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# Lake Manitoba Outlet Channels: Summary of the Existing Environment - Final Report

**Submitted to:**

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## TABLE OF CONTENTS

**1 INTRODUCTION ..... 1**
**2 BACKGROUND ..... 2**
**3 ABORIGINAL TRADITIONAL KNOWLEDGE ..... 2**
**4 PROJECT SCOPE ..... 4**
4.1 Spatial Boundaries ..... 4
4.1.1 Project Footprint ..... 5
4.1.2 Local Study Area ..... 6
4.1.3 Regional Study Area ..... 7
4.2 Temporal Boundaries ..... 7
**5 PROJECT DESCRIPTION ..... 9**
5.1 LMOC Route C ..... 9
5.2 LMOC Route D ..... 10
**6 STUDY METHODS ..... 12**
6.1 Desktop Methods ..... 12
6.2 Field Studies ..... 16
**7 EXISTING ENVIRONMENT ..... 20**
7.1 Biophysical Environment ..... 20
7.1.1 Climate ..... 20
7.1.2 Climate Change ..... 23
7.1.3 Greenhouse Gas Emissions ..... 24
7.1.4 Air Quality ..... 27
7.1.5 Noise and Vibration ..... 29
7.1.6 Terrain and Topography ..... 32
7.1.7 Geology and Soils ..... 33
7.1.8 Vegetation ..... 36
7.1.8.1 Ecological Land Classification ..... 36
7.1.8.2 Vegetation Cover Classification ..... 37
7.1.8.3 Wetland Classification ..... 37
7.1.8.4 Plant Species of Conservation Concern ..... 38
7.1.8.5 Plant Species of Significance to First Nations ..... 39
7.1.8.6 Invasive Species ..... 39
7.1.8.7 Summary of 2016 Field Investigations ..... 40
7.1.8.8 Vegetation Study Summary ..... 45
7.1.9 Wildlife and Wildlife Habitat ..... 46
7.1.9.1 Mammals ..... 46

7.1.9.2 Birds ........ 48
7.1.9.3 Reptiles and Amphibians ........ 50
7.1.9.4 Key Species For Analysis ........ 50
7.1.9.5 Data Collection and Analysis ........ 53
7.1.9.6 Wildlife Study Summary ........ 58
7.1.10 Groundwater ........ 65
7.1.10.1 Route C ........ 66
7.1.10.2 Route D ........ 68
7.1.11 Surface Water ........ 71
7.1.11.1 Water Quantity ........ 71
7.1.11.2 Water Regulation ........ 75
7.1.11.3 Water Quality ........ 76
7.1.12 Fisheries and Aquatic Habitat ........ 78
7.1.12.1 Introduction ........ 79
7.1.12.2 Fairford Study Site – Lake Manitoba, Route C ........ 79
7.1.12.3 Watchorn Bay Study Site – Lake Manitoba, Route D ........ 80
7.1.12.4 Harrison Bay Study Site – Lake St. Martin, Route C ........ 81
7.1.12.5 Birch Bay Study Site – Lake St. Martin, Route D ........ 82
7.1.12.6 Fisheries and Aquatic Habitat Study Summary ........ 83
7.1.12.7 Aquatic Invasive Species ........ 84
7.1.13 Species at Risk ........ 85
7.1.13.1 Flora ........ 86
7.1.13.2 Fauna ........ 86
7.2 Socio-Economic Environment ........ 87
7.2.1 Regional Communities and Population ........ 87
7.2.2 Aboriginal Population ........ 89
7.2.2.1 Dauphin River First Nation ........ 89
7.2.2.2 Lake St. Martin First Nation ........ 89
7.2.2.3 Pinaymootang First Nation ........ 89
7.2.2.4 Little Saskatchewan First Nation ........ 91
7.2.2.5 Peguis First Nation ........ 91
7.2.2.6 Métis ........ 91
7.2.3 Land Use ........ 92
7.2.4 Infrastructure and Services ........ 92
7.2.4.1 Roads and Highways ........ 92
7.2.4.2 Railways ........ 95
7.2.4.3 Airports ........ 95
7.2.4.4 Hydroelectric Power Transmission ........ 95
7.2.4.5 Pipelines ........ 95
7.2.4.6 Waste Disposal ........ 95
7.2.4.7 Wastewater Treatment Lagoons ........ 95
7.2.5 Resource Use ........ 96

7.2.5.1 Agriculture ... 96
7.2.5.2 Forestry ... 96
7.2.5.3 Lodges and Outfitters ... 96
7.2.5.4 Industry ... 96
7.2.5.5 Quarries and Mining ... 97
7.2.5.6 Recreational Trails and Campgrounds ... 97
7.2.5.7 Boating and Water Sports ... 97
7.2.5.8 Commercial, Subsistence and Recreational Fishing ... 98
7.2.5.9 Hunting ... 98
7.2.5.10 Trapping ... 100
7.2.6 Protected Areas ... 100
7.2.7 Culture and Heritage Resources ... 101
7.2.7.2 Culture and Heritage Resources Summary ... 106
7.2.8 Human Health and Safety ... 109
**8 CLOSURE ... 110**
**9 REFERENCES ... 111**
9.1 Personal Communications ... 121

**LIST OF TABLES**

Table 1: Summary of Project Temporal Boundaries* ... 9
Table 2: Summary of Desktop Methods Used for Each Environmental Component ... 13
Table 3: Summary of Field Study Methods Used for Each Environmental Component ... 16
Table 4: Climate Normals Summary for Lundar, Manitoba (1981-2010) ... 20
Table 5: GHG Emissions by Province and Territory for 1990, 2005 and 2014 ... 24
Table 6: Summary of GHG Emissions Reported by Facilities in Manitoba in 2014 (ECCC 2016d) ... 26
Table 7: Air Quality Parameters for Winnipeg, Manitoba, December 07, 2016 ... 28
Table 8: Common Noise Levels and Typical Human Reactions ... 30
Table 9: Summary of Key Species Selection and Rationale ... 52
Table 10: Area and Percentage of LCC Covertypes within the RSA and LSA ... 54
Table 11: LCC Habitat Analysis Comparison between LMOC Route C and LMOC Route D Outlet Channels ... 55
Table 12: Existing Linear Density within the RSA and LSA ... 57
Table 13: Linear Density within the RSA and LSA for Proposed LMOC Routes ... 57
Table 14: Summary of Status of Bird Species of Conservation Concern, Confirmed Activity in the LMOC LSA During Field Studies, and Potential Habitat Loss Due to Construction of Route C or Route D ... 62

Table 15: Summary of Fairford River Flows in Cubic Metres per Second from 1912 to 2015 ... 74

**LIST OF FIGURES**

Figure 1: Lake Manitoba Outlet Channels Project Local Study Area ... 3
Figure 2: Project Study Area, including the selected Regional and Local Study Areas ... 8
Figure 3: Windroses over the northern basin of Lake Manitoba from June through August (ECCC 2016a) ... 22
Figure 4: Windroses over the northern basin of Lake Manitoba from September through November (ECCC 2016a) ... 23
Figure 5: Winnipeg (Downtown) Air Quality Index, 1987-2008 ... 29
Figure 6: Geological information for the RSA and LSM meteor impact area (from Leybourne et al 2007) ... 34
Figure 7: Overview of Waterbodies and Watercourses Within and Connected to the Project RSA ... 72
Figure 8: Watercourses and Waterbodies in the LSA and Potential Connectivity to the Proposed LMOC Route C and LMOC Route D ... 73
Figure 9: Regional Communities ... 88
Figure 10: Aboriginal Communities and Community Interest Zones ... 90
Figure 11: Land Ownership ... 93
Figure 12: Infrastructure and Services ... 94
Figure 13: Map of Known Archaeological Sites within the Regional Study Area ... 103
Figure 14: Map of the Known Archaeological Sites and Heritage Resources That Extend to Lake Manitoba Narrows and the Former Municipality of Siglunes ... 104

**LIST OF PHOTOS**

Photograph 1: View of Seneca root (*Polygala senega*) within a tame hayfield along Route C at Plot 16, June 10, 2016 (S. Gray Environmental Services Inc. 2016) ... 44

**LIST OF APPENDICES**

Appendix 1: Vegetation Technical Report ... 122
Appendix 2: Wildlife Technical Report ... 123
Appendix 3: Aquatics Technical Report ... 124
Appendix 4: Heritage Resources Technical Report ... 125

| ABBREVIATIONS | |
|---|---|
| % | Percent |
| ≤ | Less Than or Equal To |
| °C | Degrees Celsius |
| AC | Alternating Current |
| AQHI | Air Quality Health Index |
| ASI | Areas of Special Interest |
| ATK | Aboriginal Traditional Knowledge |
| $CH_4$ | Methane |
| CIZ | Community Interest Zone |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| COSEWIC | Committee On the Status of Endangered Wildlife In Canada |
| CPUE | Catch Per Unit Effort |
| CRA | Commercial, Recreational or Aboriginal (Fisheries) |
| dB | Decibel |
| dBA | A-Weighted Decibel |
| DO | Dissolved Oxygen |
| FMU | Forest Management Unit |
| FN | First Nation |
| FRI | Forest Resource Inventory |
| GHA | Game Hunting Area |
| GHG | Greenhouse Gas |
| ha | Hectare |
| IR | Indian Reserve |
| IWSA | Integrated Wood Supply Area |
| km | Kilometre |
| km/hr | Kilometres Per Hour |
| $km^2$ | Square Kilometre |
| kV | Kilovolt |
| LCA | Life Cycle Analysis |
| LCC | Land Cover Classification |
| LSA | Local Study Area |
| m | Metre |
| m/s | Metres Per Second |

| ABBREVIATIONS | |
|---|---|
| masl | Metres Above Sea Level |
| MBCDC | Manitoba Conservation Data Centre |
| MESEA | Manitoba *Endangered Species and Ecosystems Act* |
| MI | Manitoba Infrastructure |
| mm | Millimetre |
| NO | Nitric Oxide |
| $NO_2$ | Nitrogen Dioxide |
| $NO_2$ | Nitrous Oxide |
| $NO_x$ | Nitrogen Oxides |
| NTU | Nephelometric Turbidity Unit |
| NWA | Noxious Weed Act |
| $O_3$ | Ozone |
| $PM_{10}$ | Particulate Matter ≤ 10 Microns |
| $PM_{2.5}$ | Particulate Matter ≤ 2.5 Microns |
| PR | Provincial Road |
| PSL | Permissible Sound Levels |
| PTH | Provincial Trunk Highway |
| RHA | Regional Health Authority |
| RM | Rural Municipality |
| RoW | Right-Of-Way |
| RSA | Regional Study Area |
| RTL | Registered Trap Line |
| SARA | Species At Risk Act |
| $SH_6$ | Sulphur Hexafluoride |
| $SO_2$ | Sulphur Dioxide |
| US | United States |
| VOCs | Volatile Organic Compounds |
| WMAs | Wildlife Management Areas |

# 1 INTRODUCTION

Manitoba Infrastructure (MI) is currently developing options to address ongoing flood issues in the Assiniboine River and Lake Manitoba watershed basins. As part of this endeavour, MI initiated the *Assiniboine River & Lake Manitoba Basins Flood Mitigation Study*. This study, which was completed in 2011, included several components. In particular, the "*Assiniboine River & Lake Manitoba Basins Flood Mitigation Study Lake Manitoba & Lake St. Martin Outlet Channels Conceptual Design - Stage 1 - Deliverable No: LMB-01*" (KGS Group 2014) and the "*Assiniboine River & Lake Manitoba Basins - Flood Mitigation Study LMB & LSM Outlet Channels Conceptual Design - Stage 2*" (KGS Group 2016) were key to identifying future flood protection initiatives for the Assiniboine River and Lake Manitoba watershed basins.

The Stage 1 and Stage 2 Conceptual Designs prepared by KGS and MI included the three following components:

- further development of the Lake St. Martin Outlet Channel (LSMOC), which involves development of a channel in the area referred to as Reach 2 and completion of the channel referred to as Reach 3;
- construction and operation of a new channel from Lake Manitoba (LM) to Lake St. Martin (LSM) to increase flow capacity and expedite movement of flood waters between these waterbodies; and
- construction and operation of an All Season Road (ASR) in the area of the Lake St. Martin Outlet Channels to facilitate year-round vehicle, crew and equipment access to the Lake St. Martin Outlet Channels.

These three main components formed the overall MI Lake Manitoba and Lake St. Martin Access Road and Outlet Channels Project (the Project) at the time of this writing.

MI later engaged M. Forster Enterprises (MFE) and a team of professional consultants to conduct desktop and field investigations at varying spatial scales near the Project to provide information on the existing environmental conditions for each of the three Project components listed above. The intent of these investigations was to describe the baseline conditions in vicinity of the Project to support a future Environmental Impact Assessment (EIA). While the overall Project will require approval and licensing under the federal *Canadian Environmental Assessment Act* (CEAA) and the Manitoba *Environment Act*, the realignment and construction of an ASR for construction access will require regulatory approval and licensing from the Province of Manitoba.

This report provides a summary of the existing environmental conditions, as identified through desktop, field studies and associated analysis, to facilitate an Environmental Impact Assessment (EIA) for the construction and operation of a new channel from Lake Manitoba to Lake St. Martin, referred to as the Lake Manitoba Outlet Channels (LMOC) component of the Project.

# 2 BACKGROUND

Prior to this assignment, MI had evaluated a number of different conceptual route options for the LMOC. At the time of this writing, MI had selected two preferred route options for the LMOC, referred to as the LMOC Route C and LMOC Route D. As such, the examination of existing environmental conditions for the LMOC was completed for these two preferred route options identified by MI.

The LMOC Route C would be located south of the Fairford River and run roughly parallel to the southern border of the Pinaymootang First Nation (FN).The LMOC Route D would run from an inlet on Watchorn Bay in Lake Manitoba to the outlet of Birch Creek on Lake St. Martin (KGS Group 2016). The Stage 2 Conceptual Design for Route C is presented on Plate 2 in KGS Group 2016, and the Stage 2 Conceptual Design for Route D is presented on Plate 5 in KGS Group 2016. **Figure 1** provides a map of the LMOC Project local study area and the proposed locations for LMOC Route C and LMOC Route D. Information on the boundaries selected for the Project study area is provided below in Section 3.

Based on the analysis conducted by KGS Group, the LMOC will be designed to convey a flow of 212 cubic metres per second ($m^3/s$) (7,500 cubic feet per second [cfs]) (KGS Group 2016). In addition to the design, excavation, construction and operation of the LMOC, selection of either route would require changes to existing roads and highways in the area of the channel, as well as the design, installation and operation of new bridges and new culvert crossings. At the time of this writing, the conceptual design of the LMOC included the construction and operation of a gated water control structure to manage flows within the LMOC; a permanent groyne to be constructed in Lake Manitoba at the LMOC inlet; and the use of temporary cofferdams at the Lake Manitoba inlet and Lake St. Martin outlet areas during construction (KGS Group 2016). Additional information on the conceptual design, construction and operation of the LMOC Route C and LMOC Route D is provided below in Section 4.

# 3 ABORIGINAL TRADITIONAL KNOWLEDGE

It is recognized that there are many plant species, wildlife species, fish species and areas of cultural significance to many First Nations peoples, and that these plants, wildlife, fish and areas of significance will vary by the practices of each First Nation, and their gathering locations. It is recognized that First Nations people have a special relationship with the earth and all living things in it. This relationship is based on a profound spiritual connection to the environment that guided indigenous peoples to practice reverence, humility and reciprocity. First Nations people have relied on many species of plants, wildlife and fish for subsistence needs and cultural values that extend back thousands of years. In regard to the collection and use of Aboriginal Traditional Knowledge (ATK) for the baseline investigations, MI and First Nations consultations were ongoing at the time of this writing, and ATK for plants, wildlife, fish and areas of cultural significance in the Project Study Area had yet to be compiled.

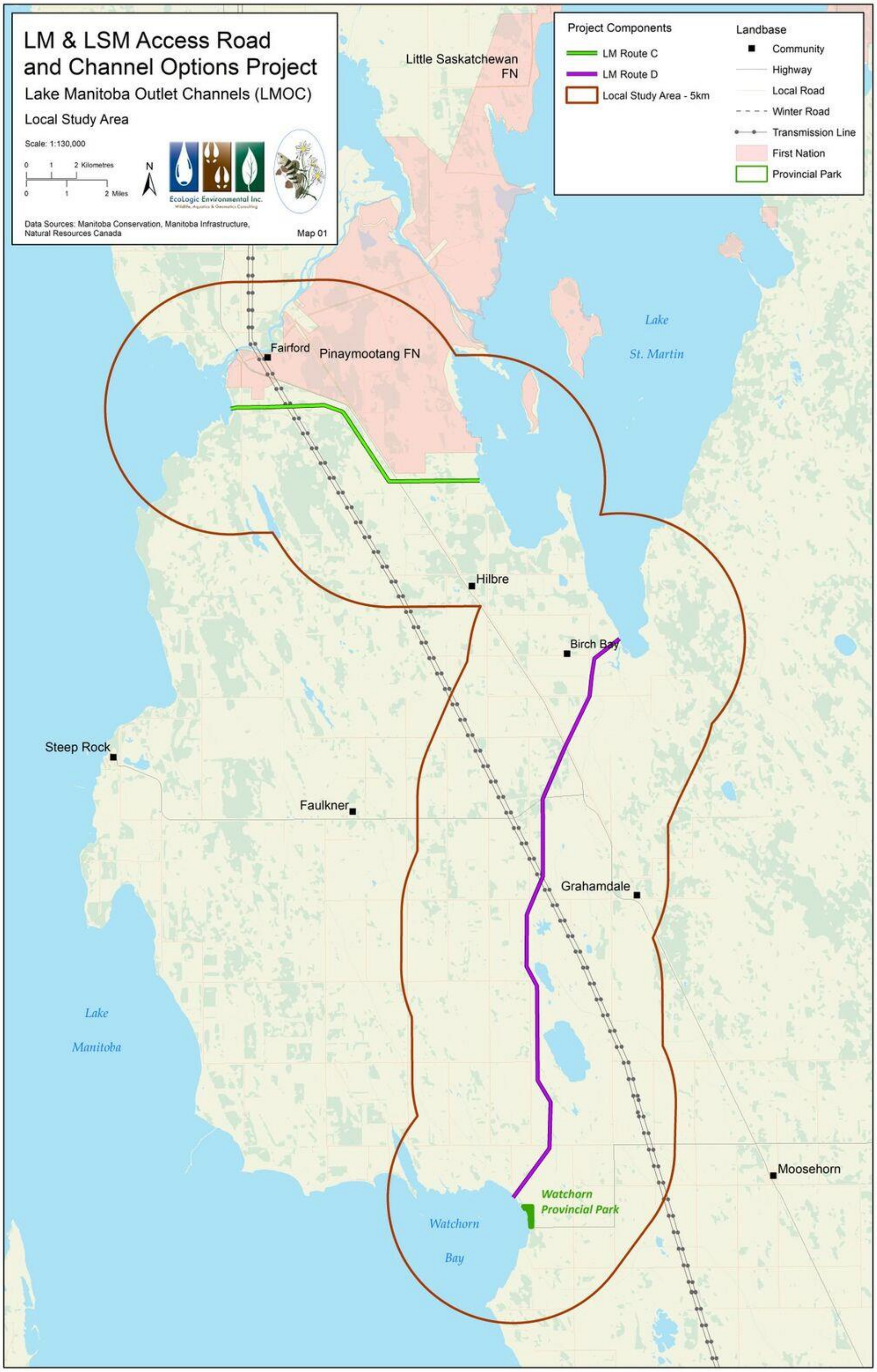



**Figure 1: Lake Manitoba Outlet Channels Project Local Study Area**

# 4 PROJECT SCOPE

The LMOC Project is defined as the works associated with the construction and operation of the selected LMOC, i.e., Route C or Route D. These works include, but may not be limited to:

- clearing of vegetation and removal of overburden along the selected LMOC route and Right of Way (RoW);
- installation and removal of temporary cofferdams;
- channel excavation, sloping, grading and bank stabilization;
- blasting (bedrock) and aquifer depressurization;
- installation and operation of a gated water control structure;
- construction and operation of new roadway alignments, bridges, culvert crossings and drainage ditches;
- re-alignment and/or rerouting of sections of existing watercourses and drainage ditches;
- construction and operation of the permanent groyne structures; and
- reclamation of areas within the LMOC RoW to the extent possible.

The scope of the LMOC Project also includes any ancillary activities such as development and/or use of borrow and/or quarry areas; crew, materials and equipment staging and/or storage areas; water and work site management; waste disposal and management; and the decommissioning and reclamation of areas used for the ancillary activities.

## 4.1 Spatial Boundaries

For the purposes of environmental assessment, the spatial boundaries for a project are typically described at three spatial scales: a Project Footprint area, a Local Study Area and a Regional Study Area. The Project Footprint (PF) is the physical space or directly affected area on which the Project components or activities are located; the Local Study Area (LSA) is the area beyond the Project footprint in which Project effects are measurable; and the Regional Study Area (RSA) is the area beyond the LSA within which most indirect and cumulative effects would occur (CEAA 2015).

These three spatial scales may vary depending on the environmental component. For example, for the aquatic environment, the PF is the area directly affected by the construction and operation of the selected LMOC, including the RoW associated with the LMOC, and areas in Lake Manitoba and Lake St. Martin where the temporary cofferdams and permanent groyne will be located. The LSA for aquatics included waterbody and watercourse areas where aquatic organisms and/or their habitat may be affected by the LMOC works (e.g., by changes in flow patterns), and the RSA for aquatics included aquatic areas outside of the LSA that are connected to the PF and LSA waterbodies and/or watercourses. For wildlife, the spatial boundaries are selected based on the type and extent of the proposed project activities that may affect wildlife and their habitat, and the need to include the seasonal movements and spatial range of the animals of interest.

Given that the information collected for the baseline studies will be used in the environmental assessment for the overall Project, the study design for the baseline studies included the establishment of appropriate study area spatial boundaries. These boundaries are further described below.

As noted above, the overall Project was presented by MI as having three components and included: 1) further development of the LSMOC; 2) construction and operation of the LMOC; and 3) construction and operation of an ASR in the area of the LSMOC. The ASR and LSMOC components are linked as the ASR needs to be in place before the LSMOC works can be undertaken, and sections of the ASR and LSMOC options are contiguous or in close proximity on the landscape. As noted in Section 1, the overall Project will require both federal and provincial approval and licensing, whereas the construction and operation of the ASR will require provincial regulatory approval and licensing. In addition, MI requires the ASR to be in place to provide access for construction and operation of the LSMOC options. As such, MI required the baseline information for the ASR in advance of the baseline information for the LSMOC options, to allow MI to secure approval and licensing from the Province of Manitoba for the ASR component of the Project.

This need for the ASR baseline information prior to the LSMOC and LMOC baseline information was met by preparing three separate reports for MI: one report for the ASR, one report for the LMOC, and one report for the LSMOC. This approach was used to resolve the timing needs for the Project, but because some sections of the ASR and LSMOC occupy the same area on the landscape, and the LMOC is in proximity to the LSMOC and ASR, it also resulted in a spatial overlap when the LSA and RSA boundaries were determined for each of the three components. The rationale and determination for the study area boundaries are further described below. Note that the spatial boundaries selected for the EIA can be modified as desired from the spatial boundaries selected for the baseline investigations; however, the data provided for the three Project components were collected using the spatial boundaries indicated below.

### 4.1.1 Project Footprint

The Project Footprint (PF) for the LMOC included the areas encompassed by the length of the proposed Route C and Route D channel options, the width of the proposed RoW for the Route C and Route D channel options, and the areas within Lake Manitoba and Lake St. Martin that will be affected by the temporary cofferdams during construction. The PF for the LMOC also included the areas within Lake Manitoba that may potentially be affected by the construction of a permanent groyne structure.

The conceptual design information provided in KGS Group (2016) indicated that the LMOC Route C would have a total length of 11.6 km and a RoW width of about 400 m, and that the LMOC Route D would have a total length of 24.0 km and a RoW of about 400 m.

As such, the PF area for the LMOC Route C was designated as the area encompassed by the total length of the route and the total width of the route, including the RoW and areas within Lake Manitoba and Lake St. Martin that will be affected by the temporary cofferdams and permanent groyne; and the PF area for the LMOC Route D was designated as the area encompassed by the total length of the route and the total width of the route, including the RoW and areas within Lake Manitoba and Lake St. Martin that will be affected by the temporary cofferdams and permanent groyne.

### 4.1.2 Local Study Area

The LSA was designated as the total lengths of the LMOC Route C and LMOC Route D with a width of 5 km from either side of the centreline of the proposed Route C channel and Route D channel for all environmental components except vegetation. This 5 km width on either side of the proposed Route C channel and proposed Route D channel was selected based on:

- Published guidance documents and environmental assessment criteria for air quality, greenhouse gas (GHG) emissions, noise, vibration and human health (e.g., Health Canada 2011);
- The need to include waterbodies and watercourses where aquatic organisms and/or their habitat may be affected by the works associated with the LMOC (e.g., by changes in flow patterns);
- Published literature on the potential local disturbance effects of roads on moose (*Alces alces*) (Laurian et al. 2008; Silverberg et al. 2003; Wasser et al. 2011; Yost and Wright 2001);
- The need to encompass wildlife movements, including Species At Risk (SAR), within the area of the proposed LMOC Route C and LMOC Route D;
- The need to provide an understanding of the existing socio-economic features of the area surrounding the proposed LMOC Route C and LMOC Route D; and
- The need to provide quantitative and qualitative information on the Heritage Resources within and surrounding the area of the proposed LMOC Route C and LMOC Route D as required under existing legislation and in accordance with environmental assessment requirements.

For vegetation, the LSA was designated as the total length of the LMOC Route C and LMOC Route D with a width of 1 km from either side of the centreline of the proposed channel routes to reflect the mostly sessile nature of plants, but also include areas of potential seed dispersal, new growth or colonization.

As noted above, the baseline data for the ASR were required separately and in advance of the baseline data for the LSMOC, which was resolved by preparing a separate report for each component. If the ASR data had not been required in advance of the LSMOC, it is expected that these two separate components could have been combined into one component (i.e., as the LSMOC and ASR component) as the application of a 5 km LSA boundary for each component resulted in some spatial overlap for the LSMOC and ASR components.

### 4.1.3 Regional Study Area

The RSA was designated as the total lengths of the LMOC Route C and LMOC Route D with a width of 20 km from either side of the centreline of the proposed Route C channel and Route D channel for all environmental components except vegetation. This 20 km width on either side of the proposed LMOC Route C and proposed LMOC Route D was selected based on the guidelines, criteria and legislation described in Section 4.1.2 above, and to capture the area of a typical moose home range of 40 km² (Hundertmark 1997). The RSA was also expanded in the area of the 'Big Bend' of the Dauphin River to include the areas of the Dauphin River located outside of the 20 km boundary that was established to capture a moose home range. For vegetation, the RSA was designated as the total length of the LMOC Route C and LMOC Route D with a width of 5 km from either side of the centreline of the proposed channel routes to allow for the assessment of vegetation at a community level, if required.

**Figure 2** provides a map of the designated PF, LSA and RSA for the LMOC component of the Project, and illustrates the overlap that occurred due to the proximity of the other two Project components. As such, information presented for the RSA in each of the three report assignments (ASR report, LMOC report; LSMOC report) was similar for many of the environmental components, e.g., climate, air quality, GHGs, noise and vibration, socio-economic setting.

## 4.2 Temporal Boundaries

The framework for an environmental assessment also includes the establishment of temporal boundaries to allow for the comparison of the existing environmental conditions in the Project study area to the conditions that will exist with the Project in place, and where a cumulative effects assessment is required, to allow for the examination of the environmental conditions in the Project study area in combination with past, present and future activities and projects in the Project study area.

Temporal boundaries may also be defined for the time required for clearing, construction and operational activities to aid in the determination of the effects of these activities on the environmental receptors, i.e., the biophysical and socio-economic components of the environment.

**Table 1** provides a summary of the temporal boundaries defined for the Project based on information provided by MI and KGS Group (2016).

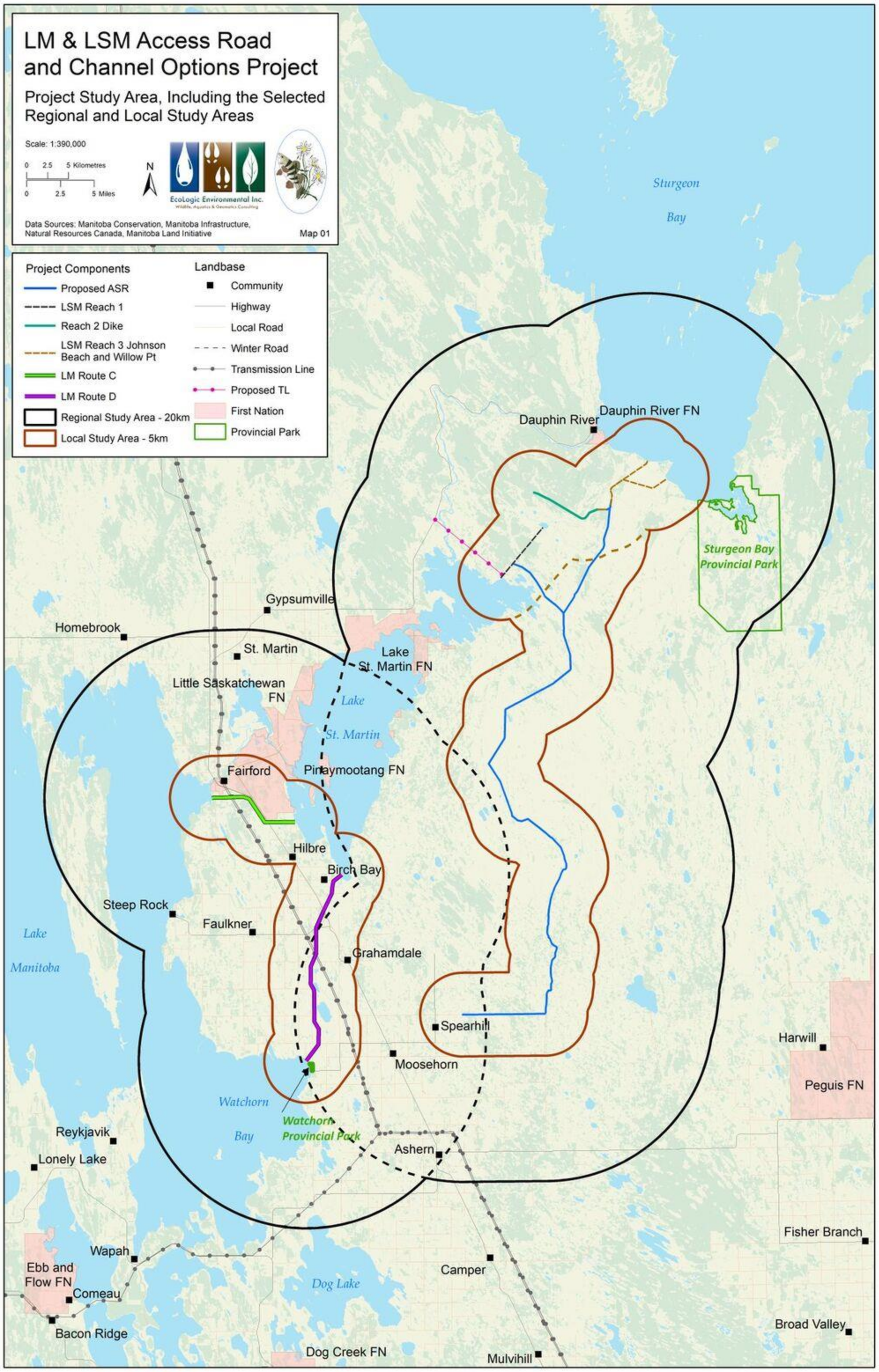



**Figure 2: Project Study Area, including the selected Regional and Local Study Areas**

**Table 1: Summary of Project Temporal Boundaries***

| Activity | Estimated Start Date | Estimated End Date |
|---|---|---|
| Baseline environmental field and desktop studies | September 2015 | January 2017 |
| Selection of the preferred LMOC route option | November 2016 | January 2017 |
| Detailed design of the selected LMOC | February 2017 | September 2018 |
| Construction of the LMOC | February 2019 | November 2021 |
| Completion of construction and start of operational phase for the LMOC | November 2021 | Not Applicable |
| Decommissioning and reclamation of areas within the LMOC RoW and areas used for ancillary activities | June 2018 | June 2021 |

* Temporal boundaries as of the time of this writing

## 5 PROJECT DESCRIPTION

Information for the project description was obtained from the "*Assiniboine River & Lake Manitoba Basins Flood Mitigation Study LMB & LSM Outlet Channels Conceptual Design - Stage 2"* (KGS Group 2016) and is described below.

### 5.1 LMOC Route C

The conceptual design for LMOC Route C includes the development of an 11.6 km channel that would be located south of the Pinaymootang FN border on a combination of privately held lands and Crown leased lands. The inlet would be located approximately 2 km south of the existing Fairford River Water Control Structure (FRWCS) in Portage Bay on Lake Manitoba, and the outlet to Lake St. Martin would be located about 1.5 km south of the Pinaymootang FN and 5 km north of the town of Hilbre (**Figure 1**). The alignment of the channel would be to the east for about 5 km, at which point the channel would turn southeast along Provincial Trunk Highway (PTH) 6 for approximately 3 km, and then turn directly east for about 3.5 km to cross PTH 6 and enter Lake St. Martin (**Figure 1**; KGS Group 2016). Flow in the channel would be regulated by the installation of a gated control structure having three bays, each measuring 9 m wide.

The proposed development of Route C would require the construction of three new bridge crossings and the realignment of the existing roadway at two of the crossings. New bridges would be required at two municipal roads and at PTH 6. The gated control structure could be combined with the new bridge crossing at PTH 6 to allow for a narrower and less costly structure than if it was located upstream near Lake Manitoba. The Route C channel alignment would also cross the Manitoba Hydro Bipole Transmission Lines about 2.4 km inland from Lake Manitoba. This feature can be accommodated by modifying the channel alignment to fit between the base of the transmission line poles and by optimization of the spoil pile at the Detailed Design Phase (KGS Group 2016).

In general, the stratigraphy at Route C was found to consist of a thin layer of topsoil overlying till materials including silt and clay till, silt till, clay till, and then bedrock. The 2015 drilling program showed that groundwater levels were generally approximately 1 m below ground surface, with no artesian conditions observed in the 2015 drilling program (KGS Group 2016). Approximately the first 6 km of the channel from Lake Manitoba inland would cut through a rock ridge with the invert of the channel located in bedrock throughout that area of the channel. The remainder of the channel to Lake St. Martin cuts through mostly till material with an occasional occurrence of bedrock (KGS Group 2016). The depth of excavation below ground surface would vary between approximately 4 m and 14 m, with the deepest cut located in the bedrock. During construction, the need to isolate work areas at the inlet and outlet of the proposed channel would be achieved through the installation of temporary cofferdams in these areas of Lake Manitoba and Lake St. Martin.

Flood routing studies conducted by KGS Group (2016) showed that the LMOC would typically begin operation in early summer and end operation by late fall, with operation of the channel in the winter not normally required. In the 54 years that were simulated for the flood routing studies, the channel would have been operated seven times in the month of December, four times in January, three times in February and two times in March. As such, the need for winter operation is only expected to occur during very large flood events such as in 2011, 2012 and 2014.

When the structure is closed, the water level in the channel on the upstream side of the gated control structure will be the same as the water level on Lake Manitoba, and the water level in the channel on the downstream side of the structure will be the same as the water level on Lake St. Martin. When the structure is fully open, flows in the channel will depend on Lake Manitoba water levels. The invert of the channel would be lower than water levels in Lake Manitoba and Lake St. Martin; therefore, there would be standing water in the channel when it is not in operation.

The flood routing studies showed that there will be many years when the LMOC will not need to be operated. As such, there is a concern that natural shoreline erosional and depositional processes in Lake Manitoba could eventually lead to infilling of the entrance to the channel with sediment. To address this concern, the conceptual design assumed the need for the construction of a groyne on the north side of the LMOC inlet that would project into the lake approximately 100 m beyond the mouth of the channel. The groyne would be built as a means of preventing the transport of sand and silt into the channel to minimize the risk of infill, and would be a substantial structure built to withstand the high wind effects on Lake Manitoba.

Additional information on the proposed conceptual design, hydraulics and flood routing studies for the LMOC Route C channel option is provided in KGS Group 2016.

## 5.2 LMOC Route D

The conceptual design for LMOC Route D includes the development of a 24.0 km channel that would be located between Watchorn Bay on Lake Manitoba and Lake St. Martin on a combination of privately held lands and Crown leased lands. The inlet would be located in Watchorn Bay northeast of Watchorn Provincial Park, and the outlet to Lake St. Martin would be located about 7 km southeast of the town of Hilbre (**Figure 1**). The alignment of the channel follows a generally northerly path (**Figure 1**). Flow in the channel would be regulated by the installation of a gated control structure, which would have three bays that would each be 9 m wide.

The proposed development of Route D would require the construction of five new bridge crossings and the realignment of the existing roadway at two crossings. New bridges will be required at three municipal roads, at Provincial Road (PR) 239 and at PTH 6. The proposed Route D channel would cross a fourth municipal road just south of Lake St. Martin, where a minor road realignment is proposed rather than construction of another bridge crossing. It may also be possible to re-align PR 239 slightly north to avoid crossing the channel; however, the bridge crossing has been assumed at this stage of the design (KGS Group 2016).

The gated control structure could be combined with the new bridge crossing at PTH 6 to allow for a narrower and less costly structure than if it was located upstream near Lake Manitoba. The Route D channel alignment would also cross the Manitoba Hydro Bipole Transmission Lines about 13.5 km inland from Lake Manitoba. This feature can be accommodated by modifying the channel alignment to fit between the base of the transmission line poles and by optimization of the spoil pile at the Detailed Design Phase (KGS Group 2016). A similar optimization process would be required around 22.0 km inland from Lake Manitoba to accommodate the municipal road realignment discussed above, a section of Birch Creek, and a private homestead located adjacent to the proposed Route D channel.

In general, the stratigraphy at Route D consisted of a thin layer of topsoil overlying till materials including clay till, silty clay till, silt till, or sandy clay till with layers of sand, and then bedrock. Results of the 2015 drilling program showed that groundwater levels ranged from 1 m above to 1 m below ground surface (KGS Group 2016). Artesian conditions were observed upon completion drilling in a number of boreholes and within the lower till below the layers of sand/silty sand. The artesian conditions were generally encountered in the very hard till (about 10 m below ground surface) and/or below the sand/silty sand layers (KGS Group 2016).

Upstream of PTH 6, the land surface elevation ranges from about 248 metres above sea level (masl) to about 252 masl near PTH 6. The ground surface elevation then drops to about 245.5 masl to Lake St. Martin (KGS Group 2016). The proposed channel would cut through mainly till material and would not intercept rock. The depth of excavation below ground surface would vary between approximately 6 m and 12 m, with the deepest cut located near PTH 6. During construction, the need to isolate work areas at the inlet and outlet of the proposed channel would be achieved through the installation of temporary cofferdams in these areas of Lake Manitoba and Lake St. Martin.

Flood routing studies conducted by KGS Group (2016) showed that the LMOC would typically begin operation in early summer and end operation by late fall, with operation of the channel in the winter not normally required. In the 54 years that were simulated for the flood routing studies, the channel would have been operated seven times in the month of December, four times in January, three times in February and two times in March. As such, the need for winter operation is only expected to occur during very large flood events such as in 2011, 2012 and 2014.

When the structure is closed, the water level in the channel on the upstream side of the gated control structure will be the same as the water level on Lake Manitoba, and the water level in the channel on the downstream side of the structure will be the same as the water level on Lake St. Martin. When the structure is fully open, flows in the channel will depend on Lake Manitoba water levels. The invert of the channel would be lower than water levels in Lake Manitoba and Lake St. Martin; therefore, there would be standing water in the channel when it is not in operation.

The flood routing studies showed that there will be many years when the LMOC will not need to be operated. As such, there is a concern that natural shoreline erosional and depositional processes in Lake Manitoba could eventually lead to infilling of the entrance to the channel with sediment. To address this concern, the conceptual design assumed the need for the construction of a groyne on the north side of the LMOC inlet that would project into the lake approximately 100 m beyond the mouth of the channel. The groyne would be built as a means of preventing the transport of sand and silt into the channel to minimize the risk of infill, and would be a substantial structure built to withstand the high wind effects on Lake Manitoba.

Additional information on the proposed conceptual design, hydraulics and flood routing studies for the LMOC Route C channel option is provided in KGS Group 2016.

# 6 STUDY METHODS

The characterization of the existing environmental conditions in the LMOC Project study area was carried out using a number of desktop and field methods. The methods used for each component of the study are provided below.

## 6.1 Desktop Methods

Desktop study methods were used for all of the environmental components discussed in this report. **Table 2** provides a summary of the desktop methods used for each component. Further details on the desktop methods used for the vegetation, wildlife, fish and fish habitat and Heritage Resources components are provided in the technical reports included as appendices 1 to 4 of this report.

**Table 2: Summary of Desktop Methods Used for Each Environmental Component**

| Environmental Component | Desktop Methods |
|---|---|
| Climate, Climate Change, GHGs, Air Quality, Noise and Vibration | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities; and<br>• Collection and review of guidance documents, policies, environmental assessment criteria and methods, regulations and relevant legislation. |
| Terrain and Topography | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities; and<br>• Review of elevation data relevant to the Project area. |
| Geology and Soils | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities; and<br>• Review of geotechnical, geological and soils reports relevant to the Project area. |
| Vegetation | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities;<br>• Submission of information requests to relevant government agencies, e.g., Manitoba Conservation Data Centre (MBCDC);<br>• Review of species listings under the federal *Species At Risk Act* (SARA), Committee on the Status of Endangered Wildlife In Canada (COSEWIC), Manitoba *Endangered Species and Ecosystems Act* (MESEA), the Invasive Species Council of Manitoba (ISCM), and the MBCDC listing of species of conservation concern;<br>• Review of other relevant legislation, e.g., *Noxious Weed Act*;<br>• Use of the *Classification of Natural Ponds and Lakes in the Glaciated Prairie Region* (Stewart and Kantrud 1971);<br>• Use of the Earth Observation for Sustainable Development of Forests (EOSD) Land Cover Classification (LCC) spatial database to create vegetation maps, characterize the vegetation types present in the Project area, and identify study plot locations for field studies; and<br>• Analysis and qualification of existing habitat, including SAR, using Geographic Information System (GIS) based technology. |
| Wildlife and Wildlife Habitat | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities; |

**Table 2: Summary of Desktop Methods Used for Each Environmental Component**

| Environmental Component | Desktop Methods |
|---|---|
| | • Submission of information requests to relevant government agencies, e.g., Manitoba Sustainable Development (MBSD), MBCDC;<br>• Detailed listing of all mammal, avian, reptile, and amphibian species within the Project study area using available provincial databases, i.e., MBCDC, Manitoba Breeding Bird Atlas (MBBA), Canada Important Bird Areas (IBA), Manitoba Herps Atlas (MHA);<br>• The selection of spatial boundaries and selection of key focal species;<br>• Detailed literature reviews of life history and habitat requirements for key focal species;<br>• Review of species listings under MESEA, SARA, COSEWIC and the MBCDC listing of species of conservation concern;<br>• Acquisition of spatial database of known locations of species at risk or of conservation concern;<br>• Historical fire analysis;<br>• Habitat mapping and spatial analysis using the LCC and Forest Resource Inventory (FRI) to assess for high quality habitat for key focal species;<br>• Habitat modelling to identify potential habitat availability for key focal species and to guide field methods;<br>• Linear density analysis for moose;<br>• Review of provincial historical records of wildlife, amphibian, and avian distribution within the Project study area;<br>• Interviews with Resource Managers, Species Specialists, and other information holders for important presence and absence information on key species;<br>• Analysis and quantification of existing habitat and potential habitat loss for wildlife, including SAR, using GIS based technology; and<br>• Data collation with the development of a GIS database in ArcGIS 10.1 through acquisition of existing and available information. |
| Groundwater | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities;<br>• Review of groundwater, hydrogeological, geotechnical and geochemical reports relevant to the Project area; and,<br>• Collection and review of guidance documents, policies, environmental assessment criteria and methods, standards, regulations and relevant legislation. |

**Table 2: Summary of Desktop Methods Used for Each Environmental Component**

| Environmental Component | Desktop Methods |
|---|---|
| Surface Water | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities;<br>• Review of surface water and hydrological reports relevant to the Project area; and,<br>• Collection and review of guidance documents, policies, environmental assessment criteria and methods, standards, regulations and relevant legislation. |
| Fish and Fish Habitat | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities;<br>• Review of Manitoba fish species zoogeographical distribution information;<br>• Review of Manitoba fish species life history and habitat requirements;<br>• Review of species listings under MESEA, SARA, COSEWIC and the MBCDC listing of species of conservation concern;<br>• Review and application of Fisheries and Oceans (DFO) guidelines, policies and legislation for fish and fish habitat, including the DFO habitat classification system (Milani 2013); and<br>• Review of aerial photography, provincial watershed maps and topographic maps to determine location, morphology and connectivity of the LMOC Project study area watercourses and waterbodies. |
| Species At Risk | • Identification of floral and faunal species and/or ecosystems in the Project study area classified as SAR and/or species of conservation concern through review of federal and provincial databases (SARA, COSEWIC, MESEA, MBBA, MHA, MBCDC);<br>• Review of federally legislated species Management and/or Recovery plans and other applicable guidance or policies; and<br>• Identification of required habitat types or Critical Habitats for floral and faunal species and/or ecosystems in the Project study area classified as species at risk or species of conservation concern, including the identification of Critical Habitat areas for the two bat species listed as Endangered on Schedule 1 of SARA that may be present in the Project study area. |
| Socio - Economic Environment | • Review of Project related reports and information provided by MI;<br>• Collection and review of other published and unpublished literature relevant to the Project area and Project activities; |

**Table 2: Summary of Desktop Methods Used for Each Environmental Component**

| Environmental Component | Desktop Methods |
|---|---|
| | • Review of available information and reports on demographics, local services, infrastructure, land use, resource use, recreational use, and protected areas relevant to the Project study area;<br>• Collection and collation of mapping information and production of a series of maps, e.g., fire history in the Project area, infrastructure in the Project area; and<br>• Collection and review of guidance documents, policies, environmental assessment criteria and methods, standards, regulations and relevant legislation, e.g., Health Canada *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise (Draft)* (Health Canada 2011). |
| Culture and Heritage Resources | • Review of Project related reports and information provided by MI;<br>• Submission of information requests to relevant government agencies, e.g., Manitoba Historic Resources Branch (MHRB);<br>• Review and application of documentation on the cultural history, archaeological records and historical records relevant to the Project study area; and<br>• Mapping of known information for the area to guide field studies. |

## 6.2 Field Studies

Field studies were conducted for the vegetation, wildlife, fish and fish habitat, SAR and Heritage Resources components of the LMOC Project. **Table 3** provides a summary of the methods used for each component. Further details on the field methods used for vegetation, wildlife, fish and fish habitat, SAR and Heritage Resources components are provided in the technical reports included as appendices 1 to 4 of this report.

**Table 3: Summary of Field Study Methods Used for Each Environmental Component**

| Environmental Component | Field Study Methods |
|---|---|
| Vegetation | • An aerial reconnaissance survey was conducted along the Route C and Route D alignments of the LMOC project;<br>• Sample sites were pre-selected and stratified based on habitat-type encountered along the proposed alignments using the LCC data and information gathered during the 2015 aerial survey; |

**Table 3: Summary of Field Study Methods Used for Each Environmental Component**

| Environmental Component | Field Study Methods |
|---|---|
| | • A handheld Garmin Oregon 450 GPS pre-loaded with the tracks of each alignment option and each sample site was used to navigate to the survey locations;<br>• All sample sites along the Route C and Route D channel options were access by a combination of pick-up truck and ATV;<br>• A total of 22 sample plots were completed along the Route C alignment and another 22 sample plots were completed along the Route D alignment during the spring and summer surveys to provide a sufficient number of plots within different habitat types;<br>• At each plot site, two 100 m transects were placed perpendicular on either side of the centre line of the proposed alignment.<br>• Transects were walked and all vascular plants observed (within a 5m visual radius) were recorded and identified to species;<br>• Immature plants or plants missing structures (e.g., fruiting bodies, etc.) that could not be identified to species were identified to genus or family;<br>• Additional data collected at each sample site included soil type, site location and description of the vegetation community;<br>• No voucher specimens were collected;<br>• Photographs of the plant and identifying characteristics were taken of any species not identifiable in the field;<br>• The relative location of each sample site, as well as any observations of invasive species, plant species of significance to Aboriginal peoples, and/or MBCDC species of conservation concern (S1, S2, S3), were recorded with a handheld Garmin Oregon 450 GPS and incorporated into the data collected for the LMOC component of the Project.<br>• Incidental observations of plant species along the proposed Route C or Route D that occurred outside of the sample sites, were also documented; and<br>  • The detailed methodologies and equipment used for the vegetation field surveys are provided in Appendix 1 in the *Lake Manitoba Outlet Channel Route Options – Vegetation Technical Report* |
| Wildlife and Wildlife Habitat | • An aerial reconnaissance survey was conducted in October 2015 by helicopter to observe the Project study area and collect georeferenced photographs and observational notes on the existing habitat; |

**Table 3: Summary of Field Study Methods Used for Each Environmental Component**

| Environmental Component | Field Study Methods |
|---|---|
| | • Field studies were conducted in the winter of 2015-16, spring 2016, summer 2016 and fall 2016;<br>• The types of field surveys conducted included:<br>  o Winter aerial moose, elk, and white-tailed deer survey; winter aerial multispecies survey;<br>  o Spring aerial shoreline survey, including a Piping Plover survey; spring avian Point Count survey; spring bird nest (egg) searches; spring raptor nest and heron rookery survey; spring amphibian Point Count survey; spring reptile hibernacula survey;<br>  o Winter, spring, summer and fall Ecologically Sensitive Site (ESS) investigations for mammal dens, mineral licks, hibernacula, rookeries, and nests;<br>• The detailed methodologies and equipment used for the wildlife field surveys are provided in Appendix 2 in the *Lake Manitoba Outlet Channels - Wildlife Technical Report* |
| Fish and Fish Habitat | • An aerial reconnaissance survey was conducted in October 2015 by helicopter to observe the Project study area and collect georeferenced photographs and observational notes on the existing habitat;<br>• Field studies were conducted in the spring, summer and fall of 2016 in the watercourse and waterbody areas potentially affected by the LMOC Route C or LMOC Route D;<br>• Field studies included the collection of instream, shoreline and riparian zone habitat data; fish community data; *in situ* water quality data; and benthic invertebrate data;<br>• Field methods included:<br>  o use of an Unmanned Aerial Vehicle (UAV, or drone) for aerial surveys and habitat mapping;<br>  o use of a BioSonics MX Echosounder with Visual Acquisition 6 software and/or Trimble RTK ground survey unit to collect bathymetric data;<br>  o manual substrate sampling with a benthic probe or Petite Ponar grab sampler;<br>  o use of Trimble RX-8 RTK 4 survey equipment along each transect to document elevation changes and describe channel morphology; |

**Table 3: Summary of Field Study Methods Used for Each Environmental Component**

| Environmental Component | Field Study Methods |
|---|---|
| | ○ velocities were measured at 40% (0.4 x depth) of the water column at 0.5 m intervals along each transect line using a SwofferTM (Model 2100) velocity meter;<br>○ boat electrofishing using a Smith-Root 2.5 GPP electrofisher system with two boom umbrella arrays;<br>○ backpack electrofishing using a Smith-Root LR 24 backpack electrofisher;<br>○ gill-net sets in lake areas using experimental gill net gangs;<br>○ hoop (fyke) net sets to capture fish within Birch Creek, Watchorn Creek, Mercer Creek and Harrison Creek;<br>• Captured fish were identified to species, enumerated by sampling site and date, and measured for fork length (+ 1 mm), and round weight (+ 25 g, gill netting only), sex and state of maturity (if captured during species' spawning window) and classified as Male (M), Female (F) or Juvenile (J), and as Pre-spawn (N), Ripe (R), or Spent (S);<br>• Use of egg mats, kick sampling and net tows for the collection and analysis of fish eggs and larvae;<br>• *In-situ* water quality parameters were measured using a hand-held YSI multi meter (model 556) and LaMotte 2020e/I turbidity meter to measure dissolved oxygen (DO, mg/L), pH, conductivity (µS/cm), turbidity (NTU), and water temperature (°C);<br>• A handheld GPS unit was used to record geographic locations of each sampling site;<br>• At each study site, three 500 ml water samples were collected at increasing levels of turbidity;<br>• Laboratory analysis of these samples provided the calibration curve for the measurement of Total Suspended Solids (TSS) interpolated from turbidity samples collected in the field;<br>• Water temperature loggers (Hobo® Water Temp Pro) were installed in LSM, LM, and the associated creeks to provide year-round water temperature data;<br>• Use of kick sampling for benthic invertebrate sampling;<br>• Laboratory sample sorting, processing and analyses;<br>• The detailed methodologies and equipment used for the aquatic field surveys are provided in Appendix 3 in the *Fisheries and Aquatic Habitat Baseline Assessment - Lake Manitoba Outlet Channel Route Options* report |

**Table 3: Summary of Field Study Methods Used for Each Environmental Component**

| Environmental Component | Field Study Methods |
|---|---|
| Species At Risk | • All the field surveys outlined for the vegetation, wildlife and fish and fish habitat components included identification and documentation of SAR and/or MBCDC species of conservation concern |
| Culture and Heritage Resources | • An aerial reconnaissance survey was conducted in October 2015 by helicopter to observe the Project study area and collect georeferenced photographs and observational notes on the existing land base;<br>• A field survey of the LMOC Project area was conducted in August 2016 to conduct ground surveys of selected areas based on the collated desktop information; site locations were surveyed on foot with access by 4x4 truck or helicopter<br>• The detailed methodologies and analysis used for the Heritage Resources field surveys are provided in Appendix 4 in the *Heritage Resources Characterization Study: Lake Manitoba Outlet Channel Route Options* report |

# 7 EXISTING ENVIRONMENT

## 7.1 Biophysical Environment

### 7.1.1 Climate

Climate can be defined as the generally prevailing weather conditions of a region throughout the year, and is typically described by variables such as air pressure, cloud cover, humidity, precipitation, hours of sunshine, temperature, wind speed and wind direction. Environment and Climate Change Canada (ECCC) has collected climate normals data for several areas within Canada from 1961 to 1990, 1971 to 2000 and 1981 to 2010. The ECCC weather station closest to the RSA with the most recent climate normals data, i.e., from 1981 to 2010, is located in Lundar, Manitoba. **Table 4** summarizes the climate normals data for the Lundar weather station, which is located at Latitude 50°45' N and Longitude 97°56' W at an elevation of 266.7 m.

**Table 4: Climate Normals Summary for Lundar, Manitoba (1981-2010)**

| Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily Average Temperature (ºC) | -18.1 | -13.5 | -6.6 | 3.3 | 10.9 | 16.4 | 18.3 | 17.7 | 11.3 | 4.4 | -6.5 | -14.6 | 1.9 |
| Daily Max (ºC) | -12.7 | -8.0 | -1.3 | 9.4 | 17.7 | 22.8 | 24.7 | 24.7 | 17.7 | 9.7 | -2.1 | -9.8 | 7.7 |

**Table 4: Climate Normals Summary for Lundar, Manitoba (1981-2010)**

| Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily Min (ºC) | -23.6 | -18.8 | -11.9 | -2.9 | 4.1 | 9.9 | 11.9 | 10.6 | 4.9 | -1.1 | -10.8 | -19.4 | -3.9 |
| Rainfall (mm) | 0.0 | 0.2 | 5.9 | 14.8 | 55.2 | 80.1 | 74.8 | 68.9 | 45.8 | 35.7 | 3.0 | 1.2 | 385.5 |
| Snowfall (cm) | 16.1 | 13.5 | 13.4 | 11.9 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 5.3 | 16.3 | 17.7 | 94.7 |
| Precipitation (mm) | 16.1 | 13.7 | 19.3 | 26.7 | 55.6 | 80.1 | 74.8 | 68.9 | 45.8 | 41.0 | 19.4 | 18.9 | 480.2 |

Source : Government of Canada 2016a.

The 30 year climate normals report an average annual temperature of 1.9 degrees Celsius (°C), with a maximum of 18.3°C in July, and a minimum of -18.1°C in January (Government of Canada 2016a). Mean annual precipitation is 480.2 millimetres (mm), of which 385.5 mm falls as rain with the remainder 94.7 mm as snow (approximately 20 percent [%]). Precipitation falls primarily as snow during the winter months, with the greatest snowfalls occurring in November, December and January. Precipitation occurs mainly as rain during the spring, summer and fall seasons, with overall levels of precipitation peaking in June, July and August.

The Development Plan for the RM of Grahamdale (2016) states that the climate of Grahamdale can be generalized from weather data collected at Gypsumville and Ashern in the RM of Siglunes. At these locations, the mean annual temperature was cited as 1.1 °C, with a mean annual precipitation of 483 mm and average frost-free period of 101 days (RM of Grahamdale 2016).

There were no wind data found for locations within the land base of the RSA; as such, wind data for the area was based on information collected at the station closest to the RSA, which is located at Dauphin, Manitoba. Average wind speeds recorded at Dauphin, Manitoba are fairly constant throughout the year, ranging from approximately 14 kilometres per hour (km/hr) to 17 km/hr. There is an average of approximately 13 days per year when wind speeds exceed 50 km/hr, with maximum hourly wind speeds of between 71 km/hr and 89 km/hr and maximum gust speeds between 85 km/hr and 122 km/hr (Weather Network 2016).

The large lakes within and around the RSA have an influence on the climate and weather. The basin size and position of Lake Manitoba, Lake Winnipegosis and Lake Winnipeg result in the creation of lake and land breeze circulations that can cause highly variable winds in the area (Environment and Climate Change Canada [ECCC] 2016a). The presence of the lakes also influence temperature and precipitation patterns in the area, with sudden storms and snow squalls that can produce strong winds over the land and water (ECCC 2016a). Manitoba's "big three" lakes are known for their rough waters and choppy waves, a feature of the large surface area but shallow depths of these lakes (ECCC 2016a).

The ECCC "Marine Topics: Prairies Regional Guide" provides information on local weather effects for marine areas in the Prairies, and cites the following information for Portage Bay, Watchorn Beach and Moosehorn Bay located on the east shore of the north basin of Lake Manitoba (ECCC 2016a):

- Portage Bay: Confused seas are possible with north and east winds between Pine Island and Sandy Point, as two areas of refraction collide. North and south winds can cause large seas over the entire bay, while winds from the southwest to northwest can create high waves at the mouth of the Fairford River, due to the long fetch, and cornering to the northeast of Birch Point.
- Watchorn Beach: Strong west to southwest winds drive large waves onto the shore.
- Moosehorn Bay: Steep, rough seas can be expected with strong west to northwest winds due to shoaling and when winds blow counter to the prevailing current.

The presence of the three large, shallow lakes creates the effects of land and lake breezes and evaporative cooling, which can have a direct influence on temperatures experienced on and off shore (ECCC 2016a). Wind roses for the north basin of Lake Manitoba show that the prevailing wind directions on all parts of the north basin are southeasterly, southerly, westerly and northwesterly during July to August (**Figure 3**), and that the prevailing wind directions on all parts of the north basin are southeasterly, southerly, westerly, northwesterly and northerly during September to November (**Figure 4**) (ECCC 2016a).

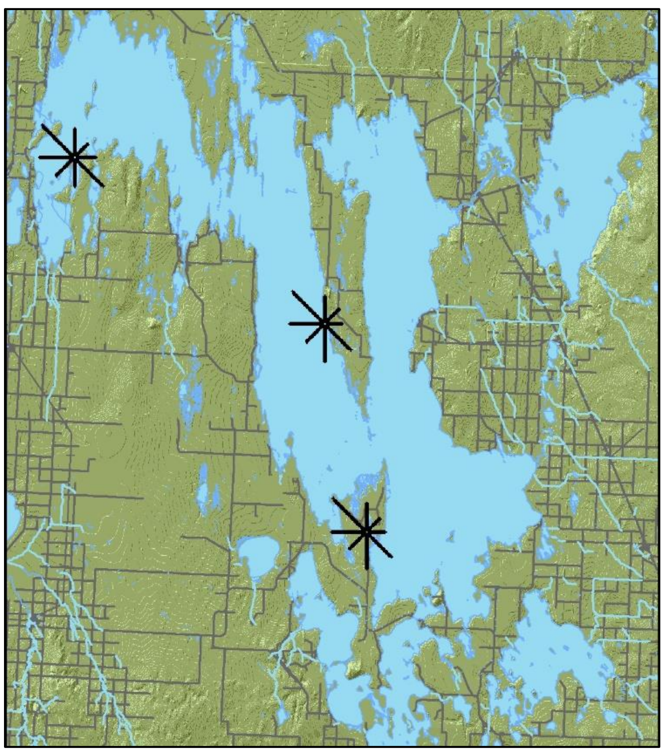


**Figure 3: Windroses over the northern basin of Lake Manitoba from June through August (ECCC 2016a)**

**Figure 4: Windroses over the northern basin of Lake Manitoba from September through November (ECCC 2016a)**

### 7.1.2 Climate Change

The effects of climate change in Manitoba have been reported to include warmer temperatures, changes in rainfall and water availability, declining snow and ice cover, and extreme weather events that can lead to increased risk of flooding and erosion in spring, and increased risk of droughts in summer (Government of Manitoba 2012a). These climate change effects could lead to declines in agricultural and ecological productivity, and warmer temperatures may cause permafrost thawing and erosion, which will put northern roads, railways and other community infrastructure at risk and result in a shorter winter road season (Government of Manitoba 2012a). To address climate change issues, the government of Manitoba enacted *The Climate Change and Emissions Reductions Act* in 2008, which set a target of reducing greenhouse gas (GHG) emissions to six per cent below 1990 levels by 2012, and required the province to report on whether emissions in 2010 were less than they were in 2000 (Government of Manitoba 2012a). Manitoba also released *Beyond Kyoto* in 2008, an action plan on climate change that outlined over 60 actions to reduce GHG emissions and adapt to the impacts of climate change across multiple sectors including energy, transportation, agriculture, municipalities, businesses and government operations.

The Government of Manitoba is responding to the effects of climate change using three main areas of focus:

- reducing Manitoba's GHG emissions

- adapting to the anticipated impacts of climate change
- collaborating and sharing best practices with other jurisdictions

Further information on climate change effects and initiatives in Manitoba is provided in *Manitoba's Report on Climate Change For 2012* (Government of Manitoba 2012a).

Other means of offsetting the potential effects of climate change include the maintenance, creation or expansion of 'carbon sinks'. Carbon sinks are processes that remove greenhouse gases from the atmosphere and store them long-term in another form, for example the storage of $CO_2$ (carbon dioxide) in perennial vegetation such as shelterbelts and woodlots and in soils as organic matter (Government of Manitoba 2016a). Hundreds of billions of tonnes of carbon are also sequestered in wetlands as peat or soil in the expanses of swamps, marshes, fens and bogs that cover many areas of Manitoba (Manitoba Water Caucus 2016), including sections of the LSA and RSA in the Project study area.

The relationship between wetland restoration and the mitigation and sequestration of GHG emissions is currently being studied in Manitoba and other prairie provinces. Research has shown that the restoration of prairie wetlands can produce a positive net GHG balance of 3.25 Mg $CO^2$ equivalents per hectare per year (3.25 Mg $CO^2$ $ha^{-1}$ $year^{-1}$) (Badiou et al. 2011). These results demonstrate that wetland restoration in the Canadian prairies has the potential to significantly contribute to the mitigation of GHG emissions (Badiou et al 2011).

### 7.1.3 Greenhouse Gas Emissions

Climate change has been linked to GHG emissions that contribute to atmospheric increases in levels of $CO_2$ and other gases (e.g., methane [$CH_4$], nitrous oxide [$N_2O$]) that increase global temperatures, change climate and precipitation patterns, and increase the frequency of extreme weather events. Environment and Climate Change Canada (ECCC) currently tracks six GHG substances as part of Canada's efforts to identify, quantify and reduce sources of GHGs. The six substances are $CO_2$, $CH_4$, $N_2O$, sulphur hexafluoride ($SH_6$), perfluorocarbons and hydrofluorocarbons (ECCC 2016b). Each GHG has a different global warming potential (GWP) and persists for a different length of time in the atmosphere; as such, GHG emissions from different types of gaseous compounds are converted into $CO_2$ equivalents to be compared and tracked over time (Climate Change Connection 2016). **Table 5** provides a summary of GHG emissions by Canadian province and territory for 1990, 2005 and 2014.

**Table 5: GHG Emissions by Province and Territory for 1990, 2005 and 2014**

| Province or Territory | 1990 Greenhouse Gas Emissions (Mt of $CO_2$ Equivalent) | 2005 Greenhouse Gas Emissions (Mt of $CO_2$ Equivalent) | 2014 Greenhouse Gas Emissions (Mt of $CO_2$ Equivalent) |
|---|---|---|---|
| Newfoundland and Labrador (NL) | 9.6 | 10.2 | 10.6 |
| Prince Edward Island (PE) | 2.0 | 2.1 | 1.8 |

| Province or Territory | 1990 Greenhouse Gas Emissions (Mt of $CO_2$ Equivalent) | 2005 Greenhouse Gas Emissions (Mt of $CO_2$ Equivalent) | 2014 Greenhouse Gas Emissions (Mt of $CO_2$ Equivalent) |
|---|---|---|---|
| Nova Scotia (NS) | 20.0 | 23.5 | 16.6 |
| New Brunswick (NB) | 16.4 | 20.5 | 14.9 |
| Quebec (QC) | 89.1 | 89.7 | 82.7 |
| Ontario (ON) | 181.8 | 210.6 | 170.2 |
| Manitoba (MB) | 18.7 | 20.7 | 21.5 |
| Saskatchewan (SK) | 45.1 | 69.6 | 75.5 |
| Alberta (AB) | 175.2 | 233.0 | 273.8 |
| British Columbia (BC) | 52.9 | 65.2 | 62.9 |
| Yukon (YT) | 0.5 | 0.5 | 0.3 |
| Northwest Territories (NT) | 1.6[A] | 1.7 | 1.5 |
| Nunavut (NU) | n/a | 0.3 | 0.3 |

Notes: [A] 1990 emissions data for the Northwest Territories include emissions for Nunavut, which was part of the Northwest Territories until 1999; Mt = megatonnes; n/a = not applicable; Emission levels for some years have been revised in light of improvements to estimation methods and availability of new data.
Source: Environment and Climate Change Canada (2016c) *National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada.*

Based on the data in **Table 5**, Manitoba was the 7$^{th}$ largest emitter of GHGs in 1990 and 2005, and the 8$^{th}$ largest emitter of GHGs in 2014, in comparison to all other provinces and territories. Additional information on the relative amounts of each tracked substance for different GHG categories (i.e., energy, industrial processes, solvent and other product use, agriculture and waste) can be found in the annual National Inventory Reports (ECCC 2016c).

ECCC also monitors GHGs under the Greenhouse Gas Emissions Reporting Program (GHGRP), which is Canada's legislated, publicly accessible inventory of facility-reported GHG data and information. The most current data set available at the time of this writing was the summary for the year 2014, provided in **Table 6** (ECCC 2016d). In 2014, there were 12 facilities in Manitoba reporting under the GHGRP. These facilities are located about 200 to 500 km from the LMOC Project area, with the exception of the Graymont limestone and gypsum processing plant, which is located on PTH 239 between the towns of Steep Rock and Faulkner (**Figure 2; Figure 8** in Section 6.2.4). The Graymont plant is located about 18 km to 20 km southwest of Route C and 18 km to 20 km west of Route D. This facility reported the 4th highest level of overall GHG emissions in Manitoba in 2014 (**Table 6**).

Other sources of GHGs in the RSA are likely from agricultural and recreational activities; vehicles travelling PTH 6, which is the main highway in the area and an important route to Thompson, Manitoba; and vehicle use on the other municipal roads and trails throughout the area. Pollutants emitted from motor vehicles include NOx (nitric oxide and nitrogen dioxide), CO (carbon monoxide), volatile organic compounds, and to a lesser extent $SO_2$ (sulphur dioxide) and particulate matter. These compounds are monitored under provincial and federal air quality guidelines and legislation, which are discussed in Section 6.14.

Infrastructure within the LSA for the proposed LMOC Route C and LMOC Route D includes: sections of paved highway, gravel roads and dirt trails; a portion of the Manitoba Hydro BiPole II transmission lines; rural residential areas, farm properties and vacation properties; the Fairford dam and fishway; two wastewater treatment lagoons; small businesses and services such as convenience stores and gas stations; the Roviera resort and campground at Fairford; Watchorn Provincial Park; and quarries located on the west side of PTH 6 at Hilbre and south of PTH 6 along the Pinaymootang FN border. Communities within the LSA include Fairford, Hilbre, Birch Bay, Grahamdale and a portion of the Pinaymootang FN. It is expected that there are minor GHG emissions released related to the operation of services and residences in the LSA; however, the human population and amount of overall development and commercial activity in the area is of low density versus more populated urban areas.

During the construction and operation of the proposed LMOC, it is expected that there will be a temporary increase in GHG emissions from intermittent use of construction equipment and vehicles. The land base located within the PF area for the LMOC will be converted from its existing state (e.g., local roads, pastures, annual crops, wetlands, forest and other vegetated areas) to a wetted channel and RoW, with flows within the channel regulated via an electrically operated concrete gated control structure. The RoW will be revegetated on completion of construction, and the conceptual design for the LMOC includes consideration of the need to preserve existing surface water and groundwater flow patterns to the extent possible. However, the LMOC will replace some areas of vegetation and wetlands in the LSA, which could change carbon storage in these areas. Based on the research being conducted on carbon sequestration in wetlands to offset GHG emissions, the restoration and protection of other wetland areas in the LSA may provide opportunity for the mitigation of any changes in GHGs in the LSA due to the construction and operation of the LMOC.

**Table 6: Summary of GHG Emissions Reported by Facilities in Manitoba in 2014 (ECCC 2016d)**

| Facility Name | City/Town | Greenhouse Gas (tonnes $CO_2$ eq) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Total |
| Brady Road Resource Management Facility – City of Winnipeg, Water & Waste Department | Winnipeg | 48,530 | 332,500 | - | - | - | - | 381,030 |
| Brandon Generating Station – Manitoba Hydro | Brandon | 71,963 | 34 | 316 | - | - | 90 | 72,404 |
| Faulkner Plant – Graymont Western Canada Inc. | Faulkner | 143,454 | 18 | 161 | - | - | - | 143,632 |
| General Scrap - Winnipeg – General Scrap Partnership | Winnipeg | 1,659 | 2 | 15 | - | - | - | 1,676 |
| HBMS Metallurgical Complex – Hudson Bay Mining and Smelting Co., Limited | Flin Flon | 34,147 | 20 | 677 | - | - | - | 34,844 |

**Table 6: Summary of GHG Emissions Reported by Facilities in Manitoba in 2014 (ECCC 2016d)**

| Facility Name | City/Town | Greenhouse Gas (tonnes $CO_2$ eq) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Total |
| Kilcona Landfill – City of Winnipeg, Water & Waste Department | Winnipeg | 6,125 | 55,825 | - | - | - | - | 61,950 |
| Koch Fertilizer Canada, ULC – Koch Fertilizer Canada, ULC | Brandon | 568,772 | 52,033 | 44,986 | - | - | - | 665,791 |
| Manitoba Kraft Papers Division – Tolko Industries Ltd. | The Pas | 57,350 | 6,676 | 4,828 | - | - | - | 68,854 |
| Minnedosa Ethanol Plant – Husky Oil Operations Limited | Minnedosa | 77,514 | 38 | 339 | - | - | - | 77,891 |
| Summit Road Landfill – City of Winnipeg, Water & Waste Department | Winnipeg | 10,509 | 95,775 | - | - | - | - | 106,284 |
| Thompson Operations – Vale Canada Limited | Thompson | 78,049 | 24 | 796 | 14 | - | - | 78,883 |
| TransCanada Pipeline, Manitoba – TransCanad a PipeLines Ltd. | Winnipeg | 252,907 | 11,806 | 3,487 | - | - | - | 268,200 |
| **Totals** | | **1,350,979** | **554,751** | **55,604** | **14** | **0** | **90** | **1,961,438** |

### 7.1.4 Air Quality

In Manitoba, air quality issues are mostly local in nature and are primarily related to odour and other pollutants such as wind-blown dust released from specific local sources or activities. Emissions from the metal smelters in Flin Flon and Thompson and smoke from forest fires tend to be the most significant sources of air pollution in northern Manitoba (Government of Manitoba 2009). Southern Manitoba has also experienced poor air quality on occasion due to smoke from forest fires or crop residue burning. Air quality within the RSA is affected by the commercial, agricultural, recreational, rural, transportation and urban activities that occur in the region, as well as from naturally occurring forest fires.

The Province of Manitoba and Environment Canada operate air quality monitoring stations in the cities of Brandon, Flin Flon, Thompson, and Winnipeg, Manitoba. The air quality monitoring stations closest to the Project area are located in the City of Winnipeg at 65 Ellen Street and at 299 Scotia Street. Air quality parameters that are monitored include: carbon monoxide (CO); particulate matter less than or equal to (≤) 10 microns ($PM_{10t}$); particulate matter ≤ 2.5 microns ($PM_{2.5}$), nitric oxide (NO); nitrogen dioxide ($NO_2$); nitrogen oxides ($NO_x$); ground level ozone ($O_3$); sulphur dioxide ($SO_2$); wind direction; and wind speed (Government of Manitoba 2016b).

**Table 7** provides a summary of the air quality parameters for Winnipeg, Manitoba on December 07, 2016 as an example of the available information.

**Table 7: Air Quality Parameters for Winnipeg, Manitoba, December 07, 2016**

| Station | Date | Time | PM10t | PM | CO | O3 | NO | NO2 | NOX | SO2 | Wind Dir | Wind Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | µg/m3 | 2.5s | ppm | ppb | ppb | ppb | ppb | ppb | | |
| Winnipeg Ellen St. | 12/7/2016 | 9:00 AM | 4.4 | 2.1 | -0.064 | 24.1 | 2.9 | 5.3 | 8.3 | 1 | 293 | 16 |
| Winnipeg Scotia St. | 12/7/2016 | 9:00 AM | - | 2.1 | - | 13.4 | 7.3 | 3.5 | 10.9 | - | - | - |

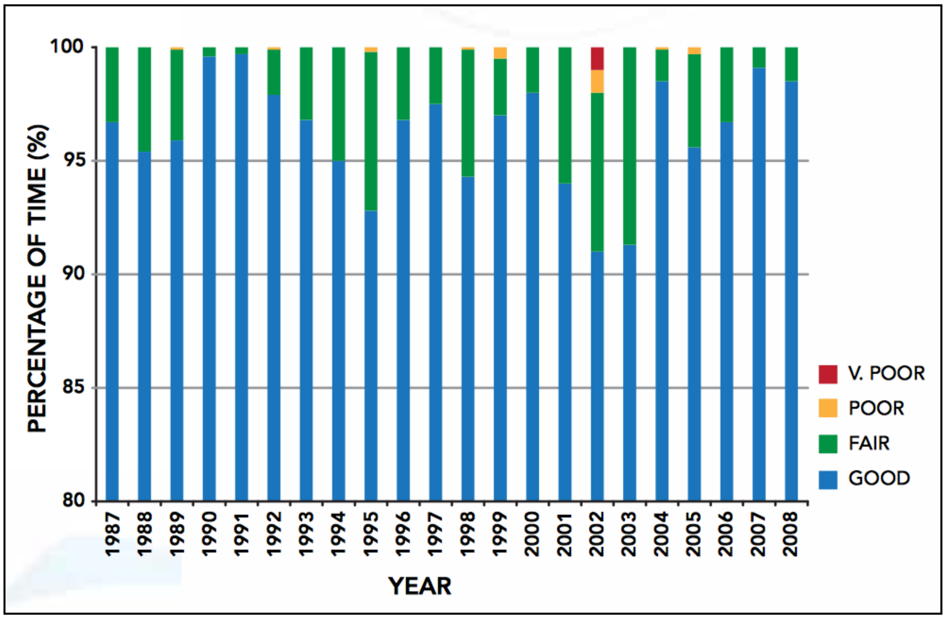
Source: Government of Manitoba 2016b.

$PM_{10t}$ = particulate matter ≤10 microns; µg/m3 = micrograms per cubic meter; $PM_{2.5s}$ = particulate matter ≤2.5 microns; ppm = parts per million; ppb= parts per billion; Wind Dir = wind direction in degrees; Wind Speed = wind speed in kilometers per hour.

The Manitoba Ambient Air Quality Criteria (Government of Manitoba 2016c) provides the maximum tolerable, maximum acceptable and maximum desirable concentrations of air pollutants required to protect and preserve air quality for human health. Comparison of the air quality parameters for December 07, 2016 in **Table 7** to the Manitoba Ambient Air Quality Criteria indicates that the measured parameters do not exceed the maximum acceptable level and meet the “maximum desirable” concentrations for parameters that have this value defined.

Environment and Climate Change Canada has also developed the “Air Quality Health Index” (AQHI), an index that is based on the relative risk to human health that can be caused by a combination of common air pollutants (ECCC 2016d). These pollutants include ground-level $O_3$, $PM_{2.5}$ and $NO_2$. The AQHI is measured on a colour-coded scale from 1 to 10+ and the values are also grouped into risk categories (low, moderate, high, very high) to identify the level of risk. The higher the number, the greater the health risk associated with local air quality (ECCC 2016e). The Province of Manitoba states that “recent monitoring has shown that the health risks associated with air quality for the cities of Brandon and Winnipeg are generally low, with an average AQHI rating of around three or lower in both locations” (Government of Manitoba 2016d). Manitoba’s Sustainability Report 2009 indicates air quality as being stable in Manitoba based on the data from three reporting stations in Winnipeg, Flin Flon, and Brandon (Government of Manitoba 2009). The AQHI data summarized for Winnipeg for the period from 1987 to 2008 indicates good air quality for the majority of the time, with one episode of very poor air quality that occurred during 2002 that was likely due to smoke from burning crop residue in surrounding agricultural land (**Figure 3**) (Government of Manitoba, 2009).

The RSA is located approximately 200 km northwest of the City of Winnipeg and has a much lower density of population and development than the City of Winnipeg and surrounding areas. As such, it is expected that the ambient air quality within the RSA is of similar or higher quality than the ambient air quality for the City of Winnipeg. The RSA for the project is in a more forested landscape than the City of Winnipeg, and therefore may experience greater frequency of smoke from forest fires. The RSA includes and is adjacent to agricultural areas, which may also result in air quality effects due to the burning of crop residues.




Source: Government of Manitoba 2009.

**Figure 5: Winnipeg (Downtown) Air Quality Index, 1987-2008**

As noted in Section 6.1.3, the human population and amount of overall development and commercial activity in the LMOC LSA is of low density versus more populated urban areas. Existing effects on air quality in the LMOC LSA include emissions and dust due to traffic on PTH 6 and other local municipal, gravel and dirt roads and trails, including ATV and snowmobile activity; naturally occurring or human induced forest fires; emissions and dust from quarrying and quarried rock processing activities; odours, emissions and dust from farming activities; emissions from boating and other water-based activities; emissions from home heating, maintenance and other residential activities; and emissions from intermittent air traffic.

The construction activities for the proposed LMOC will contribute temporary emissions and dust from interim use of construction equipment and vehicles. The use of local roadways is expected to be higher than current levels during construction activities, but is expected to return to a lower level of use once construction is completed and the Project enters the operational phase. During operation, emissions and dust would be limited to potential heating and electrical needs for the gated control structure, and occasional use of vehicles and equipment for maintenance and monitoring activities.

### 7.1.5 Noise and Vibration

Existing noise and vibration levels in the RSA are expected to be typical of an area that consists mainly of forest, wetland and grassland areas with a transportation corridor and small urban and rural centers, cottage areas, and the presence of commercial, recreational and transportation activities. Existing sources of noise and vibration in the RSA include use of light and heavy vehicles and equipment; quarrying activities; processing activities at the Graymont plant; farming activities; recreational vehicles and activities (e.g., fishing, boating, hunting, snowmobiling, use of

ATVs); occasional air traffic; wind and wave action along shoreline areas; and bird migration, nesting and breeding activities. The Canadian National (CN) rail line that runs adjacent to PTH 6 and the spurs to Spearhill and Steeprock have been abandoned since 1997 (Transport Canada 2015) and are no longer a source of noise in the RSA. Planned upgrades to sections of PTH 6 have the potential to contribute to noise and vibrations in the RSA. The upgrades to PTH 6 are part of a five-year plan by the Manitoba Government and include paving of 19.5 km of asphalt from 1.6 km south of Moosehorn to the Steep Rock Junction at PTH 239 in the RSA (**Figure 2**) (Government of Manitoba 2013).

Within the LSA for the LMOC Route C and LMOC Route D, sources of noise and vibration include road use, construction and maintenance activities by light and heavy vehicles and equipment; quarrying activities; farming activities; recreational vehicles and activities (e.g., fishing, boating, hunting, snowmobiling, use of ATVs); occasional air traffic; wind and wave action along shoreline areas; livestock; and bird migration, nesting and breeding activities.

Traffic noise objectives have not been established in Manitoba for provincial highways; however, highway traffic noise is indirectly controlled by Transport Canada under the Motor Vehicle Safety Regulations (C.R.C., c. 1038) Schedule V.1 – Noise Emissions (Standard 1106), which defines maximum permissible sound levels (PSL) for individual categories of vehicles (Government of Canada 2016b). Common noise levels and typical human reactions are summarized in **Table 8.**

**Table 8: Common Noise Levels and Typical Human Reactions**

| Source | Decibels (dB) | Effect |
|---|---|---|
| Quarry production blast at 500 m | 128 | - |
| Car horn/propeller aircraft/air raid siren | 120 | Threshold of pain |
| Amplified rock band | 110 | Maximum vocal effort |
| Rockbreaker breaking at 7 m | 100 | |
| Running train | 100 | Discomfort |
| Reversing alarm at 4 m | 92 | |
| Heavy truck at 15 metres (m)/ Busy city street | 90 | Very annoying - Hearing damage (8 hr) |
| Paver at 15 m | 89 | - |
| Jackhammer at 15 m | 88 | - |
| Concrete mixer at 15 m | 85 | - |
| Bulldozer, Grader or Loader at 15 m | 85 | - |
| Pneumatic tool at 15 m | 85 | - |
| Generator at 15 m | 81 | - |
| Backhoe at 15 m | 80 | - |
| Factory floor | 80 | Annoying |
| Concrete vibrator at 15 m | 76 | - |
| Pump at 15 m | 76 | - |
| Passenger car at 65 miles per hour at 8 m | 70 | Telephone use difficult |
| Normal conversation | 60 | Intrusive |
| Noisy office | 50 | Speech interference |
| Light automobile traffic at 30 m | 50 | - |
| Public library | 40 | Quiet |

**Table 8: Common Noise Levels and Typical Human Reactions**

| Source | Decibels (dB) | Effect |
|---|---|---|
| Soft whisper at 5 m | 30 | Very quiet |
| Rustle of leaves | 10 | Just audible |
| Threshold of hearing | 0 | - |

Sources: Beranek 1988; CMHC 1981; Explosives and Rockwork Technologies Ltd. 2002; HMMH 2014.

As shown in **Table 8**, noise levels in the vicinity of a highway can be in the range of 50 to 70 decibels (dB), although actual noise levels would be dependent on the volume of traffic, speed of the traffic and distance from the roadway. Road construction equipment noise ranges between about 76 dB and 89 dB at 15 m from the equipment.

Regulation of noise in Manitoba is intended for management of worker exposure to noise levels in occupational environments, and local municipal bylaws established for noise nuisance management in the acoustic environment. Noise control guidelines for land use planning are provided through Manitoba's published *Guidelines for Sound Pollution* for daytime and nighttime acceptable and desirable noise levels in residential areas (MCWS 1992). For residential areas, the maximum desirable level is 55 dB during the day and 45 dB at night. For road construction, the industrial maximum desirable level would be used, which is 70 dB day or night.

There will be temporary increases in noise in the proposed LMOC LSA during the construction activities for the proposed LMOC from interim use of construction equipment and vehicles. The use of local roadways is expected to be higher than current levels during construction activities, but is expected to return to a lower level of use once construction is completed and the Project enters the operational phase. During operation, noise due to the LMOC Project would include occasional use of vehicles and equipment for maintenance and monitoring activities.

D. J. Martin (1977) conducted a study on ground vibrations due to construction noise generated by different types of equipment on different types of soils and surfaces. Martin (1977) classified the construction equipment as follows:

- Tracked plant, such as dozers and tractor shovels;
- Rubber-tired plant, such as motorized scrapers and dump trucks; and
- Continuous or intermittent impacting plant, such as pile drivers and vibratory rollers.

The study found that vibration levels at 10 m from equipment such as an earth-moving plant and sheet-piling rig were above the threshold of human perception and could cause disturbance to people. However, the levels were much lower than the levels that could likely cause architectural damage to buildings. The results showed that the major sources of vibration in road construction were the tracked earthmoving plant, compaction plant and intermittent impacting plant. Rubber-tired equipment did not generate ground surface vibration levels high enough to be detected by human subjects. At distances greater than 10 m, ground attenuation effects may reduce the vibration levels to values below human sensitivity.

Vibration assessments typically measure vibration in terms of the Peak Particle Velocity (PPV), which is the maximum speed at which the ground particle moves due to the vibration, and is expressed as either millimeters or inches per second (Explosives and Rockwork Technologies Ltd. 2002). The PPV threshold for the perception of ground vibration is about 0.51 mm/s (0.02 in/s) for most people (The World of Explosives 2016). Ground vibration limits may be expressed as a single value; however, it is more likely that the limits will vary based on frequency as the limits are typically designed for the protection of property and structures.

The construction and operation of the proposed LMOC may require the need for quarried rock and excavation in bedrock areas (Section 4.1). The noise and vibration from a production blast has been estimated as 128 dBa at 500 m, with a PPV of 1.3 mm/s at 500 m and an air blast (i.e., the wave of highly compressed air spreading outward from an explosion) of 119.4 dBa at 500 m (Explosives and Rockwork Technologies Ltd. 2002).

As such, there will be instances during the construction of the proposed LMOC where noise and vibration levels may temporarily increase for short periods of time within the PF and sections of the LSA that are in proximity to the PF. Based on data on the attenuation of noise and vibration over distance, this increased noise and vibration level is not expected to extend to the entire LSA or to the RSA. Noise and vibration levels may also increase temporarily and locally during the operational phase of the proposed LMOC due to vehicle or equipment use in the PF.

#### 7.1.6 Terrain and Topography

The RSA traverses two Ecoregions, the Mid-Boreal Lowlands (148) and the Interlake Plain (155); and four Ecodistricts; Sturgeon Bay (676), Waterhen (718), Gypsumville (720), and Ashern (723) (Smith et al 1998). The LMOC Route C LSA is located within the Gypsumville (720) and Ashern (723) Ecodistricts, and the LMOC Route D LSA is located within the Ashern (723) Ecodistrict (Map 2 in Appendix 2).

The Gypsumville (720) Ecodistrict is located in a small area surrounding Lake St. Martin between Lake Winnipeg and Lake Manitoba and has a mean elevation of about 251 metres above sea level (masl) (Smith et al. 1998). The physiography of the region is mostly level to ridge till plain, partly covered with thin, glaciolacustrine clay deposits. Vegetation is dominated by forest stand mixtures of trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and white spruce (*Picea glauca*), while Jack pine (*Pinus banksiana*) prevails on drier sites (Smith et al. 1998). The principal sources of water in the Ecodistrict are groundwater, and surface water from Lake St. Martin. Topography within the Ecodistrict includes slopes of zero to 2% that are 50 m to 150 m long, with an overall gentle slope towards the northeast of approximately 0.7 m/km from Lake St. Martin (Smith et al 1998).

The Ashern (723) Ecodistrict is located between Lake Manitoba to the west and Lake Winnipeg to the east and has a mean elevation of about 274 masl (Smith et al. 1998). The Ecodistrict slopes very gently toward Lake Winnipeg and westward toward Lake Manitoba (Smith et al. 1998). The physiography is the outcome of Glacial Lake Agassiz's retreat; wave action and iceberg scouring resulted in ridges of coarse-textured small rock (cobble and gravel) and finer-textured depressions (Smith et al. 1998). Forest stand vegetation is dominated by trembling aspen in the ridge areas, but often associated with balsam poplar and white spruce whose distribution is much affected by forest fires (Smith et al. 1998). Willow, sedge, and meadow grass occur in the poorly-drained depressions. Groundwater, the principal source of water in the Ecodistrict, is from shallow sand and gravel aquifers associated with the glacial till deposits (Smith et al. 1998). Smith et al (1998) describes the topography in the Ecodistrict as a northwest-southeast trending, ridge and swale topographic pattern, with grooved ridges ranging from about 400 m to 800 m wide and slopes that are usually less than 5% and range in length from 50 m to over 200 m. The land surface in the Ecodistrict slopes gently eastward toward Lake Winnipeg and westward toward Lake Manitoba at approximately 0.6 m/km, with local relief between ridges and swales of approximately 0.5 m to 3.0 m (Smith et al 1998).

For the proposed LMOC Route C, elevation was found to rise from about 249 masl at Lake Manitoba to about 256 masl at approximately 3.5 km inland, and remains above 252 masl until the area around PTH 6, after which the ground surface falls quickly to about 246 masl to Lake St. Martin (KGS Group 2016). For the proposed LMOC Route D, the elevation ranges upstream of PTH 6 from about 248 masl to about 252 masl near PTH 6, from where the ground surface then falls quickly to about 245.5 masl to Lake St. Martin (KGS Group 2016).

### 7.1.7 Geology and Soils

The RSA is located in an area of Manitoba referred to as the "Interlake" region as it lies between Lake Manitoba and Lake Winnipeg. The geology of the RSA is composed of layers of Devonian, Silurian and Ordovician carbonates and sandstone formed during the Paleozoic era that overly or onlap with Precambrian granites or gneisses (**Figure 4**) (Leybourne et al 2007). The Lake St. Martin area is a region of great geological interest as it was struck by a meteor during the Jurassic, Triassic or Permian period (Lapenskie and Bamburak 2015; Leybourne et al 2007; McCabe 1971). The Lake St. Martin meteorite impacted dolomitic Ordovician to Devonian carbonates, basal sandstones and underlying Precambrian rock formations (Lapenskie and Bamburak 2015; Leybourne et al 2007; McCabe 1971). The Lake St. Martin impact structure was described by McCabe (1971) as a crypto-explosion crater consisting of a crater or hole 14 miles (22.4 km) in diameter and more than 1,000 feet (about 350 m) deep, with a central core 2 to 3 miles (3.2 to 4.8 km) in diameter, consisting of highly shock-metamorphosed Precambrian gneiss that was uplifted by at least 700 feet (about 213 m), and is exposed in the centre of the crater. At the crater rim, lower Paleozoic and Precambrian rocks have been uplifted by 700 feet (about 213 m) or more and are exposed in outcrop near The Narrows of Lake St. Martin; beyond the crater rim is a structurally uplifted belt extending for about 14 miles (22.4 km) (McCabe 1971). The geological history of the area also resulted in large deposits of limestone, dolomite and gypsum, many of which have been mined for use as foundations and building structures, aggregate materials, cement, wallboard and Plaster of Paris (Government of Manitoba 2016e).

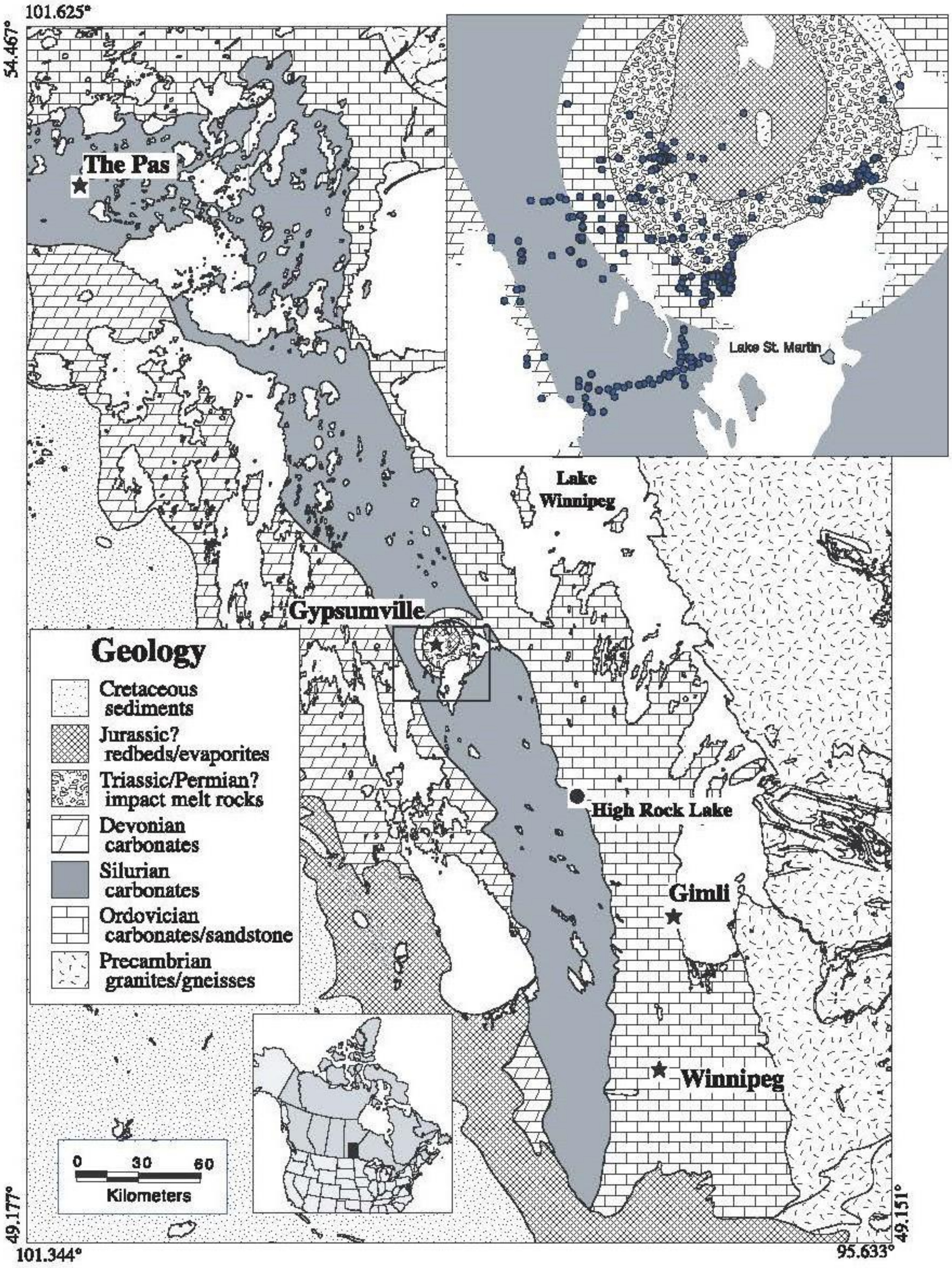



**Figure 6: Geological information for the RSA and LSM meteor impact area (from Leybourne et al 2007)**

Over time, areas within the limestone, dolomite and gypsum deposits become dissolved, forming what is referred to as karst topography, which produces a variety of features such as underground drainage systems, sinkholes and caves (Bilecki 2003). These sinkholes and caves can provide wildlife habitat for a variety of species as dens, hibernacula and resting areas (Bilecki 2003). The Paleozoic boundaries mainly encompass the Interlake Plain (155), Mid-Boreal Lowlands (148), and a small portion of the Lake Manitoba Plain (162) Ecoregions, as defined by Smith et al. (1998), and the RSA is located just south of the localized permafrost zone (Lockery 1984). The surficial geology can be described as very calcareous, stony (cobble or gravel), water-worked glacial till that is deep to shallow (20-30 m) over limestone bedrock (Smith et al. 1998). Additional information on the regional surficial and bedrock geology is provided in the "*Assiniboine River & Lake Manitoba Basins Flood Mitigation Study LMB & LSM Outlet Channels Conceptual Design - Stage 2*" prepared by KGS Group (2016).

Soils within the LSA are heavily influenced by the geology of the area. Chernozemic dark grey surface horizons result, as well as soils composed of luvisol, brunisol and organic matter (Mills 1984). The soils in the Gypsumville (720) Ecodistrict are typically imperfectly-drained, dark grey chernozems developed on strongly calcareous, loamy to clay glacial till; poorly-drained gleysol and black chernozem soils occur on shallower areas (Smith et al. 1998).

The Ashern (723) Ecodistrict is comprised of dominant soils in the higher ridges that are imperfectly-drained, dark chernozems developed on strongly calcareous, loamy to clay loam glacial till, while the low areas are dominated by poorly-drained gleysols to shallow, slightly decomposed organic soils (Smith et al. 1998). Map 3 in the Wildlife Technical Report (Appendix 2) presents the soil landscapes of the RSA and LSA.

The 2015 geotechnical investigations showed that the stratigraphy at the proposed LMOC Route C generally consisted of a thin layer of topsoil overlying till materials including silt and clay till, silt till, clay till, and then bedrock (KGS Group 2016). A thin layer of topsoil was present at the ground surface and extended to approximate depths of 0.3 to 0.9 m; the topsoil was noted as being black to grey in colour, moist, firm and contained organics. A combination of till deposits with varying amounts of clay, silt, sand and gravel underlies the topsoil layer, with the predominant grain size of the till differing spatially and with depth. The till layer extended to bedrock at approximate depths of 6.1 m, 1.4 m and 1.6 m in three of the boreholes located respectively at 8.0 km, 4.5 km and 4.0 km inland from Lake Manitoba, and to an approximate depth of 11.1 m in a borehole located about 0.4 km inland from Lake Manitoba that was terminated prior to reaching bedrock (KGS Group 2016). The till was noted as being grey in colour, moist to wet, hard and contained occasional cobbles and boulders. Thin sand and cobble layers separating the till and bedrock were encountered in boreholes located at PTH 6 about 8 km inland from Lake Manitoba and the borehole located about 4.5 km inland from Lake Manitoba. Limestone bedrock was encountered in all boreholes at approximate depths ranging from 1.4 m to 6.1 m (KGS Group 2016).

The 2015 geotechnical investigations for the proposed LMOC Route D found that the stratigraphy at Route D generally consisted of a thin layer of topsoil overlying till materials including clay till, silty clay till, silt till, or sandy clay till with layers of sand, and then bedrock (KGS Group 2016). A thin layer of topsoil was encountered at the surface of each borehole and extended to approximate depths of 0.3 m to 1.2 m and was noted as being black in colour, moist, firm and contained organics. A combination of till deposits was encountered beneath the topsoil containing varying amounts of clay, silt, sand and gravel, with the predominant grain size within the till differing spatially and with depth. The till extended to bedrock at an approximate depth of 20.7 m in the borehole located about 2.6 km inland from Lake Manitoba, and to approximate completion depths of 12.6 m to 18.7 m in other boreholes, where these boreholes were terminated prior to reaching bedrock (KGS Group 2016). The till was noted as being grey in colour, moist to wet, hard and contained occasional cobbles and boulder. Layers of sand or silty sand with a thickness of up to 3.9 m were encountered in boreholes located 2.6 km, 12.8 km,16.8 km, 19.0 km inland from Lake Manitoba, respectively. The sand was described as grey to brown in colour, wet, compact to very dense, fine to medium grained, and contained varying amounts of silt. Some clay was encountered in the silty sand in the borehole located about 19.0 km inland from Lake Manitoba at PTH 06. Limestone bedrock was encountered in the borehole located about 2.6 km inland from Lake Manitoba at an approximate depth of 20.7 m, and extended to the end of the borehole at an approximate depth of 22.3 m; all other boreholes investigated in 2015 along the Route D alignment were terminated prior to reaching bedrock (KGS Group 2016).

### 7.1.8 Vegetation

The "*Lake Manitoba Outlet Channels Route Options – Vegetation Technical Report*" was prepared by S. Gray Environmental Services Inc. (2016) and is provided as Appendix 1 to this report. Additional information on the vegetation studies for the LMOC Project, including site photographs, is provided in Appendix 1.

#### *7.1.8.1 Ecological Land Classification*

The RSA is located within the Boreal Plains Ecozone. In Manitoba, the Ecozone extends from the central portion of the Manitoba-Saskatchewan border east to Lake Winnipeg, and then south in a narrow band along the Red River (Smith et al. 1998). White spruce (*Picea glauca*), black spruce (*Picea mariana*), jack pine (*Pinus banksiana*), tamarack (*Larix laricina*), white birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*) are the most common tree species in the Ecozone (Smith et al. 1998). Within the Boreal Plains Ecozone, the RSA is situated in the Gypsumville (720) and Ashern (723) Ecodistricts of the Interlake Plain Ecoregion (Smith et al. 1998).

The Gypsumville Ecodistrict occupies a small area in the north-central part of the Interlake Plain Ecoregion and encompasses Lake St. Martin (Smith et al. 1998). Nearly all of the soils are imperfectly drained, and the vegetation varies based on moisture content of the soils (Smith et al. 1998). The forest stands in the Ecodistrict are a mixture of trembling aspen, balsam poplar and white spruce in varying quantities. Jack pine is prevalent on drier sites (Smith et al. 1998).

The Ashern Ecodistrict occupies a major portion of the area generally referred to as the "Interlake". Trembling aspen dominates the forest stands in the Ecodistrict, while balsam poplar and white spruce occur to a lesser extent (Smith et al. 1998). Poorly drained areas have willow (*Salix* spp.), sedge (*Carex* spp.) and meadow grass (e.g., *Poa* spp.) vegetation. Black spruce and tamarack dominate the vegetative cover in the bogs in association with swamp birch (*Betula pumila*), ericaceous shrubs (e.g. Labrador tea [*Rhododendron groenlandicum*]) and sphagnum (*Sphagnum* spp.) and other mosses. Willows and sedges, and to a lesser extent tamarack, and various herbs and forbs, are dominant in fen peatlands (Smith et al. 1998).

#### *7.1.8.2 Vegetation Cover Classification*

Vegetative cover classes used to represent the communities and habitats within the RSA and LSA were obtained from the LCC. The LCC provides vegetated and non-vegetated land cover classes that identify the primary ecological and vegetation/habitat conditions of an area. The LCC for the vegetation RSA and LSA for the LMOC Route C and the LMOC Route D is provided in Figure 2 and Figure 3 of Appendix 1, and a summary of the LCC information for the RSA and LSA for the LMOC Route C and the LMOC Route D is provided in Table 2 and Table 3 of Appendix 1. The primary land cover types in both the Route C and Route D RSAs and LSAs are hay and grazing pasture grasslands, which covers nearly half of the study areas. Other major land cover types include annual and perennial croplands, scattered shrub and herb dominant wetlands, and dense broadleaf forests.

#### *7.1.8.3 Wetland Classification*

The Stewart and Kantrud (1971) system of wetland classification was selected for use in the LMOC Project area as this system was developed for application in glaciated prairie habitats, and better reflected the LMOC Project area versus the Canadian Wetland Classification System (Ducks Unlimited Canada 2014). The Stewart and Kantrud (1971) system has been applied in Manitoba to classify wetland areas as part of provincial environmental approvals and drainage management regulations (MBSD 2016a). Under the Stewart and Kantrud classification system, wetland vegetation in prairie ponds and lakes can be grouped into zones; each zone is characterized by a different community structure and a distinct assemblage of plant species that vary in species composition in accordance with soil saturation and permeability (Stewart and Kantrud 1971). These vegetation zones are designated as follows:

- Wetland-low-prairie zone;
- Wet-meadow zone;
- Shallow-marsh zone;
- Deep-marsh zone;
- Permanent-open-water zone;
- Intermittent-alkali zone; and
- Fen (alkaline bog) zone.

Wetlands may only have one zone, or could contain two or more zones. These vegetation zones can occupy the central area of a depression or they may form a peripheral band around a deeper zone (Stewart and Kantrud 1971). The presence or absence and the distributional pattern of the zones are the primary factors used in distinguishing the seven major classes of wetlands, as detailed by Stewart and Kantrud (1971) below:

Class I - Ephemeral Wetlands typically have surface water for only a short period of time after snowmelt or storm events in early spring. They may be periodically covered by standing or slow moving water. Water is retained long enough to establish some wetland or aquatic processes. They are typically dominated by Kentucky bluegrass (*Poa pratenses*), goldenrod (*Solidago* spp.) and other wetland or low prairie species.

Class II - Temporary Wetlands are periodically covered by standing or slow moving water. They typically have open water for only a few weeks after snowmelt or several days after heavy storm events. Water is retained long enough to establish wetland or aquatic processes. They are dominated by wet meadow vegetation such as fine-stemmed grasses, sedges and associated forbs.

Class III - Seasonal Ponds and Lakes are characterized by shallow marsh vegetation, which generally occurs in the deepest zone (usually dry by midsummer). These wetlands are typically dominated by emergent wetland grasses, sedges and rushes.

Class IV - Semi-permanent Ponds and Lakes are characterized by marsh vegetation, which dominates the central zone of the wetland, as well as emergent or submerged plants, including cattails, bulrushes and pondweeds (*Potamogeton* spp.). These wetlands frequently maintain surface water throughout the growing season (i.e., May to September).

Class V - Permanent Ponds and Lakes have permanent open water in a central zone that is generally devoid of vegetation. Submerged plants may be present in the deepest zone, while emergent plants are found along the edges.

Class VI - Alkali Ponds and Lakes are wetlands where deep water is typically not permanently present. Alkali wetlands are characterized by a pH above 7 and a high concentration of salts. The dominant plants are generally salt tolerant and include red swampfire and spiral ditchgrass.

Class VII - Fen Ponds are wetlands in which fen vegetation dominates the deepest portion, often with wet meadow and low prairie vegetation present on the periphery. The soils are normally saturated by alkaline groundwater seepage. Fen ponds often have floating mats of emergent vegetation, which includes sedges, grasses and other herbaceous plants.

#### *7.1.8.4 Plant Species of Conservation Concern*

Based on the desktop review, there are seven vascular plant Species At Risk that occur in the Interlake Plain Ecoregion and none in the Mid-Boreal Lowland Ecoregion. However, no plant listed under MESEA, SARA, or that having a special designation by COSEWIC are known or expected to occur in the RSA (MBSD 2016b; SARA 2016). The small white lady's-slipper (*Cypripedium candidum*) and the rough agalinis (*Agalinis aspera*), are both listed federally and provincially as

Endangered, and have known distributions 100 km south of the RSA, close to St. Laurent, MB (MBSD 2016c; EC 2015a). Based on the grassland, prairies and wet meadows habitat requirements of these species, there is an extremely low probability of these species' occurrence in the RSA (MBSD 2016c; EC 2015a).

The MBCDC lists 108 vascular plant species of conservation concern within the Interlake Plain Ecoregion (Appendix A of Appendix 1) that have a provincial status of S1, S2 or S3. A search of the MBCDC database for recorded occurrences of rare species in the RSA and LSA found occurrences of three species of conservation concern in both the RSA and LSA, the ram's-head lady's-slipper (*Cypripedium arietinum*) (S2S3), long-fruited parsley (*Lomatium macrocarpum*) (S3), and hairy-fruited parsley (*Lomatium foeniculaceum*) (S3). Narrow-leaved milkvetch (*Astragalus pectinatus*) (S3S4) is within 20 km of the LSA (Friesen 2015, pers. comm.). The ram's-head lady's-slipper can be found in black spruce and tamarack sphagnum bogs and less so in drier upland coniferous forests (Foster and Reimer 2007). The long-fruited parsley, hairy-fruited parsley and narrow-leaved milkvetch prefer dry upland prairie habitats, often along hillsides (Jennings 2007). The long-fruited parsley and hairy-fruited parsley have been previously found along the Lake Manitoba shoreline near the town of Steeprock, Manitoba (Friesen and Murray 2010).

#### *7.1.8.5 Plant Species of Significance to First Nations*

MI and First Nations consultations were ongoing at the time of this writing, and a list of species important to the local First Nation communities had yet to be compiled. It is recognized that there are many plant species of significance to many First Nations peoples, and that the plant species of significance will vary by the practices of each First Nation, and their gathering locations. It is recognized that First Nations people have a special relationship with the earth and all living things in it. This relationship is based on a profound spiritual connection to the environment that guided indigenous peoples to practice reverence, humility and reciprocity. First Nations people have been sustainably harvesting plants based on subsistence needs and values extending back thousands of years.

However, it is known that Seneca root (*Polygala senega*) is gathered in the area and is an important plant used for medicinal and ceremonious purposes (NLHS 2015). The First Nations also used to gather various species of edible berries such as gooseberries, as well as medicinal plants such as sweet flag (*Acorus calamus*), which is chewed for sore throats and to prevent colds, and found along riverbanks and wetland habitats (Traverse 1999).

#### *7.1.8.6 Invasive Species*

There was no historical information found on invasive species within the LSA or RSA. However, due to the level of human and livestock disturbance and activity along the Route C and Route D alignments, it is expected that invasives have been introduced and are present within the LSA. Canada thistle (*Cirsium arvense*), common dandelion (*Taraxacum officinale*) and perennial sow thistle (*Sonchus arvensis*) are commonly found in grazing pastures where livestock traffic facilitates spread, as well as along disturbed roadsides. Scentless chamomile (*Tripleurospermum perforata*) is also commonly found within disturbed pastures, roadsides and croplands. Invasive phragmites (*Phragmites australis* sub. *australis)* is a wetland invader that spreads quickly and outcompetes native species for water and nutrients. Invasive phragmites is commonly found in disturbed wet roadside ditches and can quickly crowd out native wetland vegetation, resulting in decreased plant diversity. There have been no known occurrences of invasive phragmites within the RSA, though it may pose a potential threat in the future, as much of the RSA is located in low-lying wet habitats that could be vulnerable to invasive phragmites establishment.

#### *7.1.8.7 Summary of 2016 Field Investigations*

A total of 141 plant species were identified along Route C during the spring and summer field surveys, including: one non-vascular species, 18 graminoids (sedges, grasses, rushes), 25 shrubs, seven trees and 90 herbaceous species. A total of 143 plant species were identified along Route D during the spring and summer field surveys, including: one non-vascular species, 27 graminoids (sedges, grass, rushes), 29 shrubs, six trees and 80 herbaceous species. A complete list of species found along Route C and Route D are provided in Appendix C of Appendix 1. Forest communities were classified by 'V-type' based on the Forest Ecosystem Classification (FEC) system for Manitoba developed by the CFS (Zoladeski et al. 1995).

Four prominent land cover types were identified within the project area: modified grassland, tilled cropland, marsh wetlands and aspen dominant hardwood stands. Land use in the area is predominantly agricultural, consisting mainly of grazing and hay pastures with some cultivated croplands.

#### 7.1.8.7.1 Route C

Figure 4 in Appendix 1 shows the vegetation survey plot locations along Route C. The inlet of the proposed Route C alignment is located along a rocky and sandy shoreline of Lake Manitoba (Plot 1). A riparian buffer composed of Manitoba maple (*Acer negundo*), trembling aspen and American elm (*Ulmus americana)* bordered the rocky coast. The shoreline vegetation was dominated by sedges and other species tolerant of wet conditions. Smooth brome tame hayfields dominated the landscape as the channel heads inland (Plots 2, 6, 7 and 8). Some small permanent, semi-permanent, and seasonal wetlands were scattered throughout the hayfields. Cattails (*Typha latifolia*) and bulrushes (*Schoenoplectus* spp.) dominated the shallow to deep marsh zone of these wetlands, while sedges and mint species (e.g., wild mint [*Mentha arvensis*]) comprised the wet meadow and low-prairie zones. Other species present within these hayfields included a mix of native grassland species such as smooth blue aster (*Symphyotrichum laeve*), common blue-eyed grass (*Sisyrinchium montanum*), field pussytoe (*Antennaria neglecta*), and big bluestem (*Andropogon gerardii*), as well as some minor and moderate invasive species (e.g. perennial sow thistle, Canada thistle and common dandelion).

Large open aspen hardwood stands breakup the hayfields. The understory within these aspen forests consisted of shrub species such as beaked hazel (*Corylus cornuta)*, Saskatoon serviceberry (*Amelanchier alnifolia*) and red osier dogwood (*Cornus sericea)*. Small seasonal wetlands (Class III) were scattered throughout the forest landscape. Networks of trails and human activity have resulted in the spread of invasives such as great burdock (*Arctium lappa*), sweet clover (*Melilotus* spp.), Canada thistle and common dandelion (Plots 3, 4 and 5).

As the Route C channel alignment heads south and parallels PTH 6, it passes through a low-lying open aspen hardwood forest with numerous pockets of seasonal (Class III), semi-permanent (Class IV) and permanent (Class V) marsh and swamp wetlands (Plot 13). As it continues south, the aspen forest gives way to tame smooth brome (*Bromus inermis*) grazing pastures with lots of Seneca root and small communities of native grassland species (e.g. Canadian anemone [*Anemone Canadensis*], field pussytoe). Sedge dominant ephemeral (Class II) and seasonal (Class III) wet meadows were scattered throughout the tame pasture (Plot 14 and 15). Several invasives species were also present within the tame pasture, including scentless chamomile as well as other minor to moderate invasives.

As the proposed channel alignment crosses PTH 6 and heads east towards Lake St. Martin, the channel passed through more tame hayfields (Plot 16) with treed windrows of aspen hardwood forest habitat (Plot 17). Hayfields were composed of a mix of tame species such as timothy (*Phleum pretense*), smooth brome and alfalfa (*Medicago sativa*) with a mix of native grassland species (e.g. common blue-eyed grass, field pussytoe). Seneca root was also abundant throughout these hayfields. Minor invasive species such as sweet clover, common dandelion and Kentucky blue grass were common within the pastures. About 1 km from Lake St. Martin, Route C crosses a large permanent marsh wetland complex (Class V) (Plot 18). The wetland complex has a large willow dominant shrubby riparian zone and a diverse wet meadow zone dominated by sedges, mint species and water hemlock (*Cicuta maculata*).

East of the large wetland, the area was comprised of a mix of aspen hardwood stands (Plot 19) and smooth brome tame grazing pastures (Plot 20) right up to the proposed channel outlet at Lake St. Martin (Plot 22). The area had a high level of disturbance due to cattle grazing activity, which seems to have led to the spread and distribution of invasive species as evident by the widespread presence of Canada thistle, common dandelion and sweet clover. Scentless chamomile was also common here, likely due to the spread by livestock.

#### 7.1.8.7.2 Route D

The proposed Route D outlet channel connects Watchorn Bay on Lake Manitoba to the outlet of Birch Creek on Lake St. Martin and is adjacent to low-lying terrain between Lake Manitoba and Lake St. Martin where numerous marshes and small lakes exist.

Figure 5 in Appendix 1 shows the vegetation survey plot locations along Route D. The habitat at the inlet of the proposed Route D alignment was similar to that of Route C with a narrow strip of rocky and sandy shoreline and a small treed riparian buffer (Plot 1). A riparian buffer composed of Manitoba maple, trembling aspen and American elm bordered the rocky coast. The shoreline here was rockier than at Route C and almost void of vegetation. Smooth brome tame hayfields extended inland beyond the treed riparian buffer. Much of the area was heavily disturbed from human activity resulting in the spread of many minor and moderate invasive species including Canada thistle, absinthe (*Artemisia absinthium*), yellow sweet clover (*Melilotus officinalis*) and field bindweed (*Convolvulus arvensis*).

For the first several kilometers the alignment passed through a large permanent marsh wetland (Class V) network, with some upland pockets of cropland, smooth brome and alfalfa tame hayfields (Plot 2). As the channel continues north, the alignment followed an upland habitat along the western edge of this large wetland complex. The habitat consisted of tame hayfields and cattle grazed pastures (Plot 8 and 9) with scattered open bluffs of aspen and bur oak (*Quercus macrocarpa)* (Plot 4). The large wetland had a deep open water zone with a wide shallow to deep marsh zone dominated by cattails and rushes (Plot 6 and 7). The wet meadow zones surrounding the wetland varied in width and were composed of sedges, rushes and mint species (Plot 5). Some smaller permanent (Class V), semi-permanent, (Class IV) seasonal (Class III) and temporary (Class II) wetlands were also scattered throughout the landscape. Many of the seasonal and temporary wetlands were heavily shrubbed with willows. As the channel alignment heads northward, upland habitats became more prevalent and a mix of cultivated cropland, tame smooth brome and alfalfa hayfields dominated the landscape. Although the terrain was generally not as wet as it is further south along the alignment, some smaller permanent (Class V), semi-permanent (Class IV) and seasonal (Class III) wetlands were scattered across the landscape (Plot 13 and 14).

Just south of PR 239, the habitat shifted from tame pastures to an aspen dominant hardwood forest with a thick beaked hazel (*Corylus cornuta*) dominating shrub layer. The herbaceous ground cover was typical of moist forest and was composed of species such as star-flowered false Solomon's seal (*Maianthemum stellatum)* and wild sarsaparilla (*Apocynum androsaemifolium*) (Plot 16). Several pockets of seasonal (Class III), semi-permanent (Class IV) and permanent (Class V) marsh and swamp wetlands were scattered throughout the aspen stand (Plot 17).

Between PR 239 and PTH 6, the aspen hardwood forest continued to dominate the landscape with some pockets of tame hayfields surrounding a large permanent wetland complex that was connected to the Goodison Lake wetland (Plot 18 and 19). Seneca root was widespread within the hayfields and found mainly adjacent to the sedge dominant wet meadow zone of the wetland. Within the aspen stand just south of PTH 6, several permanent, semi-permanent and seasonal wetlands were present, including a shrubby sphagnum bog (Plot 20). The bog habitat was dominated by a shrub layer of bog birch and bog willow with some Labrador tea and three-leaved false Solomon's seal (*Maianthemum trifolium)* as ground cover amongst the sphagnum moss.

North of PTH 6 and up to Lake St. Martin, the landscape consisted of cultivated croplands as well as alfalfa and smooth brome tame hayfields and pastures (Plot 21). The habitat at the channel outlet consisted of a cattle grazed smooth brome pasture with a coastal marsh wetland (Plot 22).

Cattails and bulrushes dominated the deep and shallow marsh zones of the wetland, whereas mints and sedges dominated the wet meadow zone.

#### 7.1.8.7.3 Plant Species of Conservation Concern

No federally or provincially listed species, or any species listed by MBCDC having conservation concern, were observed during the vegetation surveys of the LMOC route options. One sphagnum bog habitat observed along Route D could provide habitat for rare orchids (e.g. ram's-head lady-slipper), though none were observed. The rocky coastal habitat along Lake Manitoba at both the Route C and Route D alignments has a similar habitat to the shoreline at the town of Steeprock, where historic observations of long-fruited and hairy-fruited parsley were made. However, neither of these species were found during the 2016 spring and summer surveys.

#### 7.1.8.7.4 Plant Species of Importance to First Nations

Seneca root was found at several locations along the Route C alignment (Figure 4 in Appendix 1: Plots 4, 6, 9, 11, 12, 15, and 16). The species was mainly found in clusters amongst other native grassland species adjacent to wet meadows and along forest edges within the tame hayfields and grazed pastures. Some pasture sage was found within some grassland openings at Plots 11 and 12 and within grazed tame pastures near the proposed outlet at Lake St. Martin (Figure 4 in Appendix 1: Plots 21 and 22).

Seneca root was only found in one area, albeit in abundance, along the proposed Route D alignment within a smooth brome dominated hay field adjacent to a wet meadow zone of a large permanent wetland (Figure 5 in Appendix 1: Plot 18).

Photograph 1: View of Seneca root (*Polygala senega*) within a tame hayfield along Route C at Plot 16, June 10, 2016 (S. Gray Environmental Services Inc. 2016)

#### 7.1.8.7.5 Invasive Plant Species

During the 2016 spring and summer vegetation surveys, there were 23 species that are invasive to Manitoba that were identified within the LSA of Route C (Table 4 in Appendix 1) and 19 invasive species identified within the LSA of Route D (Table 5 in Appendix 1). These species were mainly found along disturbed roadside habitat and within tame hayfields and grazed pastures where livestock activity and human disturbance is frequent.

No Category 1 listed species were identified during the field surveys. Scentless chamomile and ox-eyed daisy (*Leucanthemum vulgare*) are considered Tier 2 noxious weeds by the NWA and are EDRR category 2 listed species by the Invasive Species Council of Manitoba (ISCM). Both species were identified within several hayfields and pastures along both Route C and Route D. These species are well adapted to a variety of habitats, including wet, moist soils and periodic flooding, as well as drier areas and perennial forage fields. This adaptability allows them to colonize disturbed areas rapidly and outcompete native species.

Several species identified as moderate invasives by Environment Canada (EC 1999) were also found along both Route C and Route D alignments. Smooth brome was the dominant tame grass species in most hayfields and grazed pastures within the study areas. Although used as a tame grass species, smooth brome is considered a moderate invasive species to native habitats. Canada thistle and yellow and white sweet clover (*Melilotus alba*), were fairly common throughout the hayfields and grazing pastures where human or livestock activity was present.

Other minor invasives plant species such as Kentucky bluegrass, absinthe, nodding thistle (*Carduus nutans*) and common dandelion were also observed at several locations along both alignments, predominantly along roadsides and access trails. Alfalfa was a dominant tame legume species in some pastures and is considered a minor invasive to native habitats. Pasture sage is declared as a noxious weed in Manitoba (Government of Manitoba 2016f) and was observed within several high traffic grassland areas along Route C.

Invasive species vary in aggressiveness and are well adapted to a variety of habitats. They can quickly establish in disturbed areas and propagate by seed, so can be easily spread. Preventing seed production and spreading using an integrated approach of combining herbicide and/or mechanical treatment with competition from desirable native plants is an effective way of controlling these species. Another important method to prevent the spread of invasive species is the use of clean native seeds in seeding rights-of-way (Parks 2010).

#### *7.1.8.8 Vegetation Study Summary*

This study was conducted to determine the existing vegetation and delineate the vegetation habitat types within the proposed LMOC project area. Four prominent land cover types were identified within the 5 km RSA for the proposed LMOC: modified grassland, tilled cropland, marsh wetlands and aspen dominant hardwood stands. Land use in the area is predominantly agricultural, consisting mainly of grazing and hay pastures with some cultivated croplands.

No species at risk or species of conservation concern were observed along both the Route C and Route D alignments during the 2016 field surveys. However, the shoreline habitat of Lake Manitoba at both the Route C and Route D inlets were characteristic of the rocky shorelines at Steeprock, where previous observations of long-fruited parsley and hairy-fruited parsley have been recorded. A small shrubby sphagnum bog along Route D alignment also provides habitat suitable for rare orchid species that have known occurrences within the RSA (i.e. ram's-head lady's-slipper), though none were observed.

Seneca root and pasture sage were two species of significance to First Nations found during the 2016 field surveys. Seneca root was widespread and abundant within the hayfields and grazed pastures along the Route C alignment, and was found mainly adjacent to wet meadows and along forest edges. Pasture sage was only found at a few locations within open grasslands habitat and within the heavily grazed pastures near the proposed outlet at Lake St. Martin. Seneca root was only found in one area along the proposed Route D alignment within a smooth brome hayfield adjacent to a wet meadow zone of a large permanent wetland complex.

Twenty-three and nineteen invasive species were identified along Route C and Route D, respectively. No principal invasives, Tier 1 or category 1 invasive species were observed along either of the alignment options. Scentless chamomile and ox-eyed daisy are NWA Tier 2 weeds and category 2 listed species by the ISCM, and were identified within several hayfields and pastures. Other moderate and minor invasive species were observed along both channel alignments along roadsides and within tame hayfields and grazing pastures where livestock activity and human disturbance is frequent. The frequency and abundance of invasive species varied with the degree of disturbance.

### 7.1.9 Wildlife and Wildlife Habitat

The "*Lake Manitoba Outlet Channels: Wildlife Technical Report*" (EcoLogic 2017) was developed for the LMOC component of the Project to provide a detailed summary of the wildlife data collection activities, methods, analyses, and results conducted to date within the RSA and LSA. A copy of the report is provided as Appendix 2.

#### *7.1.9.1 Mammals*

The RSA, which occurs within the Manitoba Lowlands of the Boreal Forest, consists of flat, poorly drained land with forested patches of various deciduous and coniferous tree species, intermixed with swamps, meadows, and arable areas cleared for agriculture (Rowe, 1972). Based on this diversity of habitat types, typical mammal species in the area include American marten (*Martes americana*), American beaver (*Castor canadensis*), black bear (*Ursus americanus*), coyote (*Canis latrans*), elk (Manitoba subspecies *Cervus elaphus manitobensis*), ermine (*Mustela erminea*), fisher (*Martes pennanti*), grey wolf (*Canis lupus*), least chipmunk (*Tamias minimus*), lynx (*Lynx canadensis*), mink (*Neovison vison*), moose (*Alces alces*), muskrat (*Ondatra zibethicus*), otter (*Lontra canadensis*), red squirrel (*Tamiasciurus hudsonicus*), snowshoe hare (*Lepus americanus*), and white-tailed deer (*Odocoileus virginianus*).

Moose are distributed across much of forested Canada (Banfield, 1974) and are common within the boreal forest, which covers many areas of Manitoba including the Project study area. Moose often select habitats of early successional vegetation such as shrubland areas and deciduous forests (Gillingham and Parker, 2008). Such successional vegetation frequently exists after disturbance, both natural (i.e. wildfire) and anthropogenic (i.e. forest removal). Moose are most commonly found in swampy areas with aquatic plants and willows, which make up the majority of their diet (Renecker and Schwartz, 1998). Moose are an integral component of the ecosystem in their predator/prey relationships.

Elk inhabit young coniferous tree stands and dense woodlands as well as meadows and valleys, including plains areas such as those found in the larger RSA. Elk are commonly found in early successional areas after disturbances such as fires where they find good foraging vegetation

(Reid, 2006). This foraging preference correlates with the fire history described previously, where a number of fires have occurred in the area since the 1980s.

White-tailed deer are also present in the RSA. White-tailed deer tend to inhabit both woodland and open areas, which are used for cover and forage (Reid, 2006). The occurrence of higher ungulate populations in an area (increased prey) may result in increased predator populations. As a result, deer occurrence in areas near moose may result in higher wolf populations in the area and subsequent increases in predation.

Black bears are found across most wooded habitats in North America and are relatively common through northern mixed and eastern deciduous forests (Kolenosky and Strathearn, 1987; Reid, 2006). Black bear densities are highest in diverse forests at relatively early successional stages and lowest where soils are thinner and plant growth generally poorer (Kolenosky and Strathearn, 1987). Black bears can take advantage of anthropogenic landscape change such as agricultural lands and woodlots. Agricultural crops provide a variety of vegetation and insects to feed on, as do woodlots, given many small prey reside in woodlots, and they are typically comprised of a variety of tree seeds, new successional vegetation, and insects. Black bears are found in the RSA in some areas, but due to habitat needs, they tend to stay away from the wetter lowland areas and select denser areas of forest stands.

Coyote are a highly adaptable species found most commonly in mixed habitats versus dense unbroken forests (Reid, 2006). Coyotes are found throughout the RSA and feed upon small mammals and rodents, as well as predate on calves of deer and larger ungulates. Coyotes, when banding together, can also take down these large animals (Caras, 1967).

Grey wolves are also plentiful in most of Manitoba and in the RSA. They tend to inhabit forested areas with sufficient prey species such as moose, American beaver, and snowshoe hare.

The RSA offers suitable habitat to many furbearers. American beaver and muskrat provide valuable furs and, along with hares, good meat for eating. Ermine, fisher, American marten, mink, otters, red fox (*Vulpes vulpes*), and red squirrel are furbearers that are known to be present in the RSA.

Ermine habitat includes coniferous or mixedwood forests, fields, areas of dense vegetation and areas near wetlands, and can be found in most of these habitats in Manitoba, including the RSA (Reid, 2006). Both fisher and American marten can be found in most of Manitoba with American marten being limited to primarily boreal areas of the province. They generally inhabit mature coniferous or mixedwood forests and will feed on small mammals such as hares, some birds, fruit, nuts, and carrion (Reid, 2006). They also feed on rodents, hares, shrews, and insects. Mink inhabit areas along streams, lakes, and wooded cover. They can be found in all of Manitoba and will primarily feed on small to medium mammals, crayfish, frogs, snakes, and birds (Reid, 2006).

Otters can be found in most of central/northern Manitoba and within the RSA near or in lakes, streams, rivers, or swamps. They feed on fish, frogs, crayfish, and shellfish (Reid, 2006).

There are several species of small mammals that can be considered to be within or at the edge of their natural range. These include the least weasel (*Mustela nivalis*), masked shrew (*Sorex cinereus*), meadow jumping mouse (*Zapus hudsonius*), northern bog lemming (*Synaptomys borealis*), pygmy shrew (*Sorex hoyi*), raccoon (*Procyon lotor*), short-tailed shrew (*Blarina brevicauda*), striped skunk (*Mephitis mephitis*), and woodchuck (*Marmota monax).*

There are six species of bats that may be found within the RSA. These include the big brown bat (*Eptesicus fuscus*), eastern-red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), little brown bat (or little brown myotis) (*Myotis lucifugus*), northern long-eared bat (or northern myotis) (*Myotis septentionalis*), and silver-haired bat (*Lasionycteris noctivagans*). The eastern-red, hoary and silver-haired bat species migrate south for the winter, while the big brown, little brown and northern long-eared bat species overwinter in hibernacula such as caves. The little brown bat and northern long-eared bat are listed as Endangered on Schedule 1 of SARA and MESEA (SARA 2015; MC 2015). SARA currently has a proposed Recovery Strategy for the little brown bat and northern long-eared bat, with three Critical Habitat areas for these species identified in the Interlake area of Manitoba (EC 2015b; Norquay et al. 2013). Additional information on Species At Risk (SAR) in the LMOC Project area is provided in Section 7.1.13.

A listing of known mammals that can be found in the Interlake Plain Ecoregion and the Mid-Boreal Lowlands ecoregions and their conservation classification is presented in Appendix 2. Information on hunting and trapping of mammal species is provided in Section 7.2.5.

#### *7.1.9.2 Birds*

There are a number of types of birds and bird species present in the Mid-Boreal Lowland and Interlake Plain Ecoregions. These birds include raptor species such as bald eagles (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*). Bald eagles nest in tall shoreline trees along lakes, rivers, and open areas and primarily feed on water birds, small mammals, fish, and carrion (Bezener and De Smet 2000). Osprey can be found in most of Manitoba, in habitat located along slow flowing rivers, streams as well as lakes, where they nest in tall trees or on artificial platforms. Their diet consists mostly of fish, though they will also take rodents, birds, and small vertebrates (Bezener and De Smet 2000).

A variety of owl species can also be found within the RSA including but not limited to: the great grey owl (*Strix nebulosi*), great horned owl (*Bubo virginianus*), northern hawk owl (*Surnia ulula*), and short-eared owl (*Asio flammeus*).

Some of the forest birds that can be found within the RSA include: the bobolink (*Dolichonyx oryzivorus*), Canada warbler (*Cardellina canadensis*), common nighthawk (*Chordeiles minor*), eastern whip-poor-will (*Astrotomus vociferous*), eastern wood-pewee (*Contopus virens*), golden-winged warbler (*Vermivora chrysoptera*), grey jay (*Perisoreus canadensis*), olive-sided flycatcher (*Contopus cooperi*), ovenbird (*Seiurus aurocapilla*), red-headed woodpecker (*Melanerpes erythrocephalus*), and rusty blackbird (*Euphagus carolinus*), among others (Bezener and De Smet 2000; Peterson and Peterson 2002; Manitoba Avian Research Committee 2003; MBBA 2015).

Geese, ducks, and other waterfowl are also plentiful in the RSA. The RSA supports a variety of waterbirds and waterfowl such as the American white pelican (*Pelecanus erythrorhynchos*), black-crowned night heron (*Nycticorax nycticorax*), great blue heron (*Ardea herodias*), horned grebe (*Podiceps auritus*), least bittern (*Ixobrychus exilis*), trumpeter swan (*Cygnus buccinators*), and yellow rail (*Coturnicops noveboracensis*), among others (Bezener and De Smet 2000; Peterson and Peterson 2002; Manitoba Avian Research Committee 2003; MBBA 2015).

Shorebirds and gulls are found along the shores and on the islands of Lake Manitoba, Lake St. Martin, and Lake Winnipeg, including species such as the Caspian tern (*Hydroprogne capsica*), herring gull (*Larus argentatus*), and the piping plover (*Charadrius melodus*). The piping plover is very rare in Manitoba (MBCDC 2015) and is listed as endangered by SARA and MESEA. The piping plover uses low-gradient, un-vegetated, and wide shorelines with patchy gravel substrates (AESRD 2013). Additional information on SAR in the ASR Project area is provided in Section 7.1.13.

Within the RSA, there is a Canada Important Bird Area (IBA), referred to as the Lake St. Martin islands (IBA 2016). The IBA website states that "*the islands of Lake St. Martin support significant numbers of several colonial waterbird species: terns, cormorants, and pelicans. A total of 3,400 Common Tern nests were recorded at this site, representing about 3% of the estimated North American population of this species. In 1986, 1,500 Caspian Tern nests were recorded on a reef in Lake St. Martin. This number of nests is roughly equivalent to 4.5% of the North American Caspian Tern population. Double-crested Cormorants also occur in large numbers at this site. In 1991, 2,414 cormorant nests, or about 1.6% of the Interior cormorant population, were observed at this site. Hundreds of American White Pelicans nest here too, although a recent estimate is not available. In 1969, 670 nests were counted and if increases in the overall population of pelicans also occurred here, then the population on these islands may equal about 1% of the Canadian population of the species. Small numbers of Great Blue Herons and Black- crowned Night-Herons breed on islands within the lake. Twenty Great Blue Heron nests were recorded on an unnamed island in 1979, and another 20 nests were recorded on Big Fisher Island in 1991. Moderate numbers of ducks and geese breed and migrate amongst the Lake St. Martin Islands, and small numbers of Forster's Terns have nested in the past in the marshes bordering Lake St. Martin. Bald Eagles have been recorded as both a breeding and a staging species - it is thought that they are attracted to the fish that spawn at the mouth of the Dauphin River*" (IBA 2016).

A listing of known birds that can be found in the Interlake Plain Ecoregion and the Mid-Boreal Lowlands ecoregions and their conservation classification is presented in Appendix 2.

#### *7.1.9.3 Reptiles and Amphibians*

The RSA provides habitat for a number of reptile and amphibian species. The red-sided garter snake (*Thamnophis sirtalis*) has the northernmost distribution of any species of snake in North America and, along with the smooth green snake (*Opheodrys vernalis)* and the western plains garter snake (*Thamnophis radix*), are the only snake species to inhabit this area (Cook 1984; Conant and Collins 1991; Nature North 2014; Preston 1982). The red-sided garter snake prefers mesic woodlands where they can be often found at the margins of ponds (Preston 1982). They will often hibernate within crevices in upland areas. The range of the red-sided garter snake extends throughout much of the RSA (Conant and Collins 1991). The limestone substrate found within the LSA is characterized by crevices and cavernous formations that make for suitable habitat for snake hibernacula.

The species of frogs and toads that may occur within the area include: boreal chorus frog (*Pseudacris maculata*), Canadian toad (*Anaxyrus hemiophrys*), grey tree frog (*Hyla versicolor*), northern leopard frog (*Lithobates pipiens*), and wood frog (*Lithobates sylvaticus*) (Conant and Collins 1991). With the exception of the northern leopard frog, these species generally require shallow ponds and puddles for breeding and moist environments in shrubby and wooded areas for the rest of the year. The northern leopard frog requires several habitat types to meet its needs throughout the year, using different sites for overwintering, breeding, and foraging. The overwintering sites for northern leopard frogs need to be well-oxygenated bodies of water that do not freeze to the bottom (SARA 2015). A typical breeding pond is 30 m to 60 m in diameter and 1.5 m to 2.0 m deep, located in an open area with abundant vegetation and no fish (SARA 2015). The eastern tiger salamander (*Ambystoma tigrinum*) and the blue-spotted salamander (*Ambystoma laterale*) are two other amphibian species also found within the RSA (MBCDC 2015a,b). Both the eastern tiger salamander and the blue-spotted salamander prefer moist woodlots and wetland edge habitats (Nature North 2014).

A listing of known reptiles and amphibians and that can be found in the Interlake Plain Ecoregion and the Mid-Boreal Lowlands ecoregions and their conservation classification is presented in Appendix 2.

#### *7.1.9.4 Key Species For Analysis*

The federal environmental assessment process typically includes the need for the identification of Valued Ecosystem Components (VECs) in the area of interest to focus the environmental assessment on key species or key components of the environment. The Canadian Environmental Assessment Agency (CEAA) defines a Valued Ecosystem Component as “the environmental element of an ecosystem that is identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance” (CEAA 2012).

The selection of VECs is used to identify key species in the study area of interest that can represent a trophic level or guild of species (e.g., selection of a key ungulate species that is also important for human consumption), rather than conducting an assessment of all individual species in an area. Key species are selected based on their biological and socio-economic role in the ecosystem, their ability to represent the habitat and/or life history requirements of similar species, and may include SAR or species of conservation concern to ensure that protected and rare species are accounted for in an environmental assessment.

As such, the desktop and field studies for wildlife and wildlife habitat included the collection of baseline data for the wildlife species found in the Project Study Area, followed by the identification of a number of key wildlife species of interest and/or importance in the Project Study Area, to focus the analysis of potential habitat changes or other effects of the Project activities, and provide context for the future environmental assessment.

Key species of interest in the Project Study Area were identified to focus the analysis of potential habitat changes and/or other effects of the Project activities, and provide context for the future EIA. Key species were selected using the process for VEC selection defined by CEAA, information collected during the desktop studies, and previous knowledge of the area.

Table 9 provides a list and rationale for the key wildlife species in the ASR Project RSA that were selected for analysis. The key wildlife groups and species included:

- Moose;
- Elk;
- American marten;
- American beaver;
- Bats;
- Migratory birds (forest birds and water birds);
- Reptiles and amphibians; and
- Ecologically Sensitive Sites (mammal dens, rookeries, large stick nests, mineral licks, bat and snake hibernacula).

**Table 9: Summary of Key Species Selection and Rationale**

| Group | Key Species | Rationale |
|---|---|---|
| Ungulates | Moose | • Demonstrate large home ranges (~40km²)<br>• Important prey species for large carnivores e.g. wolves<br>• Hunted by rights-based and licensed hunters |
| | Elk | • Demonstrate large home ranges (50-400 km²)<br>• Important prey species for large carnivores e.g. wolves<br>• Hunted by rights-based and licensed hunters |
| Furbearers | American Marten | • Commonly trapped furbearer<br>• Important species for predatory/prey dynamics<br>• Representative of mature forest habitat |
| | Beaver | • Ecosystem engineer<br>• Representative furbearer for aquatic habitat |
| Bats | Little brown bat (Little brown myotis)<br>Northern long-eared bat (Northern myotis) | • Listed as “endangered” under SARA and MESEA<br>• Critical habitat for these species already identified in the Interlake region<br>• Geology within the RSA is conducive to support these species – representative of karst habitat |
| Migratory Birds | Forest Bird Species (including Barn Swallow, Bank Swallow, Bobolink, Canada Warbler, Common Nighthawk, Eastern Whip-Poor-Will, Eastern Wood-Pewee, Golden-winged Warbler, Olive-sided Flycatcher, Peregrine Falcon, Red-headed Woodpecker, Short-eared Owl) | • Some species listed as “endangered”, "threatened" or "special concern" under COSEWIC, SARA and/or MESEA<br>• Key species selected as representative of forest habitat types |
| | Water Bird Species (including American White Pelican, black-crowned night heron, Caspian tern, horned grebe, least bittern, | • Some species listed as “endangered”, "threatened" or "special concern" under COSEWIC, SARA and/or MESEA |

**Table 9: Summary of Key Species Selection and Rationale**

| Group | Key Species | Rationale |
|---|---|---|
| | piping plover, trumpeter swan, yellow rail, ducks and geese) | • Some species hunted by rights-based and licensed hunters |
| Reptiles and Amphibians | Northern leopard frog, red-sided garter snake | • Northern leopard frog listed under SARA and MESEA<br>• Red-sided garter snake species most commonly found snake within RSA |
| Ecologically Sensitive Sites | Bat and snake hibernacula,<br>terrestrial mammal dens (e.g. bears, wolves), rookeries<br>large stick nests, mineral licks | • Critical wintering habitat<br>• Critical breeding habitat<br>• Species fidelity to dens and nests<br>Culturally significant sites |

#### *7.1.9.5 Data Collection and Analysis*

##### 7.1.9.5.1 Habitat Evaluation

In assessing habitat for multiple wildlife species across the broad geographic landscape on the west side of Lake Winnipeg, it was necessary to adopt a habitat-based assessment tool that would provide relatively up-to-date imagery and land cover information over the entire region. The Manitoba Forest Resource Inventory (FRI) has been used in the development of Habitat Suitability Index Models (HSIs) for selected indicator species in Manitoba; however, FRI data are outdated and do not contain consistent attribute data between datasets or up to date forest fire history information.

The Federal Government has developed a Land Cover Classification (LCC) spatial database. The LCC is a national database map layer that has been harmonized across the major federal departments involved in land management and land change detection. These departments include the Agriculture and Agri-Foods Canada (AAFC), the Canadian Forest Service (CFS), and the Canadian Centre for Remote Sensing (CCRS). Existing forest classifications and inventories are based primarily on aerial photography, whereas the development of the LCC was done using remotely sensed imagery (Landsat data) as part of the Earth Observation for Sustainable Development of Forests (EOSD) program. The EOSD program utilized a hybrid supervised-unsupervised classification methodology. This approach identified unique signatures using an automated algorithm (unsupervised spectral classification) that were subsequently linked to National Forest Inventory (NFI) equivalent classes (supervised classification). The LCC provides a series of vegetated and non-vegetated land cover classes that identify the vegetation/habitat conditions of an area.

**Table 10** provides the results of the LCC analysis by area ($km^2$) and percentage of cover types within the RSA and LSA. The LCC habitat analysis results showed water, wetland shrub, wetland herb and grasslands as the most commonly occurring habitat covertypes within the RSA, and water and grasslands as the most commonly occurring habitat covertype within the LMOC LSA. There were very little (<1%) low shrub, tall shrub, developed or exposed land covertypes located within the LSA and RSA. The LCC of the RSA is provided in Map 4 in Appendix 2.

**Table 10: Area and Percentage of LCC Covertypes within the RSA and LSA**

| LCC-Cover Type | RSA | | LSA (LMOC) | |
|---|---|---|---|---|
| | Area km$^2$ | Percent (%) | Area km$^2$ | Percent (%) |
| 100-Herb | 118.26 | 1.74% | 27.56 | 5.49% |
| 110-Grassland | 691.64 | 10.16% | 183.91 | 36.65% |
| 121-Annual crops | 28.21 | 0.41% | 13.07 | 2.60% |
| 122-Perennial crops and Pasture | 70.02 | 1.03% | 28.34 | 5.65% |
| 20-Water | 1500.20 | 22.04% | 92.19 | 18.37% |
| 211-Coniferous - Dense | 415.19 | 6.10% | 1.46 | 0.29% |
| 212-Coniferous - Open | 82.87 | 1.22% | 3.39 | 0.68% |
| 221-BroadLeaf - Dense | 376.68 | 5.53% | 48.07 | 9.58% |
| 222-BroadLeaf - Open | 205.63 | 3.02% | 9.78 | 1.95% |
| 231-MixedWood - Dense | 264.79 | 3.89% | 7.41 | 1.48% |
| 33-Exposed Land | 17.74 | 0.26% | 2.57 | 0.51% |
| 34-Developed | 43.20 | 0.63% | 12.63 | 2.52% |
| 51-Shrub -Tall | 7.37 | 0.11% | 0.03 | 0.01% |
| 52-Shrub - Low | 1.87 | 0.03% | 0.00 | 0.00% |
| 81-Wetland Treed | 117.04 | 1.72% | 0.00 | 0.00% |
| 82-Wetland Shrub | 1997.31 | 29.35% | 39.27 | 7.83% |
| 83-Wetland Herb | 867.84 | 12.75% | 32.05 | 6.39% |
| Total Area | 6805.85 | 100.00% | 501.74 | 100.00% |

The habitat evaluation also included a comparison of the habitat covertypes for the LMOC Route C and LMOC Route D. **Table 11** provides the results of the LCC analysis by area (km$^2$) and percentage of cover types for the LMOC Route C and LMOC Route D. Note that the routes have significantly different lengths and the interpretation of the results should consider that difference.

**Table 11: LCC Habitat Analysis Comparison between LMOC Route C and LMOC Route D Outlet Channels**

| LCC-Cover Type | Route C – 11.6 km (400 m RoW) | | Route D – 24.0 km (400 m RoW) | |
|---|---|---|---|---|
| | Area $km^2$ | Percent (%) | Area $km^2$ | Percent (%) |
| 100-Herb | 0.31 | 6.58% | 0.71 | 7.29% |
| 110-Grassland | 2.04 | 43.31% | 5.28 | 54.21% |
| 121-Annual crops | 0 | 0.00% | 0.4 | 4.11% |
| 122-Perennial crops and Pasture | 0.21 | 4.46% | 0.88 | 9.03% |
| 20-Water | 0.18 | 3.82% | 0.2 | 2.05% |
| 211-Coniferous - Dense | 0 | 0.00% | 0 | 0.00% |
| 212-Coniferous - Open | 0 | 0.00% | 0 | 0.00% |
| 221-BroadLeaf - Dense | 0.75 | 15.92% | 0.71 | 7.29% |
| 222-BroadLeaf - Open | 0.25 | 5.31% | 0.05 | 0.51% |
| 231-MixedWood - Dense | 0 | 0.00% | 0 | 0.00% |
| 33-Exposed Land | 0.03 | 0.64% | 0.02 | 0.21% |
| 34-Developed | 0.09 | 1.91% | 0.22 | 2.26% |
| 51-Shrub -Tall | 0 | 0.00% | 0 | 0.00% |
| 52-Shrub - Low | 0 | 0.00% | 0 | 0.00% |
| 81-Wetland Treed | 0 | 0.00% | 0 | 0.00% |
| 82-Wetland Shrub | 0.25 | 5.31% | 0.31 | 3.18% |
| 83-Wetland Herb | 0.61 | 12.95% | 0.95 | 9.75% |
| Total Area | 4.71 | 100.00% | 9.74 | 100.00% |

The main differences in habitat covertypes between the two routes were observed as:

- there are no annual crop production areas along Route C, but 0.4 $km^2$ of the land for Route D is used for annual crop production;
- Route D has more area and a higher percentage of land with herb, grassland and perennial crops and pasture covertypes than Route C;
- there is more area and a higher percentage of developed land along Route D than along Route C;
- there are more areas but lower percentages of water, wetland shrub and wetland herb habitat covertypes along Route D than along Route C; and
- there is more area and a higher percentage of broadleaf dense, broadleaf open and exposed land habitat covertypes along Route C than Route D.

Neither route was found to include areas of coniferous dense, coniferous open, mixedwood dense, tall shrub, low shrub or wetland treed habitat covertypes.

#### 7.1.9.5.2 Fire History

The evaluation of the type and amount of habitat available to wildlife species is influenced by natural disturbances such as forest fires. Forest fires are important for the health, regeneration and succession of the boreal forest. Boreal forest fires play an important role in characterizing forest composition, energy cycles, and biochemical processes.

The spatial fire history data for the RSA was mapped and assessed for the timeframe between 1928 and 2013. This time frame was used given it was the timeframe of consistent data collected by the province and available for analysis. These spatial fire data that were obtained from the Manitoba Land Initiative (MLI) website were clipped (constrained) to the RSA. Burn years were classified into 5 year periods (1930-34, 1935-39 etc.) with the total area burned calculated and expressed in $km^2$ (Figure 1 in Appendix 2), thus providing a 5-year fire trend for the RSA over the majority of the last century.

Within the RSA, based on the fire history collected between 1928-2013, it would appear that a major burn cycle occurs every 20-25 years with approximately 1500-3000 $km^2$ (32-55% of total area) of mature habitat being burnt. Smaller burns are occurring during that time; however, large landscape burns appear to be on a 20-25 year cycle. As a result, within 5 to 10 years following a major fire event, successional vegetation offers quality moose habitat on the landscape. Given the last major burn event occurred in 1985-89, if the 20-25-year cycle occurs again, another major burn event should occur in 2015-2019 within the RSA. However, given that the only available spatial fire history data were from 1928 onward, there is limited information available to determine burn cycle events beyond the last 90-year period.

The data collection from the 1950s onward is more accurate in comparison to the fire data collected prior to the 1950s as data collection, technological advances and reporting techniques had improved in the 1950s and onward. Moose populations thrive in areas of frequent fire (Gillingham and Parker 2008). Given small burns occur on the landscape frequently, habitat is regenerated. However, based on the 90-year data, major large-scale burns are relatively infrequent within the RSA. In addition to fire suppression efforts in recent years, the combination of these two factors may influence the future availability of moose habitat within these areas.

#### 7.1.9.5.3 Linear Density Analysis for Moose

Although moose have been extensively studied, little research has focused on the effects of habitat fragmentation and the habitat or landscape thresholds (i.e., the boundary beyond which change occurs) in the management of the species. Salmo et al. (2004) compiled a table of management indicators and guidelines for moose based on studies across Canada and recommended that access density and stream crossing indices be used as land-use indicators, and that core areas and patch/corridor size be used as habitat indicators when conducting cumulative effects assessments. In summary, the authors identified a target threshold for linear disturbance for moose on a landscape scale at a density of 0.4 $km/km^2$ (i.e., linear disturbance features divided by the total area of interest) and a critical threshold density of 0.9 km/km$^2$. As such, analyses were conducted to identify the density of linear features in the RSA and LSA in comparison to the published Salmo et al. (2004) thresholds for moose.

**Table 12** provides a summary of the existing linear density within the RSA and LSA. The current linear density was found to be 0.22 km/km$^2$ within the RSA and 0.86 km/km$^2$ within the LSA. The existing RSA linear density is well below the published Salmo et al. (2004) thresholds and the existing LSA linear density is within 0.04 km/km$^2$ of the 0.90 km/km$^2$ linear density threshold for moose. Note that the spatial area of the RSA represents a typical moose home range size of 40 km$^2$ (Hundertmark 1997) and therefore the linear density thresholds are best examined at the RSA scale.

**Table 12: Existing Linear Density within the RSA and LSA**

| Linear Feature | RSA | | LSA | |
|---|---|---|---|---|
| | Linear Features (km) | Linear Density (km/km$^2$) | Linear Features (km) | Linear Density (km/km$^2$) |
| Minor Roads | 818.44 | 0.12 | 232.26 | 0.46 |
| Major Roads | 245.57 | 0.04 | 48.76 | 0.10 |
| Local Streets | 31.24 | 0.00 | 3.05 | 0.01 |
| Transmission Lines | 335.19 | 0.05 | 145.87 | 0.29 |
| Municipal Road | 9.98 | 0.00 | 0.00 | 0.00 |
| Idlywild Road | 48.12 | 0.01 | 0.00 | 0.00 |
| Winter Road (proposed access) | 34.72 | 0.01 | 0.00 | 0.00 |
| Total | 1523.26 | 0.22 | 429.94 | 0.86 |

The linear densities of the proposed LMOC Route C and LMOC Route D within the LSA and RSA were calculated to examine the potential changes in overall linear density for moose with construction of the selected LMOC (**Table 13**).

**Table 13: Linear Density within the RSA and LSA for Proposed LMOC Routes**

| Channel Option | RSA | | LSA | |
|---|---|---|---|---|
| | Linear Features (km) | Linear Density (km/km$^2$) | Linear Features (km) | Linear Density (km/km$^2$) |
| Route C | 11.48 | 0.0017 | 11.48 | 0.0229 |
| Route D | 24.03 | 0.0035 | 24.03 | 0.0479 |

The construction of the Route C option would result in an increase in linear density of 0.0017 km/km$^2$ in the RSA and an increase in linear density of 0.0229 km/km$^2$ in the LSA, and the construction of the Route D option would result in an increase in linear density of 0.035 km/km$^2$ in the RSA and an increase in linear density of 0.0479 km/km$^2$ in the LSA.

As noted above, the linear density thresholds are best examined at the RSA scale. The increases in linear density in the RSA remain below the published Salmo et al. (2004) thresholds regardless of which route is selected. The addition of Route C to the landscape would increase the linear density in the LSA to 0.8829 km/km$^2$, which would result in a linear density very close to the published threshold; and the addition of Route D to the landscape would increase the linear density in the LSA to 0.9079 km/km$^2$, which would result in a linear density just over the published threshold.

#### *7.1.9.6 Wildlife Study Summary*

##### 7.1.9.6.1 Desktop Studies and Key Species for Analysis

The "*Lake Manitoba Outlet Channels - Wildlife Technical Report*" (EcoLogic 2017) was developed for the LMOC component of the Project to provide a detailed summary of the wildlife data collection activities, methods, analyses, and results that were conducted to date within the RSA and LSA. The desktop and field studies for wildlife and wildlife habitat included the collection of baseline data for the wildlife species found in the RSA, followed by the identification of a number of key wildlife species of interest and/or importance in the RSA, to focus the analysis of potential habitat changes or other effects of the Project activities, and provide context for the future EIA. Data were gathered from various agencies and sources to provide historical context to mammal, avian reptile and amphibian presence and distribution within the RSA. Habitat modelling was conducted for moose, elk, white-tailed deer, beaver, marten, and a number of bird species listed as Species At Risk or species of special concern. The fire history for the area was collated and reviewed to examine changes in vegetation on the landscape over time due to fire activity, which can influence the quality and availability of browse and other habitat conditions for moose and other wildlife. The desktop studies also included a linear density analysis for moose to establish the existing presence, size and type of linear features on the landscape that may affect moose and their habitat; and examine the changes in linear density on the landscape that will occur with the construction of the LMOC Route C or LMOC Route D channel option.

##### 7.1.9.6.2 Moose

A total of 14 moose were observed to be present in the overall Project RSA during the winter 2016 winter aerial survey. There were no signs of moose or moose activity identified during the spring 2016 ground-based track and sign surveys conducted within the RoWs for the proposed LMOC Route C and LMOC Route D. Habitat modelling for moose showed the presence of summer habitat throughout the RSA and LSA, with a slightly higher amount of summer habitat present in the LMOC Route C LSA (Appendix 2). Areas of winter habitat for moose were found to be present along the eastern border of the LSA for the proposed LMOC Route D option channel, and very little to no winter habitat for moose was found within the LSA for the proposed LMOC Route C (Appendix 2).

The habitat evaluation showed that the construction of the LMOC Route C channel option would result in a loss of about 0.12% of summer habitat due to the footprint of the channel and associated RoW, and that the construction of the LMOC Route D channel option would result in a loss of about 0.11% of summer habitat due to the footprint of the channel and associated RoW. The examination of potential losses of winter habitat for moose showed no loss of winter habitat due to construction of either channel option. There are a number of existing paved, gravel and dirt roads and trails located throughout the RSA and LSA, as well as snowmobile trails (Appendix 2). The presence of these roadways and trails suggests that current access for hunting and recreation is widely available in the LSA and RSA.

The current linear density for moose was found to be 0.22 $km/km^2$ within the RSA and 0.86 $km/km^2$ within the LSA. The construction of the Route C option would result in an increase in linear density of 0.0017 $km/km^2$ in the RSA and an increase in linear density of 0.0229 $km/km^2$ in the LSA, and the construction of the Route D option would result in an increase in linear density of 0.035 $km/km^2$ in the RSA and an increase in linear density of 0.0479 $km/km^2$ in the LSA. As noted above, the increases in linear density in the RSA remain below the published Salmo et al. (2004) thresholds regardless of which route is selected.

#### 7.1.9.6.3 Elk

A total of 16 elk were observed to be present in the overall Project RSA during the winter 2016 winter aerial survey. One observation of elk scat on the proposed LMOC Route C was the only sign of elk or elk activity identified during the spring 2016 ground-based track and sign surveys conducted within the RoWs for the proposed LMOC Route C and LMOC Route D. Habitat modelling for elk showed the presence of habitat throughout the RSA and LSA for the proposed LMOC Route C and LMOC Route D (Appendix 2).

The habitat evaluation showed that the construction of the LMOC Route C channel option would result in a loss of about 0.28% of elk habitat due to the footprint of the channel and associated RoW, and that the construction of the LMOC Route D channel option would result in a loss of about 0.33% of elk habitat due to the footprint of the channel and associated RoW. There are a number of existing paved, gravel and dirt roads and trails located throughout the RSA and LSA, as well as snowmobile trails (Appendix 2). The presence of these roadways and trails suggests that current access for hunting and recreation is widely available in the LSA and RSA.

#### 7.1.9.6.4 White-Tailed Deer

Although white-tailed deer (WTD) were not identified as a key wildlife species for the Project, understanding the current location and distribution of WTD within the RSA prior to construction is important for the understanding of any potential effects of the Project on WTD movement, and interactions among WTD and other ungulate species. WTD are the host for the parasitic *Parelaphostrongylus tenuis* (*P.tenuis*) meningeal worm, also known as “brain worm”, which is a common parasitic nematode of the central nervous system that can be transmitted from WTD to other ungulate species such as moose and elk (Wasel et al. 2003). *P.tenuis* within WTD characteristically completes its life cycle without causing any significant adverse health effects (Kopcha et al. 2012). However, *P.tenuis* occurrence in other ungulates such as moose, elk and caribou (*Rangifer tarandus*), causes serious physical deterioration and eventual death.

As such, all observations and tracks of WTD that were noted during field work were recorded and used to create a map showing areas of use by WTD in the RSA and LSA (Appendix 2). A total of 628 WTD and 3495 tracks were observed in the overall Project RSA during the winter 2016 winter aerial survey. During the spring 2016 ground surveys, there were several signs of WTD activity and their presence identified along the proposed LMOC Route C, proposed LMOC Route D and the Lake Manitoba shoreline (Appendix 2). A number of deer tracks, a deer trail, a deer rub and two deer were identified within the proposed LMOC Route D RoW, and two deer were observed within the RoW for the proposed LMOC Route C. One deer was also observed at the Lake Manitoba shoreline south of the proposed inlet for the LMOC Route D.

#### 7.1.9.6.5 Furbearers

The winter 2016 aerial multispecies survey identified the presence and/or tracks of beaver, marten, otter, hare, lynx and coyote in the RSA (Appendix 2). Maps 29 to Map 34 in Appendix 2 show the core use areas (i.e., spatial distribution) for beaver, marten, otter, hare, lynx, and coyote in the RSA created from the winter 2016 aerial multispecies survey data.

Beaver activity in the LMOC LSA was limited to an area in the northwest section of the proposed LMOC Route C LSA. Marten tracks were identified in abundance throughout the RSA, but there was no marten activity identified within the LMOC LSA. Otter activity was identified in Lake Manitoba near the Fairford River and in the area of the proposed inlet for LMOC Route C, and in Lake St. Martin in the area of the proposed outlet for LMOC Route D. Hare activity within the LMOC LSA was limited to an area east of the proposed outlet for LMOC Route D and there was no lynx activity was identified within the LMOC LSA. There were a number of coyote observations and tracks identified in the area of the proposed inlet for LMOC Route D, along the length of the LSA for the proposed LMOC Route D, and in Lake St. Martin in the areas near the proposed outlets for LMOC Route C and LMOC Route D.

Table 19 in Appendix 2 provides a summary of the furbearer activity and presence identified during the spring 2016 ground surveys, and Table 20 in Appendix 2 provides a summary of the predator activity and presence identified during the spring 2016 ground surveys. Within the area of the proposed LMOC Route C, coyote tracks were observed but there were no other signs of furbearer or predator activity. Within the area of the proposed LMOC Route D, signs of coyote, muskrat, bear and wolf presence were documented. A beaver house was observed on the Lake Manitoba shoreline north of the proposed LMOC Route C inlet, and a beaver house was observed on the Lake Manitoba shoreline north of the proposed LMOC Route D inlet.

Beaver habitat modelling showed that habitat often occurs along waterways and is scattered throughout the RSA and LSA and (Appendix 2). The habitat evaluation showed that the construction of the LMOC Route C channel option would result in a loss of about 0.06% of beaver habitat in the RSA and a loss of about 1.26% of beaver habitat in the LSA due to the footprint of the channel and associated RoW; and that the construction of the LMOC Route D channel option would result in a loss of about 0.02% of beaver habitat in the RSA and a loss of about 0.38% of beaver habitat in the LSA due to the footprint of the channel and associated RoW.

Habitat modelling showed that habitat for marten is located mainly outside of the LSA for the proposed LMOC Route C and LMOC Route D. The available marten habitat in the LSA is found along the western border of the LSA for the proposed LMOC Route D, extending from the area around Grahamdale to the land located east of the proposed LMOC Route D outlet (Appendix 2). The habitat evaluation showed that there would be no loss of marten habitat with the construction of either channel option.

#### 7.1.9.6.6 Birds

Key bird species of interest in the LMOC LSA and RSA were identified through review of information from the Manitoba Breeding Bird Atlas (MBBA 2015), Manitoba Conservation Data Centre (MBCDC 2015a, b), Manitoba Sustainable Development (MBSD 2016b), Important Bird Areas of Canada (IBA 2015) and the federal Species At Risk Act (SARA 2015). Habitat modelling was conducted for the 20 bird species identified in **Table 9** to examine the available habitat for these bird species within the LSA and RSA, and the potential loss of habitat due to construction of the proposed LMOC Route C or LMOC Route D. **Table 14** provides a summary of the status of the 20 bird species under current federal and provincial legislation as of September 2015; confirmation of activity of the bird species in the LMOC LSA; and the potential loss of habitat for the species due to the construction of the LMOC Route C or LMOC Route D.

Eight of the 20 modelled species were confirmed to be present within the LMOC LSA, including species listed as Threatened or of Special Concern under federal and/or provincial legislation. Additional information on these species is provided in Appendix 2, as well as a list of all bird species confirmed to be present in the LMOC LSA.

In addition to the habitat modelling, pedestrian bird and nest searches, and point count surveys, the avian field studies included a raptor nest and heron rookery search. A number of eagle and hawk nests, nesting snags, stick nests and other nests, snags and cavities of various sizes were observed along both of the LMOC routes, and along the Lake Manitoba shoreline (Appendix 2). A significant heron rookery was observed on one of the Lake St. Martin islands south of the Narrows within the overall Project RSA, but outside of the LMOC LSA.

**Table 14: Summary of Status of Bird Species of Conservation Concern, Confirmed Activity in the LMOC LSA During Field Studies, and Potential Habitat Loss Due to Construction of Route C or Route D**

| Common Name | MESEA Status | COSEWIC Status | SARA Schedule | SARA Status | Confirmed Activity in LSA During Field Studies | % Habitat Loss – Route C | % Habitat Loss – Route D |
|---|---|---|---|---|---|---|---|
| *Forest and Land Birds* | | | | | | | |
| Bank Swallow | N/A | Threatened | N/A | N/A | Yes | 1.17 | 5.88 |
| Barn Swallow | N/A | Threatened | N/A | N/A | Yes | 2.34 | 0.34 |
| Bobolink | N/A | Threatened | N/A | N/A | Yes | 1.12 | 3.22 |
| Canada Warbler | Threatened | Threatened | Schedule 1 | Threatened | No | 1.37 | 1.09 |
| Common Nighthawk | Threatened | Threatened | Schedule 1 | Threatened | Yes | 0.50 | 0.34 |
| Eastern Whip-poor-will | Threatened | Threatened | Schedule 1 | Threatened | No | 1.50 | 0.30 |
| Eastern Wood Peewee | N/A | Special Concern | N/A | N/A | No | 1.35 | 1.28 |
| Golden-winged Warbler | Threatened | Threatened | Schedule 1 | Threatened | No | 1.82 | 5.70 |
| Olive-sided Flycatcher | Threatened | Threatened | Schedule 1 | Threatened | No | 0.58 | 0.73 |
| Peregrine Falcon | Endangered | Special Concern | Schedule 1 | Special Concern | No | 1.35 | 1.28 |
| Red Headed Woodpecker | Threatened | Threatened | Schedule 1 | Threatened | Yes | 0 | 0.33 |
| Short Eared Owl | Threatened | Special Concern | Schedule 1 | Special Concern | Yes | 1.17 | 2.88 |
| *Shoreline and Water Birds* | | | | | | | |
| American White Pelican | N/A | N/A | N/A | Not At Risk | Yes | 0.80 | 1.46 |
| Black Crowned Night Heron | N/A | N/A | N/A | Not Listed | No | 2.68 | 7.08 |
| Caspian Tern | N/A | N/A | N/A | Not At Risk | Yes | 1.43 | 2.82 |
| Horned Grebe | N/A | Special Concern | N/A | N/A | No | 3.41 | 17.65 |

**Table 14: Summary of Status of Bird Species of Conservation Concern, Confirmed Activity in the LMOC LSA During Field Studies, and Potential Habitat Loss Due to Construction of Route C or Route D**

| Common Name | MESEA Status | COSEWIC Status | SARA Schedule | SARA Status | Confirmed Activity in LSA During Field Studies | % Habitat Loss – Route C | % Habitat Loss – Route D |
|---|---|---|---|---|---|---|---|
| Least Bittern | Endangered | Threatened | Schedule 1 | Threatened | No* | 2.44 | 6.99 |
| Piping Plover | Endangered | Endangered | Schedule 1 | Endangered | No | 3.05 | 0.52 |
| Trumpeter Swan | Endangered | Not At Risk | N/A | N/A | No | 0.73 | 1.45 |
| Yellow Rail | N/A | Special Concern | Schedule 1 | Special Concern | No | 2.10 | 5.31 |

*Least bittern was observed along the Lake Manitoba shoreline within the RSA but outside of the LMOC LSA; least bittern was also observed along the Lake St. Martin shoreline near Reach 1 in the LSMOC/ASR LSA

#### 7.1.9.6.7 Reptiles and Amphibians

The reptile and amphibian surveys recorded observations and vocalizations of three amphibian species in the LSA: boreal chorus frog, northern leopard frog and wood frog (Table 69 in Appendix 2); and observation of one reptile species in the LSA, the red-sided garter snake (Table 69 in Appendix 2). The northern leopard frog is currently listed as a species of Special Concern on Schedule 1 of SARA. There were no other reptiles or amphibians observed or heard during the spring 2016 field surveys.

#### 7.1.9.6.8 Ecologically Sensitive Sites

The aerial and ground field surveys conducted in 2016 included searches for ecologically sensitive sites such as mammal dens, large stick nests, mineral licks, rookeries and potential bat or snake hibernacula. During winter aerial surveys, potential areas containing bat and snake hibernacula and large mammal dens were observed in the RSA. These sightings were in large rock outcrops with the appearance from the air of cavernous entries where snow was unable to accumulate.

These sightings were way-pointed within the RSA during the winter aerial survey and further investigated on foot during the spring and summer field work. These sites were located within the overall Project RSA, but were located outside of the LMOC LSA. Additional information on the potential bat hibernacula identified during the spring and summer 2016 surveys and follow up surveys conducted in 2017, is provided in the following reports:

- "*Lake St. Martin Outlet Channel Proposed All Season Access Road: Summary of the Existing Environment - Final Report*" (M. Forster Enterprises 2016);
- "*Lake St. Martin Outlet Channels: Summary of the Existing Environment"* (M. Forster Enterprises 2017);
- *"Lake St. Martin Outlet Channel Proposed All Season Access Road: Wildlife Technical Report"* (EcoLogic 2016);
- *"Lake St. Martin Outlet Channels: Wildlife Technical Report"* (EcoLogic 2016); and
- *"Lake Manitoba and Lake St. Martin Access Road and Outlet Channels Project - Bat Species at Risk Field Study Report"* (EcoLogic 2017).

As noted above, a significant heron rookery was observed on one of the Lake St. Martin islands south of the area where Lake St. Martin narrows within the LMOC RSA, but outside of the LMOC LSA. The Lake St. Martin islands are a designated Canada Important Bird Area (IBA) that support a number of colonial waterbird species such as terns, cormorants, and pelicans, as well as other species such as herons, ducks, geese and bald eagles (IBA 2015). These islands and bird species were observed during the 2016 aerial surveys of the LSA and RSA; however, as noted above, these areas were located within the overall Project RSA, but outside of the LMOC LSA. There were no other ecologically sensitive sites (mammal dens, large stick nests, mineral licks, rookeries, potential hibernacula) identified within the LMOC LSA.

### 7.1.10 Groundwater

The RSA is located within the Manitoba Lowland physiographic region, which is described as an area of gentle relief lying to the east of the Manitoba Escarpment (Betcher et al. 1995). This area is underlain by gently southwestwardly dipping Paleozoic and Mesozoic sediments consisting mainly of carbonate rocks with some clastic and argillaceous units, with bedrock overlain by glacial tills and proglacial lacustrine sediments (Betcher et al. 1995). The major lakes of Manitoba occupy portions of this lowland area.

The surficial deposits within the RSA consist mainly of glacial till and sand and gravel deposits, with fairly extensive sand and gravel deposits at the surface being common in the area (Rutulis 1973). The availability and quality of groundwater is dependent upon the presence of shallow aquifers, which are generally sand or sand and gravel lenses (Rutulis 1973). The depth to these aquifers may range from less than 6 m where the sand and gravel deposits are at ground surface, to more than 60 m in low-lying areas where thick clay beds cover the aquifer (Rutulis 1973). Water quality in the sand and gravel aquifers ranges from fair to excellent (Betcher et al. 1995; Rutulis, 1973). Areas where the sand and gravel deposits are at or close to the ground surface and that are probable or existing groundwater sources are susceptible to contamination from surface activities (Rutulis 1973). Flowing artesian well conditions are somewhat common in the study area, in particular along Birch Creek, and in the vicinity of Lake St. Martin (KGS Group 2016). Flowing artesian well conditions also occur in the Dauphin River area and were consistent with the 2011 and 2015 field investigation results where artesian flow conditions were encountered up to 1 m above ground surface (KGS Group 2016).

KGS Group (2016) reported that the regional groundwater flow is easterly towards Lake Winnipeg, as well as westerly toward Lake Manitoba and Lake St. Martin (and Lake Winnipegosis). Discharge from the aquifer occurs as seepage and flow into streams, marshes, and lakes found throughout the Interlake, with piezometric pressures in the aquifer between approximately El 250 m to El 260 m (820 feet [ft] to 853 ft) in the Birch Creek (Route D) area, and between approximately El 240 m to El 250 m (787 ft to 820 ft) in the Fairford River area (KGS Group 2016). KGS Group (2016) also reported that sparse data available in the northeast, near Dauphin River, show regional piezometric levels in the order of El 220 m to El 230 m (721 ft to 755 ft).

Well yields are highly variable in the region, which is a direct result of the fractured rock conditions, with water yields dependent on the number of fractures intersected by a well and the aperture size, extent, and interconnection to other fractures (KGS Group 2016). East of Lake Manitoba, the water quality is generally fresh, with Total Dissolved Solids (TDS) <1,000 mg/L, and water quality generally of the Mg-Ca-HCO3 type, with TDS in the order of 400 mg/L to 650 mg/L (KGS Group 2016). KGS Group (2016) noted that this water quality is reflective of the effects of the meteor impact described in Section 6.1.7. and aquifer recharge zone noted within the Interlake area. Due to more complex geology and evaporate mineralogy in the Gypsumville area, water quality varies and is locally poorer with TDS concentrations up to 4,550 mg/L (Betcher 1987).

KGS Group conducted groundwater studies in the LMOC LSA in 2011 and 2015 (KGS Group 2016) and again in 2016 as part of additional studies on groundwater and surface water in the LMOC LSA (KGS Group, in prep.). At of the time of this writing, the technical report outlining the findings of the 2016 hydrogeological field program were not available. As such, the information provided below for the LMOC Route C and LMOC Route D groundwater conditions was obtained from KGS Group 2016.

The groundwater studies applied a 3 km offset distance from the centreline of the proposed LMOC Route C channel and proposed LMOC Route D channel as a conservative estimate of the potential distance at which effects on groundwater (e.g., drawdown in domestic wells) could be encountered, based on the current knowledge of the aquifer in this region (KGS Group 2016). The groundwater studies included:

- monitoring of water levels via measurement of piezometric pressures in test pits and boreholes installed along LMOC Route C and LMOC Route D;
- review of the Provincial well record database (GWDrill) to determine existing well locations;
- assessment of the potential for basal heave or groundwater blowouts during excavation;
- examination of aquifer drawdown during channel construction and operation;
- assessment of Groundwater Under the Direct Influence of Surface Water (GUDI);
- review of potential changes to Lake St. Martin surface water quality; and
- for LMOC Route D, analysis of the potential drainage of surface water bodies near the channel alignment.

Further information on the methods and results of the groundwater studies are provided in KGS Group 2016. A summary of the groundwater conditions for LMOC Route C and LMOC Route D is provided below.

#### *7.1.10.1 Route C*

Results of the 2015 studies showed groundwater depths that ranged from 1.21 m to 2.70 m along the proposed LMOC Route C (Table 3.4 in KGS Group 2016). There were no artesian conditions encountered during the 2015 drilling program along LMOC Route C.

Review of the GWDrill database for the area showed records for 309 wells drilled within the 3 km offset. However, many of these wells are not used for domestic purposes (livestock wells, monitoring wells, test holes) or may have been decommissioned or abandoned. Based on the preliminary review of the area, it was determined that there are up to 145 possible residential locations within the 3 km LMOC Route C channel offset, with 135 of these wells located on the Pinaymootang FN (KGS Group 2016). The following general observations were made based on the GWDrill review:

- the depth to bedrock is generally shallow (median overburden depth of 3.4 m);
- water supplies are generally drawn from the upper carbonate aquifer (8 m to 24 m well depth range) and the channel excavation for Route C would occur within this bedrock aquifer zone;
- flowing artesian conditions were observed at three of the 62 wells reviewed;
- the depth to groundwater is generally shallow (median groundwater depth of 3.7 m below grade); and
- well capacities and aquifer transmissivity are generally low.

Based on the current channel design and available geotechnical investigations for LMOC Route C, the initial 6 km of the channel will require excavation into the bedrock, with direct connection to the upper carbonate aquifer (KGS Group 2016). The channel invert is underlain by till from approximately Km 6 to Km 7, where bedrock is again exposed within the proposed channel base. Beyond Km 8, the channel is generally underlain by till, varying in thickness from 0 m to >10 m, based on the estimated bedrock elevation along this channel reach. As such, the assessment of the potential for basal heave or groundwater blowouts during excavation found that, due to the existing geological and groundwater conditions of the area, blowout/basal heave conditions may occur within the channel excavation during the construction phase of the project and to a lesser degree in the operational phase of the Project (KGS Group 2016). The risk of basal blowout for the proposed LMOC Route C was cited by KGS Group (2016) as a significant concern for the Project that will need to be addressed as part of the detailed design.

The examination of aquifer drawdown found that drawdown of aquifer groundwater piezometric pressures would be anticipated during construction, as well as during channel operation, given the shallow depth to groundwater and deep excavation into bedrock (up to 13 m) along the proposed Route C (KGS Group 2016). The largest drawdowns are anticipated to occur during the construction phase depressurization and would decline with distance away from the excavation. The magnitude of the drawdown would be affected by a number of other variables, such as aquifer transmissivity and total groundwater discharge to the excavation, which is a function of the area of the bedrock aquifer exposed during construction and/or discharging groundwater through fractured overburden tills to the channel excavation (KGS Group 2016). Potential aquifer drawdown could also occur during channel operation, when operating surface water levels within the channel are less than the piezometric pressures within the surrounding bedrock aquifer. The preliminary assessment indicated that aquifer drawdowns within proximity to the channel can be anticipated to be significant immediately adjacent to the channel excavation. The analysis showed a potential maximum of 2 m to 3 m of drawdown at 1 km from the channel during construction, equating to as much as 5 m to 6 m of drawdown in the immediate vicinity of the channel excavation. This potential drawdown effect could have an effect on the available capacity of the local supply wells. Additional information on the methods and parameters used for the preliminary assessment of potential aquifer drawdown is provided in KGS Group 2016.

The GUDI assessment showed that the extent of excavation into the bedrock aquifer required for the proposed LMOC Route C will result in a direct connection between surface water and groundwater. This direct connection greatly increases the vulnerability of the aquifer to contamination by surface water, which can lead to contamination of local groundwater resources. The direct connection of surface water to the bedrock aquifer is a strong negative aspect of the Route C alignment, and could potentially affect the groundwater resources and domestic wells located in the Pinaymootang FN.

The review of potential changes to Lake St. Martin surface water quality found that discharge of groundwater to the channel is expected given the channel excavation depth, aquifer piezometric pressure conditions, interconnection to the carbonate aquifer, and construction and operational channel conditions (KGS Group 2016). The groundwater quality is considered to be relatively fresh (TDS = 390 to 550 mg/L, Chloride = 2 to 19 mg/L), but may have lower levels of dissolved oxygen than the surface waters. The groundwater system currently naturally discharges to Lake Manitoba and Lake St. Martin; therefore, the volume of groundwater discharge to the surface water bodies is not expected to be greatly increased. There will also be varying amounts of surface water baseflow in the channel during operation, which will provide some degree of dilution of groundwater prior to discharge to Lake St. Martin (KGS Group 2016).

#### *7.1.10.2 Route D*

Results of the 2015 studies showed groundwater depths that ranged from 2.51 m below the ground surface elevation to 5.42 m above ground surface elevation along the proposed LMOC Route D (Table 3.4 in KGS Group 2016). Artesian conditions were encountered at four of the borehole locations along the proposed LMOC Route D. The hydrogeological studies along LMOC Route D also included a well drilling and pumping test program, which was conducted in the area of the probable location of the proposed LMOC Route D Control Structure. This program was conducted to determine the aquifer properties at the site. The stratigraphy at the site consisted of an upper till layer and a lower till layer overlying the limestone bedrock, with an inter-till layer of sand observed at two borehole locations (KGS Group 2016).

Based on the results of the pumping test, the lower till zone appeared to be directly connected to the bedrock aquifer, with an immediate piezometric pressure response within the deep till piezometer. The upper till zone did not respond to pumping during the 4 hour pumping test; however, this observation does not mean that the upper till is disconnected from the bedrock aquifer, but more likely indicates that a longer duration of drawdown / pumping is required before a response could be observed. KGS Group (2016) noted that this observed response is typically a function of the low permeability of the till soils.

Review of the GWDrill database for the area showed records for 140 wells drilled within the 3 km offset. However, many of these wells are not used for domestic purposes (livestock wells, monitoring wells, test holes) or may have been decommissioned or abandoned. Based on the preliminary review of the area, it was determined that there are up to 70 possible residential locations within the 3 km LMOC Route D channel offset (KGS Group 2016). The following general observations were made based on the GWDrill review:

- water supplies are generally drawn from the upper carbonate aquifer (13 m to 25 m depth range);
- flowing artesian conditions were observed at 28 of the 140 wells reviewed;
- depth to groundwater is generally shallow (median depth to groundwater of 0.9 m below grade); and
- well capacities and aquifer transmissivity are generally low.

Based on the current channel design and available geotechnical investigations for LMOC Route D, the channel invert is above the bedrock, and is excavated within the tills, for the entire length of the channel. As such, the assessment of the potential for basal heave or groundwater blowouts during excavation found that blowout / basal heave conditions may occur within the channel excavation during the construction phase of the project, if the bedrock aquifer groundwater piezometric pressures exceed the confining overburden mass that remains between the channel excavation invert and bedrock surface elevation during excavation (KGS Group 2016). During channel operation, blowout or basal heave / seepage would be expected if these bedrock aquifer pressures exceed the operating channel surface water profile, and where not confined by sufficient overburden thicknesses (KGS Group 2016).

The examination of aquifer drawdown found that drawdown of aquifer groundwater piezometric pressures would be anticipated during channel construction and operation, given the flowing artesian bedrock piezometric pressure conditions, and potential direct connection to the bedrock aquifer via seepage through fractured till due to a possible groundwater blowout (KGS Group 2016). The largest aquifer drawdowns would occur during the construction phase, with drawdown to a level at or below the invert of the channel excavation. The analysis showed a potential maximum of 2.5 m to 4.2 m of drawdown at a 1 km distance from the channel during construction, and as much as 6 m to 8 m in the immediate vicinity of the channel excavation. During normal channel operation, upstream of the Control Structure (and assuming the Control Structure is closed), aquifer drawdown in the range of 1.5 m could be anticipated at 1 km from the channel, and in the range of 3 m downstream of the Control Structure at a distance of 1 km (KGS Group 2016). These drawdowns would be greater in the areas closest to the channel and associated channel control structure. This potential drawdown effect could have an effect on the available capacity of the local supply wells. Additional information on the methods and parameters used for the preliminary assessment of potential aquifer drawdown is provided in KGS Group 2016.

The GUDI assessment showed that there will be a varying depth of till beneath the invert of the channel and above the bedrock aquifer along Route D, although a connection between the bedrock aquifer and the channel is expected either due to blowout, or with possible installation of depressurization sumps within the channel excavation (KGS Group 2016). The potential for GUDI exists in the long-term even with a permanent depressurization system, due to the complexities of fracture flow within bedrock, and the possibility of an adjacent well user pumping heavily from a directly interconnected and transmissive fracture or bedding plane parting within the bedrock, which could result in the draw of surface water from the channel, directly into the 3rd party well (KGS Group 2016). A connection between the bedrock aquifer and the channel increases the vulnerability of the aquifer to contamination by surface water, which can lead to contamination of local groundwater resources, and could potentially affect the domestic wells located within the 3 km offset area of the proposed LMOC Route D channel.

The review of potential changes to Lake St. Martin surface water quality found that discharge of groundwater to the channel is expected given the channel excavation depth, aquifer piezometric pressure conditions, interconnection to the carbonate aquifer, and construction and operational channel conditions (KGS Group 2016). The groundwater quality is considered to be relatively fresh (TDS = 390 to 550 mg/L, Chloride = 2 to 19 mg/L), but may have lower levels of dissolved oxygen than the surface waters. The groundwater system currently naturally discharges to Lake Manitoba and Lake St. Martin; therefore, the volume of groundwater discharge to the surface water bodies is not expected to be greatly increased. There will also be varying amounts of surface water baseflow in the channel during operation, which will provide some degree of dilution of groundwater prior to discharge to Lake St. Martin (KGS Group 2016).

In regards to the drainage of surface water bodies near the channel alignment, there are several wetland areas, ponds, sloughs, and lakes (e.g., Reed Lake, Clear Lake, Goodison Lake) located within the LSA for LMOC Route D that may have connection to the groundwater aquifer, depending on the total depth of the water body, underlying soil stratigraphy, and depth to bedrock surface (KGS Group 2016). Based on the data collected in 2011 and 2015 for the measured bedrock aquifer piezometric pressures, bedrock elevations, and till thickness, there is a low possibility for groundwater baseflow contribution to the wetlands; however, there is potential for interconnections where there may be a relatively thin till confining layer, and/or a pervious intertill granular zone that allows for some seepage to the surface water system, e.g., a “spring” feed to the base of the wetland areas (KGS Group 2016). Therefore, the existing upward gradient to discharge could be periodically reversed if there is a reduction in groundwater pressures, such as during construction when there may be more significant groundwater piezometric pressure drawdowns, or the groundwater baseflow to the wetlands could be reduced (KGS Group 2016).

KGS Group (2016) noted that the contribution of groundwater to surface water areas adjacent to the proposed LMOC Route D was unknown at the time of writing and further understanding of the hydrogeology of this area is needed. For example, layered fine-grained sediments formed within the basins of the ponds, sloughs and lakes, as well as potentially thick, competent till acting as an aquiclude between the wetlands and bedrock, would be significant limiting factors to wetland drainage.

### 7.1.11 Surface Water

#### *7.1.11.1 Water Quantity*

Major named watercourses and waterbodies in the RSA from west to east include Portage Bay and Watchorn Bay in Lake Manitoba; Fairford River; Inlet Creek; Lake Pineimuta; Lake St. Martin; Reed, Clear and Goodison lakes; Birch Creek; Beardy Creek; Dauphin River; Bear Creek; Little Buffalo Lake; Big Buffalo Lake; Buffalo Creek; Sturgeon Bay in Lake Winnipeg; and a number of named and unnamed creeks, ponds and small lakes that are located throughout the RSA. **Figure 7** provides an overview of the waterbodies and watercourses within and connected to the Project RSA.

**Figure 8** illustrates the watercourses and waterbodies in the LSA and potential connectivity to the proposed LMOC Route C and LMOC Route D. The LSA for the proposed LMOC Route C encompasses portions of Portage Bay in Lake Manitoba; Inlet Creek; Fairford River; Bigstone and Little Stone lakes; Harrison Creek; Enis Lake; Lake St. Martin; and a number of unnamed creeks, drains and ditches that are connected to Harrison Creek and/or Lake St. Martin.

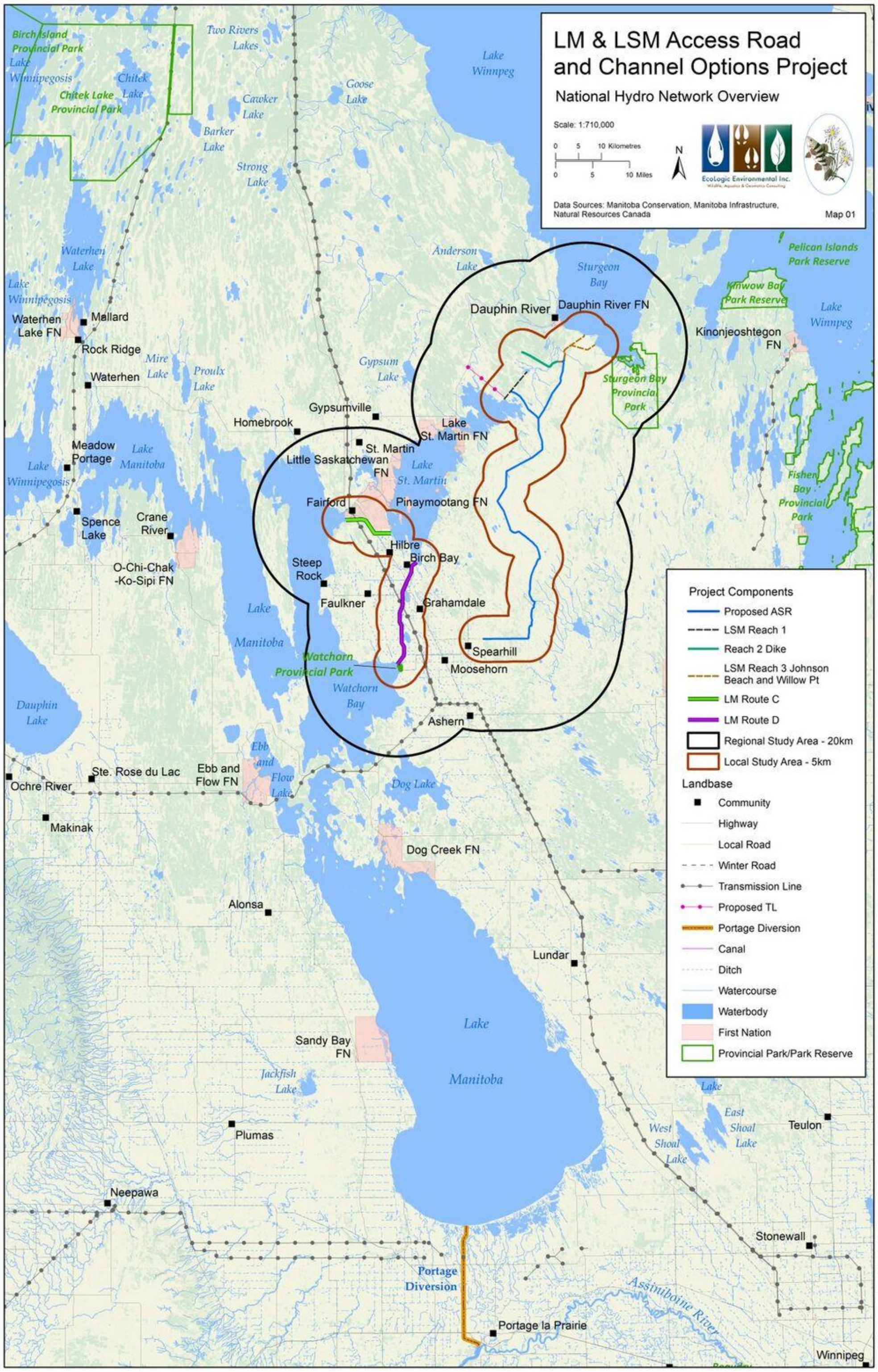



**Figure 7:** **Overview of Waterbodies and Watercourses Within and Connected to the Project RSA**

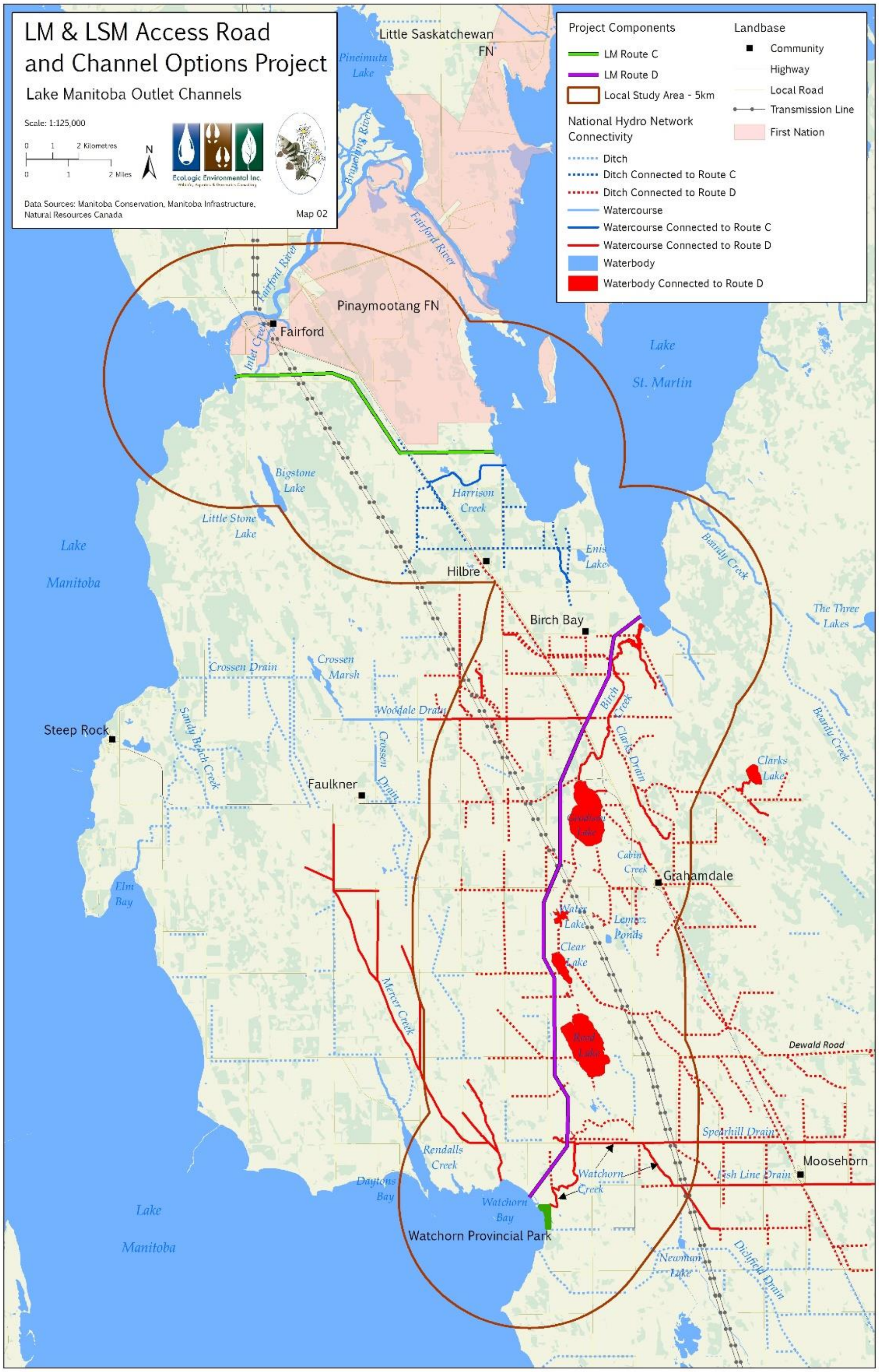



Figure 8: **Watercourses and Waterbodies in the LSA and Potential Connectivity to the Proposed LMOC Route C and LMOC Route D**

The LSA for the proposed LMOC Route D encompasses portions of Watchorn Bay in Lake Manitoba; Rendall's Creek; Mercer Creek; Watchorn Creek; Ditchfield Drain; Fish Line Drain; Spearhill Drain; a number of small lakes (Reed Lake, Clear Lake, Water Lake, Goodison Lake, Clark's Lake), ponds (Lemiez Ponds) and wetland areas; Cabin Creek; Clark's Drain; Woodale Drain (which is connected to Crossen Drain and Crossen Marsh); Birch Creek; Beardy Creek; and a number of unnamed creeks, drains and ditches that are connected to Birch Creek and/or Lake St. Martin.

The "*Assiniboine River & Lake Manitoba Basins Flood Mitigation Study LMB & LSM Outlet Channels Conceptual Design - Stage 2"* studies and report prepared by KGS Group (2016) included flood routing studies that examined historical flows and lake levels for Lake Manitoba and Lake St. Martin. Data were presented for the period of record from 1961 to 2014, which therefore includes the flood routing effects of the Fairford River Water Control Structure (FRWCS) and the Portage Diversion (PD) as these structures were operational since 1961 and 1970, respectively.

Based on review of the hydrographs and data presented in the Stage 2 report (KGS Group 2016), lake levels in Lake Manitoba for the period of record ranged from a minimum of about 247 masl (810.3 feet) in 2003 to a maximum of about 249.1 masl (817.1 feet) in 2011.

The *Lake Manitoba and Lake St. Martin Regulation Review Committee* cited the long-term, average level of Lake Manitoba as 812.2 feet (247.6 masl) (LM&LSMRRC 2013).

In Lake St. Martin, lake levels ranged from a minimum of about 242.3 masl (794.8 feet) in 1965 to a maximum of about 245.5 masl (805.5 feet) in 2011 for the same period of record (1961 to 2014) (KGS Group 2016).

The Fairford River monthly mean flows for the period of record from 1912 to 2015 have ranged from a minimum of zero flow in the winter months of 1960 and 1961, to a maximum flow of 610 $m^3/s$ in July 2011. **Table 15** provides a summary of the maximum, minimum and mean flows on the Fairford River from 1912 to 2015.

**Table 15: Summary of Fairford River Flows in Cubic Metres per Second from 1912 to 2015**

| Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max | 392 | 364 | 350 | 339 | 430 | 560 | 610 | 577 | 525 | 476 | 447 | 422 | 415 |
| Min | 0 | 0 | 0 | 0 | 0 | 0 | 1.8 | 1.84 | 0.65 | 0 | 1.22 | 0 | 1.75 |
| Mean | 72.5 | 73 | 75.4 | 89.6 | 120 | 140 | 140 | 116 | 93.8 | 86.7 | 84.7 | 77.8 | 98 |

Source: Government of Canada – Water Office 2016c.

There were no historical flow or water level data available for Harrison Creek, Watchorn Creek or Birch Creek. Estimates of flow for these creeks can be derived from the drainage area, channel slope and flow conditions observed during the 2015 and 2016 aquatics field studies, if these data are needed.

#### *7.1.11.2 Water Regulation*

The *Lake Manitoba and Lake St. Martin Regulation Review Committee Report* included a number of considerations and recommendations related to the regulation of lake levels in Lake Manitoba and Lake St. Martin, and flows through the FRWCS (LM&LSMRRC 2013). A summary of these considerations and recommendations is provided below:

- For Lake Manitoba:
  - A range of flows that incorporate the need for natural variability is necessary for the health of the lake;
  - It has been suggested that, after the recent high water period, levels need to be held in the lower part of the range, to allow marshes and shoreline vegetation to be re-established and natural beach ridges to re-develop;
  - The current range of natural variation is two feet, from 810.5 to 812.5 feet;
  - Based on the above, the Committee recommended that the range of regulation be lowered from the current range of 810.5 to 812.5 feet by half a foot to 810.0 to 812.0 for a period of five years.
- For the FRWCS, the Committee recommended that the current operating rules for the Fairford Control Structure be modified such that:
  - During recovery from flood conditions on Lake Manitoba, the Fairford Control Structure is kept wide open until Lake Manitoba recedes to the middle of the recommended range of regulation (i.e., 811 feet);
  - For recovery from drought, the Fairford Control Structure is kept at 800 cubic feet per second (cfs) until Lake Manitoba levels increase to the middle of the range; and
  - Under normal operating conditions, once outflow reaches normal, there are no further stop-log adjustments of the Fairford Control Structure, as long as Lake Manitoba remains within the range.
- For Lake St. Martin:
  - The Lake Manitoba Regulation Review Advisory Committee, in their report of 2003, recommended that the level of Lake St. Martin should be maintained within a more natural range of 797.0 feet to 800 feet asl insofar as this may be reasonably possible;
  - However, the existing recommended range of 797 feet to 800 feet asl has been achieved less than 40 percent of the time over the last 20 years;
  - To deal with this set of circumstances, the Committee has taken the approach of considering what works and measures would be necessary to achieve the levels recommended in 2003, i.e., to consider what works would have to be in place (and

how they would have to be operated) to give all parties reasonable assurances that 797 feet to 800 feet asl could be achieved;
- Therefore, the Committee recommended that, in designing the permanent outlet from Lake St Martin as recommended above, consideration must be given to both the desirable lake level range for Lake St. Martin (797 to 800 feet asl) and to the effects of an additional outlet from Lake Manitoba to Lake St. Martin.

#### *7.1.11.3 Water Quality*

The Water Quality Management Section of MBSD carries out a long term water quality monitoring network on major streams, rivers and lakes in Manitoba, including several lake and river sampling stations in the Lake Manitoba watershed and in Lake St. Martin (MBSD 2017). There are three long-term lake monitoring stations: two stations are located on Lake Manitoba, at Delta Marsh and at the Narrows, and a third station is located on the Fairford River at PTH 6 (LM&LSMRRC 2013). In addition, two other lake monitoring stations were added at Lundar and St. Ambroise in 2011, and the frequency of sampling was increased during the 2011 flood (LM&LSMRRC 2013). River monitoring is conducted at three long-term stations located on three of the major rivers of the Lake Manitoba watershed: the Waterhen River at PR 328, the Whitemud River at Highway 16, and the Assiniboine River. The frequency of sampling at the river monitoring stations was increased during the 2011 flood, and water quality was also sampled in Lake St. Martin at three locations – the North Basin, the Narrows and the South Basin (LM&LSMRRC 2013).

In addition to water quality sampling and monitoring, MBSD investigated the potential relationship between water levels in Lake Manitoba and water quality, using average concentrations of total phosphorus (TP) and total nitrogen (TN) as the basis for the examination of water quality. Lake Manitoba average TP levels from 1992 to 2011 as measured at the Delta Marsh station ranged from about 0.045 milligrams per litre (mg/l) to about 0.13 mg/l, with the highest concentration observed in the 2011 sampling (LM&LSMRRC 2013). Lake Manitoba average TN levels from 1992 to 2011 as measured at the Delta Marsh station ranged from about 0.09 mg/l to about 1.8 mg/l, with the highest concentration observed in the 1999 sampling (LM&LSMRRC 2013).

The Portage Diversion (**Figure 7**) is the largest source of phosphorus to Lake Manitoba when it is flowing; in 2011, more than 60 percent of the TP load to Lake Manitoba was transported by the Portage Diversion (LM&LSMRRC 2013). TP was elevated at Delta Marsh in 2011, as well as in other wet years, but an increase in average TP was not found in the water quality sampling done at the station located at the Narrows in Lake Manitoba (LM&LSMRRC 2013).

The Waterhen River was identified as the largest source of TN to Lake Manitoba; in 2011, nearly 60 percent of the TN load to Lake Manitoba was transported by the Waterhen River (LM&LSMRRC 2013). It was also noted that the percentage of the TN load is greater in years when the Portage Diversion does not flow, and, unlike the average TP concentrations, average TN concentrations were not affected by the 2011 flood, with no significant increases observed (LM&LSMRRC 2013).

Other indicators of water quality being sampled by MBSD include chlorophyll α, total suspended solids, conductivity, dissolved oxygen, metals and pesticides. The average chlorophyll α concentration in Lake Manitoba was slightly higher in 2011 than the long-term average, but within the range of historical concentrations. When it flows, the Portage Diversion is the largest source of TSS to Lake Manitoba, and contributed more than 85% of the lake's load in 2011; however, TSS in Lake Manitoba in 2011 was similar to the long-term average and within the range of historical concentrations (LM&LSMRRC 2013). Dissolved oxygen concentrations in Lake Manitoba are typically sufficient for aquatic life, but have occasionally been below the guideline for supporting aquatic life, including measurements in May 2011 and in August 2011. Conductivity has been declining in Lake Manitoba in recent years, it appeared to be affected by the 2011 flood and can be linked to the inflow from the Portage Diversion (LM&LSMRRC 2013).

In 2011 to 2012, monitoring was conducted at five stations – Waterhen River, Lake Manitoba Narrows, Fairford River, Dauphin River, and Sturgeon Bay - to examine the regional water quality prior to and during the operation of the LSMEOC. Monitoring showed that the Lake St. Martin water quality "met the majority of water quality objectives and guidelines" (LM&LSMRRC 2013). TP, turbidity and chlorophyll α levels were found to be lower in Lake St. Martin than in the south end of Lake Manitoba, which had the highest levels of these parameters.

Mercury levels in fish were examined in tissue samples collected from northern pike (*Esox lucius*), lake whitefish (*Coregonus clupeaformis*), white sucker (*Catostomus commersoni*) and yellow perch (*Perca flavescens*) in Lake St. Martin in the fall of 2011. The tissue concentrations of mercury were found to be generally low and within the safe limits for human consumption and unrestricted commercial sale (LM&LSMRRC 2013).

As such, water quality monitoring over time has shown increases in phosphorus and chlorophyll and decreases in conductivity in Lake Manitoba, but water levels do not appear to be a major driver of water quality (LM&LSMRRC 2013). Water quality in the south basin of Lake Manitoba does appear to have been significantly affected by the Portage Diversion.

High levels of nutrients such as nitrogen and phosphorus can lead to the development of algal blooms in lakes, where the water may appear like thick pea soup and have an unpleasant odour. MBSD monitors algal blooms at about 60 beaches across Manitoba for the presence of cyanobacteria, which can produce a toxin called microcystin. Microcystin is produced by some species of cyanobacteria and can be harmful to the liver or nervous system if large amounts of water containing this toxin are swallowed (MCWS 2011). Manitoba's recreational water quality objective for total cyanobacterial cell count is 100,000 cells per millilitre (mL), and for microcystin is 20 micrograms per litre (ug/L) (MCWS 2011). MBSD also conducts sampling for the *Escherichia coli* (*E.coli*) bacterium at about 60 beaches across Manitoba, including four beaches in Lake Manitoba: Lynch's Point; Delta; St. Ambroise and Twin Lakes. From 2006 to 2010, *E. coli* levels were below the recreational guideline at Delta and St. Ambroise Beaches, but exceeded the guideline at either Lynch's Lake Point Beach or Twin Lakes Beach on four occasions (LM&LSMRRC 2013). Manitoba's recreational water quality objective for *E. coli* is 200 *E. coli* per 100mL of sample (MCWS 2011).

The proliferation of algal toxins such as microcystin and the potential relationship to other water chemistry parameters including nitrogen, phosphorus, and chlorophyll α, is the subject of many past and current studies in Manitoba and across Canada (Pip and Bowman 2014; Orihel et al 2012; Pip and Allegro 2010; Kotak and Zurawell 2007). Orihel et al (2012) compiled measurements of microcystin concentrations in fresh waters collected in Canada between 2001 and 2011, and found that the highest concentrations tended to occur in the Canadian prairie provinces, including southwestern Manitoba. The findings supported current hypotheses that microcystin concentrations increase with lake trophic level, and meta-analysis revealed that microcystin concentrations in the sampled waters were found to be high only at low N:P ratios and were consistently low at high N:P ratios (Orihel et al 2012). The study noted that the typical conditions of warm, shallow waters and high nutrient concentrations in prairie lakes are ideal for the proliferation of cyanobacteria (Orihel et al 2012).

These monitoring activities and studies show the complicated nature and influence of inflows and outflows to Lake Manitoba and Lake St. Martin, and the range of variability of water quality parameters in these basins. Current water chemistry and water quality parameters in the Lake Manitoba and Lake St. Martin watersheds have been and continue to be significantly affected by inputs from other connected waterways. Given that the FRWCS has been in operation for many decades, it is expected that the inter-basin transfer of water between Lake Manitoba and Lake St. Martin is an historical and ongoing occurrence. As such, the transfer of nutrients and potential contaminants such as *E. coli* and microcystin from Lake Manitoba to Lake St. Martin is likely to have already taken place. However, the increased flows and transfer of water from Lake Manitoba to Lake St. Martin that will result from the development of the LMOC may increase the potential for changes to the existing Lake St. Martin water chemistry and water quality.

Water quality sampling for the proposed LMOC Route C and LMOC Route D included the collection of *in situ* measurements of temperature, dissolved oxygen, pH, conductivity, turbidity, and total suspended solids. These data are provided in the "*Fisheries and Aquatic Habitat Assessment: Lake Manitoba Outlet Channel Routes Project*" prepared by AAE Tech Services Inc. (2016) provided as Appendix 3 to this report, and are discussed below in Section 6.1.12.

### 7.1.12 Fisheries and Aquatic Habitat

The "*Fisheries and Aquatic Habitat Baseline Assessment: Lake Manitoba Outlet Channel Routes Options*" report was prepared by AAE Tech Services Inc. (2016) and is provided as Appendix 3 to this report. Additional information on the aquatic studies for the LMOC Project, including photographs of the sampling sites, fish and benthic invertebrates, is provided in Appendix 3. Appendix E in Appendix 3 provides the Fish and Aquatic Assessment Summary Documents prepared for each sampling site.

#### *7.1.12.1 Introduction*

AAE Tech Services Inc. (AAE) completed a fisheries and aquatic habitat assessment of the waterbody and watercourse areas that will be potentially affected by the proposed LMOC Route C or LMOC Route D. The assessment encompassed all waterways intersecting both channel routes, including two sampling sites on Lake Manitoba within the vicinity of the proposed inlet areas and two sampling sites on Lake St. Martin within the vicinity of the proposed outlet areas. The two Lake Manitoba channel inlet sites were located approximately 2.0 km south of the outlet into the Fairford River (Route C) and within Watchorn Bay (Route D), referred to in this report as the Fairford and Watchorn Bay sites, respectively. The two Lake St. Martin outlet sites were located 1 km north of Harrison Creek (Route C) and at Birch Bay immediately north of Birch Creek (Route D), referred to in this report as the Harrison Bay and Birch Bay sites, respectively. Data collection was also completed on four tributaries linked to these sites: Birch Creek (Birch Bay site), Watchorn Creek (Watchorn Bay site), Mercer Creek (Watchorn Bay site), and Harrison Creek (Harrison Bay site).

Fieldwork was completed during the fall of 2015 and spring of 2016. Baseline data were collected to investigate five major environmental components:

1. Desktop review of potential protected species inhabiting the area;
2. Aquatic and riparian habitat assessment;
3. Baseline water quality measures;
4. Fish distribution and composition; and
5. Benthic invertebrate analysis.

Habitat assessment included a bathymetric survey, including an analysis of depth, substrate, and vegetation cover at each study site, and cross-sectional profiles of each tributary. Baseline water quality variables measures were collected, including temperature, dissolved oxygen, pH, conductivity, turbidity, and total suspended solids. Fish distribution and composition was assessed through boat and backpack electrofishing surveys, gill net sets, hoop netting, larval fish net tows, egg mat sampling, and kick net sampling. Fall fish sampling was performed using fewer, shorter set times to avoid disrupting the migratory patterns of Lake Whitefish (*Coregonus clupeaformis*), a commercially important fall-spawning species previously documented to be utilizing the lakes. Benthic macroinvertebrates were collected and identified as an indicator of water quality and ecosystem health. Results were tabulated, compiled, and are presented for each study site.

#### *7.1.12.2 Fairford Study Site – Lake Manitoba, Route C*

The Fairford study site was characterized as having a gently sloping lake bottom reaching a maximum measured depth of 2.2 m approximately 650 m from shore. Substrate was predominantly coarse, including mixtures of gravel, sand and cobble. Vegetation cover was greatest at depths between 1 m and 1.5 m, though plant height was relatively low (<0.6 m) and biovolume was found to be relatively low across the site. Water quality measures were similar between fall and spring sampling periods, and characteristic of a healthy ecosystem. Dissolved oxygen levels remained above CCME minimum guideline values for the protection of aquatic life (CCME 1999), and turbidity and total suspended solids were relatively low.

A total of 226 fish representing 14 species were captured during spring and fall sampling at Fairford. Fall sampling found Northern Pike (*Esox lucius*) to be the most abundant species, with White Sucker (*Catostomus commersoni*) and Lake Whitefish also present. Spring sampling identified a large fish community including predominantly Yellow Perch (*Perca flavescens*), Walleye (*Sander vitreus*), White Sucker, and Northern Pike. Fish larvae net tows yielded 63 larval fish representing two species, including Walleye and White Sucker. Egg mat (70 mats) and kick sampling efforts (25 $m^2$) yielded no eggs during either the spring or fall field season.

A total of 23 taxa from 10 orders of benthic macroinvertebrates were captured at Fairford. The most common orders were Ephemeroptera (Mayflies), Diptera (True Flies), Amphipoda, and Trichoptera (Caddisfly). Mean richness (number of taxa per sample) was determined to be 8.40, overall mean was 405 BMI/$m^2$, and Simpson's Diversity was 0.55.

Overall, habitat structure and water quality were characteristic of high quality aquatic habitat for fish species. Benthic invertebrate species identified further suggest high water quality at the Fairford study site. While egg mat surveys did not identify any eggs, fish in spawning condition were identified during both the fall and spring study period, and small numbers of fish larvae sampled in the spring suggest that some spawning may take place within the Fairford site. Fish species diversity was relatively high (14 species recorded).

#### *7.1.12.3 Watchorn Bay Study Site – Lake Manitoba, Route D*

The Watchorn Bay study site was characterized as having a very shallow sloping lake bottom reaching a maximum measured depth of 2.7 m approximately 750 m from shore. Substrate was predominantly sand to depths of 1.5 m. Vegetation cover was minimal, restricted to pockets of gravel/cobble substrate at depths greater than 2 m. Water quality measures were similar between fall and spring sampling periods, and characteristic of a healthy ecosystem. Dissolved oxygen levels remained above CCME minimum guideline values for the protection of aquatic life (CCME 1999). Turbidity levels were highest at the Watchorn site, with total suspended solid measures higher than those at the Fairford site.

A total of 218 fish representing 12 species were captured during spring and fall sampling at Watchorn Bay. Fall sampling yielded predominantly Lake Whitefish, while spring sampling yielded predominantly Yellow Perch and White Sucker. Fish larvae net tows yielded 24 larval fish representing two species, including Walleye and White Sucker. Egg mat sampling (70 mats) yielded no eggs during either the spring or fall field season.

A total of 16 taxa from eight orders of benthic macroinvertebrates were collected in Watchorn Bay. The most common orders were Ephemeroptera, Diptera, Trombidiformes (Mites), and

Amphipoda. Mean richness was determined to be 5.30, overall mean was 144 BMI/$m^2$, and Simpson's Diversity was 0.62.

Overall, habitat structure and water quality do not represent diverse aquatic habitat for fish species. With primarily sandy substrate, Watchorn Bay is characteristic of a shallow and windswept bay. The increased wave action and sediment movement found at this site resulted in egg mats becoming completely clogged and embedded in sediment; this effect is not conducive to productive spawning habitat as eggs would similarly be battered and covered in sediment.

Those creeks that drain into Watchorn Bay (Mercer Creek and Watchorn Creek), however, were determined to be valuable spawning sites, with White Sucker in spawning condition migrating upstream within both systems, and the presence of licensed commercial trap nets on both creeks confirmed these creeks as productive fish migration routes. These observations would suggest that Watchorn Bay may serve as an important part of the spawning migratory route in this area, supported by the collection of Lake Whitefish (fall) and White Sucker (spring) in spawning condition within the Watchorn Bay study site. Overall quality of habitat directly impacted by Route D channel construction was assessed as low.

#### *7.1.12.4 Harrison Bay Study Site – Lake St. Martin, Route C*

The Harrison Bay study site bathymetric survey depicted a gradually sloping lake bottom throughout most of Harrison Bay, reaching a maximum measured depth of 3.2 m approximately 750 m from shore. Substrate was predominantly a gravel-sand mixture. Vegetation cover was dense at depths greater than 1.5 m, though plant height and total biovolume was extremely low. Water quality measures were only collected during the spring sampling season, and were characteristic of a productive ecosystem, with lower turbidity and increased total suspended solids. Dissolved oxygen levels remained above CCME minimum guideline values for the protection of aquatic life (CCME 1999), and turbidity and total suspended solids were relatively low.

A total of 271 fish representing sixteen species, were captured during fall and spring sampling at Harrison Bay. Fall sampling yielded predominantly Lake Whitefish, Yellow Perch and Northern Pike species. Spring sampling identified a diverse fish community (14 species), including large numbers of White Sucker. Fish larvae net tows yielded 5,844 larval fish representing two species including White Sucker and Walleye. Egg mat sampling (70 mats) yielded no eggs during either the spring or fall field season.

A total of 22 taxa from ten orders of benthic macroinvertebrates were collected in Harrison Bay. The most common orders were Ephemeroptera, Diptera, Amphipoda, and Trombidiformes. Mean richness was determined to be 8.50, overall mean was 195 BMI/$m^2$, and Simpson's Diversity was 0.72.

Riparian habitat was the most extensive and complex at the Harrison Bay site. Aquatic vegetation within the marsh is extremely dense and highly productive, draining directly into Lake St. Martin at the Route C site. This habitat is characteristic of spawning habitat for fish species such as Northern Pike and Yellow Perch. Overall, aquatic habitat quality at the Harrison Bay site was very high, with both the highest total number of species observed, and the highest total catch and CPUE of spring larval fish. The presence of both fish in spawning condition and fish larvae suggest Harrison Bay site provides important spawning habitats for the fish communities within Lake St. Martin, though egg mat sampling was not able to identify specific spawning sites.

#### *7.1.12.5 Birch Bay Study Site – Lake St. Martin, Route D*

Results of the bathymetric survey demonstrated a gradually sloping lake bottom throughout most of Birch Bay, reaching a maximum measured depth of 3.7 m. Slopes were steepest along the west shoreline at the Route D channel site, following a relatively consistent slope to a depth of 3 m approximately 250 m from shore. Substrate was predominantly sand and gravel. Vegetation cover was sparse especially in the western portion of Birch Bay at the Route D channel site, with relatively low biovolume outside the mouth of Birch Creek. Where the creek enters the lake, habitat is heavily vegetated, with long grass and cattails extending north. This narrow band of marsh habitat will likely be utilized by Northern Pike, Yellow Perch or forage fish for spawning, nursery of refuge. It is, however, less extensive than the habitat observed at Harrison Creek. Water quality measures were comparable between fall and spring sampling, and depict similar trends to that observed at Harrison Creek to the north. Dissolved oxygen levels remained above CCME minimum guideline values for the protection of aquatic life (CCME 1999), and turbidity and total suspended solids were relatively low.

A total of 89 fish representing 8 species were captured during fall and spring sampling at Birch Bay, which was the lowest diversity in species captured of all study sites. Fall sampling yielded predominantly Lake Whitefish, and spring sampling yielded predominantly White Sucker, Northern Pike, and Common Carp. Fish larvae net tows yielded capture of 2,855 larval fish representing two species, including White Sucker and Walleye. Egg mat sampling (70 mats) yielded no eggs during either the spring or fall field seasons.

A total of 22 taxa from eleven orders of benthic macroinvertebrates were collected in Birch Bay. The most common orders were Diptera, Ephemeroptera, and Amphipoda. Mean richness was determined to be 9.25, overall mean was 409 BMI/$m^2$, and Simpson's Diversity was 0.57.

Similar to Harrison Bay to the north, Birch Bay was found to include productive, high quality aquatic habitat with substrate and water quality characteristics conducive to fish spawning and habitation. While egg mat sampling did not identify specific spawning sites with this area, high larval fish counts and the presence of fish in spawning condition suggest this area plays an active role in fish spawning migration. The capture of a significant number of spawning White Sucker on Birch Creek, as well as the presence of a licensed commercial trap net on this creek, support the importance of Birch Bay and the Birch Creek tributary to the productivity of this fishery. Draining primarily agricultural land to the south and west of Lake St. Martin, nutrient levels are expected to be high, and the isolation from the main current of flow between the Fairford River inlet and Dauphin River outlet suggest this basin of Lake St. Martin likely serves as a nutrient sink, promoting more productive and complex habitat in both the Birch Bay and Harrison Bay sites.

#### *7.1.12.6 Fisheries and Aquatic Habitat Study Summary*

The baseline assessment found that all four of the study sites possessed a healthy aquatic ecosystem with established fish communities. When examining the results of the benthic invertebrate study, combined with water quality measurements, in particular turbidity and TSS levels, it can be determined that the aquatic habitat within the Route C area of impact (Fairford and Harrison Bay) represents relatively higher quality fish and aquatic habitat vs. the Route D area of impact. This determination is reflected in the comparative CPUE of adult and larval fish, species diversity, and overall habitat characteristics between the Route C and Route D sites, most notably between the Lake St. Martin sites.

Although the Fairford and Watchorn sites were comparable for fish productivity and species diversity, the Harrison site (Route C) has much higher productivity and species diversity than the Birch Bay site (Route D). The extensive riparian marsh habitat at the Harrison Bay site provides potential nursery and spawning habitat for fish, as evidenced by fish larvae sampling and between-site comparisons of fish communities. The collections at the Harrison Bay site resulted in over 3x the number of adult fish, over 2x the number of larval fish, and 2x the number of fish species than those at the Birch Bay site. The Fairford site (Route C) is also expected to offer better fish spawning habitat with its gravel-sand substrate and higher vegetation cover, in comparison to Watchorn's (Route D) windswept and sandy conditions.

In general, all four sites had good water quality and all water quality measures were consistently within the CCME guidelines for the protection of aquatic life (CCME 1999). However, when examining the results of the benthic invertebrate study, combined with water quality measurements, in particular turbidity and TSS levels, it can be determined that the aquatic habitat within the Route C area of impact (Fairford and Harrison Bay) represents higher quality fish and aquatic habitat.

In general, either route would likely have a greater potential effect on Lake St. Martin than Lake Manitoba. Both routes would empty into the lake's southern basin, increasing both flow and nutrient mixing throughout the lake. While overall water quality was high at all four sites, benthic invertebrate observations suggest that productivity and nutrient load may be higher within the two Lake St. Martin sites than the Lake Manitoba sites. The southern end of Lake St. Martin may be particularly nutrient-rich due to the influx of nitrogen and other nutrients from agricultural land to the south, although nutrient composition throughout the lake was not tested in this study.

In addition to overall effects on Lake St. Martin, each route could have several potential effects on their respective outlet sites. Harrison Bay (the outlet of Route C) contains quality spawning habitat, healthy and diverse fish and invertebrate communities, and extensive wetland habitat. Spawning fish were observed at the site in both spring and fall sampling periods, and zooplankton tows yielded large numbers of larval fish, potentially using vegetation at the site as nursery habitat. Any of these characteristics could potentially be disrupted by the placement of a route outlet at this site.

Birch Bay also contained substrate suitable for spawning, significant vegetation and adjacent wetland, and diverse fish and invertebrate communities. Fish were found in spawning condition within the bay during both fall and spring sampling conditions, and were observed spawning within Birch Creek during the spring. As in Harrison Bay, larval fish were observed in large numbers during zooplankton tows. In addition to potential effects on habitat and fish communities within the bay, Route D could also have a potential effect on Birch Creek, where fish spawning and commercial fishing were directly observed in this study. The placement of the channel within the Birch Creek watershed would effectively segment the watershed and reduce inflow to the creek itself. This activity is likely to effect habitat and water levels within the creek, particularly during spawning seasons.

The baseline results presented in this report are the product of a single seasonal cycle of the Lake Manitoba and Lake St. Martin aquatic ecosystem, and provide a snapshot of fish and aquatic habitat conditions within each study site. With the finalization of the LMOC Route selection, additional studies could be scheduled to provide more understanding of the natural variability of these aquatic systems.

#### *7.1.12.7 Aquatic Invasive Species*

The Invasive Species Council of Manitoba (ISCM) provides information on the Category 1 and Category 2 aquatic invasive species in Manitoba (ISCM 2016). There are a number of aquatic plants currently listed as Category 1, i.e., species that are not yet detected in Manitoba but pose a threat due to emigration and/or transport from other areas; and a number of aquatic plant, fish and invertebrate species currently listed as Category 2, i.e., already present in Manitoba and capable of spreading.

The fish species listed as Category 2 on the ISCM (2016) include common carp, mosquitofish (*Gambusia affinis* or *Gambusia holbrooki*), rainbow smelt (*Osmerus mordax*) and round goby (*Neogobius melanostomus*). Common carp were first introduced into Manitoba in 1886 in the Assiniboine River watershed and today are found in all watersheds in southern Manitoba northward to the Nelson River (Stewart and Watkinson 2004). Rainbow smelt were introduced into the Hudson Bay drainage and the first occurrence in Lake Winnipeg was noted in 1991 (Stewart and Watkinson 2004). It is now found in the Winnipeg River, Lake Winnipeg and the Nelson River downstream to Hudson Bay, and was observed in the Dauphin River in 2003 (Stewart and Watkinson 2004). Other than the listing on the ISCM, there was no other information found on the current presence and distribution of mosquitofish or round goby in Manitoba.

The invertebrate species listed as Category 2 on the ISCM (2016) include rusty crayfish (*Orconectes rusticus*), spiny water flea (*Bythotrephes longimanus*), and zebra mussel (*Dreissena polymorpha*). The rusty crayfish is a new invader to Manitoba that was first detected in Falcon Lake in 2007. The spiny water flea is a zooplankton species native to Eurasia that was introduced to North America from ballast waters of ocean-going ships in 1982 (ISCM 2016). This species has since invaded all the Laurentian Great Lakes, is present in the Lake of the Woods region, and has been identified to be present in the Winnipeg River and Lake Winnipeg in Manitoba (ISCM 2016). The zebra mussel is native to the Black and Caspian Sea region of Eurasia, and was likely introduced to Canada by cargo ships traveling to the Great Lakes in the 1980s; in October 2013, zebra mussel adults were confirmed in the southwest section of Lake Winnipeg in Manitoba (ISCM 2016).

The development of the LMOC will create an additional pathway for water transfer and the potential movement of species from Lake Manitoba to Lake St. Martin; however, this pathway for water transfer and aquatic species movements has already occurred with the construction and operation of the FRWCS. These invasive species can also be transferred in ballast and equipment by boaters and fishers traveling from one boating or fishing area to another. Given that the pathway of introduction for most of these aquatic invasive species is emigration or transport from Lake Winnipeg, the concerns for the introduction of aquatic invasive species in the RSA are expected to be related to preventing further movement of aquatic invasive species to Lake St. Martin, Lake Manitoba and other connected waterways.

#### 7.1.13 Species at Risk

The examination of Species at Risk in the LMOC RSA was accomplished by:

- Reviewing the regulatory parameters and terminology for Species at Risk and species of conservation concern;
- Reviewing provincial and federal databases for information on Project area species;
- Identification of Species At Risk and species of conservation concern potentially present or known to be present in the LMOC RSA;
- Habitat modelling to evaluate potential habitat in the RSA suitable for selected bird Species At Risk and/or species of conservation concern; and
- Conducting field studies that included investigations for the identified Species at Risk and/or species of conservation concern.

Based on the review of regulatory parameters and terminology, the Species At Risk for the Project area were defined as:

- Species currently designated by COSEWIC for listing on Schedule 1 of the federal SARA, including species in the risk categories of extirpated, endangered, threatened and special concern;
- Provincial species currently listed as endangered or threatened under MESEA; and

- Species of conservation concern in the RSA that are currently listed as very rare (provincial status of S1), rare (provincial status of S2) or uncommon (provincial status of S3) throughout their range by the MBCDC.

#### *7.1.13.1 Flora*

Information on the floral Species At Risk and plant species of conservation concern identified for the LMOC Project area is provided in Section 6.1.8.4 of this report. No federally or provincially listed species, or any species listed by MBCDC having conservation concern, were observed during the vegetation surveys of the LMOC route options. One sphagnum bog habitat observed along Route D could provide habitat for rare orchids (e.g. ram's-head lady-slipper), though none were observed. The rocky coastal habitat along Lake Manitoba at both the Route C and Route D alignments has a similar habitat to the shoreline at the town of Steeprock, where historic observations of long-fruited and hairy-fruited parsley were made. However, neither of these species were found during the 2016 spring and summer surveys.

#### *7.1.13.2 Fauna*

There were a number of mammal, bird, reptile and amphibian Species At Risk identified during the wildlife studies. The mammal Species At Risk identified for the Project RSA included the little brown bat (little brown myotis) and the northern long-eared bat (northern myotis). Both of these bat species are listed under Schedule 1 of SARA and MESEA as Endangered. These two species (along with two other bat species) were identified to be present in the overall Project RSA through the investigation of caves and sinkholes identified during winter aerial surveys, and placement of an Acoustic Recording Units (ARU) in the vicinity of the identified caves/sinkholes habitats. These potential hibernacula areas are located within the overall Project RSA, but were not located within the LMOC LSA.

A number of bird species listed by COSEWIC, SARA, and/or MESEA have ranges that overlap with the RSA (MBBA 2015; MBSD 2015a; SARA 2015). Appendix 2 provides a list of the species of conservation concern known to occur in the Interlake Plain and Mid-Boreal Lowland ecoregions and their status under COSEWIC, SARA, MESEA and MBCDC. **Table 14** in Section 7.1.9 above provides a summary of the bird Species At Risk or species of conservation concern that were confirmed to be present in the LMOC LSA, and their status under COSEWIC, SARA, and MESEA.

The barn swallow was the only bird Species At Risk confirmed to be present within the proposed LMOC Route C LSA. Bird Species At Risk confirmed to be present within the proposed LMOC Route D LSA included bank swallow, barn swallow, bobolink, common nighthawk, red-headed woodpecker and short-eared owl. A least bittern was observed within the RSA on the LM shoreline west of the proposed LMOC Route D and about 10 km south of Steeprock, MB.

Northern leopard frogs were observed within the proposed LMOC Route C RoW and the proposed LMOC Route D RoW. These frogs were the only reptile and amphibian Species at Risk observed or heard during the field studies.

Map 51 in Appendix 2 illustrates the locations of the faunal Species At Risk and/or species of conservation concern confirmed to be present in the LMOC LSA and RSA.

## 7.2 Socio-Economic Environment

### 7.2.1 Regional Communities and Population

Within the RSA there are two rural municipalities, the RM of Grahamdale and the RM of Siglunes (**Figure 9**). Communities within the RM of Grahamdale include Mulvihill, Camper, Moosehorn, Spearhill, Grahamdale, Faulkner, Steep Rock, Fairford, St. Martin and Gypsumville, and communities within the RM of Siglunes include the town of Ashern (**Figure 9**). Of these communities, only Fairford, Hilbre, Birch Bay and Grahamdale are located within the LSA. The largest concentrated population in the RM of Grahamdale are located in the community of Moosehorn (RM of Grahamdale 2016). As of January 01, 2015, the RM of Siglunes was incorporated with the RM of Eriksdale to form the new RM of West Interlake in accordance with the Province of Manitoba's 2013 *Municipal Amalgamations Act* (Government of Manitoba 2016g). A small portion of the RM of Alonsa and the RM of Fisher are part of the RSA boundary based on the overall study area designation, but these RMs were not included as part of the proposed LMOC study.

The 2011 census data for the RM of Grahamdale showed a population of 1364 people in the 2384.62 $km^2$ area of the RM, or a population density of 0.6 people/$km^2$ (Statistics Canada 2016), and the 2011 census data for the RM of Siglunes showed a population of 1360 people in the 837.42 $km^2$ area of the RM, or a population density of 1.6 people/$km^2$ (Statistics Canada 2016). In comparison, the population density in the City of Winnipeg in 2011 was reported as 137.7 people/$km^2$ (Statistics Canada 2016).

The communities in the LMOC LSA are typically small hubs providing local services to the regional population, travellers and tourists. Occupations in the area include farming, ranching, fishing and operation of the businesses found in the region, such as gas stations, hotels/motels, grocery stores, building materials stores, agricultural equipment stores, vehicle sales and repairs, credit unions, government and municipal services, restaurants, beach resorts, hunting and fishing outfitters, and campgrounds. The major economic sector in the region continues to be agriculture, which is focused mainly on ranching and feedlots for cattle (RM of Grahamdale 2016).

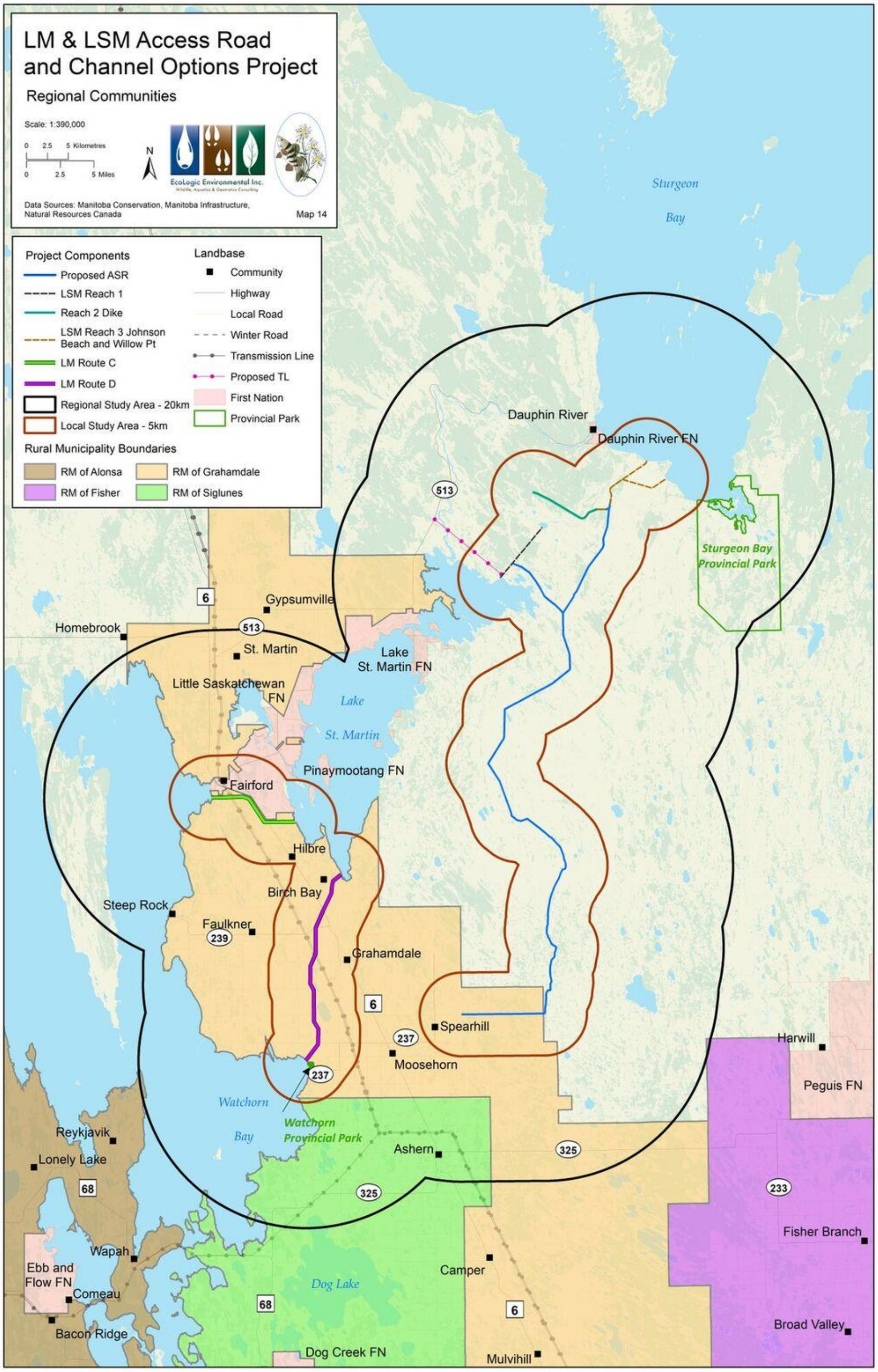



**Figure 9: Regional Communities**

### 7.2.2 Aboriginal Population

There are four First Nations located within the RSA: Dauphin River, Lake St. Martin, Pinaymootang, and Little Saskatchewan. The Peguis First Nation has a Community Interest Zone (CIZ) that includes a portion of the RSA and LSA. There are also a number of people of Métis descent whom reside in the area. **Figure 10** shows the location of the four First Nations and the CIZ. Information on these communities was gathered from the 2011 Census data prepared by Statistics Canada (2016). At the time of this writing, MI was in the process of meetings and consultations with the regional First Nations and Métis people who have interest in the Project; as such, Aboriginal Traditional Knowledge (ATK) for the area was not available for the baseline investigation studies. MI will collect and collate the ATK as part of the EIA process.

#### *7.2.2.1 Dauphin River First Nation*

Dauphin River First Nation is located along the north shore of Dauphin River where it enters Sturgeon Bay on Lake Winnipeg (**Figure 10**). Access is by gravel road on PR 513 running east from Gypsumville to Dauphin River. The Dauphin River First Nation is composed of two adjacent communities: one section is located on the Dauphin River Indian Reserve and the other section is located on Crown land formerly called Anama Bay (INAC 2017) The First Nation has a land area of 325.8 ha (INAC 2017).

The community of Dauphin River is not part of the Dauphin River First Nation but is a Manitoba Northern Affairs Community under provincial administration provided by the Aboriginal and Northern Affairs department (INAC 2017). The Census Profile for 2006 indicated a population of 84 for the Dauphin River FN and a population of 25 for the Northern community of Dauphin River (Statistics Canada 2016). The Community of Dauphin River website indicated a population of 30 people (Community of Dauphin River 2017). The Total Registered Population as of December 2016 was 374 people (INAC 2017).

#### *7.2.2.2 Lake St. Martin First Nation*

Lake St. Martin First Nation is located on the north shore of Lake St. Martin west of The Narrows (**Figure 10**). Access to the First Nation is by PR 513 east from Gypsumville. Lake St. Martin First Nation has two parcels, The Narrows 49 and The Narrows 49A. The First Nation has a land area of 2613.30 ha in the Narrows 49 and 982 ha in the Narrows 49a with a total of 3595.3 ha. The population was recorded as 505 in the 2006 census (Statistics Canada 2016) and the Total Registered Population as of December, 2016 was 2689 people (INAC 2017).

#### *7.2.2.3 Pinaymootang First Nation*

Pinaymootang First Nation (also referred to as Fairford First Nation), is located on the Fairford River at PTH 6 (**Figure 10**). Access to the first Nation is via PTH 6. The First Nation includes Dunsekikan Island in LSM, and has a land area of 7412.60 ha (INAC 2017). The population was recorded as 975 people in 2011 (Statistics Canada 2016) and the Total Registered Population as of December, 2016 was 3257 people (INAC 2017).

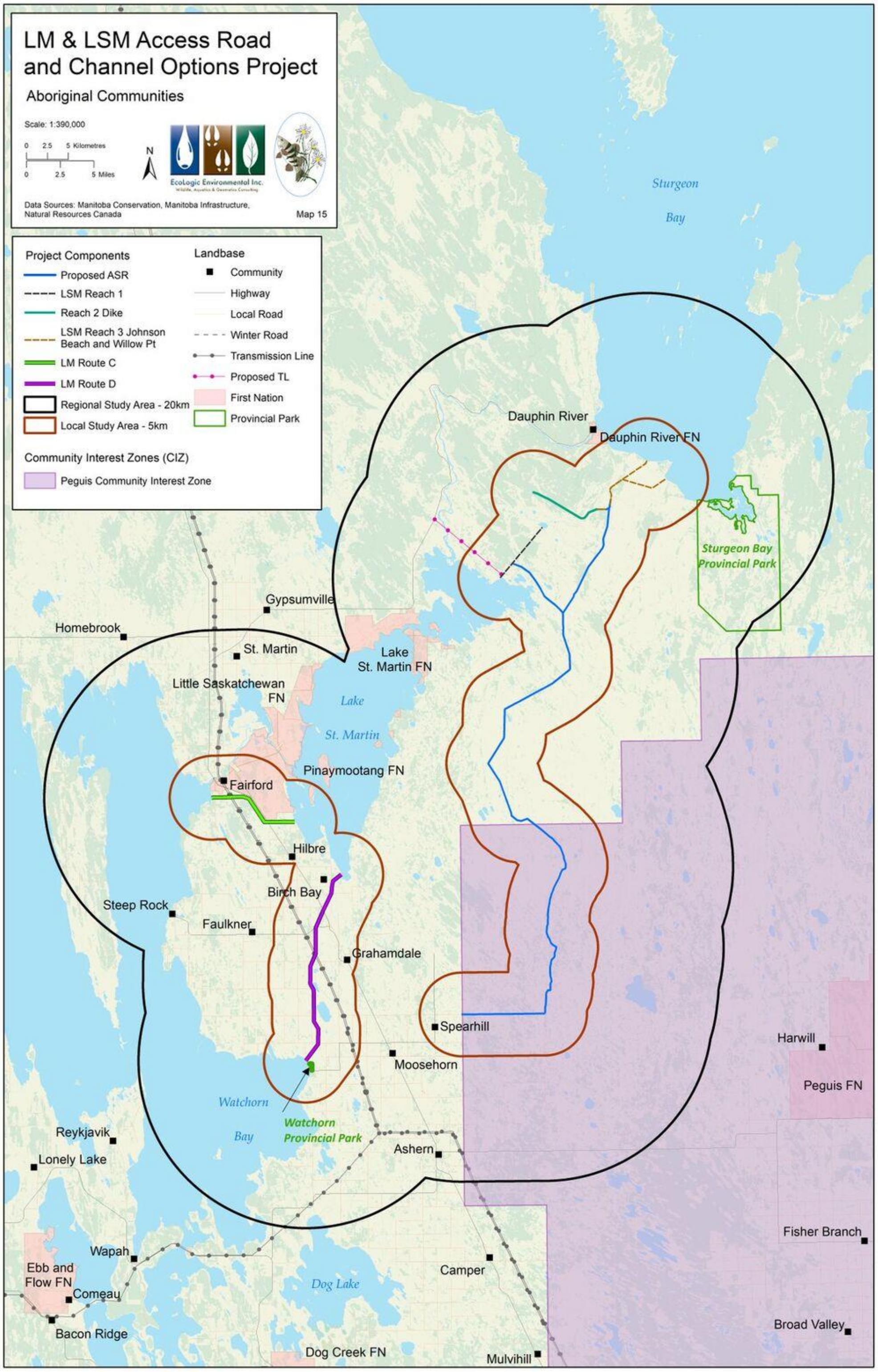



**Figure 10: Aboriginal Communities and Community Interest Zones**

#### *7.2.2.4 Little Saskatchewan First Nation*

Little Saskatchewan First Nation is located along the shoreline of LSM (**Figure 10**). The community is accessible from the north by PR 513 or from the south through the Pinaymootang First Nation. The First Nation is composed of two land parcels, Little Saskatchewan 48, which has an area of 1310.80 ha, and Little Saskatchewan 48B, which has an area of 97.50 ha (INAC 2017). The Little Saskatchewan First Nation population was recorded as 410 people in 2011 (Statistics Canada 2016) and the Total Registered Population as of December, 2016 was 1245 people (INAC 2017).

#### *7.2.2.5 Peguis First Nation*

Peguis First Nation does not have a community in the RSA, but the First Nation has a large Community Interest Zone (CIZ) in the region. Part of the CIZ falls within the RSA for the proposed LMOC, but there are no CIZs identified within the LMOC LSA (**Figure 10**). CIZs are areas of land selected by First Nations as part of Treaty Land Entitlement negotiations and processes with the Province of Manitoba (Treaty Land Entitlement Committee 2016). The process of Treaty Land Entitlement has several steps and requires time for selection, assessment and acquisition of the land; as such, the 1997 *Treaty Land Entitlement Framework Agreement* stipulates that the province must provide notification to the community if there are any other interests or proposed changes to the lands within a CIZ (Treaty Land Entitlement Committee 2016).

#### *7.2.2.6 Métis*

The 2011 Statistics Canada Census showed that Métis people made up 6.7% of the population of Manitoba (Statistics Canada 2016). The 2006 Manitoba Bureau of Statistics Census data for the RM of Grahamdale indicated that 285 of the 1415 residents identified as Métis, which represented 20% of the total population of the RM (Manitoba Bureau of Statistics 2008a). The 2006 Manitoba Bureau of Statistics Census data for the RM of Siglunes indicated that 200 of the 1460 residents identified as Métis, which represented 14% of the total population of the RM (Manitoba Bureau of Statistics 2008b).

Based on rulings in 2012 by the Supreme Court of Canada involving Aboriginal rights for Métis people, the government of Manitoba partnered with the Manitoba Métis Federation (MMF) to recognize Métis rights to harvest natural resources for food and domestic use in Manitoba, and allocated Métis Natural Resource Harvesting Zones based on the established Game Hunting Areas (GHAs) for the province (Government of Manitoba 2012b, MMF 2015). GHAs are areas of land in Manitoba designated, regulated and managed by the Province for the hunting of deer, moose, elk and other animals. Map 12 in Appendix 2 provides an overview of the GHAs located within the RSA and LSA.

These Natural Resource Harvesting Zones include GHAs 16, 20, and 25, but do not include GHA 21 (Government of Manitoba 2012b; Appendix 2). However, personal communications with MI in 2016 suggested that GHA 21 is also included as a Métis Natural Resource Harvesting Zone (M. Allard, pers.comm., 2016).

### 7.2.3 Land Use

The RM of Grahamdale Development Plan (RM of Grahamdale 2016) categorized the land base within the RM as Agriculture Restricted Areas, Agriculture Rural Areas, General Development Areas, Recreation Areas, Rural Residential Areas, and Wildlife Management Areas (WMAs). The WMAs are designated and managed by the province of Manitoba. The name, location and size of the WMAs in the RSA and LSA are shown in Appendix 2.

A large portion of the land in the RSA is designated for agricultural use. However, about 61% of the soils are rated as Class 3 due to their level of stoniness; 11% of the area is rated as Class 5 and Class 7 due to excessive stoniness and rockiness; 12% of the soils are rated as Class 6, due to wetness where soil landscapes are poorly drained and/or are more than 50% wetlands; and a further 10% of the soils are organic, and have very limited capability for agriculture (RM of Grahamdale 2016). These land and soil characteristics, coupled with the poor drainage and surface water pooling found in several areas, results in moderate to severe limitations for agriculture in the area (RM of Grahamdale 2016). As such, the majority of agricultural activities are related to cattle production, with some areas used for pastures and forage crops where the land is suitable for these practices. The RM of West Interlake cites the major products produced in the region as agricultural products, specifically grain, hay, forage seed, livestock and Pregnant Mares Urine (PMU) (RM of West Interlake 2016).

Limestone, dolomite and gypsum quarrying and processing are also important economic land use activities that take place in the RSA and LSA and are described in Section 7.2.5 of this report. As noted in Section 6.1.8, Seneca root is gathered in the area and is an important plant used for medicinal and ceremonious purposes (NLHS 2017). The majority of Seneca root for manufacture of pharmaceutical cold and cough remedies is produced in the Interlake region (NLHS 2017).

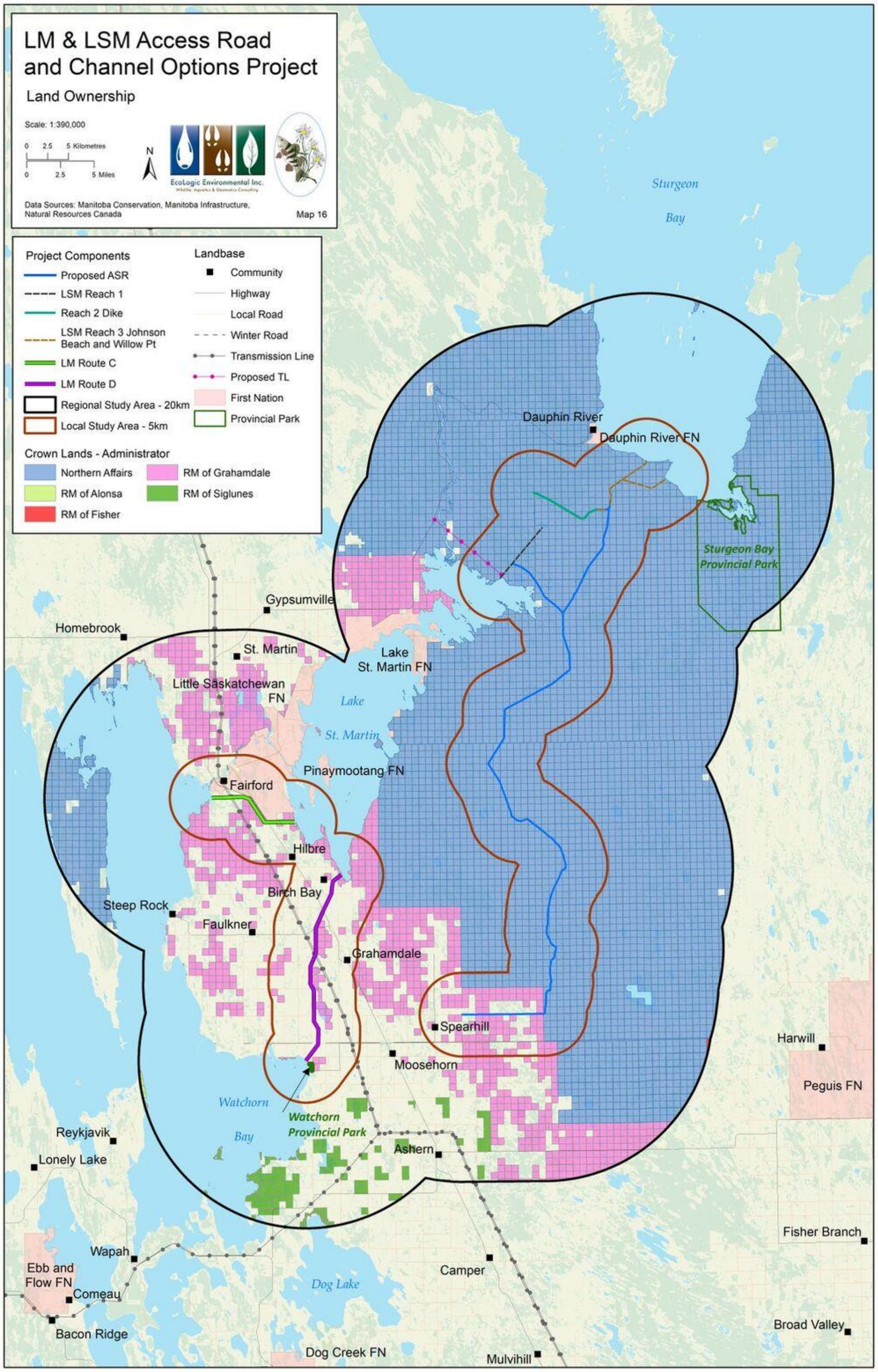
**Figure 11** shows the land ownership in the LSA and RSA. The majority of the area is Crown Lands, with the remaining areas composed of a mix of private and municipal ownership.

### 7.2.4 Infrastructure and Services

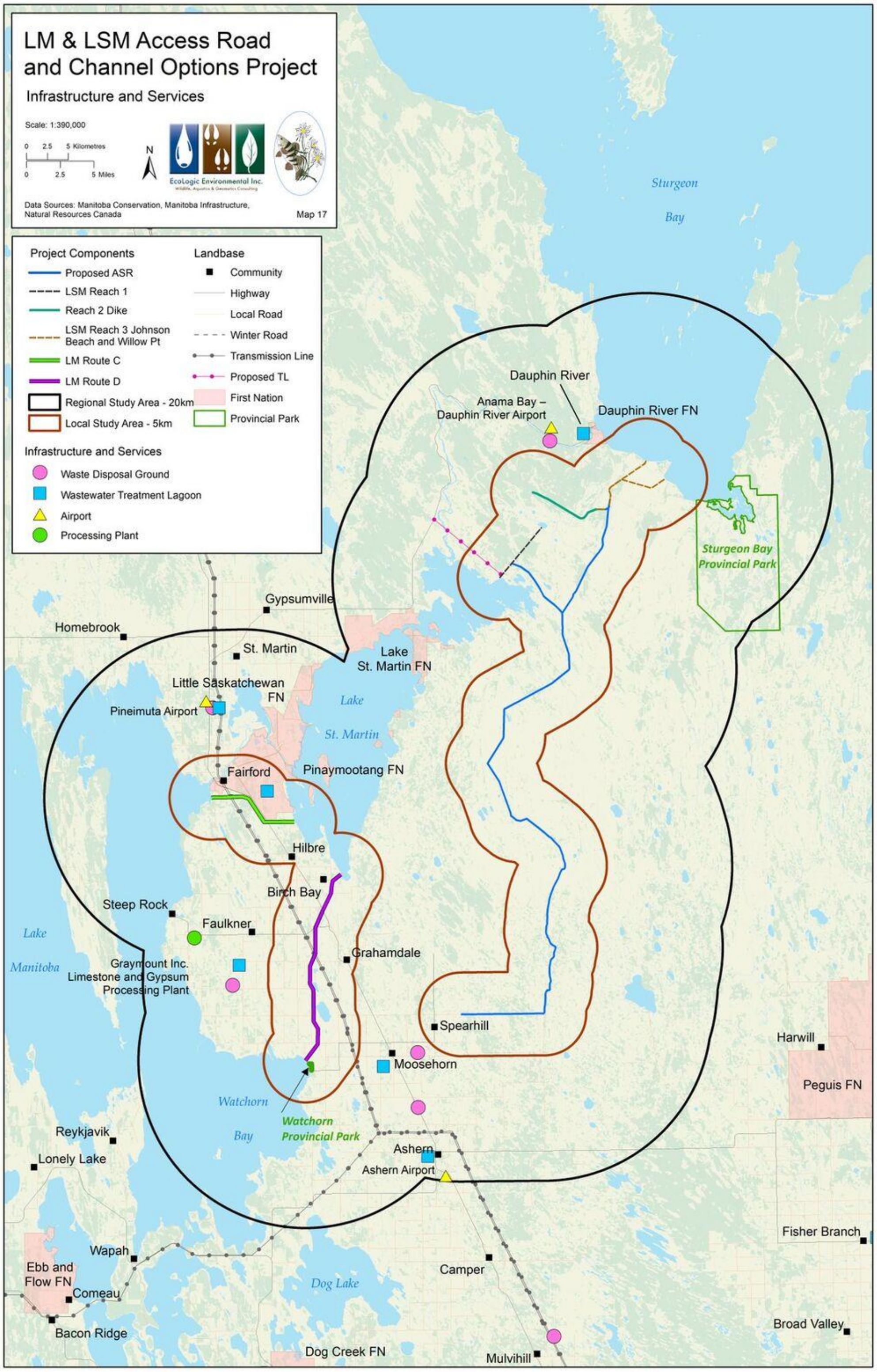
**Figure 12** provides the location of infrastructure and services in the RSA and LSA. Information on the infrastructure and services is provided below.

#### *7.2.4.1 Roads and Highways*

PTH 6 is a major road artery in the region and is the principal access to the proposed LMOC project area (**Figure 12**). PTH 6 crosses the Fairford River east of Lake Manitoba and is the connecting road for the three Provincial Roads in the RSA: PR 325 from Ashern to Hodgson; PR236 from PTH 6 to Steeprock; and PR 513, which is a paved road from PTH 6 to Gypsumville, and a gravel surface to the community of Dauphin River on the shore of Lake Winnipeg. Other roadways within the LSA consist of mostly graveled surface grid roads maintained by the municipality, and private roads of gravel or dirt.




## Figure 11: Land Ownership




## Figure 12: Infrastructure and Services

#### *7.2.4.2 Railways*

There is one rail line in the RSA that parallels PTH 6 in the RSA (**Figure 12**). The 104 km long line segment for the Warren to Steep Rock Junction route was operated by the CN Railway but was abandoned in 1997 (Transport Canada 2016). Several spur lines connected to the route were also abandoned, including the spurs to Spearhill and Steep Rock (Transport Canada 2016).

#### *7.2.4.3 Airports*

There are three airports located within the RSA at Ashern, Anama Bay-Dauphin River and Pineimuta (**Figure 12**). The Anama Bay-Dauphin River and Pineimuta airports are no longer active (Canadian Owners and Pilots Association 2016). The Ashern airport was active at the time of this writing but was not operated for nighttime flying (Canadian Owners and Pilots Association 2016).

#### *7.2.4.4 Hydroelectric Power Transmission*

Electrical services are provided to communities in the RSA by Manitoba Hydro. Transmission lines located within the RSA include a section of the Bipole I and BiPole II 500 kV lines that pass through the RSA in a RoW adjacent to PTH 6, and sections of 230 kV lines that connect the communities (Manitoba Hydro 2016) (**Figure 12**). The overall Project plans also include the potential need for additional electrical services in the LSA, shown as a 'proposed TL' that connects on the west side of Reach 1 on Figure 11 (KGS Group 2016).

#### *7.2.4.5 Pipelines*

There were no natural gas, oil, water or other pipelines identified within the RSA or LSA.

#### *7.2.4.6 Waste Disposal*

At the time of this writing, there were four waste disposal grounds located within the RSA that were in operation (RM of Grahamdale 2016; RM of West Interlake 2016). These waste disposal grounds are located in proximity to the communities of Ashern, Faulkner, Moosehorn and Pineimuta (RM of Grahamdale 2016; RM of West Interlake 2016) (**Figure 12**). There were no waste disposal grounds identified within the LSA (**Figure 12**).

Personal communications with MBSD indicated that a waste disposal ground is being constructed in the community of Dauphin River, but was not yet operational as of December 15, 2016 (K. Dorward, pers.comm., 2016).

#### *7.2.4.7 Wastewater Treatment Lagoons*

At the time of this writing, there were five wastewater treatment lagoons in operation in the RSA (RM of Grahamdale 2016; RM of West Interlake 2016) (**Figure 12**). These wastewater treatment lagoons are located in proximity to the communities of Ashern, Fairford, Faulkner, Moosehorn, and Pineimuta (**Figure 12**). The wastewater treatment lagoon within the Pinaymootang FN southeast of the community of Fairford was the only wastewater treatment lagoon identified within the LSA (**Figure 12**). Personal communications with MBSD indicated that a wastewater treatment lagoon is being constructed in the community of Dauphin River, but was not yet operational as of December 15, 2016 (K. Dorward, pers.comm., 2016). There are no wastewater treatment plants in the RSA (K. Dorward, pers.comm., 2016).

### 7.2.5 Resource Use

#### *7.2.5.1 Agriculture*

As noted in Section 6.2.3, a large portion of the land in the RSA is designated for agricultural use, but much of these lands have soil and moisture conditions that restrict some agricultural activities. Based on the LCC data calculated for the area, the predominant vegetation cover in the RSA is wetland at 43.8%, followed by water at 22.0% and grassland at 10.2% (**Table 10**; Appendix 2). Less than 2% of the land area within the RM of Grahamdale has Agricultural Suitability in Classes 1-3, i.e., the Classes that are most suited to annual crop production (Agriculture and Agri-Food Canada 1999). Agricultural classifications of annual crop and perennial crop and pasture in the LCC data account for 1.44% of the lands within the RSA and 8.25% of the lands in the LSA (**Table 10**; Appendix 2). Within the LMOC LSA, an area of about 0.21 $km^2$ or 4.46% of the land base within the proposed Route C is classified as annual crop and perennial crop and pasture, and an area of about 1.28 $km^2$ or 13.14% of the of the land base within the proposed Route D is classified as annual crop and perennial crop and pasture (**Table 10**; Appendix 2).

#### *7.2.5.2 Forestry*

The province of Manitoba manages and regulates forestry activities in Manitoba through the establishment of administrative boundaries such as Forest Management Units (FMUs) and Integrated Wood Supply Areas (IWSAs), which are used to delineate and manage harvestable timber areas and wood supply areas. FMUs within the RSA include units 41, 43, and 45, and IWSAs in the RSA includes IWSA #2 (MCWS 2013) (Appendix 2). The majority of the LSA for the proposed LMOC is in FMU 43 (Appendix 2).

#### *7.2.5.3 Lodges and Outfitters*

Map 9 in Appendix 2 shows the location of lodges and outfitters in the RSA and LSA. There were four lodges or outfitters identified: Einarsson’s Guide Service, near Dauphin River; Bear Track Outfitters, northeast of Gypsumville; Steep Rock Canoe and Kayak, at Steep Rock; and Wildwood Outfitters near Moosehorn (Appendix 2). None of these lodges or outfitters are located within the LSA. Map 9 also presents the hunting shacks and hunting camp that were identified in the RSA during field studies in 2016. There were five hunting shacks noted in the LMOC Route C LSA around the community of Hilbre, and one hunting shack noted in the LMOC Route D LSA located west of the community of Grahamdale (Appendix 2).

#### *7.2.5.4 Industry*

As noted above, the major economic sector in the region continues to be agriculture, which is focused mainly on ranching and feedlots for cattle (RM of Grahamdale 2016). Other notable industry in the RSA includes the Graymont Western Canada Inc. limestone and gypsum quarries and processing plant, which is located on PTH 239 between the towns of Steep Rock and

Faulkner, Manitoba (**Figure 12**), and provides employment for a number of local residents (Groom 2004).

#### *7.2.5.5 Quarries and Mining*

Map 10 in Appendix 2 shows the locations of quarry and mining activity in the RSA and LSA at the time of this writing. The map shows that there are many existing quarrying sites in the RSA, with the majority being quarry withdrawal activity and the remainder are quarry lease, private quarry permit, mining claims and casual quarry permits. Seven quarries adjacent to Highway 6 are past or current producers of aggregate that were opened in the late 1960s to provide material for the construction of the highway (Groom 2004) (Appendix 2). Other quarry activity within the LSA includes a quarry withdrawal and a casual quarry permit located south of the proposed LMOC Route C and the Pinaymootang FN.

Limestone, dolomite and gypsum, have been mined in the RSA since the early 1900s (Government of Manitoba 2016e, 2016h; Groom 2004; RM of Grahamdale 2016;). Materials produced from these mineral resources include building foundations and building structures, aggregate materials, cement, wallboard and Plaster of Paris (Government of Manitoba 2016e).

The Graymont Western Canada Inc. limestone and gypsum quarries and processing plant are located on PTH 239 between the towns of Steep Rock and Faulkner (**Figure 12**).

#### *7.2.5.6 Recreational Trails and Campgrounds*

Map 11 in Appendix 2 provides an overview of the recreational trails and campgrounds identified in the RSA and LSA. There were five campgrounds identified within the RSA: Benson's Big Rock Camp and Campground on the north shore of Lake St. Martin near the entrance to the Dauphin River; the Roviera Resort and Campsite at Fairford; the Steep Rock Beach Park Campsite at Steep Rock; the Elm Point Campground south of Faulkner on the east shore of Lake Manitoba; and the Watchorn Bay Provincial Park Campground located west of Moosehorn (Appendix 2). The Sturgeon Bay Provincial Park was established in 2015 and lies within the northeast section of the RSA on the western shore of Lake Winnipeg. The park is designated as a wilderness camping area and there is no road access or facilities located on park land, and there are no plans for development (MBSD 2016d).

There are many recreational and snowmobile trails located within the RSA. A spatial data layer for the known and available recreational trails was acquired from the Natural Resources of Canada, Earth and Sciences Sector, and the available snowmobile trail data were digitized from the Manitoba Provincial Snowmobile Trail Guide, 2015-2016 (www.snoman.mb.ca). In addition to the publicly available data, the trail network in the RSA and LSA was further enhanced with the digitization of access trails recorded by GPS during the 2016 winter aerial survey work. These additional access trails have been included on Map 11 in Appendix 2.

#### *7.2.5.7 Boating and Water Sports*

The lakes and large rivers in the RSA are enjoyed by residents and tourists to the area for a number of water related activities such as recreational boating, windsurfing, sailing, canoeing, kayaking, swimming and the use of jet skis. During the winter months, the frozen lakes provide access for snowmobiles and other vehicles. The proposed LMOC will have an inlet located in Lake Manitoba and an outlet to Lake St. Martin, and permanent groyne structures will be constructed at the inlet area to offset the potential transport of sediment to the channel, and reduce the effects of wind and currents in the inlet areas. These shoreline changes could affect existing water related activities and navigation in these areas. The inlet, groyne and outlet areas will need to be marked for safety reasons in accordance with Transport Canada marine regulations, including regulations under the current Navigation Protection Program (NPP). Note that the NPP is presently under review and the current federal government is taking steps to 'restore lost protections and introduce modern safeguards to the Fisheries Act and the Navigation Protection Act' (Transport Canada 2017).

#### *7.2.5.8 Commercial, Subsistence and Recreational Fishing*

Information on commercial and subsistence fishing activities in the RSA was obtained from AAE Tech Services Inc. (2016) provided as Appendix 3 to this report. Lake Manitoba and Lake St. Martin provide fisheries resources to First Nations communities, permanent and seasonal residents, tourists, farmers, and recreational and commercial fishermen within the region. Commercial, recreational and subsistence fishing takes place in the open water and winter seasons. Fish within Lake Manitoba and Lake St. Martin are an important food source to the over 10,000 on-reserve inhabitants of the eight First Nations communities located on or very near the lakes. The Lake Manitoba and Lake St. Martin fisheries provide income for First Nations, commercial fishermen, and their assistants. The most commonly captured fish species include cisco (*Coregonus artedi*), lake whitefish, northern pike, walleye, white sucker (also referred to as 'mullet') and yellow perch, although relative quantities differ between the lakes. Harvests within both lakes have fluctuated, but at reduced levels since the 1970's (Figure 3 in Appendix 3). The 362 commercial fishing licenses granted for Lake Manitoba in 2010 yielded an average income of only $4,114. However, the average total payouts per year for fish harvested from Lake Manitoba and Lake St. Martin were substantial at $1.9 million (1.1 million kilograms of fish) and $123,738 (118,459 kilograms of fish) respectively between the 1990/91 and 2011/2012 fishing seasons (LM&LSMRRC 2013). Within the LMOC LSA, commercial fishing for white suckers is also practiced in Birch Creek, Mercer Creek and Watchorn Creek during the open water season.

Some areas of Lake Manitoba, Lake St. Martin and large rivers (Dauphin, Fairford, Mantagao) in the RSA are popular recreational fishing areas with angling for freshwater drum (also referred to as silver bass), northern pike, sauger, walleye, and yellow perch, and bow fishing for carp in the spring (Benson's Big Rock Camp and Campground 2017).

#### *7.2.5.9 Hunting*

Map 12 in Appendix 2 provides an overview of the GHAs located within the RSA and LSA. The GHAs located within the RSA include GHAs 16, 20, 21 and 25. The LSA for the LMOC Route C is located within portions of GHAs 16, 20, 21 and 25, and the LSA for the LMOC Route D is located within GHAs 21 and 25 (Appendix 2).

Boreal woodland caribou (*Rangifer tarandus*) were not found to be present in the RSA or LSA; however, MBSD indicates that hunting of boreal woodland caribou is not permitted in GHA 16, 20, 21, or 25 (MBSD 2016e).

Moose are important big game animals for hunting within the RSA and LSA. Moose are valued for licensed hunting and rights-based subsistence hunting. Moose populations are in decline in some areas of Manitoba, and conservation measures such as hunting closures and access restrictions are in place in these areas (MBSD 2016e). Currently, licensed moose hunting is available in GHA 20 and GHA 21, but is closed in all of areas of GHA 16 and GHA 25 (MBSD 2016e).

Elk are valued for rights-based subsistence harvesting and licenses for recreational hunters can be purchased from MBSD during certain times of year for GHAs 20, 21 and 25 (MBSD 2016e). Season dates in these GHAs are late-September to mid-October for one bull elk in the general rifle draw and early- October to mid-October for one bull elk by general (rifle) draw. The archery draw is active in GHAs 20, 21 and 25 from early-September to mid-September.

White-tailed deer are valued for rights-based subsistence harvesting and licenses for recreational hunters can be purchased from the MBSD for Zone B, which is open to deer harvest during certain times of year for GHAs 20, 21, and 25 (MBSD 2016e). An archery season for resident, non-resident, and foreign resident hunters is open for parts of September and again in late October to early November (MBSD 2016e). A general rifle season for white-tailed deer in Zone B for resident, non-resident, and foreign resident hunters is open from early-November to mid-November (MBSD 2016e). Zone C (GHA 16) is also open to deer harvest; archery season is open to resident, non-resident, and foreign resident hunters from early-September to early November. General rifle is open for Zone C from early November to mid-November.

MBSD licenses hunters for resident, and non-resident bear hunting, along with registered outfitters for foreign resident bear hunting in GHAs 16, 20, 21, and 25 (MBSD 2016e). GHAs 16, 20 and 21 are part of black bear hunting Zone B, where licensed hunting is allowed between late April to end of June and late August to early October for one adult black bear (not female with cubs). GHA 25 is a part of Zone C where licensed hunting is allowed between late April to mid-June and then again in the beginning of September until mid-October.

MBSD licenses hunters for resident, non-resident, and foreign resident wolf hunting in GHAs 16, 20, 21, and 25 (MBSD 2016e). GHAs 16, 20 and 21 are part of grey wolf and coyote Zone B for licensed-based hunting between late August and late March for one wolf. GHA 25 is a part of Zone C for grey wolf and coyote season between the same dates. Coyotes have been designated for recreational hunting by MBSD and licenses for hunters can be purchased for certain dates in these four GHAs (MBSD 2016e).

GHAs 16, 20, 21 and 25 are a part of Game Bird Hunting Zone 3 (GBHZ3), which has a grouse (ruffed grouse [*Bonasa umbellus*], spruce grouse, and sharp-tailed grouse [*Tympanuchus phasianellus*]) hunting season between the beginning of September and mid-December with a possession limit of 12 birds (MBSD 2016e). Other birds that can be hunted within GBHZ3 include ducks such as mallard (*Anas platyrhynchos*), coots such as American coot (*Fulica americana*), snipe, such as the common snipe (*Gallinago gallinago*), geese such as the Canada goose (*Branta canadensis*), and sandhill crane (*Grus canadensis*).

MBSD also enforces vehicle restrictions to increase the quality of the hunting experience, decrease illegal hunting from vehicles, and provide undisturbed areas for big game animals (MBSD 2016e). Vehicles may not be used while hunting white-tailed deer, elk or moose except to travel to or from a hunting area, or to retrieve a kill by the most direct route (MBSD 2016e). GHA 16 lies within the 'Northern Zone', and therefore the use of off-road vehicles (ORVs) as transportation from one hunting site to another is allowed. GHAs 20, 21, and 25 lie within the 'Roads, Trails and Waterways Zone', where all vehicles operated by white-tailed deer, elk or moose hunters are restricted to roads, established trails and waterways. For example, an ORV may be used to access a hunting area along an established trail, but hunters may not establish their own trails or venture off existing trails (MBSD 2016e).

#### *7.2.5.10 Trapping*

Commercial trapping of furbearers is administered by MBSD through the Registered Trap Line (RTL) system (MBSD 2016f). The RSA lies within the Interlake RTL district (Trapping Area 7), and intersects a portion of the Crane River RTL on the west side of the RSA, and a portion of the Gypsumville RTL in the north-central area of the RSA (Appendix 2). The remainder of the RSA, as well as the entire LMOC LSA, is part of Open Trap Area #3 (MBSD 2016f).

Animals trapped within the RSA include badger, beaver, coyote, cross fox, fisher, lynx, marten, mink, muskrat, otter, raccoon, red fox, squirrel, weasel, and wolf (Appendix 2). MBSD tracks trapping production in the RTLs, but does not track production within an open block (Appendix 2). Additional information on trapping within the RSA and LSA is provided in Appendix 2.

### 7.2.6 Protected Areas

Manitoba's Protected Areas Initiative is a government program developing and managing land to protect Manitoba's enduring features and biodiversity, in terrestrial, marine and freshwater environments (MBSD 2016g). Protected areas fall under several designations and levels of protection including Areas of Special Interest (ASIs), Ecological Reserves, Parks and Park Reserves, and Wildlife Management Areas (WMAs) (MBSD 2016g). Map 7 in Appendix 2 provides the location and size of the ASIs, Ecological Reserves, Parks and Park Reserves, and WMAs in the RSA and LSA.

Within the area of the RSA, there are six land areas designated as ASIs: Lynx Bay ASI, Sturgeon Bay ASI, Gypsum Lake ASI, and Idylwild ASI. The Sturgeon Bay ASI is composed of three parcels (Appendix 2). The Reindeer Island Ecological Reserve is located north of Sturgeon Bay in Lake

Winnipeg, but is not part of the RSA. There are two Provincial Parks located within the overall Project RSA, the Sturgeon Bay Provincial Park and the Watchorn Bay Provincial Park.

There are six WMAs in the RSA: Grahamdale WMA, located northeast of Grahamdale; Hilbre WMA, located west of Hilbre; Little Birch WMA, located southeast of Ashern; Mantagao Lake WMA, located east of Spearhill; Moosehorn WMA, located southwest of Moosehorn; and Peonan Point WMA, located northwest of Steep Rock (Appendix 2).

The protected areas within the LMOC LSA include Watchorn Provincial Park and parts of the Hilbre WMA and (Appendix 2).

### 7.2.7 Culture and Heritage Resources

The "*Heritage Resources Characterization Study: Lake Manitoba Outlet Channel Route Options*" (NLHS 2017) is provided as Appendix 4 to this report. A baseline overview of the cultural history of the RSA and the LSA was undertaken to provide the heritage resources information for the LMOC Project. Attention was given to heritage resources protected under The *Manitoba Heritage Resources Act* (Government of Manitoba 1986) (The Act) as well as human remains, which are further protected by Manitoba's Policy Concerning the Reporting, Exhumation and Reburial of Found Human Remains (Government of Manitoba 1987). The Policy refers to burials and found human remains that occur outside of registered cemeteries.

Existing data for the region were reviewed prior to field studies to gain an understanding of the area and provide information to focus the field studies on sites and/or areas in need of investigation. Three main sources of information were reviewed: the archaeological and historical records and, where possible, accessible sources of Aboriginal Traditional Knowledge (ATK). Ground and aerial based field studies were carried out in the RSA and LSA in the summer of 2016. A summary of the findings from the desktop and field studies is provided below. Additional information on the archaeological record, historical record and available ATK for the RSA and LSA is provided in Appendix 4.

#### 7.2.7.1.1 Archaeological Record

The archaeological record of Manitoba contains evidence of First Peoples dating to 10,000 years ago in southwestern Manitoba, with gradual movement into the interior following deglaciation and dewatering of glacial Lake Agassiz. The overall archaeological record for the RSA is not well documented, mainly due to lack of research. However, the record of the surrounding area indicates that ancient people could have been present in the vicinity probably by 7,000 years ago. The earliest occupation in this area appears to be associated with the Archaic cultural period circa (ca.) 5,000 to 4,000 years ago, although there is the possibility of earlier occupation by Plano culture.

The Provincial Archaeological Site Inventory for the RSA noted that only six registered archaeological sites were documented (**Figure 13**).

Four of the sites were identified as historic period and included fur trade and homestead influence; the two remaining sites were identified as Middle to Late Woodland Period (ca. 2,000 to 350 years ago), based on the stone tools and Native ceramics. Five of the sites are located within or adjacent to the Pinaymootang FN lands, with four of these sites located in the LMOC Route C LSA (**Figure 13**). The sixth site is located within the Dauphin River FN lands outside of the LMOC LSA (**Figure 13**). A review of the Provincial designated sites and commemorative plaques indicated that there were no Provincial commemorations within the RSA. However, a private plaque was noted to have been erected commemorating Spear Hill at some time in the past. The location of the plaque requires verification since it is noted by the Heritage Resources Branch records to be on the southwest shore of Lake St. Martin; however, Spear Hill is located some 30 km to the southeast of this area.

The low number of archaeological sites is not reflective of the pre-European and historic periods of the study area, but rather shows that little or no archaeological studies have taken place throughout this area. For this reason, the search for baseline data was expanded to include areas immediately north and south of the RSA. **Figure 14** provides a map of the known archaeological sites and heritage resources that extend east and south of the RSA to LM Narrows and the former municipality of Siglunes.

The expanded desktop review revealed a number of additional archaeological sites and heritage resources in the region, including Campsites and Palaeontological sites located south of Watchorn Provincial Park in the RSA, a Workshop located northeast of Steeprock in the RSA, and an Uninterpreted site in the LMOC Route D LSA (**Figure 14**). The Bayton St. Thomas Lutheran Cemetery is also located in the LMOC Route D LSA on Bayton Road about 1.3 km southwest of Reed Lake; this cemetery is located about 100 m from the west side of the proposed LMOC Route D RoW, and about 3 km south of the Uninterpreted archaeological site.

In 1984 and 1985, an archaeological field study was carried out by the Historic Resources Branch for the Western Interlake Planning District (Siglunes, St. Laurent, Coldwell and Eriksdale) (Riddle, 1985; Riddle and Pettipas 1992). Throughout the course of the study, 46 archaeological sites were identified. Thirteen of these sites were found inland away from water and consisted of stone tools and tool- making stone waste, indicating hunting in the interior regions; the remaining sites were located on the Lake Manitoba shore. The majority of the sites were associated with the Middle and Late Woodland periods (ca. 2,000 to 350 years ago) when native pottery was a signature part of the artifact assemblage.

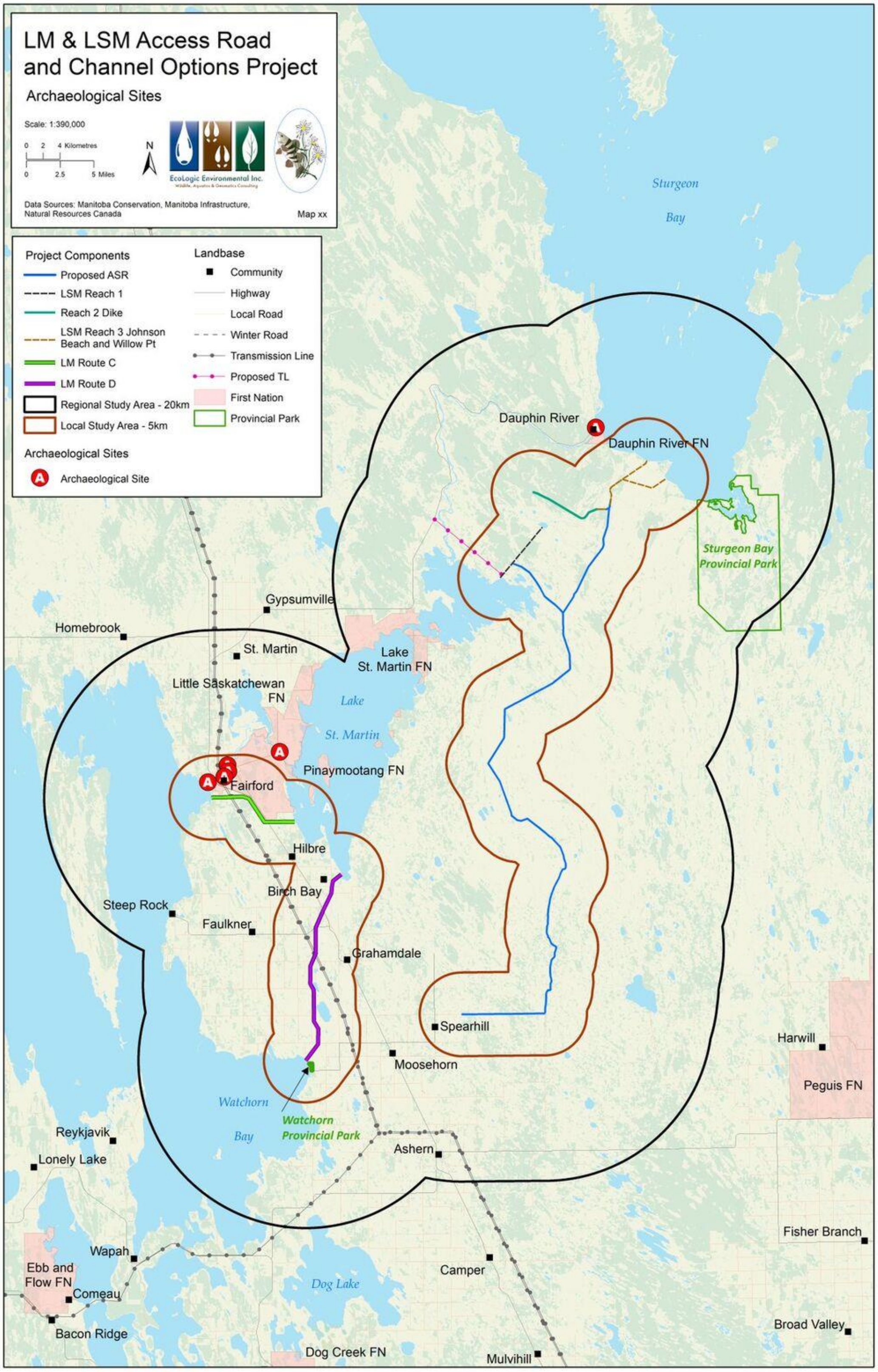



**Figure 13: Map of Known Archaeological Sites within the Regional Study Area**

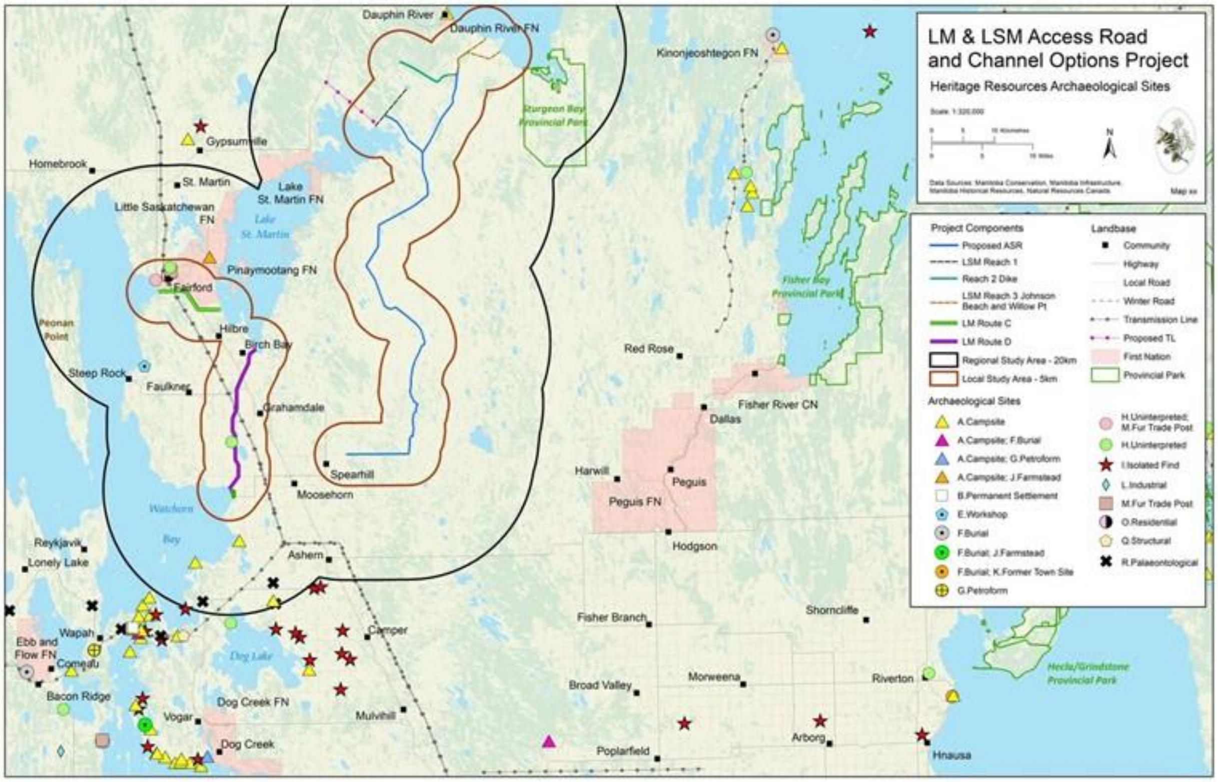



**Figure 14: Map of the Known Archaeological Sites and Heritage Resources That Extend to Lake Manitoba Narrows and the Former Municipality of Siglunes**

Later, under the supervision of Petch (1994), an analysis of the ceramics recovered from the Bensa Tanki Site (EfLq-04) in 1984 was completed by Moravetz and Jezik (1994). This analysis provided interesting Pre-European contact connections between the east side of Lake Winnipeg and Lakes Manitoba and Winnipegosis based on comparison of selected metric and non-metric attributes. Ceramics related to a tradition called Blackduck appear to have spread across north-central Manitoba from the Lake of the Woods area.

According to Moravetz and Jezik (1994), 35 unique motifs representing 49 separate vessels were present in the Bensa Tanki collection. Attributes of lip/rim shape, design elements and presence/absence of punctates contributed to the overall motif.

In 2000, Northern Lights Heritage Services (NLHS) conducted a field study of the Fairford River between Lake Manitoba and the bridge crossing at the Fairford Reserve. Four new archaeological sites were registered and one formerly recorded site was revisited. These sites are noted in Table 1 of Appendix 4 as EjLq-2,3 & 4 and EjLp-1. One site, ElLm-1, was not visited as it was outside the study area of the project.

During HRIA and monitoring of installation of fibre-optic cable between Ashern, Manitoba and Dauphin, Manitoba at The Narrows, approximately 32 km southwest of Ashern, three archaeological sites were identified by NLHS (NLHS 2006). Ceramics representing Middle and Late Woodland periods were recovered. Further, several kilometres west of The Narrows, a Thunderbird Nest is located near the north-west shore of Lake Manitoba. This area is actively used by the local First Nations (Petch, personal observation).

#### 7.2.7.1.2 Historical Record

The Interlake was not habitable until at least 8,000 BP[1] or at the time that glacial Lake Agassiz had diminished to the extent that successional vegetation and wildlife were established. Immediately following the drainage of glacial Lake Agassiz, other processes were also taking place. The retreat of the glaciers caused rebound of the land that had been hard pressed for thousands of years. This isostatic process, plus the slope/tilt of the land, played havoc with early drainage patterns. The Manitoba Great Lakes changed in size and shape until today's present configuration. These processes had great bearing on the movement of early human inhabitants, as noted on the series of Holocene evolution of the lakes (Figure 2 in Appendix 4). It is worth noting the large mesa-like feature that has persisted from the first post glacial Lake Agassiz phase (7,700 BP) to the present (Mataille et al. 1996). Known locally as "Big Ridge" (Richtik 1964), the feature rises 62 m above Lake St. Martin with the highest point of the post-glacial ridge recorded as 306 masl. This prominent attribute may have been an important landscape feature. Hind (1971) noted occasional spring flooding at Lake St. Martin that occasionally forced people to seek temporary relief on higher lands. This relief may have included refuge along the most dominant landscape feature in the area. Ancient and recent traditional camps may have been established in some of the interior pockets such as the limestone "Big Ridge" and other outcrops, and may contain important cultural and heritage information regarding former land use patterns.

Given that the altithermal warming some 7500-5000 years ago would have elicited a much different environment, and given that two lakes called Big and Little Buffalo drain into Buffalo Creek, there is a strong possibility that bison hunting occurred in this area. One could expect to find former "ancient bison" *(Bison antiquus*), American bison (*Bison bison*) and more recent Plains bison *(Bison bison bison)* faunal remains and perhaps bison kill and butchering sites in and around the ridge and lakes.

Small pockets of Seneca root may be found in some of the drier areas. Seneca root is a ubiquitous plant found throughout the Interlake. Seneca root grows profusely in dry areas and is a source of traditional medicines and cash economy for local First Nation and Métis. In the past, it was most likely an item traded at the Mandan and Shoshone Rendezvous, in which much of pre-European Native Americans participated. The Interlake produces the majority of Seneca root for manufacture of pharmaceutical cold and cough remedies. Other herbs and plants contribute to a small, local medicinal practice.

[1] BP is Before Present. The year 1950 marks the beginning of this time scale, which was established at the time of C-14 dating.

#### 7.2.7.1.3 Available Traditional Knowledge

The sources found for available Traditional Knowledge within the RSA included Ballard's [Traverse] MA Thesis (1999) and PhD Dissertation (2012), which provide important traditional knowledge from the Lake St. Martin First Nation that is relevant to the regional and local study area. Ballard speaks to certain general areas where resource use occurs. Both her studies were related to the changing water regimes caused by the Fairford Dam and the 2011 flooding of Lake St. Martin. This, plus anecdotes such as from Warms (2001), Russenholt (n.d.) and Hind's descriptive narration (1971) provide evidence of an active and varied resource base and local First Nations had a seasonal round (i.e., travel to places for hunting, fishing, medicinal and edible plants and other resources and during the different seasons of the year) that would span distances of over 160 km. Anecdotal information was provided by John Warms (2001) regarding the history of local hideouts of the escaped convict Percy Moggey in 1960. Areas of Seneca root digging by local First Nations were identified to have occurred in the Spearhill area. This location is verified by Turcotte's 1997 thesis *Towards Sustainable Harvesting of Seneca Snakeroot (Polygala senega L.) on Manitoba Hydro Rights-of-Way* where the area in the vicinity of Spear Hill is also identified as an area of distribution (Turcotte 1997).

The vulnerable ram's head lady's slipper (*Cypripedium arietinum* R. Br), a member of the Orchidae family, is known to grow within the RSA. Roots of various orchids are known to have been used in "…North America both by indigenous and immigrant peoples for their sedative and antispasmodic properties and to counter insomnia and nervous tension. …" (Wilson 2007). Densmore (1928) also noted that the Anishinaabeg of the Rainy River area used *Cypripedium* spp. roots both as an infusion and mixed with food, depending on the nature of the illness. Hutchens (1991) also noted the medicinal properties of *Cypripedium* spp. in combination with other plants. The ram's head lady's slipper may have been used locally for these medicinal purposes.

Cranberries were noted by Hind (1971) to occur at the mouth of Big Buffalo Creek. Other inland areas with similar properties may exist in the area around the northeast portion of the forestry road and the access roads. Cranberries were an important emergency winter food; the twig tips were also chewed to treat sore throat, cold sores and teething. The tea is also used as a blood purifier, to reduce urinary tract infections and a variety of female ailments (Marles et al. 2000). Fishing appears to have been mainly associated with the large lakes and main rivers; however, if inland spawning areas were known, there is a potential for stone weirs to be present.

### *7.2.7.2 Culture and Heritage Resources Summary*

A baseline overview of the culture history of the study area was undertaken to provide the background heritage resources information for the Project in preparation for a HRIA. Attention was given to heritage resources protected under The Manitoba Heritage Resources Act (Government of Manitoba 1986) as well as human remains, which are further protected by Manitoba's Policy Concerning the Reporting, Exhumation and Reburial of Found Human Remains

(Government of Manitoba 1987). The Policy refers to burials and found human remains that occur outside of registered cemeteries.

Existing data for the region were reviewed prior to field studies to gain an understanding of the area and provide information to focus the field studies on sites and/or areas in need of investigation. Three main sources of information were reviewed: the archaeological and historical records and, where possible, accessible sources of ATK.

The Provincial Archaeological Site Inventory for the RSA noted six registered archaeological sites. Four of the sites were identified as historic period and included fur trade and homestead influence; the two remaining sites were identified as Middle to Late Woodland Period (ca. 2,000 to 350 years ago), based on the stone tools and Native ceramics. Five of the sites are located within or adjacent to the Pinaymootang FN lands, with four of these sites located in the LMOC Route C LSA. The sixth site is located within the Dauphin River FN lands within the overall RSA and outside of the LSMOC and ASR LSA (**Figure 13**). A review of the Provincial designated sites and commemorative plaques indicated that there were no Provincial commemorations within the RSA. However, a private plaque was noted to have been erected commemorating Spear Hill at some time in the past. The location of the plaque requires verification since it is noted by the Heritage Resources Branch records to be on the southwest shore of Lake St. Martin; however, Spear Hill is located some 30 km to the southeast of this area.

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The expanded desktop review revealed a number of additional archaeological sites and heritage resources in the region, including Campsites and Palaeontological sites located south of Watchorn Provincial Park in the RSA, a Workshop located northeast of Steeprock in the RSA, and an Uninterpreted site in the LMOC Route D LSA (**Figure 14**). The Bayton St. Thomas Lutheran Cemetery is also located in the LMOC Route D LSA on Bayton Road about 1.3 km southwest of Reed Lake; this cemetery is located about 100 m from the west side of the proposed LMOC Route D RoW, and about 3 km south of the Uninterpreted archaeological site.

The general archaeologic and historic records for the study area indicate human occupation over the past 8000-7000 years. Within the RSA and LSA, minimal archaeological field research has occurred only along a portion of the Fairford River, leaving the impression that the land was never used. However, the archaeological record to the immediate south in the Siglunes and The Narrows area confirms occupation by First People at least by 5000 years ago. Increased seasonal occupation is apparent by the presence of numerous Middle and Late Woodland Sites (ca. 2000-

350 BP) found around the RSA. The Woodland traditions are considered to be the ancestors of today's Cree and Anishinaabeg (Ojibwa).

The history of the general study area, as recorded in archival and other documents reviewed, is concerned mainly with the chronology of facts such as European exploration, the historic First Nations and early European settlement, and is focussed on the waterway between Lake Manitoba and Lake Winnipeg and the lands immediately adjacent. The record takes into account fur trade, historic First Nations and immigrant settlements and homesteads. It does not address potential heritage resources associated with the footprints of the proposed LMOC.

The available oral history is found in the thesis and dissertation of Ballard (nee Traverse) (Ballard 1999; 2012) for the Lake St. Martin First Nation, which suggests traditional use of areas within the RSA and LSA. Available TK indicated the use of plants such as cranberries, ram's head lady's slipper and Seneca root by local First Nations for medicinal purposes.

The lands between LM and LSM are low and wet and have been modified by agriculture, ranching, transmission lines and roads. As such, the LMOC study area was considered to be of low potential for archaeological sites. An Uninterpreted site in the LMOC Route D LSA was the only archaeological site identified within the LMOC Route D LSA (**Figure 14**). The Bayton St. Thomas Lutheran Cemetery is also located in the LMOC Route D LSA on Bayton Road about 1.3 km southwest of Reed Lake; this cemetery is located about 100 m from the west side of the proposed LMOC Route D RoW, and about 3 km south of the Uninterpreted archaeological site. The presence of hunting cabins in areas around Hilbre and west of Grahamdale in the LMOC LSA observed during field studies indicated ongoing resource harvesting by local residents.

ATK data to be collected and collated by MI for the EIA can be integrated with the existing information on Culture and Heritage Resources in the RSA and LSA and provide further context for the study and future EIA process.

Heritage resources are often buried beneath the ground surface. It is important to understand that there is potential for heritage resources to be discovered during construction activities. Therefore, a Heritage Resources Protection Plan should be prepared that will provide guidance to contractors and equipment operators should artifacts or human remains be unearthed. If heritage resources are found during construction, activity at that location must stop immediately and the project archaeologist contacted. If human remains are exposed during construction, activity at that location must stop immediately and the RCMP and Historic Resource Branch contacted immediately (Manitoba's Policy Concerning the Reporting, Exhumation and Reburial of Found Human Remains 1987), and the Project archaeologist will also be informed.

### 7.2.8 Human Health and Safety

The EIA process includes the assessment of potential project activities that could be linked to potential effects on human health and safety. For the proposed LMOC project, the potential project activities that could be linked to effects on human health and safety include:

- GHG emissions;
- Vehicle and equipment emissions;
- Vehicle and equipment noise and vibration;
- Changes to soil, vegetation, groundwater or surface water quality or quantity;
- Changes to the quality and/or contaminant uptake of trapped, captured or hunted fish and wildlife consumed by local residents and tourists;
- Changes to traffic patterns and/or access to homes, services or recreational areas;
- Alteration or loss of natural areas, recreational areas, or Protected Areas; and
- Alteration or loss of archaeological, historical or Heritage Resources.

The potential linkages between project activities and human health and safety will be examined as part of the EIA for the Project.

# 8 CLOSURE

We trust that the above information meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

Sincerely,

Maureen Forster, MSc., EP – Fisheries and Wildlife
M. Forster Enterprises

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## 9.1 Personal Communications

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# Appendix 1: Vegetation Technical Report

# Appendix 2: Wildlife Technical Report

# Appendix 3: Aquatics Technical Report

# Appendix 4: Heritage Resources Technical Report