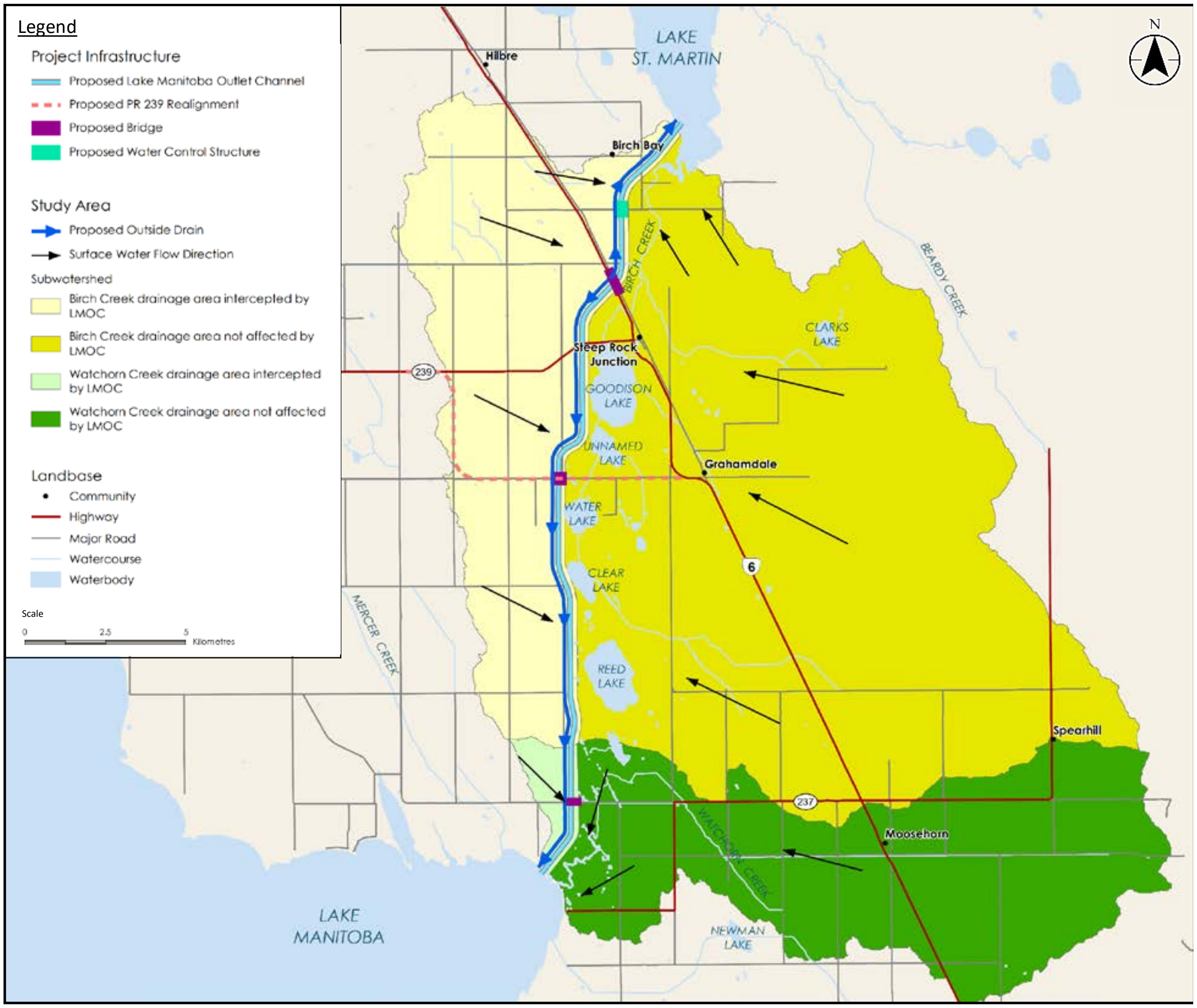
The primary method of managing surface water during construction of the channel works will be via the outside drain, which will be constructed in advance of the channel. The outside drain will be located along the west side of the LMOC to intercept the watershed runoff originating from the west (which will include drainage from a portion of the realigned and upgraded section of PR 239) and prevent it from flowing into the construction zone. The outside drain will also be used to convey water from local construction dewatering and groundwater depressurization works along the LMOC. The drain will be sloped from a highpoint near PTH 6, draining north to Lake St. Martin and south to Lake Manitoba, as shown on Figure 5. Culverts will be installed wherever the outside drain crosses a road. Design details of the outside drain will be provided in the preliminary engineering channel design report once it is complete.

Management of surface water flows and groundwater seepage within the channel excavation will be the responsibility of the contractor. Pumping will be required for construction of the channel works to manage surface water runoff within the excavation and to facilitate groundwater depressurization requirements.

Water from within the work area will be treated, as required, to comply with the water quality criteria outlined in Section 3.1. Settling ponds will be constructed, as deemed necessary, prior to discharge into the outside drain and/or the waterbodies east of the LMOC, or at alternate locations that may be approved by MI during construction.

As described in Section 7.2, the primary method to prevent or minimize the potential for erosion will be through the establishment of permanent vegetation. Until vegetation is established, temporary erosion and sediment control measures will be employed during construction, as described in the SMP.

Figure 5: Conceptual LMOC Outside Drain



6.1.2 Inlet Works

The inlet works, will consist of excavating the lake bottom within an approximately 100 m long by 200 m wide area of Lake Manitoba. The preliminary design assumes that this excavation will take place in the wet with the construction area isolated by a double turbidity curtain (i.e., two separate turbidity curtains) to prevent or minimize the migration of disturbed sediments into the lake during construction. A fish salvage program will be required within the isolated area.

Installation and removal of the double turbidity curtain, as well as the excavation work itself, will comply with DFO's Restricted Activity Timing Windows, and will be completed in accordance with the conditions outlined in the DFO Authorization. Removal of the curtain would occur once monitored water quality parameters on both sides of the curtain are similar and meet the criteria outlined in Section 3.1.

Methods of construction within the area will be left to the contractor. Alternate construction methods may be proposed, such as isolating the area with a cofferdam that would be constructed behind a turbidity curtain. In this case, any water that must be pumped outside of the work area would be discharged into settling ponds, if necessary, prior to release into Lake Manitoba.

6.1.3 Outlet Works

The outlet works will consist of excavating the lake bottom within an approximately 130 m long by 115 m wide area of Lake St. Martin. Construction activities and measures to manage surface water during construction will be similar to the inlet works, which were described in Section 7.1.2.

6.1.4 Water Control Structure

As is also the case for the channel works, pumping will be required for construction of the WCS to manage surface water runoff within the excavation and to facilitate groundwater depressurization requirements. The WCS work area will be isolated from rest of the channel construction work areas to reduce the amount of pumping required and to prevent additional surface water runoff from entering the construction area. Other potential sources of water include various types of processed water, as described in Section 6.3. Management of surface water flows and groundwater seepage within the excavation will be the responsibility of the contractor.

Water from within the work area will be treated, as required, to comply with the water quality criteria outlined in Section 3.1. Settling ponds will be constructed adjacent to the work area, as deemed necessary, prior to discharge into the outside drain and/or the waterbodies east of the LMOC, or at alternate locations that may be approved by MI during construction.

6.1.5 Road Bridges

As is also the case for the channel works, pumping will be required for construction of the bridges to manage surface water runoff within the excavation and to facilitate groundwater depressurization requirements. The bridge work areas will be isolated from rest of the channel construction work areas to reduce the amount of pumping required and to prevent additional surface water runoff from entering the construction area. Other potential sources of water include various types of processed water, as described in Section 6.3. Management of surface water flows and groundwater seepage within the excavation will be the responsibility of the contractor.

Water from within the work area will be treated, as required, to comply with the water quality criteria outlined in Section 3.1. Settling ponds will be constructed adjacent to the work area, as deemed necessary, prior to discharge into the outside drain and/or the waterbodies east of the LMOC, or at alternate locations that may be approved by MI during construction.

6.1.6 PR 239 Realignment

Management of surface water flows associated with the PR 239 realignment will be the responsibility of the contractor. It is anticipated that existing ditches along the PR 239 realignment route will be used for the conveyance of surface water runoff during its construction with appropriate erosion and sediment control measures in place.

6.1.7 Sediment Management

A separate SMP for the control of erosion and sediment has been prepared for the Project. The SMP identifies temporary and permanent measures that will be incorporated during construction until vegetation has been established on disturbed areas to prevent or minimize the potential for erosion and to mitigate the transport and deposition of sediments beyond construction areas and into off-site receiving water bodies. These measures will be developed to meet requirements outlined in the environmental license and federal decision statement conditions.

6.2 Operation Phase (Permanent Measures)

Once construction is complete, surface water from outside of the project area (i.e., west of the channel) will be managed with a permanent outside drain, as described in Section 7.2.1. Surface water runoff within the LMOC Right of Way will either discharge into the LMOC or away from the channel.

Temporary erosion and sediment control measures will be maintained post-construction until vegetation has fully established, and it is confirmed that the water quality criteria outlined in Section 3.1 can be maintained in the long term. Refer to the SMP and Revegetation Management Plan for further details.

Construction of the LMOC will result in a reduction to the catchment area of Birch Creek and Watchorn Creek, as described in Section 6.1. Plans to address the potential impacts to these watercourses will be included with the Offsetting Plan and therefore are not discussed in the SWMP. Note that allowing discharge across the LMOC to maintain natural flow patterns from west to east towards Birch Creek is not practical as it would require an aqueduct with a pump station or a siphon and would be very costly to construct and maintain. As such, this is not a design requirement for this project and has been addressed separately as part of the EIS and the AEMP.

6.2.1 Outside Drain

The outside drain that will be initially constructed to facilitate management of runoff during construction, as described in Section 7.1.1, will be utilized as part of the permanent drainage works for the LMOC to collect surface water runoff arriving from the west and convey it into Lake Manitoba and Lake St. Martin, as shown previously on Figure 5.

The overall capacity of the outside drain may be augmented by incorporating overflow structures at a few locations to allow for excess water to enter the LMOC during large runoff events, thus potentially improving drainage in some areas to the west of the LMOC. On the east side, surface water naturally flows away from the LMOC toward the existing waterbodies. Accordingly, no outside drain will be required on the east side of the channel.

Design details of the outside drain and any overflow structures will be provided in the preliminary engineering channel design report once it is complete.

6.2.2 Conditions in the Outlet Channel

Expected flow sources into the LMOC include discharge from Lake Manitoba (when the WCS gates are open), runoff originating from within the LMOC Right of Way, and local surface water that may be conveyed during large runoff events by any drainage overflow structures that may be incorporated into the design.

Water will be present throughout the LMOC when the WCS gates are closed. Under this condition, the water level in the channel upstream of the WCS will be equal to the water level on Lake Manitoba, and on the downstream side of the WCS it will be equal to the water level on Lake St. Martin. When the WCS gates are opened, the water level in the LMOC will drop approximately 2 m immediately upstream of the WCS and will increase in the upstream direction such that it is equal to the level of Lake Manitoba at the inlet. Immediately downstream of the WCS, the water level in the LMOC will rise by approximately 1 m and will decrease in the downstream direction such that it is equal to the level of Lake St. Martin at the outlet (see Figure 3).

Because of the two different modes of operation, portions of the channel side slopes will experience alternating periods of submergence (wet) and exposure (dry). This may lead to a zone where vegetation may not survive or grow well, thus making these portions of the slopes potentially susceptible to erosion. Although the re-vegetation plan will consider these conditions, additional mitigation measures may be considered during detailed design to address the risk of erosion along exposed side slopes. This may consist of installing permanent erosion control measures or implementing a long-term monitoring and management approach.

6.2.3 Revegetation Plan

Maintaining and establishing a vegetation cover along the LMOC is fundamental to minimizing the erosion potential, during both its construction and operation. The revegetation approach will be dynamic and flexible in terms of its implementation under potentially challenging hydrological conditions and is described further in the Revegetation Management Plan.

7.0 MONITORING

7.1 Historical Monitoring

Historic surface water quality data will serve as a baseline to identify changes in water quality parameters, should they occur during construction and operation of the LMOC. Below is a summary of historical surface water quality information that has been gathered in the vicinity of the proposed LMOC over the last few years.

In 2017 and 2018, surface water quality monitoring was conducted in the LMOC area at nine field sites including locations in Lake Manitoba, Lake St. Martin, Watchorn Creek, Reed Lake, Clear Lake, Clark's Drain, Birch Creek and Woodale Drain. Samples were collected seasonally during four field campaigns in May 2017, August 2017, October 2017, and May 2018. In-situ surface water chemistry measurements were recorded, and water samples were collected and analyzed for general water quality, metals, ion balances and water hardness types. The data is summarized in separate annual monitoring reports for 2017 and 2018.

In 2019, surface water quality was monitored at seven previously established sites and three new sites, which were added to provide information on Water Lake, Birch Creek and Goodison Lake. Figure 6 identifies these presently monitored locations. Monitoring campaigns were completed in June, August, and October 2019, which included in-situ water quality measurements (temperature, pH, conductivity, dissolved oxygen, turbidity, nitrite) at each site. Water depth was measured at two sites and in-situ water quality readings were recorded at depth increments of 1 m. The 2019 data will be summarized in an annual monitoring report presently under preparation. A similar monitoring campaign is presently underway for 2020, and data gathered during that program will be documented in a future annual monitoring report.

7.2 Construction Phase Monitoring

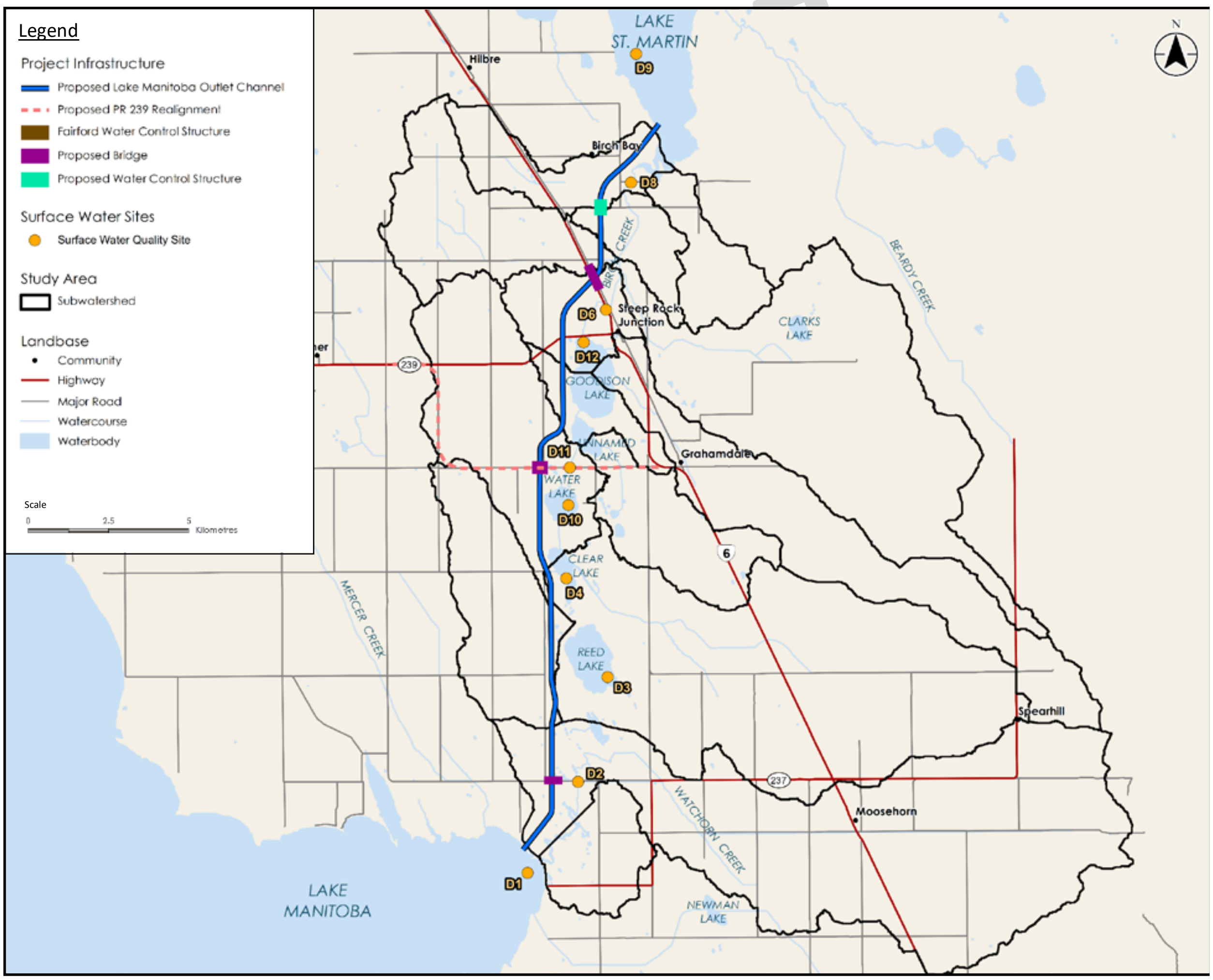
Surface water will be monitored during construction to identify changes that may result from construction activities and to assess the effectiveness of proposed mitigations and the SMP. If the water quality criteria identified in Section 3.1 are exceeded and attributed to the project, then additional mitigation measures would be considered as described in Section 10.0. Monitoring will include collection of surface water samples and water level measurement throughout the LMOC area, which will include previously established baseline sites.

The proposed water quality parameters to be monitored for, as well as the monitoring locations and the frequency of monitoring, will be refined as the LMOC design is advanced. These aspects will be based on the nature of construction work being done; the specific environmental conditions present during construction; environmental considerations described in the EIS; proximity to and potential for change in local fish bearing receiving waters as a result of the works; monitoring plans being developed for the Project as part of other management plans (such as the AEMP and GWMP); as well as input from engagement processes and regulatory input. As construction proceeds, monitoring results may dictate that adjustments be made to the monitoring plan as part of adaptive management.

Table 2 identifies the presently proposed water quality monitoring parameters.

The LMOC will require active groundwater depressurization and dewatering to facilitate its construction. Groundwater discharged to the surface will be monitored periodically for adherence to the federal and provincial guidelines (CCME-PAL and MWQSOG-PAL). Groundwater will be passively treated if required (i.e., aerated) based on surface water quality monitoring results and diverted to the waterbodies east of the LMOC and/or the outside drain west of the LMOC. Should monitoring results indicate an adverse effect of the diverted groundwater or site dewatering water on the quantity or quality of surface water, then additional treatment will be considered.

Figure 6: 2019 Surface Water Quality Monitoring Locations



Water levels will be monitored at selection locations in small lakes and wetlands along Birch Creek using staff gauges and/or continuous level recorders, which will be determined during the detailed design phase. Options to measure and monitor changes in local drainage and flows during construction will be incorporated in the SWMP at detailed design, as required, in consideration of the AEMP.

Table 2: Proposed Surface Water Quality Monitoring Parameters

Water Quality Parameters	
Field Parameters	Dissolved oxygen Electrical Conductivity Oxidation Reduction Potential pH Temperature Turbidity
General Chemistry	Alkalinity, Bicarbonate (as CaCO3) Alkalinity, Carbonate (as CaCO3) Alkalinity, Hydroxide (as CaCO3) Alkalinity, Total Hardness (as CaCO3) Total Dissolved Solids Sulfate Chloride Fluoride
Sediment	Total Suspended Solids
Microbiological Parameters	Escherichia coli (E.Coli)
Nutrients	Ammonia (as N) Nitrate (as N) Nitrite (as N) Total Kjeldahl Nitrogen Nitrogen (Total) Phosphorus, Total Phosphorus, Total (Dissolved) Phosphorus, Total (Particulate)
Petroleum Hydrocarbons	BTEX Hydrocarbons
Metals	Standard Metals Scan (Dissolved/Total)

7.3 Operation Phase Monitoring

Collection of surface water quality samples and water level measurements at previously established baseline sites will continue following construction of the LMOC. This monitoring will initially be carried out during the first two years post-construction, however the duration may be extended depending on the monitoring results, environmental conditions present, success of revegetation and the frequency of use of the LMOC.

The frequency and locations of the water quality monitoring conducted during the operation phase will be based on specific environmental conditions present, as well as the success of revegetation, and may be adjusted based on the monitoring results. Operation phase water quality monitoring parameters are expected to be consistent with those monitored for during the construction phase, as summarized in Section 8.2.

7.4 Reporting

Annual surface water monitoring reports will be prepared throughout the construction phase and for the duration of monitoring ultimately conducted during the operation phase.

8.0 ADAPTIVE MANAGEMENT AND FOLLOW-UP

8.1 General

A follow up process is a form of adaptive management to improve practices by learning about their effects and then making changes in those practices as new information is available. The federal Impact Assessment Act defines a follow up program as "a program for verifying the accuracy of the impact assessment of a designated project and determining the effectiveness of any mitigation measures." An associated Operational Policy Statement (https://www.canada.ca/content/dam/iaac-acei/documents/ops/ops-follow-up-programs-2011.pdf) indicated that "a follow-up program is used to:

- verify predictions of environmental effects identified in the environmental assessment
- determine the effectiveness of mitigation measures in order to modify or implement new measures where required
- support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects
- provide information on environmental effects and mitigation that can be used to improve and/or support future environmental assessments including cumulative environmental effects assessments, and
- support environmental management systems used to manage the environmental effects of projects."

As discussed in Section 12.4.1.2 of the EIS, construction activities and the changes in flows and water levels caused by the Project may have minor effects on fluvial geomorphology, sediment and debris transport, in the surface water LAA, but primarily during and immediately after construction. Suspended sediment levels may temporarily increase at work sites during construction activities, and at outlet areas during initial operation (gates open) of the outlet channels after a period of non-operation (gates closed). As such, the purpose and objectives of follow-up activities will be to monitor and further understand the residual effects due to the Project.

Although the methods and recommendations outlined in the SWMP were developed based on site-specific expectations and conditions, it is accepted that these conditions are subject to change. For example, weather conditions and climate change will inevitably drive some of the design decisions during implementation and long-term operation. By employing adaptive management strategies, assumptions used in the initial design will be evaluated and management practices modified in response to the outcomes during the Project construction period and subsequent operation phase based on baseline investigations, follow-up monitoring and reporting.

Adaptive management uses the Project designs while learning from field performance to manage risk and allow the incorporation of new knowledge into subsequent steps. The foundation of this process relies on data input and implementation of sound monitoring programs. Based on the monitoring results and feedback during construction, temporary mitigation measures described in this SWMP, as well as those included in the

SMP and RVMP, should be revisited and updated, as required. For example, if the establishment of vegetation following excavation work is more difficult than expected, alternate vegetating methods may be considered, or additional temporary erosion control measures may be warranted. Adaptive management will play an important role in acknowledging and working through management challenges in the presence of uncertainty.

8.2 Follow Up Response

As described in Section 8, monitoring will include visual inspections and water quality monitoring as part of the SWMP and AEMP. The data and analyses generated by monitoring will be used to provide information on the effectiveness of mitigation measures, aid in the validation of predicted residual effects, and provide data and results required for environmental licensing requirements. These plans will include management thresholds developed as part of the monitoring plan and may utilize regulated criteria, input from stakeholders, and consideration of findings from applicable management plans. Based on the management thresholds and the results of the surface water monitoring program, follow up responses will be implemented where conditions recorded appear to be outside of anticipated seasonal fluctuations in both surface water quantity and quality.

9.0 CONTINGENCY MEASURES AND EMERGENCY RESPONSE

Contingency measures and emergency response will be developed prior to construction so that they can be deployed in the event that aspects of this SWMP do not meet the water quality objectives or if the prescribed measures are overwhelmed during a severe runoff event greater than the design condition. Contingency planning will also be incorporated for unexpected events such as, but not limited to, an uncontrolled breach of a settling pond, or the failure of a pumping system for depressurization or dewatering.

Mitigation measures will be identified in the “base” plan that may include, for example, choosing locations of construction phase settling ponds to reduce direct surface runoff to aquatic environments. Contingency measures that would be implemented in the event of an emergency will also be identified that may include the deployment of straw rolls/wattles, erosion control blankets, rapid stabilization techniques, supplementary seeding, temporary settling ponds, etc.

In the event of an emergency, the contractor would be notified and advised as to which of the contingency and emergency control measures should be implemented. These contingency and emergency control measures would be carried out within a predetermined time period depending on the site conditions and nature of the emergency.

10.0 REFERENCES

10.1 Additional Sources

A number of background reports and data sources were reviewed and considered as part of the SWMP for the LMOC. The following lists the most pertinent information applicable:

- Ongoing Preliminary Design of the LMOC including surveys and investigations.
- Development of Operating Rules for Lake Manitoba and Lake St. Martin Outlet Channels with recommended Revisions. February 2019, Manitoba Infrastructure.
- Flood Frequency Analysis – Lakes Manitoba and St. Martin, June 2017, Manitoba Infrastructure.
- Investigations and Preliminary Engineering for LMB Channel Options C and D Summary Report. May 2017. KGS Group.
- Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C & D. Deliverable D2. Annual Monitoring Report to July 1, 2017. KGS Group. August 2018.
- Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C & D. Deliverable D3. Annual Monitoring Report to July 1, 2018. KGS Group. August 2018.
- Lake Manitoba and Lake St. Martin Outlet Channels Impacts on Lake Manitoba and Lake St. Martin. Memorandum. Manitoba Infrastructure. June 14, 2019.
- Lake Manitoba and Lake St. Martin Outlet Channels Project EIS. Stantec Consulting. March 2020.

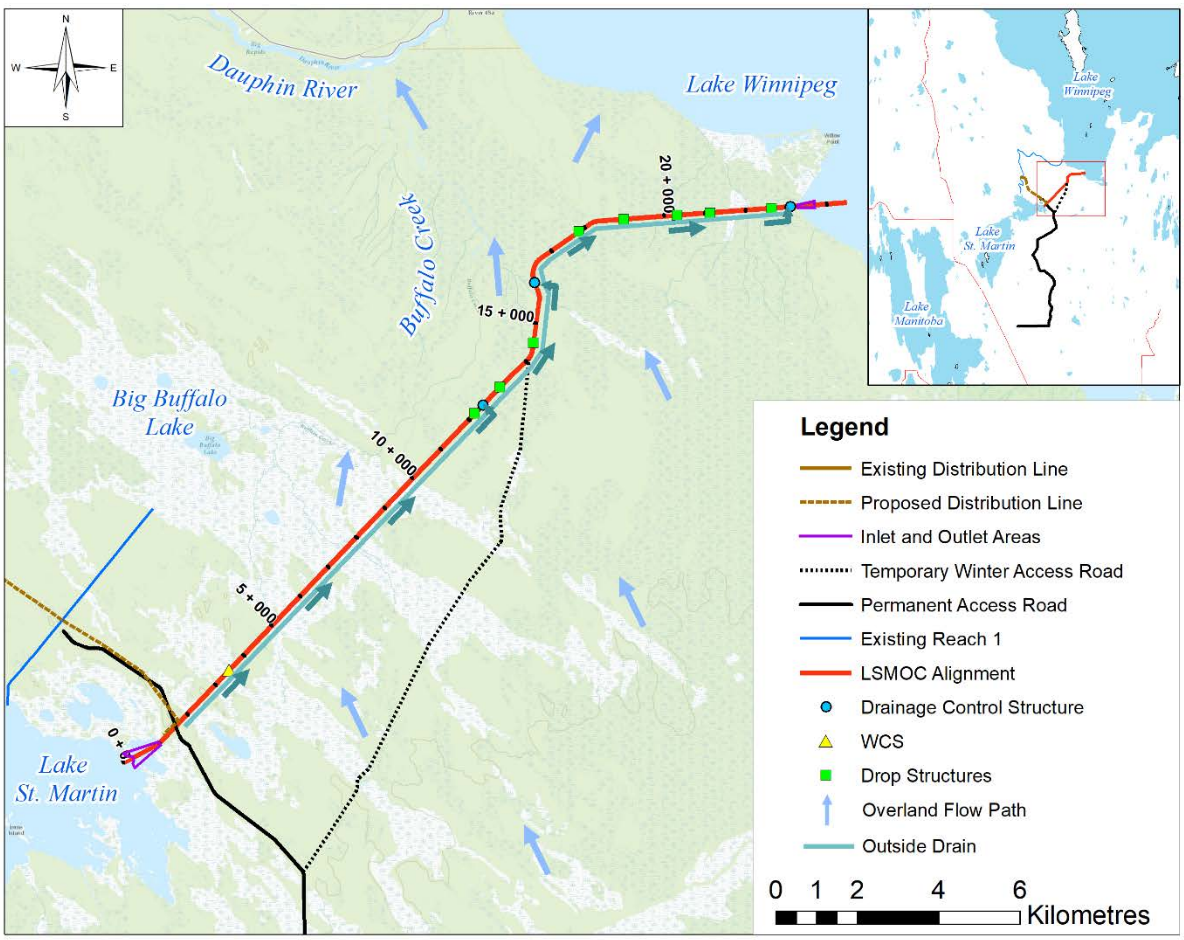
Part 3: Lake St. Martin Outlet Channel

11.0 PROJECT INFORMATION

11.1 Project Description

The LSMOC Project consists of an approximately 23 km long outlet channel, with the inlet positioned at the east end of Lake St. Martin and the outlet south of Willow Point on Sturgeon Bay of Lake Winnipeg. A plan showing the LSMOC and key project infrastructure is provided in Figure 7.

Figure 7: Overview Plan of the LSMOC



The LSMOC will have a capacity of 326 m^3/s at a Lake St. Martin south basin water level of 244.14 m and is designed to convey flows up to the Inflow Design Flood (IDF), considering the intent of the Canadian Dam Association Dam Safety Guidelines. A 1:1000-year flood event has been assumed for the IDF and will be updated at detailed design based on the results of a detailed dam safety classification and dam breach assessment.

The proposed channel will have an invert elevation of about 241 m at Lake St. Martin and about 213 m at Lake Winnipeg and designed to limit erosion. The design is based on a trapezoid shaped channel with a flat base approximately 42 m wide, 6 to 8 m depth and 4H:1V to 4.5H:1V side slopes. The hydraulic profile of the channel will require the lake bottoms to be excavated at the channel inlet and outlets to match proposed channel invert elevations. The excavations will be tapered over a short distance out from shoreline to meet natural lake bed elevations.

At the outlet, rock jetties will be situated over the first 100 m distance to reduce the potential for debris accumulation and sediment deposition within the excavation limits from littoral drift during non-operation of the channel. The length of the jetties was selected to limit sedimentation within the deepest portion of the outlet when the water control structure is closed, while also limiting the length of the structures to minimize its footprint and cost. Sand from the lake that may be moving in the area is expected to freely deposit beyond the extent of the jetties when the channel is not in operation, which would then likely be transported further into the lake when the channel is operated again. The process of sand deposition and transport is not expected to be significant but would repeat itself each time the LSMOC is operated. Since the movement of sand along the shoreline is a naturally occurring process, a long-term plan for maintenance (e.g., dredging) was not included at the preliminary design phase. This will be reviewed during detailed design with input from the environmental approval and engagement process. The exact length and configuration of the jetties will also be refined at detailed design based on updated results from the shoreline morphology assessment.

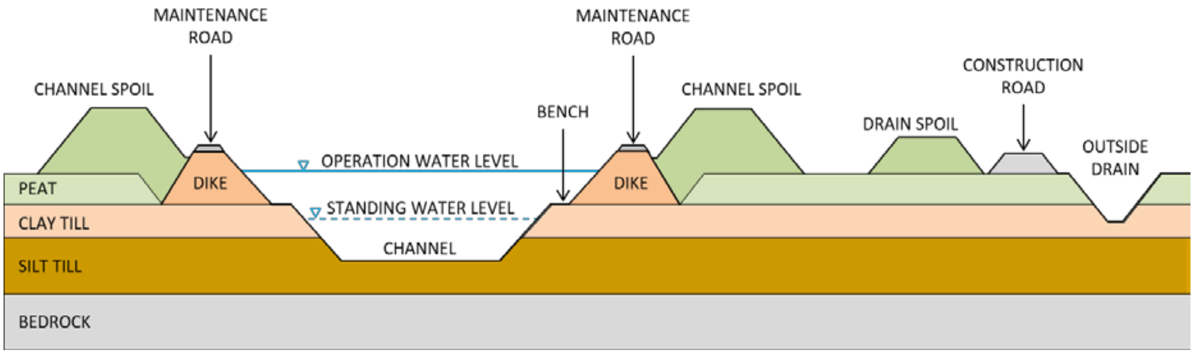
At the inlet, results from a baseline shoreline morphology indicated a low wave energy environment in the area. It was therefore concluded that rock fill jetties are not likely required and were therefore omitted from the preliminary design of the inlet works. Since there is a minimal potential for sand to migrate into the area, a long-term plan for maintenance is not anticipated.

Permanent water retaining dikes will be located on both sides of the excavated channel to contain design flows within the LSMOC and also to isolate the surface water and the upper saturated peat system (see Section 14.2) from the excavated channel. Spoil piles for the excavated material will be located outside of the channel dikes.

An outside drain will be constructed on the east side of the project to intercept the surface water runoff flowing towards the LSMOC. The design of the outside drain is described in more detail in Section 15.2.1.

Access for long term maintenance and inspection will be available on top of the dikes on both sides of the LSMOC for the entire 23 km with a maintenance road. A typical cross section for the LSMOC is provided in Figure 8.

Figure 8: Typical Cross Section



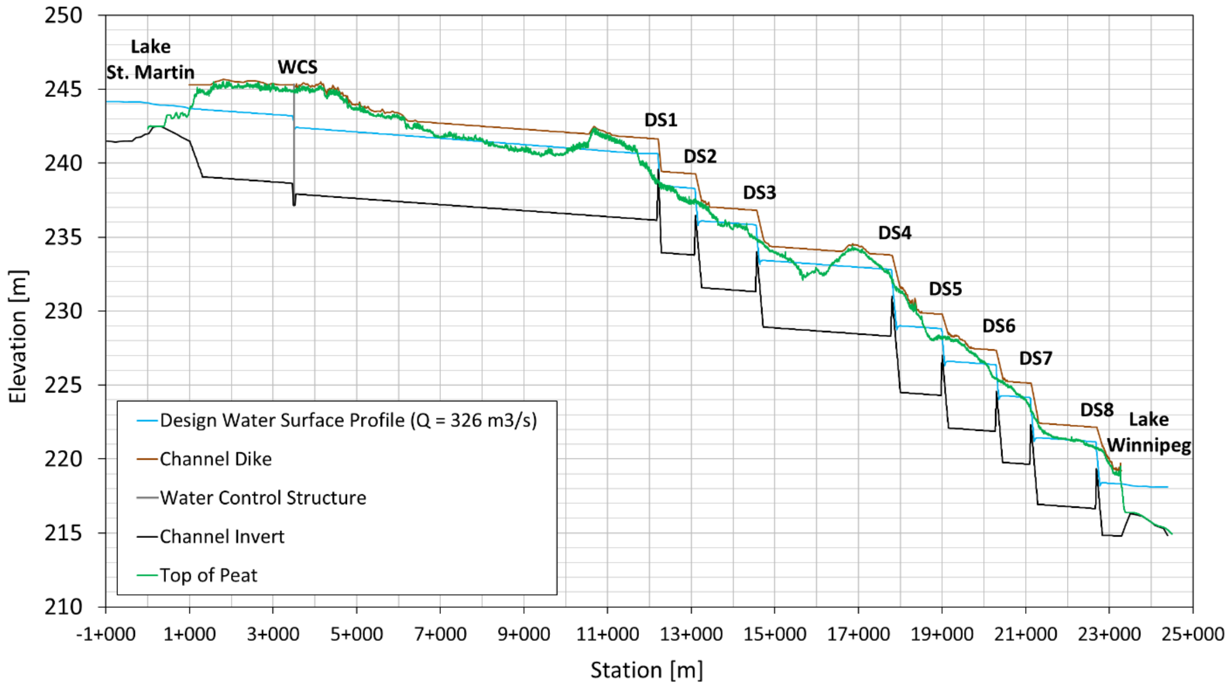
A water control structure is required to control flows through the LSMOC while ensuring that Lake St. Martin water levels remain within their planned range. The structure will be constructed near the inlet, although the exact location of the structure will be confirmed at detailed design. It will also act as a bridge to provide access to both sides of the channel. The water control structure will be a concrete structure with two 9 m wide sluice bays, guides and sill beams for upstream stoplogs, vertical lift gates and downstream stoplogs.

The LSMOC will require approximately eight drop structures to minimize channel flow velocity and erosion in areas of steep sloping terrain. The drop structures will be constructed of rockfill, with a sheet pile cutoff at the upstream crest. When the water control structure gates are closed, a minimum one-meter depth of water will be maintained in the channel to minimize the growth of aquatic vegetation. Near the drop structures, the minimum water depth during non-operation will be at least 2.0 m to maintain a pool of water below the surface ice cover during the winter, to minimize potential impacts to aquatic habitat (fish).

A base flow will be provided through the water control structure with gated conduits to maintain appropriate water quality conditions (oxygen levels) in the channel. Dissolved oxygen will be monitored, as described in Section 16.3, and the base flow may be increased through the conduits by increasing the gate opening if oxygen levels are below the criteria identified in Section 3.1.

The hydraulic profile for the LSMOC is provided in Figure 9. Additional project details, including design information and drawings, are available with the preliminary design.

Figure 9: Hydraulic Profile of the LSMOC



11.2 LSMOC Operation

When the LSMOC is in operation, the water level in the channel increases. This can affect surface water drainage and erosion and sediment control measures. The range in water levels expected within the LSMOC and frequency of operation were therefore considered for developing the SWMP.

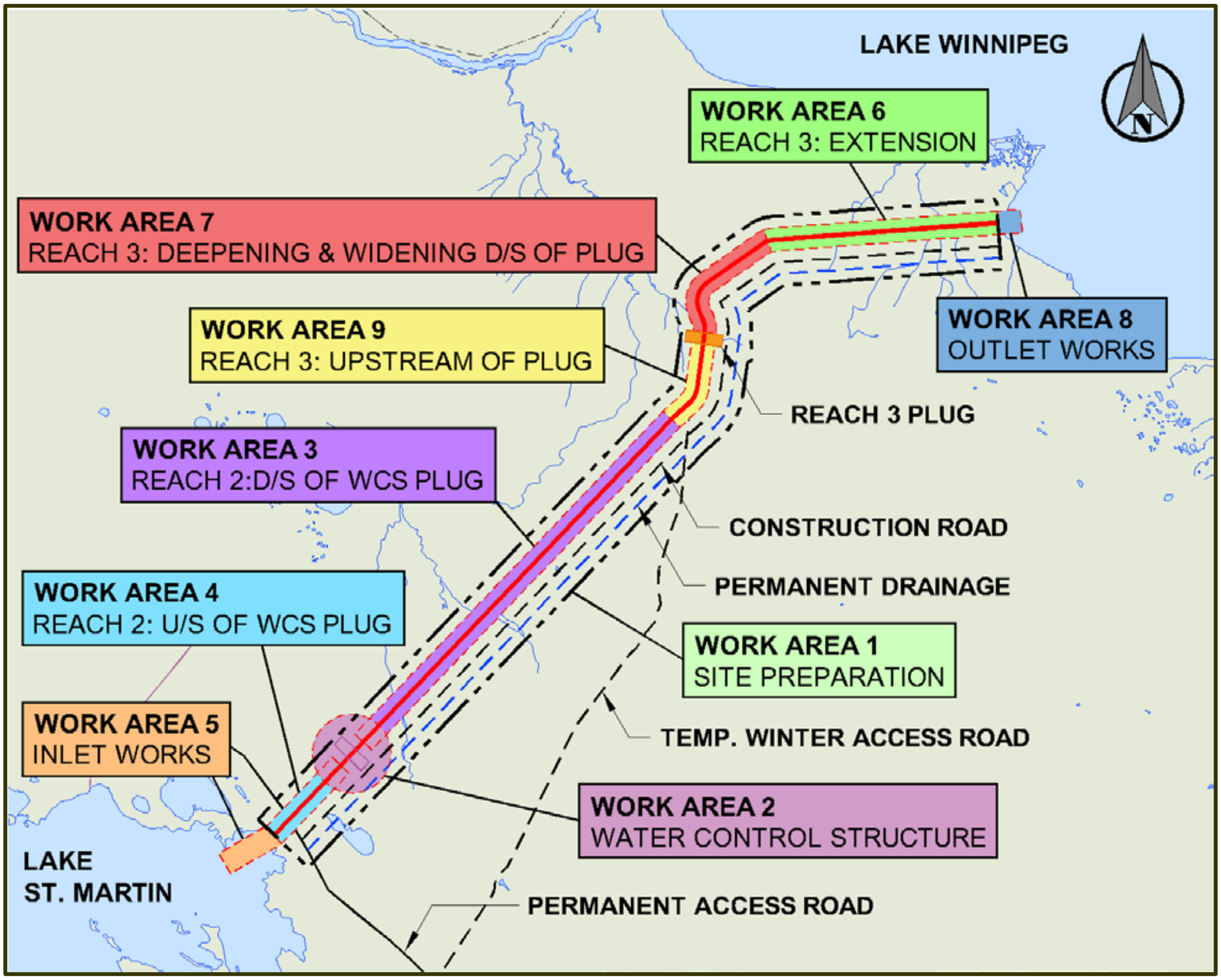
The LSMOC is designed to be operated in both open water and ice covered conditions. Based on historic lake levels and inflows, MI has simulated the operation of the LSMOC for the 103 year period from 1915-2017. Results indicate that the LSMOC would have been operated approximately 22% of the time (days) and in 38 years of the 103 year period. The average duration of operation was approximately one year and the average discharge in the channel during periods of operation was 130 m^3/s.

11.3 Sequence of Construction

A preliminary construction sequencing plan has been developed for the project as part of preliminary design. A brief summary has been included below as it provides a basis for developing the SWMP for the construction phase of the project.

The project has been subdivided into the nine work areas shown on Figure 10. The work areas were numbered considering the preliminary sequencing plan.

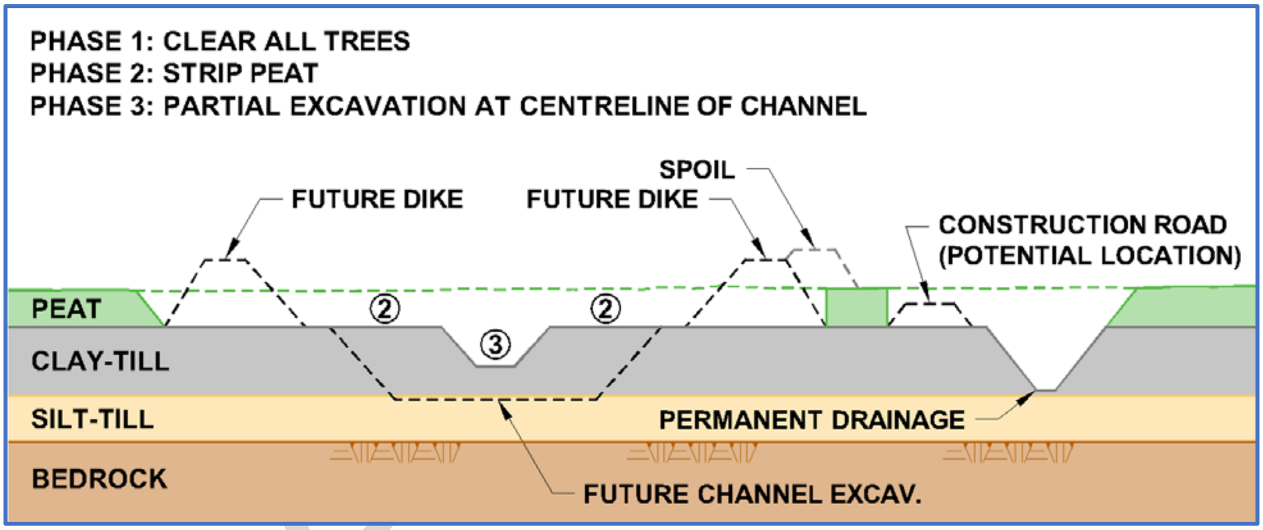
Figure 10: Overview of Work Areas for Construction and Preliminary Sequencing of Work



Work Area 1 – Site Preparation and Peat Excavation, must be tendered first. It is a critical path activity to be undertaken before construction can begin in the other work areas. Tree clearing, peat excavation, and construction access road development is best done in the winter months allowing for access over the peatland, simplifying water management requirements, and avoiding interference with the nesting window for migratory birds. It is important to construct permanent drainage to the east of the channel and excavate the peat within the channel/dike footprint early in construction to reduce (but not eliminate) surface water runoff and groundwater seepage into the work area, as well as to promote drainage within the channel construction limits thus improving access to the underlying mineral soils. Overland drainage from the east side will be collected in the permanent drainage ditch and routed towards Buffalo Creek and/or Lake Winnipeg during construction.

A partial pilot ditch along the centerline of the channel (within the mineral soil) is proposed to collect and drain seepage/surface runoff entering the excavation area during construction, particularly in Reach 2 and the Reach 3 Extension where there is currently no existing excavation. This will improve drainage of the materials underlying peat and promote better access conditions for the subsequent earthworks contracts. Figure 11 shows the assumed construction sequencing for Work Area 1.

Figure 11: Construction Sequencing for Work Area 1



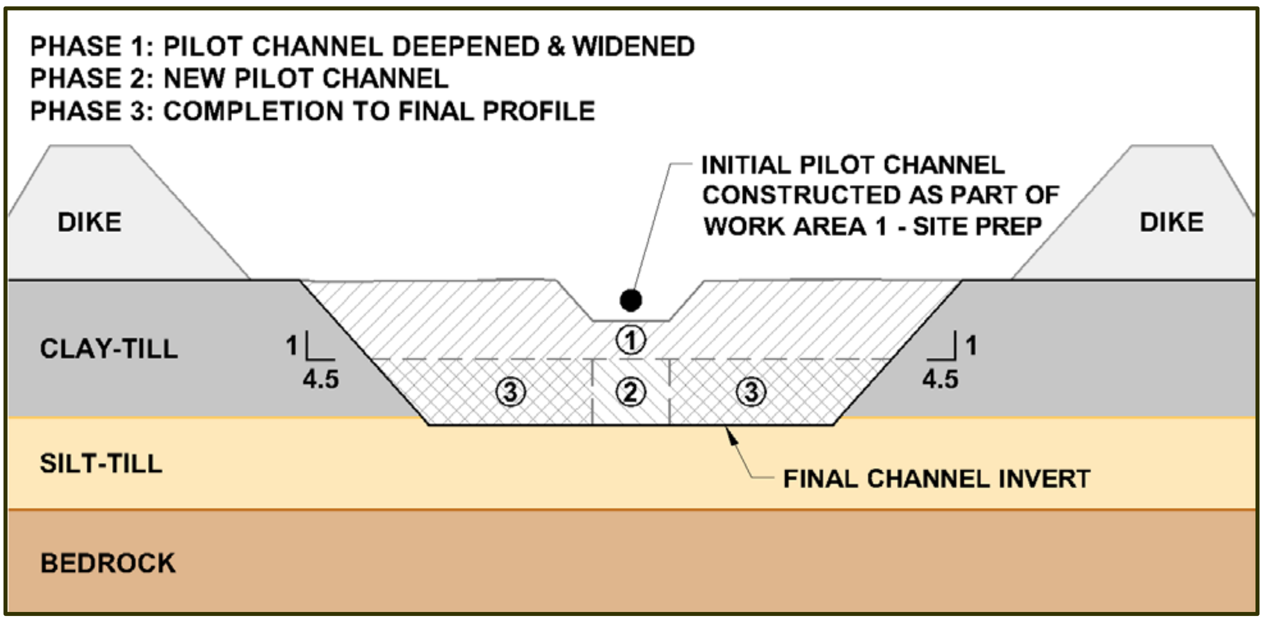
Work Area 2 - The Water Control Structure, will likely be tendered as a stand-alone contract due to the unique scope of work included. Localized excavation and foundation preparation are required for construction of the WCS. Due to high bedrock piezometric pressures (at times artesian) within the bedrock aquifer in this area, an active depressurization system will be required to limit the risk of excavation basal heave and to control, monitor and dewater the work area.

Work Areas 3 to 9 - The remaining work areas (3 to 9) could be tendered separately, or in different combinations based on contractor capabilities and consideration of the increased complexity of managing multiple contracts.

Earthwork activities are planned to start at the downstream end of the construction reach, gradually progressing up the channel, to promote gravity drainage of the work areas. The existing plug in Reach 3 will facilitate the isolation of Work Areas 6, 7 and 8 from Work Areas 3 and 9 to help manage drainage during construction. The existing plug in Reach 3 maintains natural flow patterns towards Buffalo Creek and provides an opportunity to start channel excavation in Work Area 7 and Work Area 3 independently and simultaneously. Once Work Area 7 is completed, the plug in Reach 3 can be removed, allowing Work Area 9 to be dewatered (by gravity drainage) for construction. Alternate construction sequencing plans will also be considered during detailed design, including the option of discharging flows towards Buffalo Creek by utilizing the existing Reach 3 emergency channel.

Due to high bedrock piezometric pressures along the channel alignment, excavation activities are expected to advance in stages to manage risks associated with basal heave and fracturing of the till aquitard. The anticipated excavation sequence within the mineral soil (following peat excavation) is shown in the schematic on Figure 12. Stage 1 involves advancing channel excavation at full width to a level where the risk of basal heave is considered acceptable. Stage 2 involves advancing a new pilot channel to full depth along the channel centerline. The intent is to promote concentration of potential interconnections between the bedrock aquifer and channel invert (i.e., fracturing of the till) along the centreline while improving drainage to the remaining excavation areas moving toward the excavation slopes (Stage 3). Stage 3 involves expanding the new pilot ditch to full width, completing the excavation to the final geometry.

Figure 12: Channel Excavation Phases



Construction of the channel dikes and associated channel excavation used as fill source, will need to occur above freezing temperatures to facilitate subgrade preparation and material compaction. The remaining channel excavation activities could occur at any time. Construction of the drop structures can occur at the contractor's discretion during or after completion of channel excavation. Drainage control structures will be constructed at the same time as dike construction.

Upstream of the water control structure, construction of Work Area 4 is expected to occur towards the end of the project to maintain access towards Reach 1 until the water control structure is completed and also to maintain a natural barrier between Lake St. Martin and the Water Control Structure.

The inlet and outlet works (Work Areas 5 and 8) were assumed to start construction in the summer, outside of the restricted spring (April 1 to June 15), summer (May 1 to June 30) and fall (September 15 to April 30) fish spawning windows. The in-water works to be conducted outside of these restricted windows includes the installation and removal of the cofferdams. Construction activities in the area isolated from the lakes will then proceed at the discretion of the contractor for approximately a one-year period. Alternate construction methods will also be considered at detailed design, including construction behind a double turbidity curtain or winter excavation in locations where the lake ice freezes to the lake bottom, as described in Section 15.1.1 and 15.1.2.

Each work area will have associated roadworks and revegetation which can occur as soon as possible as channel excavation and dike construction advances.

12.0 SOURCES OF WATER

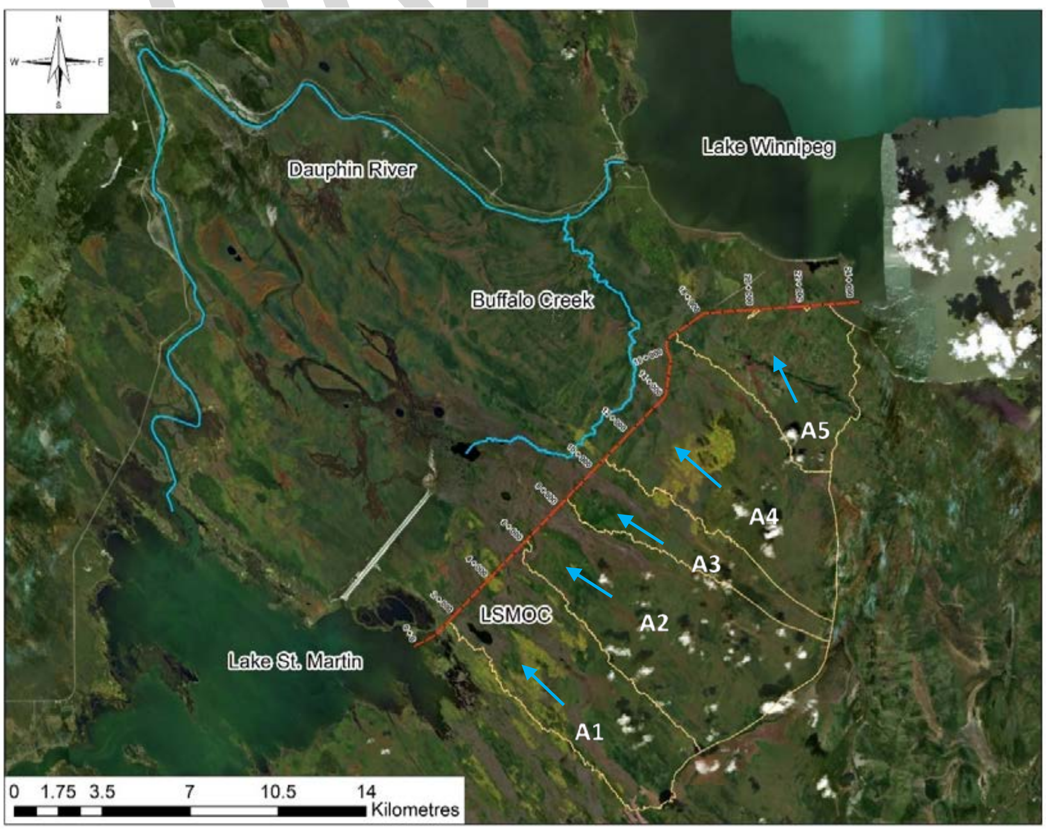
12.1 Surface Water

Surface water includes the runoff contribution from snowmelt and rainfall within the project area (e.g., excavated areas) as well as any additional runoff from outside of the project area which naturally or artificially drains towards the LSMOC.

Along the LSMOC, the majority of the surface water flows naturally towards Buffalo Creek. Flows in Buffalo Creek were monitored between 2011 and 2015 to support aquatic monitoring of the Lake St. Martin Emergency Outlet Channel. Base flow in the creek, when the emergency outlet channel was not in operation, were measured between approximately 1 m^3/s and 10 m^3/s and was estimated to range up to approximately 25 m^3/s in response to significant rainfall events.

A hydrologic analysis was completed to estimate the runoff from the upstream watershed intercepted by the LSMOC. Figure 13 shows the catchment area for the watershed subdivided into five sub-basins.

Figure 13: Surface Water Catchment Areas Intercepted by the LSMOC



The runoff flow rates were determined using the Province of Manitoba Transitional Method for Design Discharges as described in *Integration of Rational Method and Regional Flood Curve Design Discharges* (Harrison & Harden, Jan 1986). The method includes a blended flow rate computed as a combination from the modified Rational Formula method and the Regional Flood Discharge method based on the size of the drainage area. The runoff from drainage areas less than 5 square miles (13 km^2) is determined using the Rational Formula while runoff from drainage areas greater than 15 square miles (38.8 km^2) is determined by the Regional Flood Formula. The discharge for drainage areas between the two limiting areas is determined by prorating the limiting discharges on the basis of the ratio of the areas.

The index stream used in the Regional Flood Formula was the Netley Creek near Matlock (Water Survey of Canada Gauge No. 05OJ009). This stream was selected considering the similar watershed characteristics between Buffalo Creek and Netley Creek. Both watersheds have significant areas covered by peat which reduces flood peaks downstream due to the water holding capability of the peat. As such, both basins are anticipated to yield similar flows for drainage areas of the same size.

Table 3 summarizes the computed discharge for the various catchments intercepted by the LSMOC. It should be noted that based on the drainage plan described in Section 15.2.1, Catchments A1, A2 and A3 are cumulative and therefore have been combined together.

Table 3: Computed Discharge or Surface Water Runoff Intercepted by LSMOC

Catchment	Drainage Area (ha)	1:10 Year Discharge (m^3/s)	1:100 Year Discharge (m^3/s)
A1	4,127	2.31	5.89
A1 + A2	9,590	4.40	11.22
A1 + A2 + A3	11,498	5.05	12.90
A4	4,726	2.56	6.53
A5	2,727	1.78	3.68

The interception of surface water runoff by the LSMOC will reduce the catchment area of Buffalo Creek basin. Quantification of these impacts will be undertaken at detailed design, as required, considering the other environmental management and monitoring plans that are being developed by MI for the project. Information on water quality within the Buffalo Creek basin is provided in Section 16.1.

12.2 Groundwater and Seepage Water

Two distinct groundwater systems are known to be present within the region of the LSMOC, within the upper saturated peat and the lower confined carbonate bedrock aquifer.

The upper, saturated peat unit is perched above the clays (where present) and underlying till units. The peat is recharged directly from surface rainfall and snowmelt. Small-scale flow systems develop from raised bog/peat mound areas, flowing radially outward toward relatively lower-lying depressions and other associated open water areas. Construction of the LSMOC will result in temporarily localized discharge from this system into excavated areas until channel dikes are constructed. Localized discharge will also occur into the outside drain and will vary seasonally depending on the water table and surface conditions.

The lower, confined bedrock aquifer is comprised of a Paleozoic rock sequence commonly referred to in Manitoba as the “Carbonate Aquifer System”. This aquifer system is isolated from the peat unit by the upper clay zone and underling tills. In areas where the pressures are high relative to the confining till units, there is a risk of upward pressure fracturing the till, and producing some uncontrolled groundwater discharge, which is anticipated to be limited by the low permeable nature of the tightly fractured bedrock. Because these conditions cannot be avoided in the region, it was estimated for the project that there will be a degree of groundwater discharge. In general, consideration of groundwater piezometric pressures and any associated aquifer depressurization requirements will apply to the channel excavation, the channel inlet/outlet excavations, and channel water control structure foundations, including long-term water control structure uplift pressure mitigation.

Seepage water may also be attributed to minor leakage downstream of a cofferdam. Quantification of groundwater and seepage volumes will be defined, as required, during detailed design. More information on groundwater and seepage water are available in the Groundwater Management Plan.

12.3 Processed Water

Processed water consists of any water considered to be a direct product of the construction activities only and, as such, may require the implementation of mitigation measures, such as settling ponds and/or chemical remedies to meet natural discharge criteria. Potential sources of processed water for the LSMOC project will be defined during detailed design and may include, but is not limited to:

- Blasting (if required).
- Leachate from rock stockpiles and structures containing rock exposed to surface waters and/or drainage.
- Discharge of wastewaters from processing of aggregate materials and concrete batch plant, dewatering of cofferdams, water treatment plant filter backwash and dewatering of excavation areas.
- Accidental spills and releases.
- Control and treatment of sewage water.

13.0 SURFACE WATER MANAGEMENT

13.1 Construction Phase (Temporary Measures)

Temporary measures will be required during construction to manage surface water to improve constructability, control the potential for erosion, and manage sediments. The specific measures will depend on construction staging and sequencing until the permanent works are completed. Construction methods for temporary drainage works will consider the erosion and sediment control measures described in the SMP.

13.1.1 Channel Works

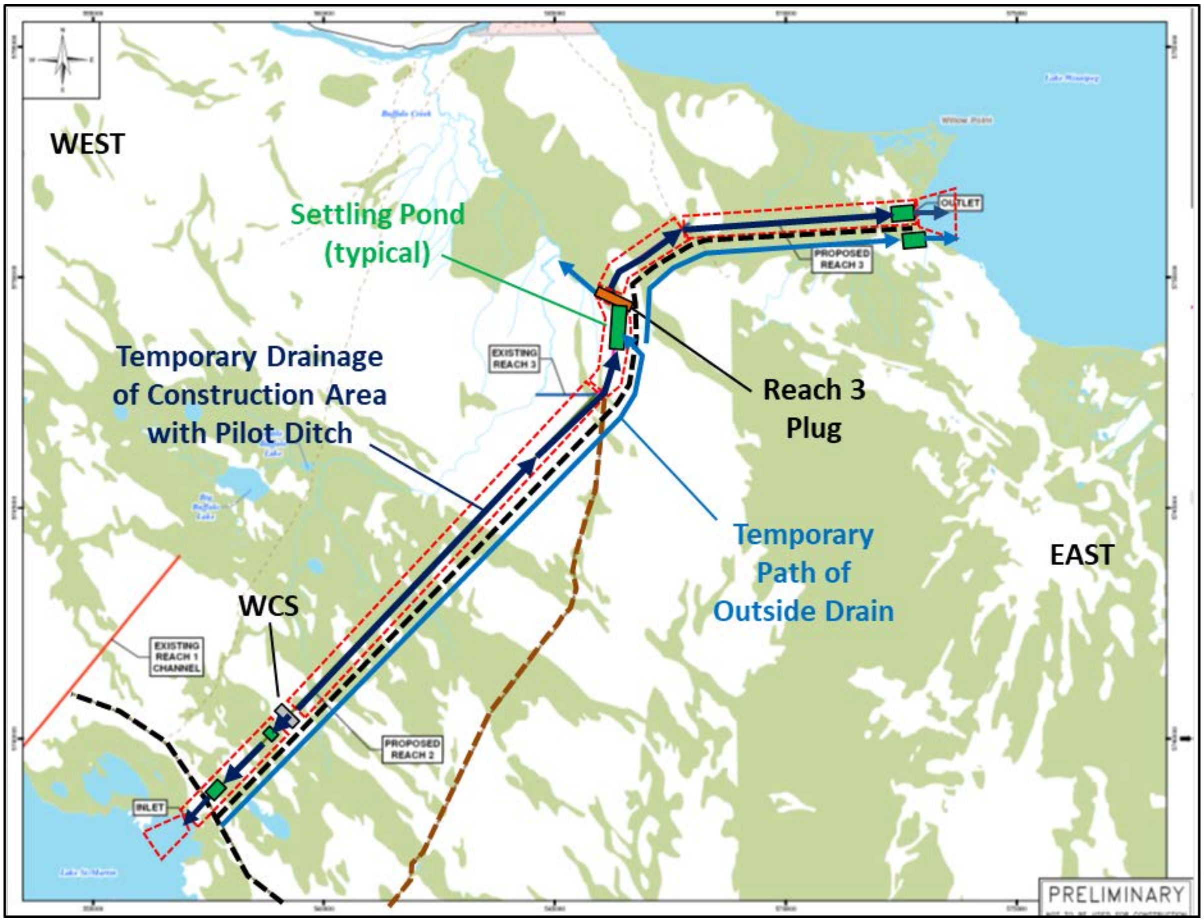
Channel works include all construction activities excluding the inlet and outlet works as well as the water control structure. More specifically, it includes the proposed site preparation contract and Work Areas 3, 4, 6, 7 and 9, as described in Section 13.3.

The primary method of managing surface water for channel works will be with construction of the outside drain during the site preparation contract. Design details of the outside drain are provided in Section 15.2.1. During construction, the purpose of the outside drain is to intercept surface water runoff from the east side of the project upstream of the construction areas to minimize potential for contamination of surface and/or inflow into the construction zone. Intercepted flows will be discharged into Reach 3 and/or Lake Winnipeg with a temporary outlet channel protected with rip-rap. Flows discharged into Reach 3 will temporarily be directed towards Buffalo Creek, as described in Section 13.3.

Efforts to mitigate erosion, as described in Section 15.1.5, will be undertaken during construction. Settling ponds will be incorporated upstream of the discharge points, as defined in the SMP, to mitigate any increases in TSS. The storage capacity of each sediment pond will be defined according to the total run-off volume that meets the event criteria defined in Section 3.3.

Figure 14 shows the proposed temporary drainage plan and potential location of settling ponds for channel works. Options to measure and monitor changes in local drainage and flows during construction will be incorporated in the SWMP at detailed design, as required, with consideration of the AEMP.

Figure 14: Temporary Drainage Plan



Within the excavated channel, a pilot ditch will be constructed as part of the initial site preparation contract, as described in Section 13.3. The pilot ditch will also discharge into settling ponds, as shown on Figure 14. After the site preparation contract is complete, surface water management will be the responsibility of the contractor. The likely method of construction will be to start work at the downstream end of a designated work area progressing in the upstream direction. This will allow runoff to flow by gravity away from the construction site. The contractor may then choose to discharge the water toward Buffalo Creek, into the temporary outside drain or at alternate locations to be approved by MI during construction.

As described in Section 15.2, the primary method to prevent or minimize the potential for erosion within the LSMOC will be the establishment of permanent vegetation. Until vegetation is established, temporary erosion and sediment control measures will be employed during construction, as described in the SMP.

13.1.2 Inlet Works

Inlet works, identified as Work Area 5 as described in Section 13.3, will consist of excavating the lake bottom within an approximately 800 m long by 400 m wide area of Lake St. Martin. The preliminary design assumes that the construction area will be surrounded with a temporary rock plug or cofferdam to allow work activities to be isolated from the lake. Riprap protection will be incorporated into the design to protect the plug/cofferdam against wave action from a wind event consistent with the criteria defined in Section 3.3. A turbidity curtain will be temporarily installed in Lake St. Martin prior to construction of the rock plug/cofferdam, or as required, to prevent or minimize the migration of sediments into the lake during construction. A fish salvage program may be required within the isolated area and will be determined based on the environmental approval process.

Once construction of the LSMOC is complete, the rock plug/cofferdam will be removed in part or in whole, as required and in accordance with environmental requirements. Installation and removal of the rock plug or cofferdam will also comply with DFO's Restricted Activity Timing Windows, and will be completed in accordance with the conditions outlined in the DFO Authorization. Removal of the turbidity curtain would occur once monitored water quality parameters on both sides of the curtain are similar and meet the criteria outlined in Section 3.1.

Methods of construction within the area will be left to the contractor. Excavation works may occur in the wet or within one or multiple areas that have been dewatered for construction. Any water that must be pumped outside of the work area will be discharged into settling ponds, if necessary, prior to release into Lake St. Martin. Alternate construction methods will also be considered, such as isolating the area with a double turbidity curtain instead of a rock plug/cofferdam, or allowing excavation works to occur in the winter in shallow areas where the lake ice freezes all the way through to the bottom elevation. These options will be reviewed at detailed design with input from the environmental approval process.

13.1.3 Outlet Works

Outlet works, identified as Work Area 8 as described in Section 13.3, will consist of excavating the lake bottom within an approximately 200 m long by 200 m wide area of Lake Winnipeg. Construction activities and measures to manage surface water during construction will be similar to the inlet works, which were described in Section 15.1.2.

13.1.4 Water Control Structure

Dewatering activities will be required for construction of the water control structure (Work Area 1) to collect surface water runoff and to address groundwater depressurization requirements, as described in the Groundwater Management Plan. Construction of the water control structure will be isolated from channel construction activities to prevent additional surface water runoff from entering the work area. Other potential sources of water include various types of processed water, as described in Section 14.3.

Water from within the work area will be treated, as required, to comply with the criteria outlined in Section 3.1. Settling ponds will be constructed adjacent to the work area, as deemed necessary, prior to discharge into the temporary outside drain or at alternate locations to be approved by MI during construction.

13.1.5 Sediment Management

A separate SMP for the control of erosion and sediment has been prepared for the Project. The SMP identifies temporary and permanent measures that will be incorporated during construction until vegetation has been established on disturbed areas to prevent or minimize the potential for erosion and to mitigate the transport and deposition of sediments beyond construction areas and into off-site receiving water bodies. These measures will be developed to meet compliancy requirements outlined in the Environmental license and federal decision statement conditions.

13.2 Operation Phase (Permanent Measures)

Once construction is complete, surface water from outside of the project area (i.e., east of the channel) will be managed with a permanent outside drain and drainage control structures, as described in Section 15.2.1. Surface water runoff within the Right of Way of the LSMOC will either discharge into the LSMOC or away from the channel, as described in Section 15.2.2.

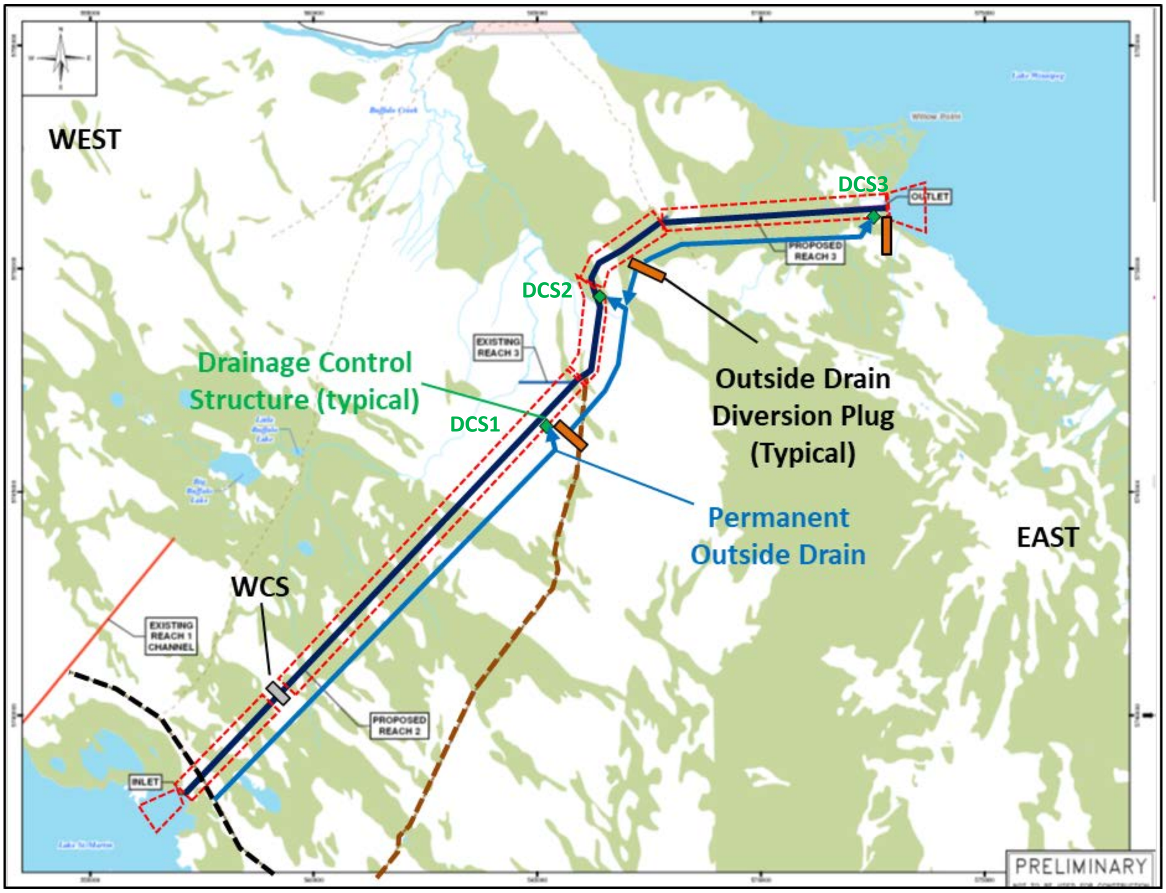
Permanent erosion control measures, such as the drop structure, will help minimize erosion in the LSMOC. In addition, temporary erosion and sediment control measures will be maintained post construction until vegetation has fully established and it is confirmed that the criteria identified in Section 3.3 can be maintained in the long term. Refer to the SMP and Revegetation Management Plan for further details.

Construction of the LSMOC will result in a reduction to the catchment size of the Buffalo Creek basin, as described in Section 14.1. Plans to address the potential impacts to Buffalo Creek will be included with the Offsetting Plan and therefore are not discussed in the SWMP.

13.2.1 Outside Drain

The outside drain will collect all surface runoff from the east side of the project area and was assumed during preliminary design to discharge into the LSMOC with drainage control structures (i.e., culvert structures) installed through the LSMOC dike at three different locations, as shown on Figure 15. An alternate option to discharge the outside drain directly into Lake Winnipeg instead of into the LSMOC will be considered during detailed design considering construction risks, costs and the environment. Methods to address potential aquatic impacts of surface water flow in the LSMOC are addressed in the AEMP.

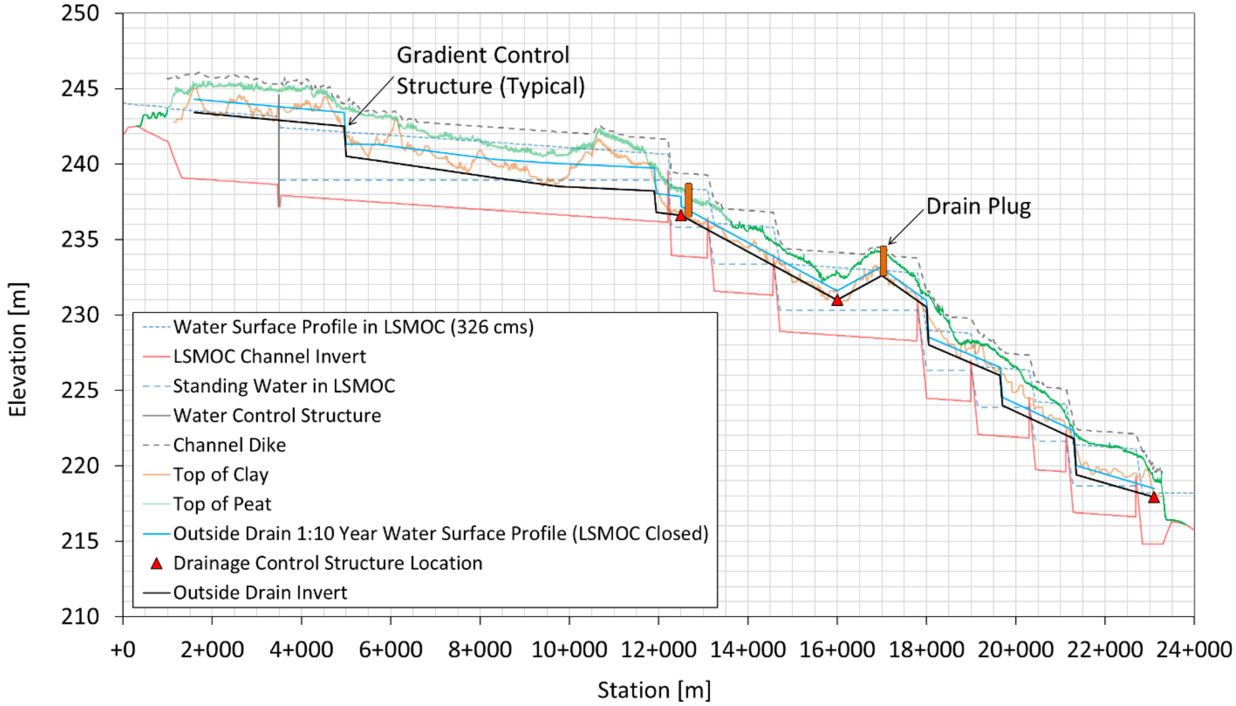
Figure 15: Permanent Surface Water Drainage Plan



The estimated design discharge for the outside drain was provided in Section 14.1. On the west side, surface water naturally flows away from the channel, therefore, an outside drain on that side of the channel is not required.

The hydraulic design of the outside drain was based on a trapezoidal channel shape with a 4 m wide channel base and 4H:1V side slopes. The longitudinal slope was optimized to minimize excavation depths and erosion while ensuring the channel invert is located within mineral soil and not perched within the peat layer. To achieve the design criteria described in Section 3.3 and not exceed the maximum permissible tractive force of 10 Pa, a number of small outside drainage gradient control rockfill structures have been incorporated into the design. Figure 16 shows the hydraulic profile for the outside drain for the 1:10 year design event, assuming the LSMOC water control gates are closed. Hydraulic design details, including drawings for the drain and associated structures, are available with the preliminary design.

Figure 16: Profile of the Outside Drain



As described in Section 15.1.1, the outside drain will be constructed as part of the site preparation contract and will initially provide temporary drainage during construction. During detailed design, the hydraulic design of the outside drain will be updated, as required, considering the final project sequencing and construction plan, and input from the environmental process.

To provide adequate drainage during construction, a continuous excavated drainage channel will be constructed as part of the site preparation contract. Once construction of the LSMOC and drainage control structures is completed, outside diversion plugs will be required across the drain at three locations to divert flow to the channel at drainage control structures rather than following the temporary outside drain adopted during construction. Without the diversion plug, the outside drain would have to increase in size to convey the increased design flow from the larger catchment area. To reduce excavation costs and manage the magnitude of the outside drain discharge, the preliminary design considered that the diversion plugs will be added for the permanent drain configuration. The locations of the outside drain diversion plugs are shown on Figures 15 and 16. This configuration, as compared to an option that would convey all of the surface water runoff to Lake Winnipeg without including diversion plugs or drainage control structures will be reviewed at detail design considering costs and risks.

Drainage Control Structure 1 will consist of 3 x 1200 mm CMP culverts, while Drainage Control Structures 2 and 3 will consist of 2 x 1000 mm CMP culverts. A permanent gate chamber consisting of flap gates and manually operated slide gates will be installed at Drainage Control Structures 1 and 2 to mitigate the risk of water from the LSMOC exiting the channel and flowing along the outside drain or overland towards Lake Winnipeg.

When the LSMOC is in operation (i.e. about 22% of the time or about once every 3 years, as described in Section 13.2), surface water runoff in the outside drain will pond upstream of the drainage control structures until there is sufficient head for the outside drain discharge to the channel to occur by gravity. This will likely result in some overland flooding in vicinity of Drainage Control Structure 2 due to the lower topography in that area and would depend on the LSMOC water levels and discharge in the outside drain.

Regardless of whether the LSMOC is in operation, when the surface water runoff significantly exceeds the design condition, overland flooding will occur along the outside drain in low lying areas. In proximity of the outside drain diversion plugs, overland flooding may bypass the plugs and flow downhill towards Lake Winnipeg. If overland flow is deemed not acceptable for environmental reasons, a larger drain and drainage control structures would be required to accommodate the increased design requirements.

Additional details on the hydraulic design of the outside drain and drainage control structures will be provided at the detailed design stage, as required.

13.2.2 Conditions in the Outlet Channel

When the LSMOC water control structure gates are closed, a minimum one meter depth of water in the channel will be maintained and a base flow will be provided through the water control structure to maintain appropriate water quality conditions (oxygen levels), as described in Section 13.1. Alternate water depths may be considered at detailed design with input from the aquatic environment consultant to optimize potential aquatic habitat benefits and costs, if deemed necessary. Other sources of water will include flow discharged from the outside drain at each of the drainage control structures, groundwater discharge, and runoff within the channel banks and along the slopes of the channel dikes. Runoff from the maintenance road and the slopes of the spoil pile (see Figure 8) will be collected by a small ditch adjacent to the road and discharged into the outside drain.

Maintaining and establishing a vegetation cover in the LSMOC is a key component to minimizing the erosion potential during construction and over the long-term. A summary of the revegetation plan is provided in Section 15.2.3. Temporary erosion and sediment control measures will be maintained along the channel banks until vegetation has fully established.

As described in Section 13.2, simulation of the historic period from 1915-2017 indicated that the LSMOC would have been operated approximately 22% of the time (days) and 38 years of the 103 year period. When the LSMOC is in operation, water levels will typically increase by two to three meters for extended periods. As a result, portions of the channel side slopes will experience alternating periods of submergence (wet) and exposure (dry). Under these conditions, there will be a zone where vegetation may not survive or grow well, thus making the slopes susceptible to erosion. Although the revegetation plan will consider these conditions, additional mitigation measures will be considered during detailed design to address the risk of erosion along exposed side slopes. This may consist of installing permanent erosion control measures or implementing a long-term monitoring and management approach.

13.2.3 Revegetation Plan

Maintaining and establishing a vegetation cover in the LSMOC is fundamental to minimizing the erosion potential during construction and over the long-term. The revegetation approach will be dynamic and flexible in terms of its implementation under potentially challenging hydrological conditions and is described in the Revegetation Management Plan.

14.0 MONITORING

Surface water quality will be monitored to identify any changes that may result from channel construction activities and to assess the effectiveness of the proposed mitigations and the SMP. If water quality criteria defined in Section 3.1 are exceeded and attributed to the project, additional mitigation measures would be considered, as described in Section 18.0.

The proposed water quality parameters to be monitored, as well as the proposed locations and detail on methodologies (including baseline and long-term monitoring requirements) will be confirmed at detailed design and will be based on the monitoring plans being developed for the project as part of other management plans, such as the AEMP and GWMP. The preliminary water quality monitoring plan is described in this section and is prefaced by a summary of historical surface water monitoring data.

14.1 Historical Monitoring

Surface water quality sampling and monitoring in both the regional study area and in the Local Assessment Area (LAA) was conducted prior, during and after construction and post operation of the Lake St. Martin Emergency Outlet Channel (EOC). Surface water quality monitoring in the LAA was broken into three phases. The first phase was the 2011 Construction Monitoring Program, which began during construction in September 2011 and continued until just after initial operation of Reach 1 in November 2011. The second phase was the 2012 Water Quality Monitoring Program with the objective of continuing to monitor the EOC System during operation of Reach 1, as well as during the construction and potential operation of Reach 3. The third phase was the operation and post-closure monitoring of EOC System, which included sample events during a second operation of Reach 1 in 2014.

A select list of parameters was used to monitor the effects on water quality in the LAA, while the Regional Water Quality Monitoring Program used a more comprehensive list of parameters. The 2012 and 2013 water quality monitoring programs followed the protocols established during the 2011 Construction Monitoring Program. These protocols included special consideration in assessment of concentrations of TSS and dissolved oxygen (DO) to determine the potential impacts on aquatic life as a result of project activities. Other parameters analyzed included nutrients (ammonia, nitrate and nitrite, total Kjeldahl nitrogen, and total and dissolved phosphorus), mercury, and petroleum hydrocarbons (Table 4). *In situ* measurements of various water quality parameters including turbidity, DO, temperature, pH, and electrical conductance were conducted with every water quality sample collected.

Table 4: Emergency Outlet Channel 2011 Construction Monitoring Water Quality Parameters

Parameter	Detection Limit (mg/L)	Guidelines (CCME PAL)
Sediment		
Total suspended solids	5	25[(1)]
Nutrients		
Ammonia	0.05	0.055
Nitrate and nitrite	0.071	-
Nitrate-N	0.05	13
Nitrite-N	0.05	0.06
Total Kjeldahl Nitrogen	0.2	-
Total nitrogen	0.2	-
Total dissolved phosphorus	0.01	-
Total phosphorus	0.01	-
Petroleum Hydrocarbons		
Benzene	0.0005	0.37
Ethylbenzene	0.0005	0.9
Toluene	0.001	0.002
o-xylene	0.0005	-
m+p-Xylenes	0.0005	-
Xylenes	0.0015	-
Total hydrocarbons (C6-C50)	0.44	-
Fraction F1(C6-C10)	0.1	-
Fraction F2 (C10-C15)	0.25	-
Fraction F3 (C16-C34)	0.25	-
Fraction F4 (C35-C50)	0.25	-
Metals		
Total Mercury	0.00006	0.000025
Dissolved Mercury	0.00005	-

Notes:
1: Total Suspended Solids CCME guideline exceedance is 25 mg/L greater than baseline value

There were a few aspects of the 2012 and 2013 water quality programs that were modified, when compared to the 2011 Construction Monitoring Program, prior to continuing monitoring in January 2012:

- Sample stations were added and removed, as required.
- The analytical detection limit for TSS was reduced to 2.0 mg/L rather than the less stringent 5.0 mg/L previously used in 2011.
- Turbidity was added to the analytical data to provide an alternate estimation of impacts from suspended solids and to correlate with any in situ data measured in the field.

- Mercury was only sampled at selected locations and only at the onset of the monitoring program in 2012 as this parameter was sufficiently being monitored by the Regional Water Quality Monitoring Program conducted by North/South Consultants.
- Petroleum hydrocarbons were only sampled at selected locations and only at the onset of the monitoring program and again during closure activities in 2012 (not in 2013), as these parameters had been included in 2011 to monitor impacts during construction activities in proximity to surface water or when working in water.

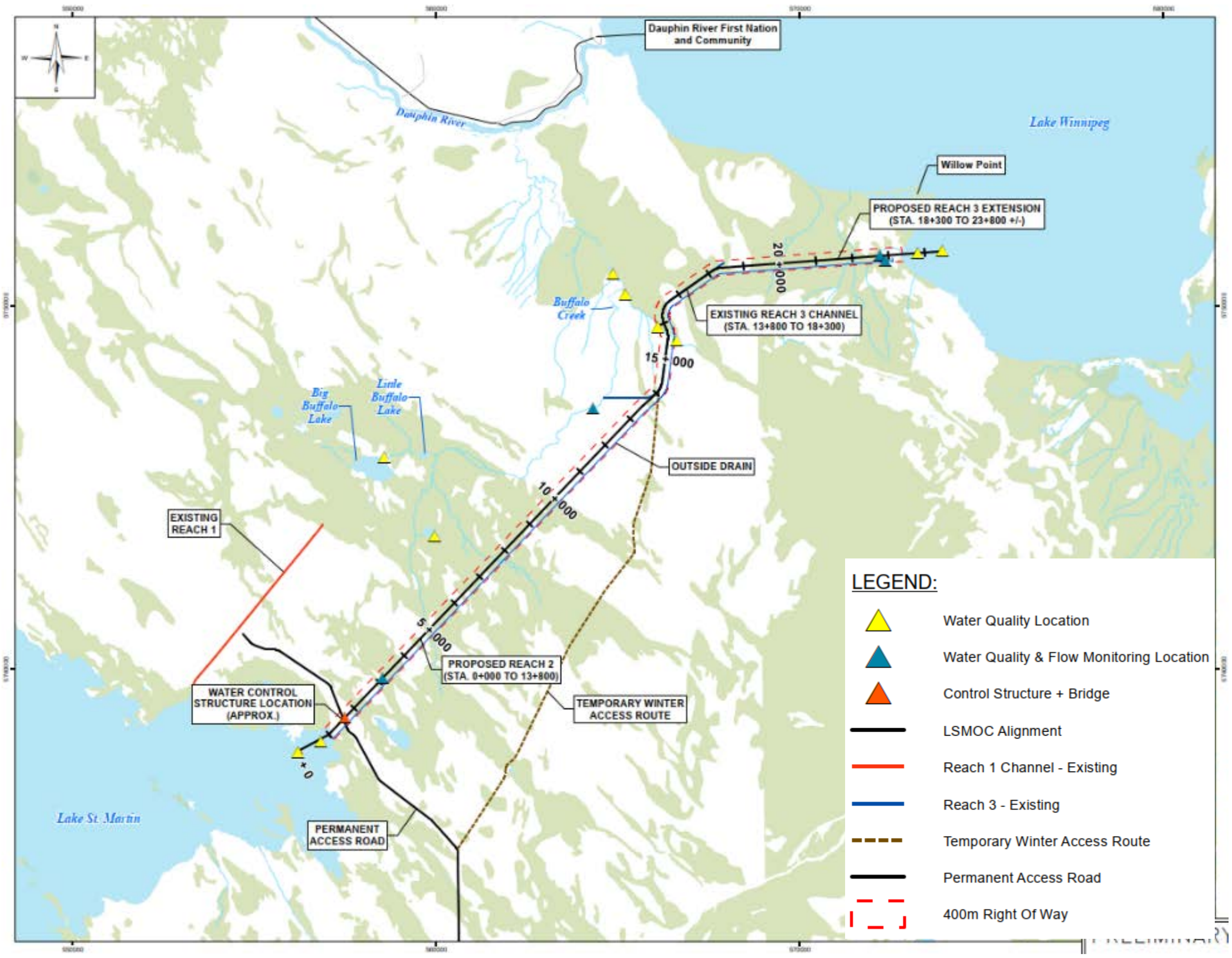
Where available, historic surface water quality data will serve as baseline for any identified changes in concentrations of water quality parameters. Applicable sample stations monitored during previous studies (in Big Buffalo Lake and Buffalo Creek) are included in the proposed locations for the SWMP. Additional surface water samples at select locations included in the SWMP (inlet, outlet, and along Creek 3 that intersects the channel alignment) were collected by KGS Group beginning in June 2020. Additionally, surface water quality samples collected during historic Regional Water Quality sampling programs and from sample stations in the LAA collected by North/South Consultants beginning in August 2020 will be used to support the baseline data for the LSMOC, as required.

14.2 Construction Phase Monitoring

Surface Water Quality Monitoring in support of the LSMOC will begin at the onset of the construction phase of the project as part of the Resident Contract Administration and will continue through to the end of the Construction phase. The frequency and location of sample stations included in the program will change as the construction staging advances creating more sampling location including pilot channels, LSMOC channel and outside drains and any other location deemed necessary as staging of construction is completed. Determination of frequency and location of samples will also be based on environmental considerations described in the EIS and with special consideration for proximity and potential for change to local fish bearing receiving waters. For specific construction activities, increased water quality sampling and laboratory analysis for TSS and turbidity and subsequent monitoring of in situ parameters (turbidity, pH, dissolved oxygen, and conductivity) may be required, as was done during initial operation of the EOC. Water Quality parameters will be compared to the more stringent of either the CCME Canadian Environmental Quality Guidelines or applicable MWQSOG.

Figure 17 identifies preliminary locations where water quality monitoring may occur. These include locations on both Lake St. Martin and Lake Winnipeg, downstream and upstream of discharge points such as the pilot channel and outside drain. Flow metering has been included to support assessment of surface water quality parameters at select surface water sampling stations in the LSMOC Channel and outside drain, and in Buffalo Creek.

Figure 17: Locations of Water Quality Monitoring



14.3 Operation Phase Monitoring

Upon completion of the construction phase, quarterly surface water sampling events will occur at specified locations for a minimum of two years post construction. The frequency, locations and parameters of the water quality monitoring conducted during operation will be similar to the construction phase as described in Section 16.2. The program will be updated based on specific environmental conditions present, success of revegetation, time between last operation and current operation and adjusted, as required, based on monitoring results. Figure 17 shows the preliminary locations where water quality monitoring may occur. These include locations on both Lake St. Martin and Lake Winnipeg, downstream and upstream of discharge points and the outside drain. Flow metering will also be included to support assessment of surface water quality parameters at select surface water sampling stations in the LSMOC Channel and outside drain, and in Buffalo Creek.

14.4 Reporting

Annual surface water monitoring reports will be prepared throughout the construction phase and for the duration of monitoring ultimately conducted during the operation phase.

15.0 ADAPTIVE MANAGEMENT AND FOLLOW-UP

15.1 General

A follow up process is a form of adaptive management to improve practices by learning about their effects and then making changes in those practices as new information is available. The federal Impact Assessment Act defines a follow up program as "a program for verifying the accuracy of the impact assessment of a designated project and determining the effectiveness of any mitigation measures." An associated Operational Policy Statement (https://www.canada.ca/content/dam/iaac-acei/documents/ops/ops-follow-up-programs-2011.pdf) indicated that "a follow-up program is used to:

- verify predictions of environmental effects identified in the environmental assessment
- determine the effectiveness of mitigation measures in order to modify or implement new measures where required
- support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects
- provide information on environmental effects and mitigation that can be used to improve and/or support future environmental assessments including cumulative environmental effects assessments, and
- support environmental management systems used to manage the environmental effects of projects."

As discussed in Section 12.4.1.2 of the EIS, construction activities and the changes in flows and water levels caused by the Project may have minor effects on fluvial geomorphology, sediment and debris transport, in the surface water LAA, but primarily during and immediately after construction. Suspended sediment levels may temporarily increase at work sites during construction activities, and at outlet areas during initial operation (gates open) of the outlet channels after a period of non-operation (gates closed). As such, the purpose and objectives of follow-up activities will be to monitor and further understand the residual effects due to the Project.

Although the methods and recommendations outlined in the SWMP were developed based on site-specific expectations and conditions, it is accepted that these conditions are subject to change. For example, weather conditions and climate change will inevitably drive some of the design decisions during implementation and long-term operation. By employing adaptive management strategies, assumptions used in the initial design will be evaluated and management practices modified in response to the outcomes during the Project construction period and subsequent operation phase based on baseline investigations, follow-up monitoring and reporting.

Adaptive management uses the Project designs while learning from field performance to manage risk and allow the incorporation of new knowledge into subsequent steps. The foundation of this process relies on data input and implementation of sound monitoring programs. Based on the monitoring results and feedback during construction, temporary mitigation measures described in this SWMP, as well as those included in the SMP and RVMP, should be revisited and updated, as required. For example, if the establishment of vegetation following excavation work is more difficult than expected, alternate vegetating methods may be considered, or additional temporary erosion control measures may be warranted. Adaptive management will play an important role in acknowledging and working through management challenges in the presence of uncertainty.

15.2 Follow Up Response

As described in Section 15, monitoring will include visual inspections, and water quality monitoring as part of the SWMP and AEMP. The data and analyses generated by monitoring will be used to provide information on the effectiveness of mitigation measures, aid in the validation of predicted residual effects, and provide data and results required for environmental licensing requirements. These plans will include management thresholds developed as part of the monitoring plan and may utilize regulated criteria, input from stakeholders, and consideration of findings from applicable Management Plans. Based on the management thresholds and the results of the surface water monitoring program, follow up activities will be implemented where conditions recorded appear to be outside of anticipated seasonal fluctuations in both surface water quantity and quality.

16.0 CONTINGENCY MEASURES AND EMERGENCY RESPONSE

Contingency measures and emergency response will be developed prior to construction so that they can be deployed in the event that aspects of this SWMP does not meet the water quality objectives or if the prescribed measures are overwhelmed during a severe runoff event greater than the design. Contingency planning will also be incorporated for unexpected events such as, but not limited to, an uncontrolled breach of a settling pond, or the failure of a pumping system for dewatering.

Mitigation measures will be identified in the “base” plan and may include, for example, choosing final locations of settling ponds to minimize direct surface runoff to aquatic environments, or incorporating secondary containment cells at each of the main settling ponds. Contingency measures that would be implemented in the event of an emergency will also be identified and may include, for example, the deployment of straw rolls/wattles, erosion control blankets, rapid stabilization techniques, supplementary seeding, temporary settling ponds etc.

In the event of an emergency, the Contractor would be notified and advised as to which of the contingency and emergency control measures would be implemented. These contingency and emergency control measures would be carried out within a predetermined time period depending on the site conditions and nature of the emergency.

17.0 REFERENCES

17.1 Additional Sources

A number of background reports and data sources were reviewed and considered as part of the SWMP for the LSMOC. The following lists the most pertinent information:

- Ongoing Preliminary Design of the LSMOC including 2019 surveys and investigations.
- Development of Operating Rules for Lake Manitoba and Lake St. Martin Outlet Channels with recommended Revisions. February 2019, Manitoba Infrastructure.
- 2011 and 2017 LiDAR and ortho imagery provided by Manitoba Infrastructure.
- Flood Frequency Analysis – Lakes Manitoba and St. Martin, June 2017, Manitoba Infrastructure.
- Preliminary Design for Reach 2 of the Lake St. Martin Outlet Channel. June 2017. KGS Group.
- Investigations and Preliminary Engineering for LMB Channel Options C and D Summary Report. May 2017. KGS Group.
- Lake St. Martin Emergency Relief Channel Monitoring and Development of Habitat Compensation (Draft Report). August 2016. North/South Consultants Inc.
- Lake St. Martin Emergency Relief Channel Monitoring and Development of Habitat Compensation - Physical Processes (Volume 2 - Draft Report). March 2016. KGS Group.
- Assiniboine River & Lake Manitoba Basins Flood Mitigation Study, LMB & LSM Outlet Channels, Conceptual Design – Stage 2, Final Report. January 2016. KGS Group.
- Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels; Binder Series of Deliverables. November 2015. KGS Group in association with North/South Consultants Inc.