LAKE MANITOBA
LAKE ST. MARTIN

OUTLET CHANNELS PROJECT

MANITOBA INFRASTRUCTURE

Revegetation Management Plan

November 10, 2020

Manitoba

TABLE OF CONTENTS

List of Tables

List of Figures

DISCLAIMER

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

PREFACE

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

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

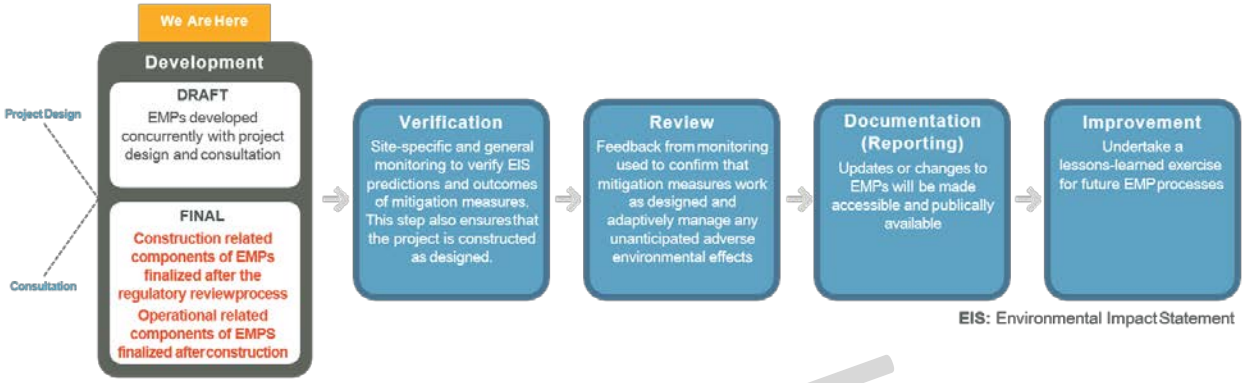
Manitoba Infrastructure remains committed to ongoing engagement and consultation with Indigenous groups and other stakeholders that are potentially impacted by the Project. Detailed EMP review discussions have been incorporated into community-specific consultation work plans and additional engagement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

The EMP provides the overarching framework for the Construction Environmental Management Program (CEMP) and the Operation Environmental Management Program (OEMP), which will be finalized as separate documents prior to Project construction and ideally operation, respectively. Their finalization will consider applicable conditions of *The Environment Act* Licence and associated approvals, any other pertinent findings through the design and regulatory review processes and key relevant outcomes of the ongoing Indigenous and public engagement and Consultation processes.

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

ENVIRONMENTAL MANAGEMENT PROGRAM PROCESS AND ASSOCIATED ENVIRONMENTAL MANAGEMENT PLANS

Environmental Management Program (EMP) Process



EIS: Environmental Impact Statement

EMPs

- Construction Environmental Management Program[1]
- Operational Environmental Management Program[1]
- Environmental Protection Plan
- Project Environmental Requirements
- Access Management Plan
- Quarry Management Plan
- Surface Water Management Plan
- Ground Water Management Plan
- Revegetation Management Plan
- Biosecurity Management Plan
- Dust Control Plan
- Decommissioning Plan
- Ice Management Plan

[1]Includes information on waste management, hazardous materials management, debris management, emergency response, heritage resources protection and wildlife protection planning

LAKE MANITOBA
LAKE ST. MARTIN
OUTLET CHANNELS PROJECT

GLOSSARY OF TERMS AND ACRONYMS

Acronyms

%	Percent
cfs	Cubic feet per second
cm	Centimeter
cms	Cubic meters per second
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EA	Environmental Assessment
EDDMapS	Distribution Mapping System
EDRR	Early Detection and Rapid Response (with respect to weed management)
EIS	Environmental Impact Statement
EMP	Environmental Management Program
EOC	Emergency Outlet Channel
ft	Foot
IDF	Inflow Design Flood
ISCM	Invasive Species Council of Manitoba
IVM	Integrated Vegetation Management
km	Kilometre
LMOC	Lake Manitoba Outlet Channel Project
LSMOC	Lake St. Martin Outlet Channel Project
m	Metre
MBCA	*Migratory Birds Convention Act*
MBCDC	Manitoba Conservation Data Centre
MESEA	Manitoba Endangered Species and Ecosystems Act
MI	Manitoba Infrastructure
NIR	Near-infrared (related to satellite imagery)
NWA	*Noxious Weeds Act*
PR	Provincial Road

PTH	Provincial Trunk Highway
ROW	Right of Way
RVMP	Revegetation Management Plan
SAR	Species at Risk
SARA	*Species at Risk Act*
SMP	Sediment Management Plan
SOCC	Species of Conservation Concern
sp.	Species, one
spp.	Species, more than one
SWMP	Surface Water Management Plan
WCS	Water Control Structure

Glossary of Terms

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

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

Critical habitat: The resources and environmental conditions required for persistence of local populations of listed wildlife species throughout their current distribution in Canada.

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

Invasive plant species: Plants that are growing outside the country or region of origin and outcompeting or replacing native plant species.

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

Noxious weed: A plant that is harmful to the environment or animals and is designated as a tier 1, tier 2 or tier 3 noxious weed in the regulations of the *Manitoba Noxious Weeds Act* and includes the seed of a noxious weed, whether it is still attached to the noxious weed or is separate from it.

Quarry: An open excavation or pit from which stone, gravel or sand is obtained by digging, cutting or blasting.

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

(Revegetation) Site Preparation: Activities such as surface roughening, decompaction, and topsoil placement to prepare the surface for seeding, planting or foster natural regeneration.

Species at Risk: Species that are listed, tracked and protected under the Species at Risk Act.

Species of Conservation Concern: Species in addition to species at risk (SAR) that are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); for listing under SARA) as special concern, threatened, or endangered (Government of Canada 2019a) or those listed by the Manitoba Conservation Data Centre (MB CDC) as provincially rare (i.e., S1 or S2 rankings; MB CDC 2018).

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

Wetland: Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by the formation of water altered soils, growth of water tolerant vegetation, and various kinds of biological activity that are adapted to wet environments (National Wetlands Working Group 1988).

Part 1: Introduction

1.0 PURPOSE AND SCOPE

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

The purpose of the RVMP is to outline measures that will be used to establish vegetation in areas impacted by the Project. The Project will result in clearing and grubbing for the excavation of the LMOC and LSMOC, local drainage construction, and road construction/realignment. Revegetation will be conducted in disturbed areas of the Project as a key component of the Sediment Management Plan (SMP) as well as monitoring for vegetation response adjacent to Project.

The following sections of the RVMP have been developed to provide direction on the methods and processes involved in establishing long-lived perennial vegetative cover across the LMOC and LSMOC right-of-way (ROW). Revegetation using native plant species will provide long-term erosion and sediment control for the site, while also helping to mitigate the potential impacts of the Project on adjacent natural vegetation and plant communities.

The RVMP addresses all Project phases. RVMP activities during early phases of construction will include weed management, seed collection, coarse woody debris management and temporary revegetation of soil stockpile. Permanent re-vegetation activities will begin as soon as possible after finished grades are established.

The RVMP is intended to be a living document that will be refined over the life of the Project and will be updated as preliminary and detailed design advances, incorporating applicable engagement feedback provided via regulatory review of the Environmental Impact Statement (EIS), landowners and/or Indigenous Groups. At present, this document has been prepared to facilitate MI's consultations with stakeholders and Indigenous groups.

Different revegetation management strategies are required for the LMOC and the LSMOC as these distinct components of the Project are located in significantly different land use settings. The LMOC, for example, is located in a well-developed agricultural area, whereas the LSMOC is located in an undeveloped wetland and forested area. Furthermore, the strategies for revegetation site preparation, weed management and monitoring differ between the two channels as their specific designs affect how revegetation prescriptions are implemented. Given these overarching site-specific differences, the RVMP is organized into three parts:

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

The RVMP includes revegetation prescriptions for areas disturbed due to road realignment and the areas of the Channel ROW above the waterline including:

- the dikes and spoil berms
- temporary topsoil stockpiles
- channel side areas
- outside drains
- within the channel ROW temporary project support ancillary features (such as construction laydown areas)

The RVMP also identifies site characteristics, activities during construction and operation, monitoring requirements and adaptive management strategies. A detailed RVMP will be developed during the detailed design stage as the Project progresses. The RVMP considers environmentally sensitive features and species at risk (SAR).

Through establishing a vegetation cover, the RVMP also supports the Surface Water Management Plan (SWMP), Sediment Management Plan (SMP), Biosecurity Management Plan, Wetland Compensation Plan and Wildlife Management Plan (WMP).

2.0 OBJECTIVES

The RVMP for the Project will be implemented as one of the plans associated with the Environmental Management Program (EMP), as described in Section 3.7 of the EIS.

The objectives of the RVMP are as follows:

- establish self-sustaining permanent plant cover
- provide erosion and sediment control
- control the spread of invasive plant species along the channel and into adjacent environments

The RVMP provides a process to track revegetation progress, to monitor for environmental compliance, and to identify deficiencies and requirements for remedial planting work. Long-term vegetation monitoring and management requirements will be developed as part of an operations and maintenance plan (to be developed). The RVMP also provides monitoring requirements for potential effects to the vegetation adjacent to the channel to identify project-related changes to vegetation species diversity.

3.0 RELEVANT LEGISLATION AND GUIDELINES

This section outlines the legislation and guidelines that are considered relevant to the revegetation work for the Project. The RVMP considered the following legislation and guidance in developing design and monitoring program.

3.1 Provincial Seed Mix Guidance

Manitoba Infrastructure (MI) has shared generally accepted vegetation practices and regional seed mixes used on past highway projects. These seed mixes were reviewed and where applicable (e.g., realignment of PR 239) were considered or applied in the revegetation prescriptions.

3.2 Weed Management

The control of non-native invasive plant species is regulated in Manitoba by the *Noxious Weeds Act*. This act lists 90 regulated non-native invasive plants across three tier designations (Appendix 1A):

- Tier 1 species must be destroyed or eradicated immediately upon discovery.
- Tier 2 species are already established in Manitoba and have been observed to spread easily.
- Tier 3 species are all other designated species that do not require immediate control unless the spread of the occurrence poses a threat to the economy, environment, or the wellbeing of residents.

This legislation provides guidance on what species need to be treated, reporting and forms of acceptable treatment. The weed management listed in this document is written to be compliant with the current Act and will be updated during the life of the Project.

3.3 Wildlife Considerations

There are four wildlife related Acts that affect the RVMP. The project intersects habitat that supports species at risk (SAR) that are regulated under the *Species at Risk Act* (SARA). The legislation provides a framework to facilitate recovery of species listed as threatened, endangered, or extirpated and to prevent species listed as special concern from becoming threatened or endangered. The SARA provides protection for both SAR and their critical habitat by prohibiting: 1) the killing, harming, or harassing of endangered or threatened SAR (Sections 32 and 36); and 2) the destruction of critical habitat and endangered or threatened SAR (Sections 58, 60, and 61; Government of Canada 2002). Threatened and endangered ecosystems and plant and animal SAR in Manitoba are protected under Manitoba's *Endangered Species and Ecosystems Act* (MESEA). The MESEA facilitates the management and development of recovery strategies for threatened, endangered, and extirpated or extinct species to prevent further declines and promote recovery. MESEA-listed species are those that, "are of ecological, educational, aesthetic, historical, medical, recreational and scientific value to Manitoba and the residents of Manitoba" (Government of Manitoba 2015, 2019). Revegetating suitable areas

of the Project for wildlife habitat has been considered in the selected prescriptions of plant species as well as monitoring wildlife habitat adjacent to the Project.

Migratory birds, including nests and eggs, are protected under the *Migratory Birds Convention Act, 1994* (MBCA). Relative to the Project, protection is afforded to all native bird species, except for American white pelican (*Pelecanus erythrorhynchos*), double-crested cormorant (*Phalacrocorax auritus*), upland gamebirds, raptors, belted kingfisher (*Megaceryle alcyon*), owls, corvids, and icterid blackbirds (Government of Canada 1994). The *Wildlife Act* provides general provisions for regulating the activities relating to the take and trade of wild animals in Manitoba. A “wild animal" is defined as “an animal or bird of a species or type listed in Schedule A or declared by the regulations to be a wild animal”, and includes select amphibian, reptile and mammal species and most bird species (including those not protected under the *Migratory Bird Convention Act*) known to exist in Manitoba (Government of Manitoba 2000). The *Wildlife Act* includes protection for bird species not already afforded protection under the MBCA (Schedule A, Division 6), and as such, all bird species in Manitoba are considered protected by law. These two acts influence mitigation of vegetation clearing effects on avian habitat via scheduling to avoid nesting periods and/or confirming the absence of nests prior to construction activities. Bird nesting habitat considerations are also incorporated into revegetation prescriptions through prescription of suitable plant species and, where feasible, snag installment to support nesting of species such red headed woodpecker (*Melanerpes erythrocephalus*).

4.0 REFERENCES

Government of Canada, 1994. Migratory Birds Convention Act. Available from http://laws-lois.justice.gc.ca/eng/acts/m-7.01/.

Government of Canada, 2002. Species at Risk Act. Available from http://laws-lois.justice.gc.ca/eng/acts/s-15.3/FullText.html.

Government of Manitoba, 2000. The Wildlife Act. Available from https://web2.gov.mb.ca/laws/statutes/ccsm/w130e.php.

Government of Manitoba, 2015. The Endangered Species and Ecosystems Act. Available from https://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php.

National Wetlands Working Group, 1988. Wetlands of Canada. Sustainable Development Branch, Environment Canada, Ottawa, ON and Polyscience Publications Inc., Montreal, QC.

SG Environmental Services Inc. (SG Environmental). 2016. Lake Manitoba Outlet Channel Route Options Vegetation Technical Report. Prepared for M. Forester Enterprises and Manitoba Infrastructure. Final report, 12 December 2016.

Part 2: Lake Manitoba Outlet Channel

5.0 PROJECT INFORMATION

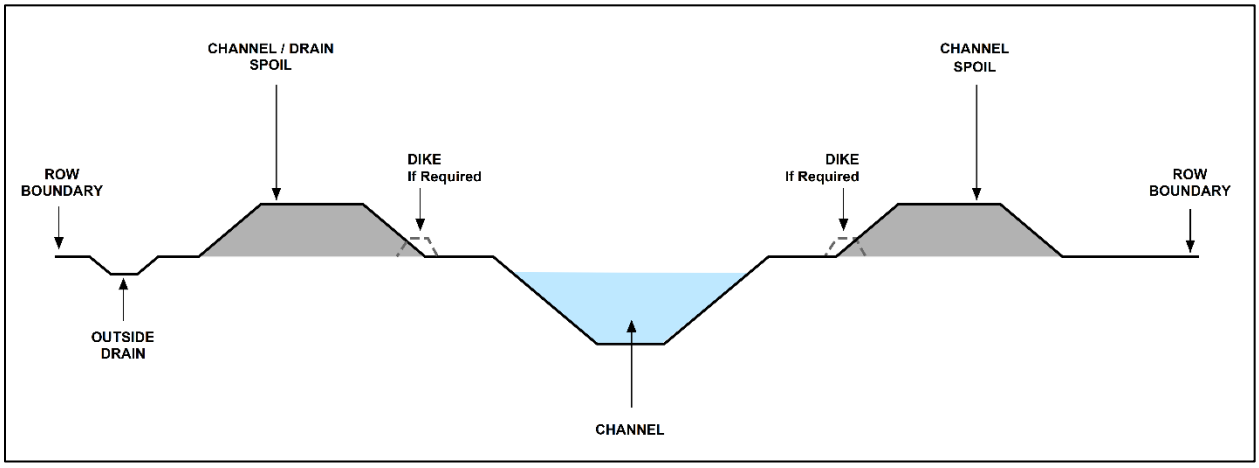
5.1 Project Description

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

Figure 1: Lake Manitoba Outlet Channel Project Area

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

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



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

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

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

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

5.2 LMOC Operation

The LMOC will work in conjunction with the existing Fairford River WCS to regulate water levels on Lake Manitoba as established by the Operating Guidelines prepared for the Project. The LMOC will carry water directly into Lake St. Martin.

As the LMOC is operated, planting areas along the side slopes may experience dry conditions or may become submerged for extended periods of time. The duration, frequency, timing, and magnitude of channel operation will contribute to the response of the cover vegetation to flood events. When the flood tolerance of a specific species is exceeded, the plants will die back and will create gaps in the planting that can create opportunities for erosion and weed infiltration. Likewise, incidences of erosion as well as prolonged periods of drought also have the potential to impact vegetation cover along the channel side slopes.

The design of seed mixes and seeding rates will be suitable for the range of site conditions anticipated during operation of the Project. Species used in areas that will be seasonally inundated will be selected based on their inherent capability to withstand flooding as well as seasonal drought. Mitigation measures may be required to address the risk of poor vegetation growth on portions of the channel side slopes that will experience alternating periods of submergence and exposure as a result of long-term operation of the Project. Other key considerations include hydraulic considerations (such as limiting the height of species that can be seeded in the channel to maintain the hydraulic capacity), weed management, and species that support use by wildlife for the foreseeable future.

5.3 Site Characterization

The RVMP planting prescriptions for the LMOC were based on the proposed Project features and existing vegetation conditions in the LMOC Right-of-Way (ROW). The understanding of existing vegetation conditions was based on the Environmental Impact Statement (EIS, MI 2020) and a reconnaissance survey completed in August 2019. General site information is summarized in the following subsections.

5.3.1 Soil Conditions

The surficial soils within the LMOC ROW are underlain by till substrates. The thickness of till over the underlying bedrock ranges from 10 to 20 m. Based on modal soil properties from existing desktop soil resource information, the predominantly mineral surficial soils in the LMOC area will be expected to have topsoil (surficial organic and mineral A horizons) thicknesses ranging from 0 cm along shorelines to 40 cm in agricultural and deciduous forest areas (CanSIS 2019) as follows:

- Brunisol (40 cm) – deciduous parkland forest and agricultural lands
- Chernozem (30 cm) — agricultural lands and some areas of deciduous parkland forest

- Gleysol (40 cm) — imperfectly drained wetland soils or wet pastures
- Organic (15 cm) — wetlands that are peat forming in isolated areas near lower lying topographic areas near Goodison Lake, Clear Lake, Lake Manitoba and Reed Lake
- Regosol (0 cm) — newly formed soils with no topsoil such as shorelines

The soil materials occurring in the LMOC area from Lake Manitoba to the south end of Lake St. Martin (including the west and east side) consist primarily of extremely calcareous, very stony water-worked loamy textured glacial till (CanSIS 2019). A portion of this area was modified by wave action and scouring by icebergs during the retreat of glacial lake Agassiz (Smith et al. 1998). The ridges are generally composed of more coarse-textured, cobble and gravel deposits, while depressions contain finer deposits (Smith et al. 1998). Under current conditions soils are rated predominantly as a negligible risk for wind erosion losses and a very low risk for water erosion losses. A significant portion of the assessment areas are rated as moderate, and no soils are rated as high, for water erosion losses (MI 2020).

The sensitive soil sites identified along the LMOC ROW were sandy soils subject to erosion on both the Lake Manitoba (Watchorn Bay) and Lake St. Martin shorelines at the Inlet and Outlet, and areas near Goodison Lake. Four manure-impacted sites were identified within the ROW that will have to be addressed prior to construction. There are no immediate terrain sensitive sites as they are level to nearly level with slopes less than 2 percent.

Compaction risk is rated from low to moderate on the west side of the LMOC channel and as predominantly high on the east side of the LMOC channel (MI 2020).

5.3.2 Vegetation Conditions

A field reconnaissance program was carried out to collect information on pre-Project vegetation conditions within the LMOC Right of Way (ROW) in support of the RVMP design. A reconnaissance survey of the nine locations where roads presently cross the proposed channel route, and some adjacent areas, was carried out in August 2019. Results are summarized below.

The vegetation communities along the ROW comprised of a mixture of cropland, pasture, wetlands, and parkland forests. Much of the ROW included forage crop and pasture supporting agronomic species. Pastured fields were an agronomic mix and some contained weeds listed under the *Manitoba Noxious Weeds Act* such as creeping or Canada thistle (*Cirsium arvense*). Cattle were present in many of the pastures, while some fields were croplands planted with wheat and some were planted with predominantly alfalfa and supported apiculture. Five rare plant species were recorded along the LMOC during Project surveys as part of the survey. Undocumented rare plant occurrences may also occur along the ROW. A vegetation baseline study report, which is currently under development, will be used to confirm this information.

Wetlands, including ditches and stream edges were dominated by shallow marsh communities graminoids, including narrowleaf cattail (*Typha angustifolia*), woolgrass (*Scirpus cyperoides*), Canada bluejoint (*Calamagrostis canadensis*), tussock sedge (*Carex stricta*), hardstem bulrush (*Shoenoplectus acutus*) and willows along the edges including pussy willow (*Salix discolor*), beaked willow (*S. bebbiana*), and sandbar willow (*S. exigua*). A review of available rare plant information for the Project also indicates federally and

provincially listed plant species at risk are generally found in wetlands. A vegetation baseline study report, which is currently under development, will be used to confirm this information.

Parkland forests were interspersed throughout the area and were predominantly deciduous young trembling aspen (*Populus tremuloides*) and poplar (*Populus balsamifera*) stands with shrubby understories of beaked hazel (*Corylus cornuta*), chokecherry (*Prunus virginiana*), western snowberry (*Symphoricapus occidentalis*), willows (*Salix spp.*), prickly wild rose (*Rosa acicularis*), and saskatoon (*Amelanchier alnifolia*) with groundcover of Canada goldenrod (*Solidago canadensis*), black-eyed Susan (*Rudbeckia hirta*), and bluegrass (*Poa spp.*). Bur oak (*Quercus macrocarpa*), hackberry (*Celtis occidentalis*), hawthorn (*Crataegus chrysocarpus*) and Manitoba maple (*Acer negundo*) were minor components of most woodlands in the ROW especially near forest edges. Some of these forested areas contained dead standing trees that had evidence of bird use for nests and a source of food.

5.3.3 Non-Native Invasive Species and Weeds

During the August 2019 reconnaissance field survey non-native plant species and weeds were observed throughout the ROW, particularly along the edges of farm fields and roads, ditches, and pastures. Weeds identified in the ROW were all herbaceous perennial and biennial species, including the Invasive Species Council of Manitoba (ISCM) Tier 1 (orange hawkweed (*Hieraciam aurantiacum*), Tier III (common burdock (*Arctium minus*), perennial sow thistle (*Sonchus arvensis*)), and unranked species (prickly lettuce (*Lactuca serriola*) and scotch thistle (*Onopordum acanthium)*). Canada thistle and burdock formed larger infestations in some portions of the ROW, particularly on inactive farm fields and disturbed sites.

No Category 1 listed species were identified. Scentless chamomile and ox-eyed daisy are classified as Tier II noxious weeds by the *Noxious Weeds Act* (NWA) and are Early Detection and Rapid Response (EDRR) Category 2 listed species by the Invasive Species Council of Manitoba (ISCM) (SG Environmental 2016). Smooth brome is considered a moderate invasive species to native habitats. Canada thistle and yellow and white sweet clover were fairly common throughout the hayfields and grazing pastures where human or livestock activity was present. Kentucky bluegrass, absinthe, nodding thistle and common dandelion are minor invasive plant species that were observed predominantly along roadsides and access trails.

5.3.4 Wildlife Habitat

Pasture, wetlands, and parkland forests occur along LMOC and have the potential to support a diversity of amphibians, reptiles, birds, and mammals including SAR and SOCC. Wildlife typical of open grass-dominated habitats include red-tailed hawk (*Buteo jamaicensis*), barn swallow (*Hirundo rustica)*, savannah sparrow, bobolink (*Dolichonyx oryzivorus)*, western meadowlark (*Sturnella neglecta*), coyote (*Canis latrans)* and red fox (*Vulpes vulpes)*. Wetlands, creeks, and streams support waterfowl such as ducks and geese, muskrat (*Ondatra zibethicus)*, and beaver (*Castor canadensis)*.

Deciduous forest patches support red-eyed vireo (*Vireo olivaceus)*, ovenbird (*Seiurus aurocapilla)*, white-throated sparrow (*Zonotrichia albicollis*), and red-backed vole (*Myodes gapperi*), whereas edge species such as red-headed woodpecker (*Melanerpes erythrocephalus*), yellow warbler (*Setophaga petechia*), brown-

headed cowbird (*Molothrus ater*), white-tailed deer (*Odocoileus virginianus)*, and American elk (*Cervus canadensis*) are found where grassland and haylands meet patches of deciduous forest.

The mosaic of habitats along LMOC have the potential to support a diversity of SAR and SOCC. Little brown myotis, northern myotis (both SARA-listed as endangered) and American badger (*Taxidae taxus;* SARA-listed as special concern) are the only mammal SAR having potential to occur along the LMOC. Bats forage in forest openings and over wetlands in the summer and hibernate in caves during the winter. The closest known bat hibernacula (federally designated as critical habitat) to LMOC occurs near the communities of Gypsumville and St. Martin. American badger is a grassland species that burrows in loose soil, often near ground squirrel colonies. Although badger have not been detected, they have the potential to occur along LMOC where grassland or pastureland exists.

Bird SAR and SOCC having potential to inhabit riparian and/or wetland habitats along LMOC and/or at the outlets are: trumpeter swan (MESEA-listed as threatened), horned grebe (*Podiceps auritis;* COSEWIC-listed as special concern), least bittern (*Ixobrychus exilis;* SARA-listed as threatened), yellow rail (*Conturnicops noveboracensis;* SARA-listed as special concern), piping plover (*Charadrius melodus*; SARA-listed as endangered), and bank swallow (*Riparia riparia;* SARA-listed as threatened). Short-eared owl (*Asio flammeus;* SARA-listed as special concern), barn swallow (SARA-listed as threatened), and bobolink (SARA-listed as threatened) are associated with grassland habitat and eastern whip-poor-will (*Antrostomus vocife*rous; SARA-listed as threatened), common nighthawk (*Chordeiles minor;* SARA-listed as threatened*)*, red-headed woodpecker (SARA-listed as threatened), and evening grosbeak (*Coccothraustes vespertinus;* SARA-listed as special concern) are associated with forests, forest edges or forest openings.

Red-headed woodpecker is a cavity-nesting woodpecker that breeds in open deciduous forest or forest edges, and open habitats (e.g., grasslands or pastures containing windrows) where mature or dead trees are available for nesting (COSEWIC 2007). The LMOC is near the northern limit of the species' breeding range (MB BBA 2019) but suitable habitat, including two- 10 x 10 km squares of federally protected critical habitat, exists along the LMOC (ECCC 2019). The species is known to occur in hayland and pasture habitats located along the LMOC ROW near Reed and Goodison lakes.

Northern leopard frog (SARA-listed as special concern) is the only at-risk amphibian known to occur along LMOC. Northern leopard frogs require shallow waterbodies for breeding, deep waterbodies for overwintering, and moist upland habitats (e.g., grasslands) for summer foraging and dispersal (COSEWIC 1998). Snapping turtle (SARA-listed as special concern) has the potential to occur along the LMOC where permanent waterbodies exist.

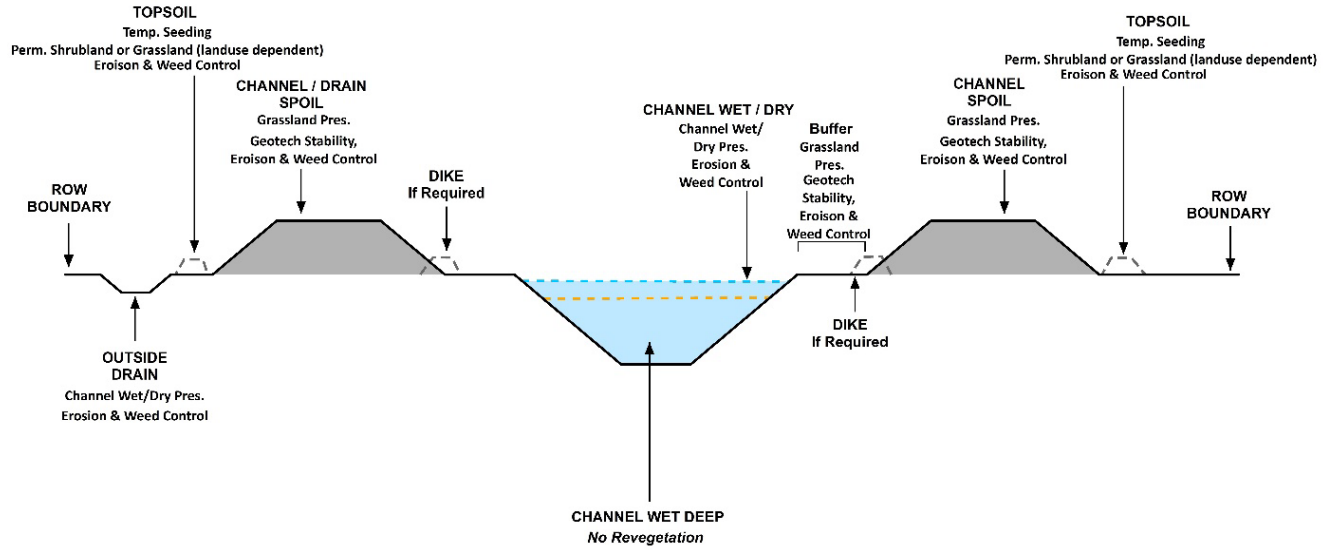
Two invertebrate SAR and one SOCC have the potential to occur along the LMOC: transverse lady beetle (COSEWIC-listed as special concern), yellow-banded bumble bee (SARA-listed as special concern), and gypsy cuckoo bumble bee (SARA-listed as endangered). All three invertebrate species have broad distributions in Canada and are habitat generalists, occupy a variety of habitats such as farmland, grasslands, riparian areas, and deciduous and coniferous forests (COSEWIC 2014, 2015, 2016).

6.0 CONSTRUCTION PHASE

6.1 Rehabilitation Sites and Zones

The proposed revegetation prescriptions for the LMOC are illustrated schematically on Figure 3 and spatially in Appendix 2A. More detailed revegetation information will be provided in the preliminary engineering channel design report once it is completed.

Figure 3: Schematic of Revegetation Prescription and Options



Note: Pres. – Prescription; Perm. – Permanent.

The rehabilitation of LMOC is broadly divided into areas that have geotechnical and hydrological function considerations that influence revegetation prescriptions, and areas that will focus on connectivity with adjacent land uses which include wildlife habitat, shoreline ecosystems and agricultural land use. All disturbed areas will undergo revegetation site preparation prior to soil placement and preparation prior to seeding and planting activities. Revegetation zones are composed of upland areas comprising top of channel spoil or top of dike, mid-slope (dry channel slope and spoil slopes), and lower slope zones (wet/dry channel area and ditches and drains).

After Project construction, access routes not required for ongoing maintenance of the LMOC will be decommissioned by contouring, de-compacting and trimming to encourage natural revegetation and will be seeded and/or planted as required.

6.2 Rehabilitation and Revegetation Treatments

The proposed rehabilitation treatment measures to be used for LMOC are described in Table 1 and in revegetation prescription fact sheets in Appendix 2B, which will be further developed in the detailed design phase. The pre-construction measures include salvaging coarse woody debris and snags, collecting native seed and willow stakes and salvage of topsoil to be stored and then replaced on applicable Project features prior to revegetation. Any areas of weed infestation will be treated prior to soil salvage and replacement. Areas that are compacted or rutted will be ripped prior to soil replacement. Soil replacement depth will be on average 30 cm and will be left rough and loose in the shrubland planting areas and will be furrowed for grassland areas.

Native seed mixes and plants will be used where possible; however, non-invasive agronomic species that support cover establishment will be used where appropriate. Planned seeding considered Manitoba Infrastructure's Native Revegetation Policy and was adapted to meet specific revegetation design criteria. The prescription placement areas are shown in the cross section in Figure 3 and on the plan view in Appendix 2A. The prescriptions are summarized below:

- A grassland prescription consisting of a native and agronomic seed mix will be used to revegetate the buffer between the channel and the spoil piles, dikes, and spoil piles.
- Periodically flooded channel areas and the outside drain will have a wet/dry prescription for species that can tolerate both flooded and dry conditions. Due to variable water levels, this prescription will be monitored if there are prolonged flood events. Areas along the edge of the Channel ROW or areas where topsoil was located prior to soil replacement in areas requiring revegetation will receive either a grassland or shrubland prescription. The determination of the shrubland prescription will be based on whether it existed in that location prior to disturbance. The shrubland will be planted with native shrubs and some areas will receive enhancements such as coarse woody debris placement and installation of wildlife snags to support bird nesting including eastern whip-poor-will habitat. Areas revegetated with a mix of grass and forbs may serve as potential nesting habitat for bobolink and foraging habitat for short-eared owl.
- The Inlet and Outlet areas will have a shoreline prescription that will support control of wind and wave erosion, as sandy soils are located there and there is a need to withstand wave action. These areas will also consider wildlife habitat along the shoreline and may receive live stakes collected from local willows in addition to seeding to control erosion.
- An erosion control prescription would be applied to temporary topsoil stockpiles during construction if stockpiles are to be left in place for more than a growing season. The stockpiles will be contoured and seeded to reduce erosion and control weed establishment. These locations are not indicated on the plan view in Appendix 2B as they will be applied as needed. The erosion control prescription will also be applied to other areas in the ROW as needed.
- A channel bends prescription consisting of jute netting in conjunction with heavy seeding will be applied at select channel bends for erosion control. The locations have been identified as "Erosion Control" on the plan view in Appendix 2B.

- For the PR 239 realignment a standard seed mix will have a broadcast seed application to the roadsides (Appendix 1A). This is not indicated in the plan view in Appendix 2B.

6.3 Revegetation Sequence and Schedule

The timing of revegetation activities is seasonally dependent to support successful plant growth. Table 1 outlines a general schedule of activities. Manitoba Infrastructure will endeavor to conduct revegetation using a staged approach and start as soon as practical after construction commences.

Table 1: Revegetation Schedule for the Lake Manitoba Outlet Channel

Revegetation Activity	Timing of Activity	Description of Activity
Weed Management	Pre-construction and Operations	Weed management should occur at all phases of the project from pre-construction prior topsoil salvage, during operations if weeds are in the topsoil stockpiles prior to replacement and then during monitoring and maintenance.
Native Seed Collection/Willow Stake Collection and Coarse Woody Debris and Snag Salvage	Pre-construction	Salvage of material for future revegetation for local provenance of seeds and coarse woody debris and snags for the shrubland prescription for supporting endangered species habitat, where required.
Topsoil Salvage	Construction	Salvage of soil and storage so that on average 30 cm of soil is preserved for future replacement. Volumes will be calculated prior to construction.
Revegetation	Construction and post construction	Seeding to be conducted as construction segments are completed. Optimal growth will occur in spring. Seeding outside of spring months will require adjustment of revegetation prescriptions to improve seed propagation. Planting of stakes and shrubs to occur in spring or fall.
Monitoring	Two years post construction and adaptive management monitoring	Confirm sufficient vegetation cover and erosion and sedimentation are controlled. This monitoring occurs the first two years after planting and during maintenance inspections after flood events.
Maintenance	Operations	Manage weeds, mow grass areas, and repair areas of erosion.

6.4 Weed Control

Weed control is required when revegetating disturbed lands with an intended function (i.e., erosion control, aesthetics, protection of adjacent farmland, rare habitat, etc.). Persistent weed species have already established either in or near the LMOC ROW, where soil salvage and revegetation will occur; thus, weed treatment will be required during pre-construction prior to soil salvage, and may be required as part of maintenance once revegetation is complete. The duration of, and the weed management techniques employed, will vary depending on level of infestation, as well as proximity to fish-bearing water. As the LMOC construction will take more than one growing season, revegetation will be phased to help prevent the establishment of weeds in project-disturbed areas to be revegetated.

To help avoid spreading weeds that have been documented during site investigations, treatment measures established by Manitoba Infrastructure and the following actions are recommended:

- Treat areas of known weed infestation prior to stockpiling—broadcast herbicide application is likely needed in the areas identified.
- Soil stockpiles should be managed for weeds and treated as necessary prior to replacement.
- When soils with a history of weeds must be used as growth media, closely monitor stockpiles for weed regeneration and undertake appropriate weed control measures, including herbicide applications where required.
- Clean construction machinery prior to working on site.
- Phase revegetation efforts, including topsoil seeding, to occur as soon as possible.
- Additional measures for surrounding farmland are outlined in the biosecurity management plan

The following monitoring practices will be implemented:

- Revegetated areas are to be monitored for weed encroachment until the vegetation cover is established. The survey should be undertaken by individuals that can identify plant species and make best practice weed control recommendations.
- When invasive weed species are documented, a timely and appropriate weed control response should be undertaken to control the weed infestation.
- A site-specific weed control strategy will be developed as part of the soil salvage and revegetation schedules.

Herbicide applications could be conducted in June to early July depending on date of seeding and prevailing weather conditions.

6.5 Erosion and Sediment Control

The RVMP through establishing a vegetation cover provides mitigations supporting the Sediment Management Plan (SMP). Erosion control measures will be applied throughout the project ROW as needed but will exclude the areas that will be occupied by concrete or riprap features and the areas covered by water

in the channel and outside drain. Erosion control extents along the channel bends are described in the channel bend prescription fact sheet in Appendix 2A and shown as “Erosion Control” on the plan view in Appendix 2B.

Revegetation will be conducted following completion of individual segment construction. The grassland prescription to be applied over the majority of the project ROW includes some species which will establish quickly to promote vegetation cover. Additional erosion control measures will be applied as needed. Manufactured erosion control products may be used strategically in areas that pose the greatest risk of erosion and where impacts of erosion are most detrimental. Additional detail on the use of erosion control materials and products can be found in the SMP.

7.0 OPERATIONS PHASE

The design of seed mixes and seeding rates will be suitable for the range of site conditions anticipated during operation of the Project. Species used in areas that will be seasonally inundated will be selected based on their inherent capability to withstand flooding as well as seasonal drought. Erosion control in the channel and outside drain under both dry and wet conditions will be implemented using dry and wet condition tolerant plants and seed mixes with some species in the seed mix establishing more quickly to promote vegetation cover. Mitigation measures may be required to address the risk of poor vegetation growth on portions of the channel side slopes that will experience alternating periods of submergence and exposure as a result of long-term operation of the Project.

Drier areas on the new landscape may also develop on berms. Seed mixes comprising species capable of tolerating these conditions into the long-term foreseeable future will include mix of native cool season and warm season species. Plantings on the side slopes will be exposed to normal seasonal water deficit.

Weed management practices will be applied throughout operation of the Project to minimize weeds and invasive plants, which is critical for success since seeded and planted areas may be outcompeted by weeds, adjacent land uses for farming may be detrimentally affected by the spread of weeds, and there is limited use for wildlife.

Other key considerations include plant species that support use by wildlife and hydrotechnical considerations, i.e., limit the height of plant species that can be seeded in the channel to maintain the hydraulic capacity of the channel.

Table 1 outlined a general schedule of activities including the operation phase of the Project.

7.1 Weed Control

Weed treatment will be required as part of maintenance during the Operations Phase.

Monitoring practices similar to the weed control practices during Construction Phase will be implemented:

- Revegetated areas are to be monitored for weed encroachment until the vegetation cover is established. The survey should be undertaken by individuals that can identify plant species and make best practice weed control recommendations.
- When invasive weed species are documented, a timely and appropriate weed control response should be undertaken to control the weed infestation.
- A site-specific weed control strategy will be developed as part of the soil salvage and revegetation schedules.

7.2 Vegetation Management

To promote establishment of a healthy vegetation cover for the Project and to allow for the proper function of water flow the following measures are part of the maintenance program during the Operations Phase:

- maintenance of the vegetation cover in areas where erosion might be present
- ongoing mowing of the outside drain to promote drainage and berms to support geotechnical stability that requires no tree cover
- ongoing weed control, where required.

7.2.1 Channel Maintenance

To maintain the efficient conveyance of water in the channel, vegetation maintenance will be required. Over time, naturally-establishing woody vegetation such as willows and deciduous species such as poplar may require management (e.g., mowing) to maintain channel hydraulic function. Channel areas are subject to water fluctuations during flood events and may require maintenance after prolonged flood events. When the WCS gates are opened during the growing season there may be some dieback of vegetation along channel sides if areas are submerged/exposed for sufficiently long periods of time during the growing season.

8.0 MONITORING

Revegetation monitoring will be conducted, for construction, and operation phases.

A method of systematic grid sampling will be used for the assessments (i) along the slopes of the channel, outside drain, dikes, and channel and drain spoil piles and (ii) along the flat areas, including the top of dikes, channel buffer, and top of spoil piles. Approximately equidistant transects will be created perpendicular to the longest axis of narrow and long reclamation areas. Monitoring sites will be placed at predetermined locations at equal spacing along the transect for systematic annual monitoring.

A computer-based geographic information system (ESRI's ArcGIS) will be used for the archiving, processing, and use of the field-captured data, including GPS locations and photos of the monitoring sites and monitoring parameters. The field-captured data will be fed into the ESRI Geospatial system of record.

Monitoring will document and measure the success of revegetation efforts and confirm that sufficient physical stability of the reclaimed landscape has been achieved to control surface erosion and sedimentation. In some areas of sensitive habitat, it may be feasible to determine revegetation success by observed wildlife use and by noting the structural and species composition of the sensitive habitat.

To avoid growth and establishment of regulated weeds, topsoil and subsoil piles will be monitored for weed growth during construction and corrective measures (e.g., spraying, mowing, hand-pulling) will be implemented where necessary. Shortly after construction, monitoring will be focused on assessing the rate of establishment of a healthy vegetation cover, and the quick recognition and mitigation of soil erosion. Areas of poor vegetation growth will also be identified for additional seeding. Proposed survey methods will be discussed with Manitoba Sustainable Development in advance of field survey.

Wetland mapping will be evaluated to identify potentially affected wetlands as further described in the Wetland Compensation Plan. MI will follow the requirements of the Manitoba *Water Rights Act* and its regulations for wetland compensation on this Project. Wetland compensation may include wetland creation, and wetland enhancement or restoration.

8.1 Construction Phase Monitoring

In the construction phase, temporary vegetation prescriptions will be applied to areas such as soil stockpiles to reduce the risk of erosion. This work will be completed during the growing season and seeding will best be done in late May to early June.

In the pre-construction phase, weed infestations that have been identified will be addressed prior to soil salvage. The monitoring will be based on the efficacy of the herbicide treatments prior to soil salvage.

8.1.1 Monitoring Cover Vegetation

Temporary revegetation will be considered stable if there is no significant decline in the following parameters between assessments:

- Plant cover (total and by species) provides a measure of the reduction in erosion potential and rainfall capable of reaching and infiltrating the ground.
- Observation of erosion issues such as rill erosion that may require adapted revegetation prescriptions.

8.1.2 Monitoring for Effects on Vegetation

Effects on vegetation will be monitored in proximity of the LMOC and PR 239 realignment. During the construction phase, Project activities have the potential to transfer soil, manure, and weeds to and from the LMOC ROW and agricultural areas outside of the ROW. These materials may contain disease-causing pathogens, weeds or other pests as described in the Agricultural Biosecurity Management Plan. The introduction of pests can have lasting adverse effects on production (reductions in yield and quality) and production cost (increased input and management costs). Diseases can spread between regions and fields by human-related means through transport of infested seed, soil and crop residues, and within and between fields by natural means (e.g., wind, rain, water and soil erosion and insects).

During the pre-construction and construction phase, measures to protect cropland biosecurity will focus on preventing and minimizing the potential of soil and weed seed transfer from the ROW to agricultural areas outside of the ROW.

Monitoring and salvage of important revegetation material (coarse woody debris, woodpecker/wildlife trees, seed collection) supports environmentally sensitive features such as species at risk habitat of eastern whip-poor-will (*Antrostomus vociferus*) and red-headed woodpecker. This measure would reduce effects to federally and provincially listed species, plants and wildlife, and effects to wetlands, provincially important for conservation and water management.

Avoiding wetlands will reduce impacts to other bird SAR known to breed in wetlands along LMOC. Wetlands that cannot be avoided will be documented.

Remote sensing may be applied for monitoring vegetation health within and outside of the ROW. The vegetation health can be identified using near-infrared (NIR) energy, which is highly sensitive to vegetation stress detected through photosynthesis absorption and reflection rates.

8.2 Operations Phase Monitoring

The purpose of ongoing operational vegetation monitoring will primarily be to monitor erosion and sediment control, with the frequency linked to Project maintenance works or prolonged flood or large storm events.

A three-year vegetation establishment monitoring program will determine if revegetation objectives are being met and support the development of ongoing vegetation maintenance.

Revegetation monitoring is planned to occur according to the following phases:

1. Within the first growing season after revegetation treatments — Measuring the effectiveness of the revegetation program which includes weed control, erosion and sediment control and establishment of the vegetation cover.
2. Two years after revegetation — Monitoring will include programs to assess longer-term productivity and sustainability of revegetation, including species composition, percent cover, weed occurrences and erosion and sediment control effectiveness.
3. Maintenance — Monitoring will be for weeds and confirming that erosion control in revegetated areas is maintained. The monitoring frequency may be adjusted depending on the long-term site-specific effectiveness of vegetation as an erosion control measure.

Additional mitigation measures may be required to address poor vegetation growth, identified from monitoring, on portions of the channel side slopes that will experience alternating periods of submergence and exposure as a result of long-term operation of the Project.

8.2.1 Monitoring Cover Vegetation

Vegetation cover would be considered stable and self-sustaining if there is no significant decline in the following parameters between assessments:

- Species composition assessment: Changes in composition and abundance over time, including non-native plant species and weed infestation. Species composition assessment provides a measure of species richness (number of species) and will indicate whether vegetation is dominated by native species.
- Plant cover (total and by species) provides a measure of the reduction in erosion potential and rainfall capable of reaching and infiltrating the ground.
- Health and vigor, including total plant biomass: Biomass production provides a reliable measure of the live vegetative material present on a site. A sudden decline in plant biomass production following withdrawal of maintenance fertilization could indicate that the site is not yet self-sustaining.
- Observation of erosion issues such as rill erosion that may require adapted revegetation prescriptions.

8.2.2 Monitoring for Effects on Vegetation

Vegetation performance within the ROW and outside of ROW for edge effects, such as changes in species composition will be compared against the baseline conditions as identified in the EIS and the Lake Manitoba and Lake St. Martin Outlet Channel Project Preconstruction Environmental Field Work. An appropriate reference site will be established within the area that will not be disturbed by the Project for continuous vegetation performance assessment.

The ROW will be managed to minimize weed growth and the potential for weed transfer to agricultural land adjacent to the ROW.

Changes in hydraulics that may affect wetland function will be assessed against the baseline conditions and a reference site established for wetlands. Wetland compensation for affected wetlands may include wetland creation, and wetland enhancement or restoration.

Remote sensing may be applied for monitoring vegetation health within and outside of the ROW. The vegetation health can be identified using NIR energy, which is highly sensitive to vegetation stress detected through photosynthesis absorption and reflection rates.

9.0 ADAPTIVE MANAGEMENT AND FOLLOW-UP

9.1 General

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

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

As discussed in Section 12.6 of the EIS, vegetation monitoring will examine how predicted changes to vegetation species diversity and wetlands will be verified and how the effectiveness of mitigation strategies (e.g., revegetation) will be evaluated. As described in Section 9, shortly after construction, monitoring will be focused on assessing the rate of establishment of a healthy vegetation cover, and the quick recognition and mitigation of soil erosion. To avoid growth and establishment of regulated weeds, topsoil and subsoil piles will be monitored for weed growth during construction and corrective measures (e.g., spraying, mowing, hand-pulling) will be implemented where necessary. Areas of poor vegetation growth will also be identified for additional seeding.

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

9.2 Follow Up Response

As described in Section 9, monitoring will include monitoring of cover vegetation establishment and Project effects on vegetation. The data and analyses generated by monitoring will be used to provide information on the effectiveness of mitigation measures, aid in the validation of predicted residual effects, and provide data and results required for environmental licensing requirements. Management thresholds developed as part of the monitoring plan may utilize regulated criteria, input from stakeholders, and consideration of findings from applicable management plans. Based on the management thresholds and the results of the vegetation monitoring program, follow up activities will be implemented where conditions recorded appear to be outside of anticipated seasonal fluctuations of vegetation cover.

Table 2 summarizes the criteria indicators, methods and thresholds that will be used to assess the revegetation success and any adaptive management that may need to be implemented during the monitoring of LMOC.

Table 2: Indicators, Threshold and Targets for Measuring Revegetation Success

Indicators	Measure	Method	Targets	Timeline for Surveys	Thresholds	Mitigations for Adaptive Management
Soil Moisture Regime	Estimate in field (e.g., soil depth; texture; landscape position)	Test for soil moisture in the field (conditions that the vegetation is growing in)	Within the natural range of species planted	First year after soil replacement	Sufficient soil moisture for plant survivorship.	Understanding soil moisture levels in the LMOC main channel and Outside Drain may need adjustments depending on final moisture levels achieved.
Grass Cover in Geotechnical /Hydraulic Conductivity Design Areas	% cover and biomass	Survey plots (count/species)	70% cover with no signs of rill erosion	Up to first three years after revegetation	Less than 50% survivorship	Additional site prep needed, or adjust seed mix for species that show good survivorship.
Weed Control	Management of weeds	Survey plots; site observations	Absence of noxious weeds	Up to first three years after revegetation	Non-compliant with the *Noxious Weeds Act*	Remove noxious weeds. Note: if cover is less than 50% after weed removal reseed areas.

Indicators	Measure	Method	Targets	Timeline for Surveys	Thresholds	Mitigations for Adaptive Management
Shrub Area	Other woody plants (shrubs)	Survey plots (species diversity)	>2 shrub species survive with 40% cover, no weeds and wildlife use	Up to first three years after revegetation	< 2 shrub species	Complete infill planting with a more tolerant species based on the establishment of naturally regenerated species or planted stock.
Shoreline Area	Willow stake survivor ship and grass seeding establishment	Survey plots (species diversity) and percent cover	>2 shrub species survive with minimum 40% cover, no weeds and wildlife use	Up to first three years after revegetation	Stake survivorship is 40% or less from direct cuttings. Rill or gully erosion and/or soil surface deflation.	Willow stakes can be collected, and potted and then out planted to improve success. Grass cover should be reapplied as these sandy soils along the shoreline are sensitive to erosion.

9.2.1 Construction Phase

During the construction phase adaptive management strategies may be needed within the ROW and in adjacent areas. For areas adjacent to the ROW the prevention of the spread of weeds and soil moisture changes and the associated vegetation response during construction should be monitored and, if needed, appropriate strategies developed to address any adjacent vegetation changes outside of the ROW.

Within the ROW after the temporary seeding of topsoil piles, if the areas are left for more than one growing season, they should be monitored for weed establishment and determine if herbicide treatment is required prior to topsoil spreading. If topsoil piles are to remain over winter until the next spring, they will be monitored for sufficient vegetation cover in the early fall and to determine if a temporary fall seed cover crop should be applied to reduce erosion in the spring.

Within the ROW after permanent vegetation cover has been applied within the first growing season there should be sufficient ground cover to reduce erosion and limit weed establishment. The criteria are dependent on the revegetation prescription as outlined in Table 2. Follow-up monitoring and remedial revegetation activities will be continued until sufficient cover has established to mitigate the risk of erosion and controlling the spread of weeds. Weed control is needed for both the establishment of the required vegetation and to protect surrounding agricultural land and wildlife habitat. The type of weed control selected, whether mechanical and/or chemical treatment, will be based on site specific prescriptions that will consider the weed species being treated, extent of the infestation, time of year and assessing risk to water quality and adjacent land uses (e.g., apiculture).

9.2.2 Operations Phase

During the operations phase, observations on the condition of the cover vegetation following prolonged channel operation during the growing season, may prompt adaptive management by adjusting revegetation activities, or corrective weed control treatments. Adaptive management is to be implemented if revegetation along the channel and outside drain is showing:

- active erosion occurring in the form of rills or gullies
- more than 40% of the vegetation cover has died back and not recovered

The following recommendations are meant to guide decision-making where the objective is re-establishing cover vegetation that was lost following channel operation during a flood event. These thresholds should be evaluated and adjusted to help standardize remedial responses based on monitoring vegetation establishment success.

While monitoring for effects to adjacent plant communities if the spread of weeds is sourced from the ROW, then adaptive management will be implemented. The management threshold for weed control mitigation action will use the same criteria identified during the construction phase.

During maintenance of the channel, there may be need for adaptive management to be implemented. To control or limit woody vegetation in the channel mowing has been identified as the maintenance technique. Other vegetation maintenance techniques to control the establishment of woody species that may be implemented may include brushing, girdling, and blading.

10.0 REFERENCES

10.1 Literature Citation

Canadian Soil Information Service (CanSIS). 2019. National Soil Database. Available from http://sis.agr.gc.ca/cansis/nsdb/index.html. Last Modified 2013-07-08.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 1998. COSEWIC assessment and status report on the Northern Leopard Frog (*Rana pipiens*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 40 pp.

COSEWIC. 2007. COSEWIC assessment and update status report on the red-headed woodpecker (*Melanerpes erythrocephalus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON, ON. vi+ 27 pp.

COSEWIC. 2014. COSEWIC assessment and status report on the gypsy cuckoo bumble (*Bombus bohemicus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 56 pp.

COSEWIC. 2015. COSEWIC assessment and status report on the yellow-banded bumble bee (*Bombus terricola*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 60 pp.

COSEWIC. 2016. COSEWIC assessment and status report on the transverse lady beetle (*Coccinella transversoguttata)* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 57 pp.

ECCC. 2019. Recovery strategy for the red-headed woodpecker (*Melanerpes erythrocephalus*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 118 pp.

Government of Manitoba, 2019. Species listed under the Manitoba Endangered Species and Ecosystems Act. Available from https://www.gov.mb.ca/sd/environment_and_biodiversity/species_ecosystems/index.html.

Invasive Species Council of Manitoba (SCM), 2020. Website: Alien plant and animal species that threaten Manitoba's ecological balance. Available from http://invasivespeciesmanitoba.com/site/index.php?page=terrestrial-species.

MB CDC, 2019. Historical Records and Species and Plant Database from Manitoba Sustainable Development. Available at: https://www.gov.mb.ca/sd/environment_and_biodiversity/cdc/index.html. Accessed June 2019.

Manitoba Infrastructure, 2020. Lake Manitoba and Lake St. Martin Outlet Channels Project EIS. March 9, 2020.

SG Environmental Services Inc. (SG Environmental), 2016. Lake Manitoba Outlet Channel Route Options Vegetation Technical Report. Prepared for M. Forester Enterprises and Manitoba Infrastructure. Final report, 12 December 2016.

WSP, 2020. Lake Manitoba and Lake St. Martin Outlet Channel Project Preconstruction Environmental Field Work – Vegetation (CONS15843). Prepared for Manitoba Infrastructure by WSP, September 2020.

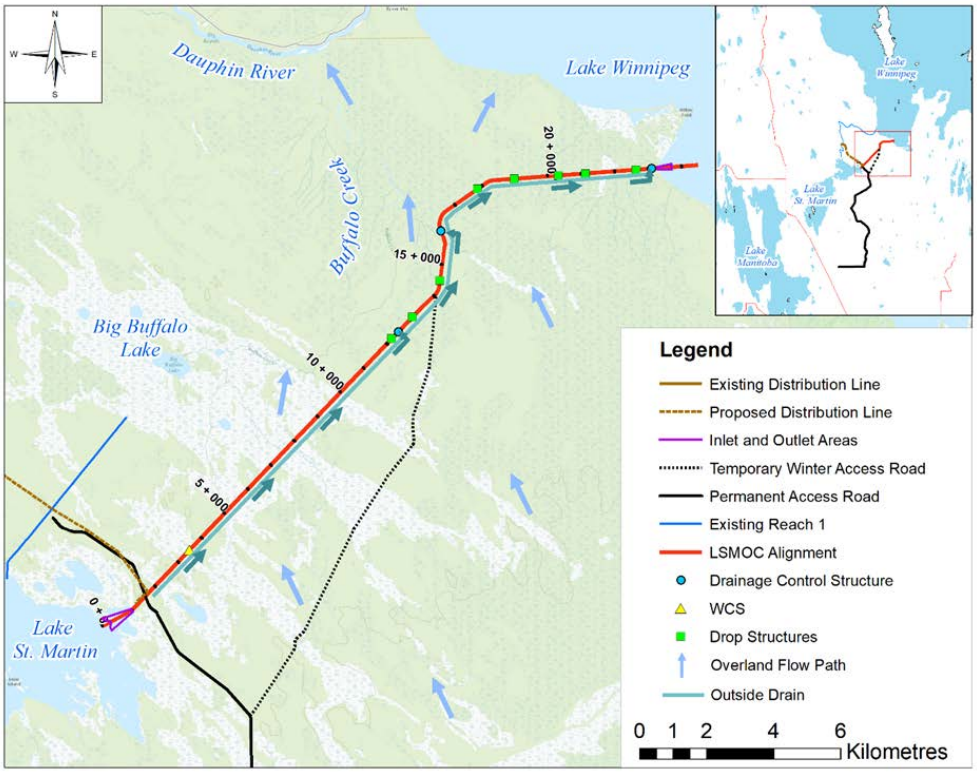
Part 3: Lake St. Martin Outlet Channel

11.0 PROJECT INFORMATION

11.1 Project Description

The LSMOC Project consists of an approximately 23 km long outlet channel, with the inlet positioned at the east end of Lake St. Martin and the outlet south of Willow Point on Sturgeon Bay of Lake Winnipeg. A plan showing the LSMOC and key Project infrastructure is provided in Figure 4.

Figure 4: Overview Plan of the of the Lake St. Martin Outlet Channel



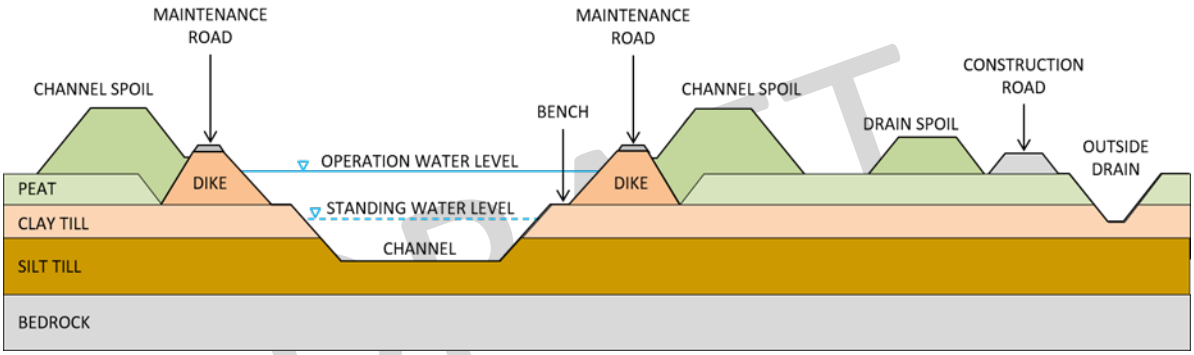
The LSMOC will have a capacity of 326 m^3/s at a Lake St. Martin south basin water level of 244.14 m and is designed to convey flows up to the Inflow Design Flood (IDF), considering the intent of the Canadian Dam Association Dam Safety Guidelines.

The proposed channel will have an invert elevation of about 241 m at Lake St. Martin and about 213 m at Lake Winnipeg and designed to limit erosion. The design is based on a trapezoid shaped channel with a flat

base approximately 42 m wide, 6 to 8 m depth and 4H:1V to 4.5H:1V side slopes. Permanent water retaining dikes will be located on both sides of the excavated channel to contain design flows within the LSMOC and also to isolate the surface water and the upper saturated peat system from the excavated channel. Spoil piles for the excavated material will be located outside of the channel dikes.

An outside drain will be constructed on the east side of the project to intercept the surface water runoff flowing towards the LSMOC, and access for long term maintenance and inspection will be available on top of the dikes on both sides of the LSMOC for the entire 23 km with a maintenance road. A typical cross section for the LSMOC is provided in Figure 5.

Figure 5 Typical Cross Section of the Lake St. Martin Outlet Channel



11.2 LSMOC Operation

As the LSMOC is operated, planting areas along the side slopes will become inundated and cover vegetation will be submerged for extended periods of time. The duration, frequency, timing, and magnitude of channel operation will contribute to the response of the cover vegetation to flooding. When the flood tolerance of a specific species is exceeded, the plants will die back and will create gaps in the planting that can create opportunities for erosion and weed infiltration. Likewise, incidences of erosion as well as prolonged periods of drought also have the potential to impact vegetation cover along the channel side slopes.

11.3 Site Characterization

11.3.1 Soil Conditions

During soil sampling, frost was encountered at a depth of 20 to 30 cm in wetland and coniferous sites. Therefore, soil sampling was mostly restricted to the 0 to 15 cm and 15 to 30 cm depths in these areas. Frost was absent from upland mineral soils associated with aspen cover and generally better drainage conditions. In these areas, field personnel were able to obtain additional soil samples from the 30 to 45 cm depth. Only occasionally was mineral soil encountered and this was typically in upland forest cover types where surface organics were relatively thin compared with wetland soils.

A subset of 15 soil samples representing major cover types was submitted for laboratory analysis. A summary of relevant soil parameters for revegetation are provided in Appendix 3A. Generally, sampled soils were found to be significantly more fertile than glacial till. Mineral soils were encountered only in cover classes containing deciduous forest cover types. All other soils were organic in nature. Soil pH and electrical conductivity were generally found to be within the environmental tolerance ranges of most grass species being considered for revegetation within the project area.

11.3.2 Vegetation Conditions

A field survey of the LSMOC alignment was conducted by revegetation biologists in early June 2019, mainly within a 20 m wide cleared alignment following the centerline of the channel. A total of 26 sampling locations were selected covering all representative land cover classes (Appendix 3A). At each survey site, vegetation was described, and soil samples were collected for analysis.

The vegetation cover was native and characteristic of undisturbed landscape across all land cover classes. Wetland cover types dominate the footprint of the LSMOC, accounting for over 80% of the land cover. Shrub and herb dominated wetlands are most common, accounting for 54.4% and 25.7% of the project footprint, respectively. Within the 'Wetland – Shrub' cover class, tamarack *(Larix laricina*) and black spruce (*Picea mariana*) occur sporadically in clusters, but shrub species such as bog birch (*Betula pumila* ssp.*glandulosa*) are more prevalent. These areas have groundcover vegetation that includes reed grass (*Phragmites* sp.), sedges (*Carex* spp.), horsetails (*Equisetum* spp.), bog rosemary (*Andromeda polifolia*) and palmate-leaved colt's foot (*Petasites palmatus*). 'Wetland – Herb' cover classes rarely have any notable tree presence and only occasional pockets of shrubby vegetation such as bog birch and willow (*Salix* spp.). Groundcover is dominated by sedge species as well as mosses, and northern pitcher plant (*Sarracenia purpurea*) is a common component. 'Treed Wetland' cover types were characterized by a tamarack and black spruce overstory with occasional poplar, and their shrub slayers included alder (*Alnus* spp.), bog birch and Labrador tea (*Ledum groenlandicum*).

Upland cover types are much less prevalent throughout the LSMOC footprint, with the largest cover contributions coming from 'Broadleaf Dense' and 'Coniferous Dense' cover types (both accounting for 6.3% of the project footprint). 'Broadleaf Dense' cover types are dominated by trembling aspen (*Populous tremuloides*) and balsam poplar (*Populous balsamifera*) and feature relatively diverse herbaceous groundcover. 'Coniferous Dense' cover was dominated by black spruce, with Labrador tea and poplar within the shrub layer and species that include bluejoint (*Calamagrostis canadensis*), marsh marigold (*Caltha palustris*), raspberry (*Rubus idaeus*) and velvetleaf blueberry (*Vaccinium myrtilloides*).

11.3.3 Non-Native Invasive Species and Weeds

The LSMOC project area is largely free of weed encroachment; however, Canada thistle (*Cirsium arvense*) and dandelions (*Taraxacum officinale*) were found in two areas noted during the site investigations in June 2019. In both circumstances a small number of specimens were encountered on mineral soils within forested upland sites. Exposed upland mineral soils are generally more prone to weed encroachment than wetland soils encountered in the region.

The general lack of non-native plant species observed throughout the project footprint is not surprising given the undeveloped and undisturbed nature of the existing landscape. The presence of Canada thistle near the inlet location is notable and should be addressed as soon as possible to ensure this Tier 3 Noxious Weed does not have the opportunity to spread and degrade the quality of adjacent landscapes and site soils.

11.3.4 Wildlife Habitat

The LSMOC traverses relatively intact, remote patches of wetland and spruce-dominated peatlands. Wildlife typical of the spruce-dominated peatlands include moose, black bear, gray wolf (*Canis lupus*), Canada lynx (*Lynx canadensis*), marten (*Martes Americana*), snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciurus hudsonicus*), and red-backed vole. Bats also have potential to occur in this region due to the widespread availability of forest and wetland habitat.

Mammal SAR or SOCC having potential to occur along LSMOC include two bat species, little brown myotis and northern myotis (both SARA-listed as threatened) and wolverine (*Gulo gulo*; SARA-listed as special concern). Bats forage in forest openings and over wetlands in the summer and hibernate in caves during the winter. The closest known bat hibernacula (federally designated as critical habitat) to LSMOC occurs near the communities of Gypsumville and St. Martin. Although suitable habitat types may exist for wolverine the LSMOC is outside of this species current range (COSEWIC 2014b).

SAR and SOCC having potential to inhabit riparian and/or wetland habitats along LSMOC and/or at the outlets are: trumpeter swan (MESEA-listed as threatened), horned grebe (COSEWIC-listed as special concern), least bittern (SARA-listed as threatened), yellow rail (SARA-listed as special concern), piping plover (SARA-listed as endangered), bank swallow (SARA-listed as threatened) and short-eared owl (SARA-listed as special concern). Eastern whip-poor-will (SARA-listed as threatened), common nighthawk (SARA-listed as threatened), eastern wood-pewee (*Contopus virens*; COSEWIC-listed as special concern), olive-sided flycatcher (*Contopus cooperi*; SARA-listed as threatened), golden-winged warbler (SARA-listed as threatened), rusty blackbird (SARA-listed as threatened), and evening grosbeak (SARA-listed as special concern) may inhabit forests, forest edges or forest openings along LSMOC.

Northern leopard frog (SARA-listed as special concern) has the potential to occur along LSMOC. Northern leopard frogs require shallow waterbodies for breeding, and moist upland habitats for summer foraging and dispersal (COSEWIC 1998). Snapping turtle (SARA-listed as special concern) has the potential to occur along the LSMOC where permanent waterbodies exist.

The only invertebrate SAR or SOCC having potential to occur along LSMOC are transverse lady beetle (COSEWIC-listed as special concern), yellow-banded bumble bee (SARA-listed as special concern), and gypsy cuckoo bumble bee (SARA-listed as endangered). All three invertebrate species have broad distributions in Canada and are habitat generalists, occupy a variety of habitats that include riparian areas, and deciduous and coniferous forests (COSEWIC 2014a, 2015, 2016).

12.0 CONSTRUCTION PHASE

12.1 Rehabilitation Sites and Zones

The LSMOC revegetation plan can be broadly divided into active and passive revegetation zones and treatments. Areas where construction-related disturbance has occurred will be actively revegetated to an appropriate perennial native grass groundcover, while areas cleared but not heavily disturbed will be encouraged to naturally regenerate. Active revegetation zones will require site preparation as well as cover soil placement and preparation prior to seeding activities. Conversely, natural revegetation zones will require much less site preparation and, depending on the rate of natural revegetation, may not require additional seeding.

12.2 Rehabilitation and Revegetation Treatments

12.2.1 Active Revegetation Zones

Following channel excavation and construction, the active revegetation zones will be composed primarily of exposed glacial till along with a mixture of other subsoil material. These exposed subsoils will require amendment with peat to be considered a suitable growth media for revegetation. Stockpiled peat and topsoil generated during channel construction will be used to amend the subsoils and create the cover soil that will be revegetated. Soil stockpiles not used in site rehabilitation will be stabilized by contouring and seeding to an appropriate perennial native grass cover.

Site Preparation and Cover Soils

Subsoil compaction must be alleviated to allow for deep seedling root penetration, which will improve long-term survival of the planting during periods of extended moisture limitation. Subsoils will be de-compacted to a depth of 20 to 30 cm using equipment such as a bulldozer with ripper teeth or tandem discs and a tractor prior to placing and blending the organics. Areas that have been heavily compacted, for example hauling routes and construction roads, may require multiple passes in multiple directions to alleviate compaction.

Results of field trials conducted within Reach 1 of the Emergency Outlet Channel during 2019 and 2020 suggest that an approximate depth of at least 15 cm of peat incorporated into exposed till is required to achieve satisfactory grass establishment and growth (Appendix 3A). Assuming 15 cm of peat is incorporated across this area, there is a requirement for up to 900,000 m^3 of peat for revegetation purposes after accounting for an expected loss of 30% during handling and spreading.

Organics (peat) will be spread over de-compacted subsoils using equipment and methods that avoid compacting prepared ground. Strategic staging of organics stockpiles along the ROW will allow the contractor to efficiently place organics and minimize travel over the revegetation area. Once placed, organics will be incorporated into the mineral subsoils using discs or other suitable field-scale equipment to a depth of roughly 20 to 25 cm while ensuring organics are not buried.

The soil surface will require some level of conditioning after organic soils are placed and integrated to create seedbed conditions that will facilitate proper and consistent seed placement. Seedbed conditions must be smooth, level, firm and free of excessive woody debris to allow for accurate seed placement and consistency in the seeding rate. Firm seedbeds can also conserve moisture and ensure good seed-to-soil contact.

Seed Mixes and Seed Sourcing

The LSMOC ROW can be divided into active revegetation zones defined largely by an anticipated gradient in moisture availability from the uplands to the channel side slopes (Figure 5). These zones reflect patterns seen in natural communities but are also influenced by the potential for inundation during future channel operation. For the purposes of this plan, these zones are identified as the Upland Berm (UB) zone and the Lower Slope (LS) zone, with the Mid-Slope (MS) being a transitional zone between the two.

The UB zone includes sites that will regularly be subjected to drought conditions during dry summer months. In extreme wet conditions these sites may also experience flooding that will typically not exceed three to four days. Species planted in this zone will include drought tolerant native grasses well-suited to upland sites and local climatic conditions. Several species in this mix will also have a degree of flood tolerance to account for flooding potential.

The LS zone includes channel and drain side-slopes that will be periodically flooded during heavy rainfall periods and channel operation. In times of water deficit, this area may also be subjected to extended periods of drought. To account for these moisture variations, the seed mix in the LS zone will be designed using species capable of tolerating inundation as well as those adapted to drought conditions.

The transitional MS zone between UB and LS zones will be seeded to a cover that includes select species used in both the UB and LS zones.

An overview of native and tame perennial grass species that are suitable for use in the LSMOC project setting are provided in Table 3B-1 and Table 3B-2, respectively (Appendix 3B). A summary of select growth characteristics of relevance to site revegetation are provided, including a preliminary indication of suitability to the UB and LS active revegetation zones.

Final perennial seed mixes will be developed during detailed design and finalized based on seed lot characteristics and seed availability at the onset of site revegetation. These perennial seed mixes will be designed to promote early growth and establishment as well as long-term competitiveness in seeded grass stands. Site appropriate warm season grasses will be included to reduce competition for nutrients and create a more sustainable perennial groundcover. Likewise, a site-appropriate native nitrogen-fixing species such as Canada milkvetch (*Astragalus canadensis*) will be included in the designed seed mixes, where appropriate, to improve soil fertility over time and yield a more sustainable long-term groundcover.

Commercially-sourced native grass seed will serve as the primary component of seed mixes employed during LSMOC revegetation work. Seed purchased for the Project would be adapted to the regional climate of the Project area. Given the substantial quantity of native grass seed required for site revegetation, seed procurement should be initiated well in advance of anticipated seeding dates to ensure access to high quality seed lots that meet standards for weed seed content and percent purity.

Seeding Equipment and Methods

Drill seeding using a Truax brand native seed drill is the preferred method of seeding multi-species native grass seed mixes. These seed drills feature various optimization mechanisms to ensure even and consistent placement of native seeds at the appropriate depth, they are available in a wide range of sizes, and different set-ups can be facilitated. In situations where drill seeding is not possible (e.g., too wet, too steep, or excessively rough surface conditions), broadcast seeding will be used as a back-up seeding method. Broadcast seeding requires approximately two times more seed than drill seeding and tends to result in less consistent grass establishment. Hydro-seeding should be regarded only as a last option and where other seeding methods are not feasible because this method typically does not provide the necessary seed-to-soil contact to promote reliable seed germination and seedling survival.

Native grass seeding is planned to occur in early spring, from May through mid-June. This seeding window gives establishing grasses access to spring moisture that greatly enhances the establishment of seedlings. Seeding native grasses after mid-June exposes seedlings to periods of summer moisture deficit that can be detrimental to the establishing grasses. An alternate option is dormant seeding, which has a seeding window beginning approximately on October 20th and extending until frost or snow inhibits normal seed placement. Dormant seeding is ideal for cool season grass species but does not accommodate warm season grass species, which have seedlings that are sensitive to spring frosts.

Due to the slightly shorter growing season in the Project area, it is recommended that seeding be undertaken at the earliest possible opportunities within the recommended seeding windows. Seeding early in the recommended seeding windows helps to safe-guard planting success against uncharacteristic weather.

Erosion control cover crops can be seeded throughout the growing season, up until August 15th; however, as summer progresses the germination of seeded annual cover becomes dependent on getting a well-timed rainfall, typically, within two weeks of seeding.

Fertilization and Irrigation

The Water Protection Act, Nutrient Management Regulation restricts the application of nutrients within 35 m of the LSMOC due to its proximity and connection to Lake Winnipeg. In marginal soil conditions, such as those anticipated along the constructed LSMOC, a low rate phosphorous fertilizer banded into the soil during seeding can improve the rate of establishment and growth of perennial grass seedlings. To hasten early establishment of seeded grass cover, it is recommended to supply a low rate of phosphorous fertilizer to areas of the disturbed ROW that are being actively revegetated to bring the available phosphorous levels within the range of 4 to 10 ppm.

When native grass seed mixes are seeded following appropriate site preparation and seeding methods during the proper seeding window, irrigation is typically not needed for seedling establishment. When seeding takes place outside of the specified seeding window (after mid-June), or if unseasonable dry conditions occur throughout spring and early summer, irrigation may be required to ensure grass establishment.

12.2.2 Natural Regeneration Zones

Areas within the LSMOC ROW that are cleared but not significantly disturbed will be allowed to naturally revegetate through spontaneous regeneration. These areas will typically be along the outer periphery of the LSMOC ROW and will not include areas immediately surrounding the channel. These areas are expected to be relatively flat and will not pose a risk of active soil erosion and sedimentation. Under normal circumstances, these areas will be outside of the influence of channel operations.

Changes in light levels, soil temperatures, and hydrology will encourage a different assemblage of plant species relative to the pre-construction plant communities. However, in many cases the remaining vegetation and soil seed bank will be sufficient to rebound and re-establish healthy and sustainable cover vegetation. Pioneering woody plant species such as poplar and willow species, as well as many herbaceous species, are expected to regenerate rapidly in portions of the LSMOC ROW after tree clearing, particularly in areas with regularly high soil moisture levels.

Where channel construction has resulted in an alteration to the prevailing site conditions that differ markedly from the pre-construction conditions, some level of revegetation intervention will be needed. In these cases, seeding will be undertaken to hasten revegetation and introduce a plant cover that is better suited to altered growing conditions. Seed mixes will be specifically designed based on the post-construction site conditions to establish a functional plant cover that will support project objectives and hasten site naturalization. Site preparation and seeding methods in these areas will seek to minimize further disturbance to existing vegetation by employing low-ground pressure equipment and a minimum number of equipment passes. Surface conditions through these areas are expected to be rough and irregular due to the residual plant biomass and regenerating vegetation. Seeding will occur by broadcast seeding followed by light incorporation.

12.3 Revegetation Sequence and Schedule

Construction is currently anticipated to occur over approximately two and a half to three years followed by an additional one to two years for site clean-up, surveying and environmental offset works following the major construction works.

During construction of the LSMOC, tree clearing, soil stripping, excavation, soil handling and stockpiling will take place. Excavation of the LSMOC is anticipated to occur primarily during winter months and is expected to generate approximately 450 ha of exposed mineral subsoils (channel/dike slopes, spoil piles made of mineral soil) that will require active revegetation treatments to establish desirable cover vegetation. As the channel construction will take place over multiple years, revegetation works will be phased into the overall channel construction to minimize the exposure of channel slopes and hasten the channel revegetation. Once a segment of the channel is fully excavated and constructed, site preparation and soil placement for revegetation will be phased in at the earliest opportunity possible.

After Project construction, access routes not required for on-going maintenance of the LMOC will be decommissioned by contouring, de-compacting and trimming to encourage natural revegetation and will be seeded and/or planted as required.

12.4 Weed Control

12.4.1 Objectives and Targets

Non-native invasive and weed species have the capacity to rapidly invade areas of disturbance and, once present, these species can expand into adjacent and interconnected natural communities. The following Weed Management procedures have been developed to mitigate the risk of weed invasion and establishment during the construction revegetation phase of the Project. Early detection and rapid response to incidences of invasive and weedy plant species is critical to ensuring small weed invasions do not become challenging infestations.

During revegetation activities, competition from weedy vegetation can result in poor native plant establishment and reduced growth rates, particularly during the first year after seeding native grass cover. By managing the weeds at this early stage, desirable plant establishment is hastened, which in turn becomes a barrier to weed invasion.

The main targets of weed management include:

- Noxious weed species as listed by the *Manitoba Noxious Weeds Act*.
- Category 1 and 2 invasive species as identified by the Invasive Species Council of Manitoba.
- Non-native plant species known to compete aggressively in native grass plantings.

12.4.2 Prevention

Where problematic weedy species are absent from landscapes prior to construction, which is often the case in remote wilderness sites like the LSMOC Project area, the need for pre-plant weed control may be minimal or altogether unnecessary. In these cases, the best approach is to take steps to ensure that weeds are not imported onto the site with machinery and equipment and to undertake proper revegetation measures on prepared sites as soon as possible.

To help avoid spreading broadleaf weeds that have been documented during site investigations, the following measures will be considered/implemented:

- Avoid stockpiling and using soils with a history of weeds or treat areas of known weed presence prior to soil salvage.
- When soils with a history of weeds must be used as growth media, project managers should direct environmental monitors to inspect stockpiles for weeds and undertake appropriate weed control measures, including herbicide applications where required.
- Ensure equipment and machinery is clean and weed-free prior to reaching the project site.

- Initiate revegetation process as soon as possible following channel construction to limit opportunities for weeds to invade and establish on-site.

12.4.3 Thresholds for Action

The management threshold for weed control action will depend on the species of weed detected. Tier 1 noxious weeds or Category 1 invasive species detected should be destroyed or eradicated immediately upon discovery. Identification of Tier 2 noxious weeds or Category 2 invasive species should prompt follow-up investigation to determine the full extent and distribution of the weed population, followed by an appropriate treatment response. Tier 3 species detected on the LSMOC ROW should be monitored in an ongoing fashion. Where it is determined that these species present a threat to native vegetation communities, or the successful establishment of desirable cover vegetation, appropriate treatment response will be implemented.

12.4.4 Methods and Treatments

Treatment approaches and methods to weed control will be developed on a site and situation specific basis in response to the target species in question and will be influenced by the extent and distribution of the weed population. Weed control will follow integrated approaches that may include mechanical treatment (mowing, cutting, and cultivation), targeted herbicide application, and active revegetation. While prescribed burns are used as a management tool for native prairie grass stands this is not anticipated to be a viable approach along the LSMOC, given site specific considerations and implications. Treatment approaches will seek to minimize impacts to non-target vegetation while achieving maximum long-term control on the target species. Treatment approaches should be developed in consultation with professional personnel with local expertise in integrated weed management and weed control in natural settings and perennial grass stands.

12.5 Erosion and Sediment Control

Erosion and sediment control is a major consideration in the construction and revegetation of the LSMOC. Perennial vegetation is typically considered a stable erosion protection measure once 75% live groundcover has been achieved. To achieve this level of consistent vegetative cover, temporary and alternative measures are needed to prevent soil loss and allow for establishing vegetation to take hold. The approaches described below are intended to supplement the SMP during site rehabilitation and revegetation.

12.5.1 Site Preparation and Grading Approaches

Site preparation and grading approaches can be implemented to reduce the likelihood of soil erosion and sediment loss. For example, organic stockpiles may be windrowed strategically to control water runoff and reduce rill formation on the side slopes prior to soil placement and incorporation. Likewise, throughout the revegetation process surface conditions should be left in a rough, unfinished state to reduce overland water velocity and minimize erosion.

12.5.2 Temporary Cover Crops and Nurse Crops

Temporary cover crops and nurse crops are a cost-effective way to stabilize soils during periods where perennial vegetation has not been seeded or has not yet established sufficiently to provide soil protection. During the revegetation of the LSMOC, cover crops will be used to mitigate erosion risks in prepared soils that cannot be seeded to perennial cover due to the seasonal timing of soil preparation (i.e., during hot summer conditions). Likewise, nurse crops will be included within the seed mixes during perennial seeding activities to provide erosion protection during early seedling growth and establishment.

Areas that cannot be prepared and seeded during the May to mid-June seeding window can still be prepared throughout the growing season, and once soil has been placed and incorporated, these areas can be protected by seeding an annual cereal crop like common oats (*Avena sativa*). Common oats may be seeded until mid to late August, but late summer seeding may yield poor plant establishment due to high temperatures and low moisture availability.

Perennial grass seed mixes should include an annual nurse crop component composed of an annual cereal crop like common oats, at a rate of approximately 5.6 to 8.9 kg/hectare when revegetating an erodible slope. The fast-growing annual crop species facilitate native grass seedling establishment by assisting in erosion protection during early establishment, while also serving to improve soil conditions and competing with undesirable weed species.

12.5.3 Erosion Control Materials/Products

Manufactured erosion control products may be used strategically in areas that pose the greatest risk of erosion and where impacts of erosion are most detrimental. Additional detail on the use of erosion control materials and products can be found in the SMP.

13.0 OPERATIONS PHASE

Revegetation activities required during the operations phase of the Project will primarily relate to the frequency and duration of channel operation. The duration, frequency, timing, and magnitude of channel operation will affect the health and rigor of all planted species. Prolonged channel operation may result in periods of inundation that exceed the inherent flood tolerance of species planted on the side slopes. In this scenario, vegetation die-off will leave gaps in plant cover. Likewise, extended periods of drought, particularly during early stages of revegetation, can result in weak or inconsistent plant cover, potentially leading to a requirement for remedial revegetation.

The following section describes the approach to remedial revegetation after channel operation, as well as long-term management consideration relating to weed control and vegetation management.

13.1 Weed Control

Weed control during operation and maintenance will be directly influenced and largely informed by the initial post-construction revegetation outcomes of the LSMOC. That being the case, the current weed control plan is considered generic and should be updated to reflect existing site conditions following the completion of revegetation and during the initial years of the operation and maintenance phase.

Elements of an integrated management plan include:

- prevention
- identification
- monitoring
- thresholds for action
- treatment approaches and methods
- evaluation

13.1.1 Prevention

Preventing introduction of non-native and invasive species is the most effective method of weed control. Preventative measures are particularly important during construction and revegetation while the site is disturbed and subject to introductions, largely via equipment, construction materials, and seed. During operations, prevention will be achieved by thorough follow-through on any outstanding weed control issues left following revegetation and by maintaining established controls over seed import via vehicle access and in seed mixes used for remedial seeding.

Heathy and undisturbed native vegetation communities are inherently resistant to invasion of non-native species. Monitoring the condition of vegetation for signs of decline and limiting disturbances to established vegetation will provide opportunities for preventing conditions that will encourage introductions of non-native and invasive plant species. There is no foreseeable way to prevent the introduction of weed seed via

wildlife and water conveyance during channel operation. Regular monitoring will serve to mitigate the risk of invasion over long-term operations of the LSMOC.

13.1.2 Identification

The primary target vegetation to be controlled on the LSMOC ROW are noxious and invasive species, specifically those listed in *The Noxious Weeds Act* and those identified by the Invasive Species Council of Manitoba (ISCM) as Category 1 and Category 2 species (Appendix 1A).

13.1.3 Monitoring and Reporting

Monitoring and reporting requirements for weed control are described in Section 16.0. These include opportunistic visual assessment across the entire LSMOC ROW (on-going throughout operations phase) as well as annual targeted visual assessment in areas adjacent to roads, quarries, and other disturbed areas. When remedial revegetation works are required after channel operation, follow-up monitoring of revegetation outcomes will include a survey for weed establishment.

Any detection of Tier 1 noxious weed or Category 1 invasive species will be immediately reported to the Manitoba Invasive Species Council and uploaded to the early detection and distribution mapping system (EDDMapS) for the Prairie Region (Manitoba and Saskatchewan). Weed control activities will be documented and reported on annually, complete with results from follow-up monitoring and assessment of treatment efficacy.

13.1.4 Thresholds for Action

The management threshold for weed control action will depend on the species of weed detected. Any Tier 1 noxious weed or Category 1 invasive species detected will be destroyed or eradicated immediately upon discovery. Identification of any Tier 2 noxious weed or Category 2 invasive species will prompt follow-up investigation to determine the full extent and distribution of the weed population, followed by an appropriate treatment response. Tier 3 species detected on the LSMOC ROW will be monitored in an on-going fashion. Where it is determined that these species present a threat to native vegetation communities, or the successful establishment of desirable cover vegetation, appropriate treatment response will be implemented.

13.1.5 Treatment Approaches and Methods

Treatment approaches and methods to weed control will be developed on a site and situation-specific basis in response to the target species in question and will be influenced by the extent and distribution of the weed population. Weed control will be achieved by following integrated approaches that may include mechanical treatment (mowing, cutting, and cultivation), targeted herbicide application, and active revegetation. While prescribed burns are used as a management tool for native prairie grass stands, it is not anticipated that this would be a viable approach along the LSMOC, given site specific considerations and implications. In all cases, treatment approaches will seek to minimize impacts to non-target vegetation while

achieving maximum long-term control on the target species. Treatment approaches should be developed in consultation with professional personnel with local expertise in integrated weed management and weed control in natural settings and perennial grass stands.

13.1.6 Evaluation

Evaluation is a key component of the integrated weed management program for the operation and maintenance phase. Weed control activities will be evaluated during follow-up monitoring to determine if additional measures are required and to inform future management and treatment approaches through the adaptive management framework.

13.2 Vegetation Management

As the LSMOC ROW is revegetated and construction activities subside, the site will enter a period of naturalization where species that are adapted to the prevailing site conditions will begin to colonize the site. The adjacent forested environments will act as a catalyst for the encroachment of woody vegetation along the ROW peripheries and in places of higher regular soil moisture. Over time, the control of woody species may be required to allow for safe and efficient operation of the channel. As the channel is operated, impacts to cover vegetation may occur, prompting remedial seeding.

13.2.1 Remedial Revegetation

When channel operation results in the die-off of established cover vegetation, some degree of remedial seeding may be required to mitigate the potential for erosion. The approach to remedial seeding will depend on the site conditions once the water levels drop for a prolonged period. Post-operation monitoring and site assessment, conducted once there is no projection of additional flooding, will inform all subsequent activities. If site assessments suggest that the reasons for vegetation cover failure cannot be overcome, alternative long-term solutions may be considered. Remedial activities will reflect site conditions at the time of assessment and are subject to change if remedial activities are not implemented in a timely fashion. Greatest efficiencies and most reliable revegetation outcomes are realized when small disturbances are corrected upon their detection. Small impacts to vegetation left un-corrected can quickly degrade resulting in more costly and time-consuming remedial work. Recommended management thresholds for remedial revegetation activities are described in Section 18.0.

13.2.2 Channel Maintenance

Over time, naturally establishing woody vegetation along the channel may require management to ensure this vegetation does not impact its hydraulic function. Willow (*Salix spp*.) and poplar (*Populus spp*.) species, in particular, are common pioneering species along water conveyance and drainage features where soils are wet but periodically dry down.

14.0 MONITORING

Revegetation monitoring will be conducted for construction and operation phases to monitor the condition of cover vegetation and to monitor for project impacts to adjacent vegetation and plant communities.

During construction and revegetation, cover establishment will be monitored to ensure that surface erosion and sedimentation are controlled. Likewise, the LSMOC ROW and some adjacent areas will be monitored to mitigate the risk of noxious or invasive non-native plant species establishment during this phase. Adjacent native plant communities will be monitored for changes in composition and structure.

During operations, cover vegetation will be monitored after channel operation to detect any loss of perennial cover due to flooding. Monitoring for non-native and invasive weed establishment are planned to continue during operations, and adjacent native plant communities may be monitored for changes in composition and structure.

All monitoring programs will be documented using a computer-based geographic information system (ESRI's ArcGIS) and will include GPS locations and photos of the monitoring sites and monitoring parameters.

Wetland mapping will be evaluated to identify potentially affected wetlands as further described in the Wetland Compensation Plan. MI will follow the requirements of the Manitoba *Water Rights Act* and its regulations for wetland compensation on this Project. Wetland compensation may include wetland creation, and wetland enhancement or restoration.

14.1 Construction Phase Monitoring

During the construction phase of the project, monitoring will be performed to evaluate and assess the condition of the LSMOC ROW cover vegetation as well as the potential impacts of the project on adjacent vegetation and plant communities.

14.1.1 Monitoring Cover Vegetation

The establishment and condition of cover vegetation will be closely monitored throughout the site revegetation process to ensure any potential issues are detected and acted upon rapidly. The entire LSMOC ROW will be sampled for plant establishment and condition, with a minimum of 30 sample quadrats (10 m x 10 m) being placed at a range of sites throughout the ROW including each active revegetation zone as well as natural revegetation areas. Surveys will be conducted twice annually, in June and September, and biennial reporting will be provided. Information collected during revegetation monitoring includes:

- species
- seedling density
- percent live cover
- percent dead cover
- percent bare ground

- photographs
- site conditions (including visible dust deposits, erosion and weed presence)

The introduction of non-native and invasive species will be monitored through opportunistic visual assessments across the entire LSMOC ROW during regular environmental monitoring duties. Any detection of invasive species will be reported immediately to allow for rapid response and remedial action. Information that will be collected whenever weeds are detected includes:

- species of weed
- extent of weed cover (by species)
- full description of existing vegetation
- site conditions
- geo-referenced location
- photography

14.1.2 Monitoring for Effects on Vegetation

Monitoring will describe baseline conditions and track changes in community composition over time, allowing an accurate description of the effects of LSMOC on adjacent vegetation communities. The vegetation monitoring program includes 15 permanent sample transects running perpendicular to the LSMOC ROW. Permanent sample transects are situated strategically to capture the full diversity of vegetation community types present along the LSMOC ROW while accounting for relative abundance of each community type. Baseline information on vegetation community structure will be collected at each selected permanent sample location, and again once annually, within a two-week window during the summer (July 15-30) for the duration of the construction phase. Site photographs will be taken and site conditions will be described, including comments on visible dust deposits, erosion, and weed presence. Parameters that will be measured include:

- species
- diameter at Breast Height (DBH)
- percent alive canopy
- score

To monitor for the invasion and establishment of non-native invasive or weed species, surveys will be conducted twice annually during the LSMOC construction phase. These will focus on native vegetation communities adjacent to haul roads, roads, quarry and borrow areas and other areas identified as having a high likelihood of weed invasion. The first survey will occur between June 15-30 and the second will occur from August 1-15 to capture the full range of cool and warm season weeds that may establish. To maximize the area covered by each survey, visual assessment (presence/absence) as described by meander surveys throughout identified high likelihood areas will be used. Information that will be collected whenever weeds are detected includes:

- species of weed

- extent of weed cover (by species)
- full description of existing vegetation
- site conditions
- geo-referenced location
- photography

14.2 Operations Phase Monitoring

During the operations phase of the Project, monitoring will be performed to assess the condition of the LSMOC ROW cover vegetation following channel operation, as well as to evaluate the potential impacts of the project on adjacent vegetation and plant communities.

14.2.1 Vegetation Condition Following Channel Operation

Monitoring and assessment of vegetation conditions should be completed three weeks after high water levels have receded. This delay in monitoring will allow any live cover vegetation to re-sprout and an accurate assessment of any vegetation dieback can be made. Since the effects of flooding will be confined to the channel side slopes, all monitoring activities related to channel operation will be restricted to this area. Monitoring efforts will seek to achieve full coverage of the channel alignment, when possible. Aerial imagery or the use of a drone may be used to expedite initial monitoring, but follow-up ground monitoring is required for any areas with significant vegetation die-back. Information collected during post-operation monitoring includes:

- species
- height
- number of live plants (by species)
- number of dead plants (by species)
- percent cover live plants (by species)
- percent cover dead plants (by species)
- photographs
- site conditions (including erosion and weed presence)

14.2.2 Effects on Vegetation

Operations phase monitoring will track changes in adjacent community composition over time, allowing an accurate description of the effects of the LSMOC on adjacent vegetation communities. The vegetation monitoring program includes 15 permanent sample transects running perpendicular to the LSMOC ROW. Permanent sample transects will be situated strategically to capture the full diversity of vegetation community types present along the LSMOC ROW while accounting for relative abundance of each community type.

Information on vegetation community structure will be collected at each selected permanent sample location annually within a two-week window during the summer (July 15-30) for up to the first five years after

construction has completed. Following this annual monitoring phase, consideration should be given to reducing sampling frequency to a bi-annual interval. During monitoring, site photographs will be taken and site conditions will be described, including comments on visible dust deposits, erosion, and weed presence. Parameters that will be measured include:

- species
- height
- diameter at breast height (DBH)
- percent alive canopy
- health score

Changes in hydraulics that may affect wetland function will be assessed against the baseline conditions to confirm EIS predictions.

The operations phase monitoring approach for introduction of non-native and invasive species will be informed by the outcomes of site revegetation and the associated monitoring. If active infestations of listed noxious weeds are present on or near the LSMOC PDA biennial monitoring as described in Section 15.1.2 shall continue. Once listed noxious weeds or invasive species are eliminated from site, long-term monitoring can shift to an annual interval. Surveys will follow a visual assessment approach to maximize area coverage. Visual assessments of pre-determined locations will be conducted, and opportunistic observations of weed establishment during normal site visits and inspections will be made. When monitoring has shifted to an annual interval, the period of June 15-30 will be used for field surveys to maximize the detection of problematic weed species. When detected the following information about non-native and invasive plant species will be recorded:

- species of weed
- extent of weed cover (by species)
- full description of existing vegetation
- site conditions
- geo-referenced location
- photography

15.0 ADAPTIVE MANAGEMENT AND FOLLOW-UP

15.1 General

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

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

As discussed in Section 12.6 of the EIS, vegetation monitoring will examine how predicted changes to vegetation species diversity and wetlands will be verified and how the effectiveness of mitigation strategies (e.g., revegetation) will be evaluated. As described in Section 9, shortly after construction, monitoring will be focused on assessing the rate of establishment of a healthy vegetation cover, and the quick recognition and mitigation of soil erosion. To avoid growth and establishment of regulated weeds, topsoil and subsoil piles will be monitored for weed growth during construction and corrective measures (e.g., spraying, mowing, hand-pulling) will be implemented where necessary. Areas of poor vegetation growth will also be identified for additional seeding.

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

15.2 Follow Up Response

As described in Section 15, monitoring will include monitoring of cover vegetation establishment and Project effects on vegetation. The data and analyses generated by monitoring will be used to provide information on the effectiveness of mitigation measures, aid in the validation of predicted residual effects, and provide data and results required for environmental licensing requirements. Management thresholds developed as part of the monitoring plan may utilize regulated criteria, input from stakeholders, and consideration of findings from applicable management plans. Based on the management thresholds and the results of the vegetation monitoring program, follow up activities will be implemented where conditions recorded appear to be outside of anticipated seasonal fluctuations of vegetation cover. For example, if there are areas where cover vegetation does not establish sufficiently, it may warrant remedial action. If certain grass species are documented to better perform in certain locations/situations than other planted species, future seed mixes can be adjusted to include higher rates of the successful species.

15.2.1 Construction Phase

During the construction phase observations on the condition of the cover vegetation and adjacent plant communities may prompt remedial revegetation activities, or corrective weed control treatments. At the end of the first growing season, areas seeded to perennial vegetation should show a minimum of six mature grass seedlings per 0.1 m^2. Areas that do not meet these criteria may warrant re-enforcement seeding or full re-seeding during the next available seeding window. In the natural revegetation zones, revegetation mitigation actions will be triggered if after one full growing season, no native vegetation has established, and active soil erosion is observed.

Re-enforcement seeding should only be done by drill seeding to limit disturbance to other seedlings present while full re-seeding can be done following either method as described in Section 14.2.1. Areas with insufficient perennial cover should be protected by seeding a temporary cover crop until they can be seeded to perennial cover. Follow-up monitoring and remedial revegetation activities shall be continued until sufficient cover has established to mitigate the risk of erosion.

The management threshold for weed control mitigation action will depend on the species of weed detected. Tier 1 noxious weeds or Category 1 invasive species detected should be destroyed or eradicated immediately upon discovery. Identification of Tier 2 noxious weeds or Category 2 invasive species should prompt follow-up investigation to determine the full extent and distribution of the weed population, followed by an appropriate treatment response. Tier 3 species detected on the LSMOC ROW will be monitored and if it is determined that these species present a threat to native vegetation communities, or the successful establishment of desirable cover vegetation, appropriate treatment response will be implemented.

Treatment approaches and methods to weed control will be developed on a site and situation-specific basis in response to the target species in question and will be influenced by the extent and distribution of the weed population. Weed control will follow integrated approaches that will include mechanical treatment (mowing, cutting, and cultivation), targeted herbicide application, and active revegetation.

15.2.2 Operations Phase

During the operations phase monitoring, observations of the condition of the cover vegetation following channel operation may prompt remedial revegetation activities, or corrective weed control treatments. Thresholds for remedial revegetation activities following channel operation will depend on both the extent of vegetation dieback as well as the risks associated with erosion. Remedial revegetation activities will be required in sections of the channel side slopes if:

- more than 20% of the vegetative cover has been lost and active erosion is occurring, or
- more than 40% of the vegetation cover has been lost, regardless of active erosion.

The following recommendations are meant to guide decision making where the objective is re-establishing cover vegetation that was lost following channel operation. These thresholds should be continually revisited following channel operation to adjust and optimize remedial responses based on evaluation of the effectiveness of remedial activities.

Dieback <20%

- Do nothing unless significant active erosion is occurring. Correct erosion through surface preparation and seeding.

Dieback 20-40%

- Wait and see unless significant active erosion is occurring. Correct erosion through surface preparation and seeding.

Dieback >40%,

- When plant dieback without excessive soil erosion is encountered, direct seeding priority areas with a drill seeder is the preferred method for remedial seeding. The drill seeder can be engaged and disengaged as machinery passes through vegetative cover and seeding can target priority areas.
- If soils have been eroded in areas of plant dieback, soil preparation may need to take place prior to seeding work. The amendment of eroded soils with peat moss may be required prior to seeding. In these cases, site conditions will typically favour broadcast seeding methods.
- The assessment of plant species dieback will inform adjustments to the remedial seed mix design. Seed mix rates and species composition will be adjusted accordingly based on the how the vegetative cover responds to flooding

While monitoring for effects to adjacent plant communities, detections of non-native invasive or weed species may prompt corrective weed control. The management thresholds for weed control mitigation action will depend on the species of weed detected. Management thresholds and mitigation actions during the operations phase will remain consistent with those described in Section 18.1.1.

Finally, in some cases, there may be a need for vegetation management due to safety, access, and operational considerations. Control of woody vegetation in the project area is warranted when it:

- impedes safe use of the Project site,

- restricts site access, or
- impacts hydraulic conditions within the channel outside of designed operational range.

In order to manage the encroachment of woody species, it is recommended that MI follow an Integrated Vegetation Management (IVM) strategy to control woody plant growth as required. Typically, an IVM includes the following principles (Manitoba Hydro 2019):

- remove tall, woody vegetation where required
- encourage the establishment of low-growing, ecologically appropriate plant species that can inhibit the establishment of taller woody species
- allow for a shared use of the project area with local peoples
- respect culturally important plant species and potential harvesting sites

There are several options for controlling woody vegetation in the LSMOC ROW; they include mowing, brushing, girdling, and blading. Another option for control is the use of herbicide application. Selection of herbicides and application methods for vegetation management must be considerate of the proximity to the waterway and potential for downstream transport to Lake Winnipeg. Methods and products should be developed in consultation with a professional agronomist in compliance with applicable provincial and federal regulations. Broadcast application methods must be avoided in proximity to the channel. There are numerous methods to conduct herbicide applications on woody vegetation; they include the following application options:

- basal bark method
- cut surface
- selective foliar
- broadcast foliar
- injections

16.0 REFERENCES

16.1 Literature Citation

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 1998. COSEWIC assessment and status report on the Northern Leopard Frog (*Rana pipiens*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 40 pp.

COSEWIC. 2014a. COSEWIC assessment and status report on the gypsy cuckoo bumble (*Bombus bohemicus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 56 pp.

COSEWIC. 2014b. COSEWIC assessment and status report on the wolverine (*Gulo gulo*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 76 pp.

COSEWIC. 2015. COSEWIC assessment and status report on the yellow-banded bumble bee (*Bombus terricola*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 60 pp.

COSEWIC. 2016. COSEWIC assessment and status report on the transverse lady beetle (*Coccinella transversoguttata)* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 57 pp.

Manitoba Infrastructure, 2020. Lake Manitoba and Lake St. Martin Outlet Channels Project Environmental Impact Statement (EIS): Volume 3 Biophysical Effects Assessment. March 2020. Pp. 354.

Manitoba Hydro, 2019. Bipole III Transmission Project – Integrated Vegetation Management Plan. Licensing and Environmental Assessment Department.

APPENDIX 1A

Plant Species Listed in the *Noxious Weeds Act* (NWA) and Invasive Species Council of Manitoba (ISCM) as of 2020

Designated Tier 1 Noxious Weeds Common name	Scientific name	Area for which Designation applies
Amaranth, Palmer	*Amaranthus palmeri*	Whole province
Bartsia, red	*Odontites vernus*	All areas of the province outside the Municipality of Bifrost-Riverton and the Rural Municipalities of Armstrong, Fisher, Gimli, Rockwood, St. Andrews and St. Clements
Crupina, common*	*Crupina vulgaris*	Whole province
Cupgrass, woolly *	*Eriochloa villosa*	Whole province
Goatgrass, jointed*	*Aegilops cylindrica*	Whole province
Hawkweed, orange	*Hieracium aurantiacum*	Whole province
Hogweed, giant	*Heracleum mantegazzianum*	Whole province
Hound's-tongue	*Cynoglassum officinale*	Whole province
Knapweed, diffuse*	*Centaurea diffusa*	Whole province
Knapweed, Russian*	*Acroptilon repens*	Whole province
Knapweed, spotted*	*Centaurea stoebe*	Whole province
Knapweed, squarrose	*Centaurea virgata*	Whole province
Knotweed, Japanese	*Fallopia japonica*	Whole province
Mile-a-minute weed*	*Persicaria perfoliata*	Whole province
Mustard, garlic	*Allaria petiolata*	Whole province
Patterson's curse*	*Echium plantagineum*	Whole province
Pigweed, smooth	*Amaranthus hybridus*	Whole province
Saltcedar*	*Tamarix ramosissima*	Whole province
Star-thistle, yellow*	*Centaurea solstitialus*	Whole province
Tussock, serrated	*Nassella trichotoma*	Whole province
Waterhemp, tall	*Amaranthus tuberculatus*	Whole province
Designated Tier 2 Noxious Weeds		**Area for which Designation applies**
Alyssum, hoary	*Berteroa incana*	Whole province
Baby's-breath	*Gypsophila paniculata*	Whole province
Bartsia, red**	*Odontites vernus*	Municipality of Bifrost-Riverton and the Rural Municipalities of Armstrong, Fisher, Gimli, Rockwood, St. Andrews and St. Clements
Bouncingbet**	*Saponaria officinalis*	Whole province
Brome, downy**	*Bromus tectorum*	Whole province
Brome, Japanese**	*Bromus japonicas*	Whole province
Campion, bladder	*Silene vulgaris*	Whole province
Chamomile, scentless** ¥	*Matricaria perforata*	Whole province
Common reed, invasive**	*Phragmites australis australis*	Whole province
Daisy, ox-eye** ¥	*Leucanthemum vulgare*	Whole province
Nutsedge, yellow	*Cyperus esculentus*	Whole province
Scabious, field**	*Knautia arvensis*	Whole province
Spurge, Cypress	*Euphorbia cyparissias*	Whole province
Spurge, leafy**	*Euphorbia esula*	Whole province
St. John's-wort**	*Hypericum perforatum*	Whole province
Tansy, common**	*Tanacetum vulgare*	Whole province
Thistle, nodding** ¥	*Carduus nutans*	Whole province
Toadflax, Dalmatian**	*Linaria dalmatica*	Whole province
Designated Tier 3 Noxious Weeds **Common name**	**Scientific name**	**Area for which Designation applies**
Absinth	*Artemisia absinthium*	Whole province
Barberry	*Berberis vulgaris*	Whole province
Barley, foxtail	*Hordeum jubatum*	Whole province
Bellflower, creeping	*Campanula rapunculoides*	Whole province
Buckthorn, European**	*Rhamnus cathartica*	Whole province
Burdock, common	*Arctium minus*	Whole province
Burdock, greater ¥	*Arctium lappa*	Whole province
Burdock, woolly	*Arctium tomentosum*	Whole province
Campion, biennial	*Silene dioica*	Whole province
Catchfly, night-flowering	*Silene noctiflora*	Whole province
Cleavers	*Galium aparine*	Whole province
Cleavers, false	*Galium spurium*	Whole province
Cockle, white	*Silene alba*	Whole province

Designated Tier 3 Noxious Weeds Common name	Scientific name	Area for which Designation applies
Dandelion, common*** ¥	*Taraxacum officinale*	Whole province
Dodder	genus *Cuscuta*	Whole province
Fleabane, Canada	*Conyza canadensis*	Whole province
Flixweed	*Descurainia sophia*	Whole province
Hawk's-beard, narrow-leaved	*Crepis tectorum*	Whole province
Hemlock, poison	*Conium maculatum*	Whole province
Hemp-nettle ¥	*Galeopsis tetrahit*	Whole province
Hoary-cress	*Cardaria draba*	Whole province
Jimsonweed	*Datura stromonium*	Whole province
Kochia	*Kochia scoparia*	Whole province
Lamb's quarters	*Chenopodium album*	Whole province
Lettuce, prickly	*Lactuca serriola*	Whole province
Milkweed, common	*Asclepias syriaca*	Whole province
Milkweed, showy	*Aslepias speciosa*	Whole province
Mustard, wild	*Sinapis arvensis*	Whole province
Nightshade, American black	*Solanum americanum*	Whole province
Nightshade, cutleaf	*Solanum triflorum*	Whole province
Nightshade, hairy	*Solanum sarachoides*	Whole province
Parsnip, wild ¥	*Pastinaca sativa*	Whole province
Ragweed, common	*Ambrosia artemisiifolia*	Whole province
Ragweed, false	*Iva xanthifolia*	Whole province
Ragweed, giant	*Ambrosia trifida*	Whole province
Sow-thistle, annual	*Sonchus oleraceus*	Whole province
Sow-thistle, perennial ¥	*Sonchus arvensis*	Whole province
Sow-thistle, spiny annual	*Sonchus asper*	Whole province
Stinkweed	*Thlaspi arvense*	Whole province
Stork's bill	*Erodium cicutarium*	Whole province
Thistle, bull	*Cirsium vulgare*	Whole province
Thistle, Canada*** ¥	*Circium arvense*	Whole province
Thistle, Russian	*Salsola pestifer*	Whole province
Toadflax, yellow**	*Linaria vulgaris*	Whole province
Water hemlock, bulb-bearing	*Cicuta bulbifera*	Whole province
Water hemlock, northern	*Cicuta virosa*	Whole province
Water hemlock, spotted	*Cicuta maculata*	Whole province
Water hemlock, western	*Cicuta douglasii*	Whole province
Whitetop, hairy	*Cardaria pubescens*	Whole province
Whitetop, lenspod	*Cardaria chalepensis*	Whole province
Category 1 Invasive Species not lsited by Noxious Weed Act		
Common name	**Scientific name**	
Purple nutsedge	*Cyperus rotundus*	Whole province
Kudzu vine	*Pueraria montana*	Whole province
Category 2 Invasive Species not lsited by Noxious Weed Act		
Blueweed	*Echium vulgare*	Whole province
Flowering rush	*Butomus umbellatus*	Whole province
Himalayan balsam	*Impatiens glandulifera*	Whole province
Purple loosetrife	*Lythrum salicaria*	Whole province

*Category 1 Invasive Species.

**Category 2 Invasive Species.

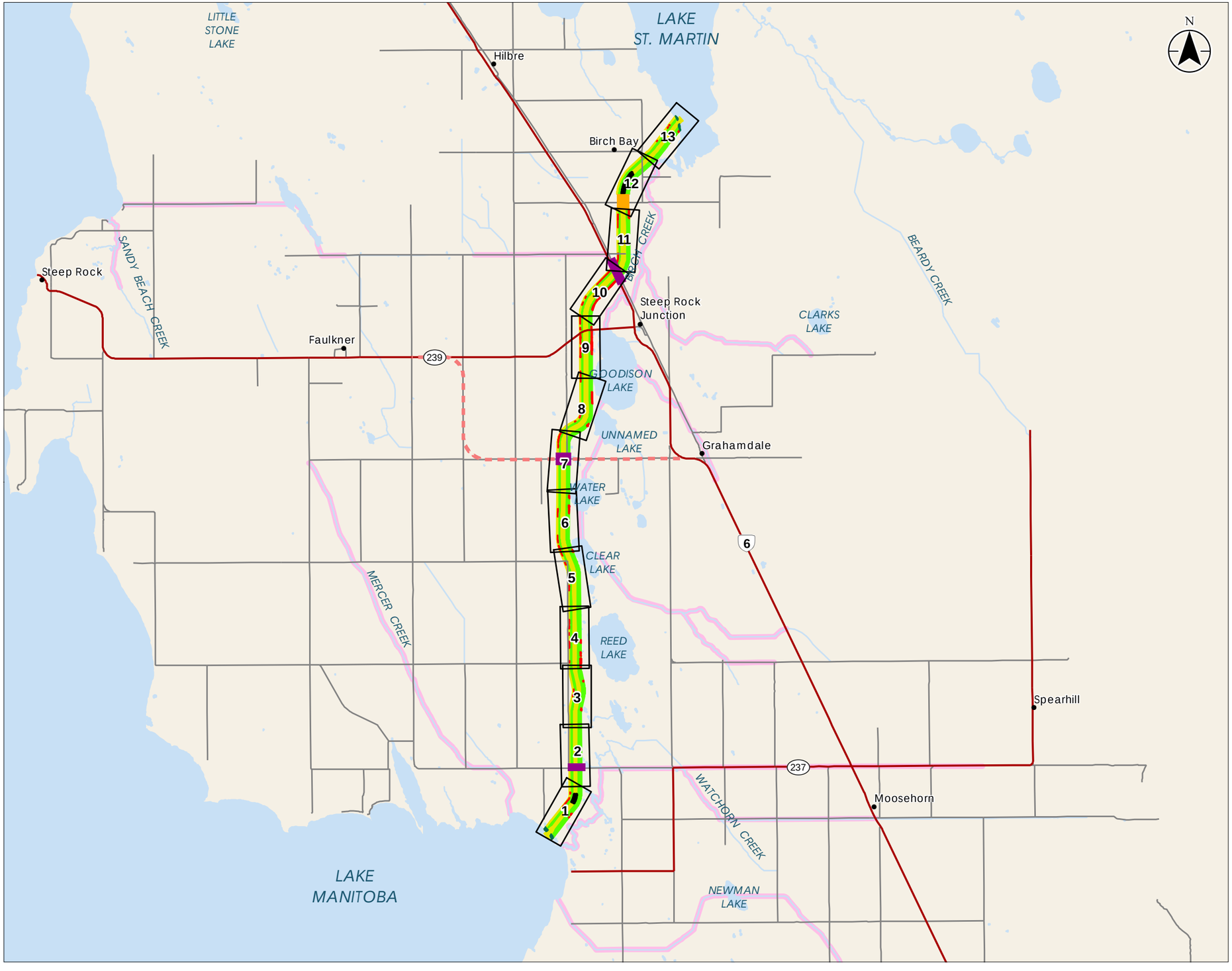
***Detected on LSMOC ROW during preliminary site investigations.

¥ Identified for LMOC ROW during a reconnaissance survey completed in August 2019 and based on available literature (SG Environmental 2016).

Hawkweed spp., water hemlock spp., and sow-thistle spp. are observed at LMOC ROW

APPENDIX 2A

LMOC Revegetation Map Book



Stantec

Project Infrastructure

- Proposed PR 239 Realignment
- Proposed Bridge
- Proposed Water Control Structure

Prescription Application

- Channel Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)
- Shoreline Prescription (Sensitive Site)
- Erosion Control (for wave action)

Temporary Seeding for Topsoil Stockpile Followed by Permanent Shrubland where Applicable

Landbase

- Community
- Highway
- Major Road
- Watercourse
- Provincial Waterway/Drain
- Waterbody
- 1 Mapbook Pages

0 2.5 5 Kilometres

1:125,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base features provided by the Government of Manitoba and the Government of Canada.

Project Location
Lake Manitoba and Lake St. Martin Outlets

111475107

Prepared by ACampigotto on 2020-09-11
Technical Review by NTache on 2020-09-11

Client/Project
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

Map No.
Cover Map - Page 1

Title
Revegetation Prescriptions
Mapbook Cover Map

DRAFT - FOR DISCUSSION PURPOSES ONLY

G:\...\GIS_Project_Folder\111475107_LakeManitobaOutlet\ArcMap\Revegetation\Contours Manitoba\Mt Revegetation Mapbook\Summary_20200911.mxd Revised: 2020-09-11 By: ACampigotto

530000

SW-31-26-8-W

NW-30-26-8-W

NE-31-26-8-W

LAKE MANITOBA

SE-31-26-8-W

NE-30-26-8-W

NW-32-26-8-W

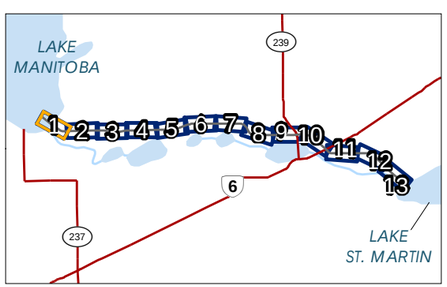
SW-32-26-8-W

SE-30-26-8-W

NW-29-26-8-W

530000

DRAFT



Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Sensitive Sites
- Coarse Materials (Sands)

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections
- Inlet Channel

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)
- Shoreline Prescription (Sensitive Site)
- Erosion Control (for wave action)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres

(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

Client/Project
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

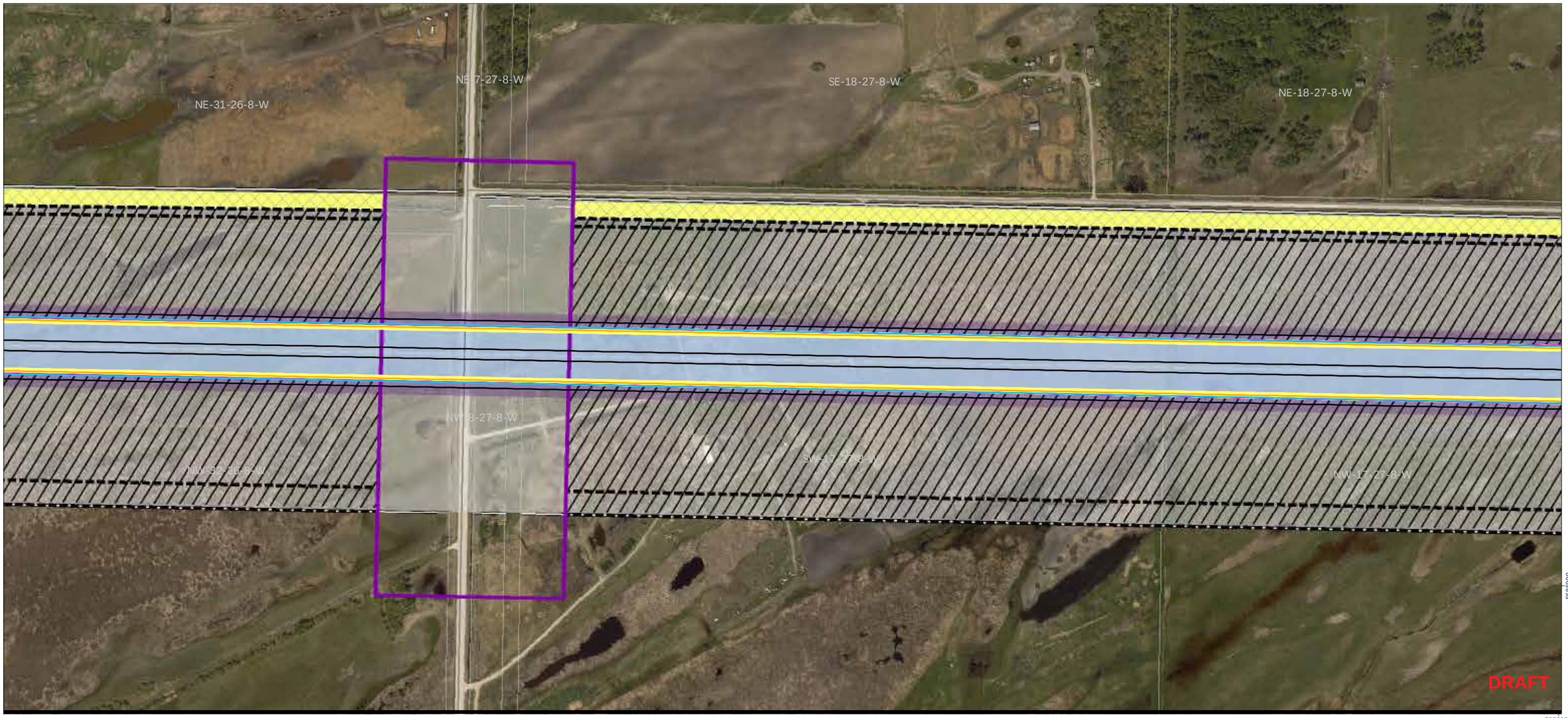
111475107 REVB

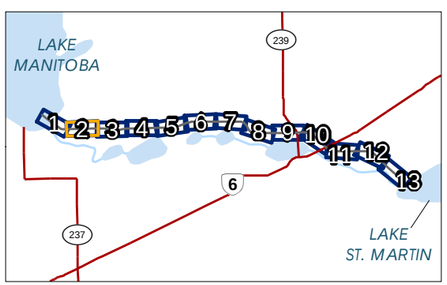
Figure No.
Figure 1- 1

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

C:\GIS Project Folder\111475107 - LakeManitobaOutlet\Arc\Map\Revegetation\Contracts Mapping\M Revegetation - PrescriptionLocations Manitoba 20200914.mxd Revised: 2020-09-14 By: ACamuccio





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI

*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Project Components
- Proposed Bridge

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres

(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

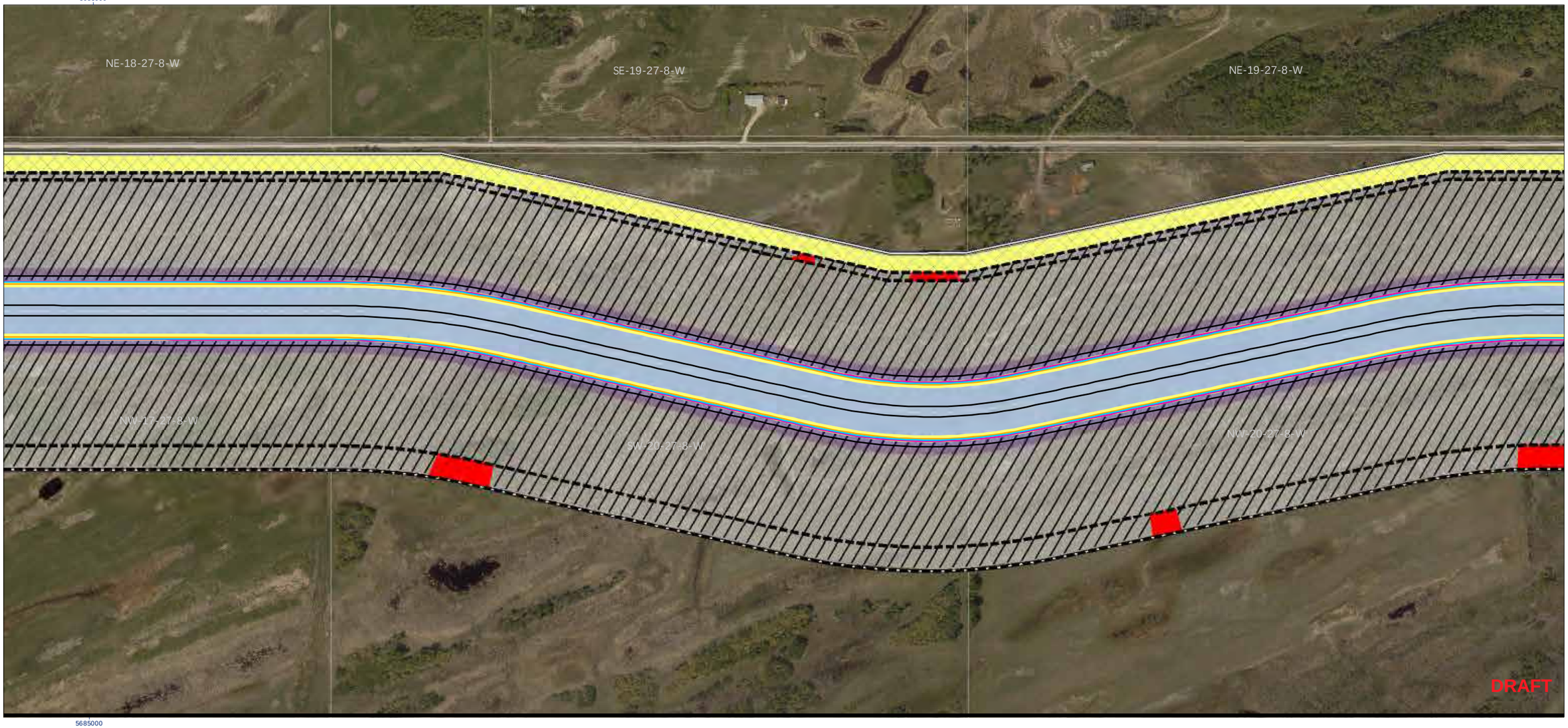
Client/Project
111475107 REVB
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

Figure No.
Figure 1- 2

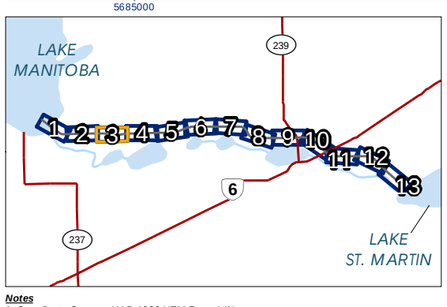
DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

5685000



5685000



Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

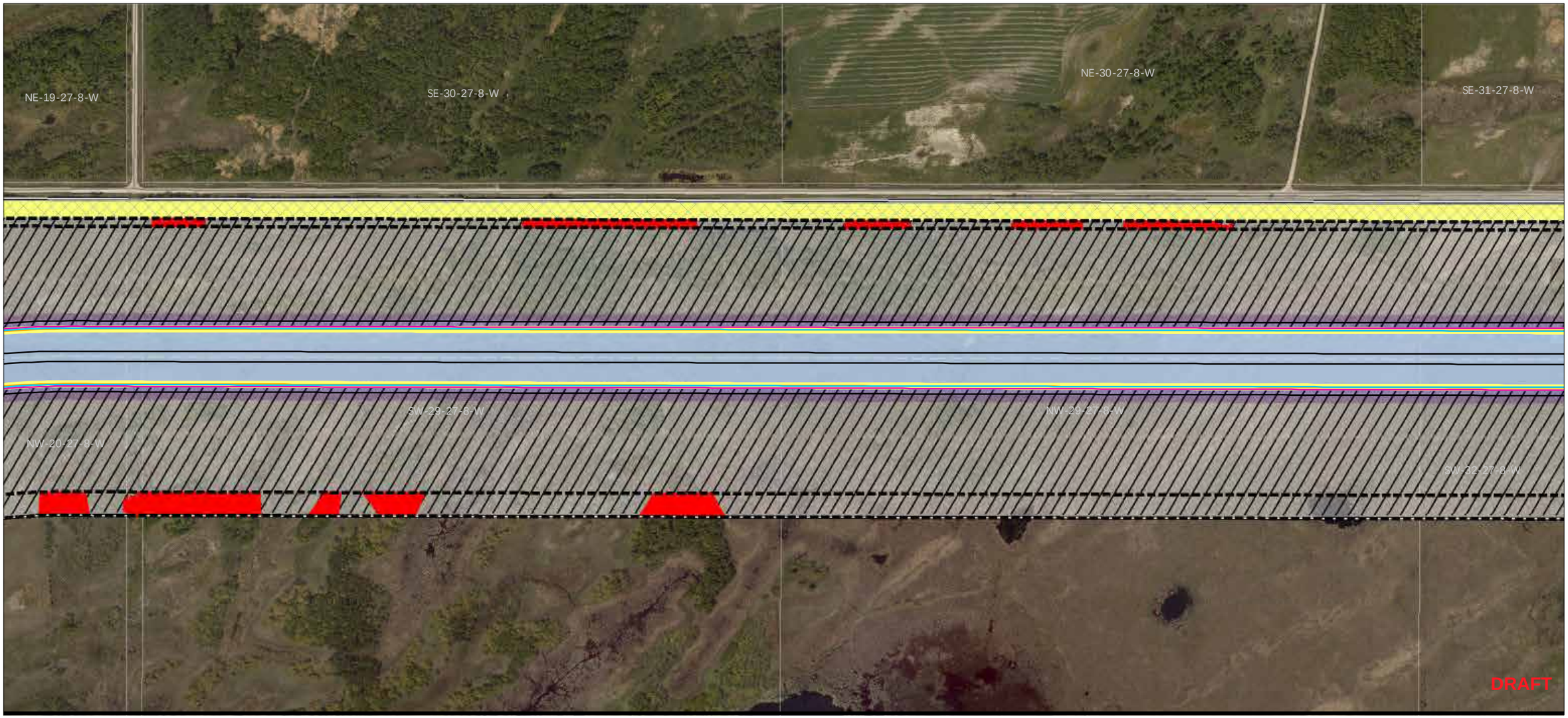
Client/Project
111475107 REVB
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

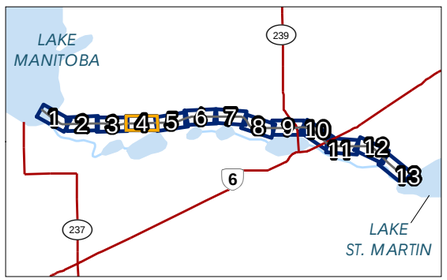
Figure No.
Figure 1- 3

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS_Project_Folder\111475107_LakeManitobaOutlet\Arc\Map\RevegetationConstraints_Mapbook\MI_RevegetationPrescriptionLocations_Mapbook_20200914.mxd Revised: 2020-09-14 By: ACamuccio





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

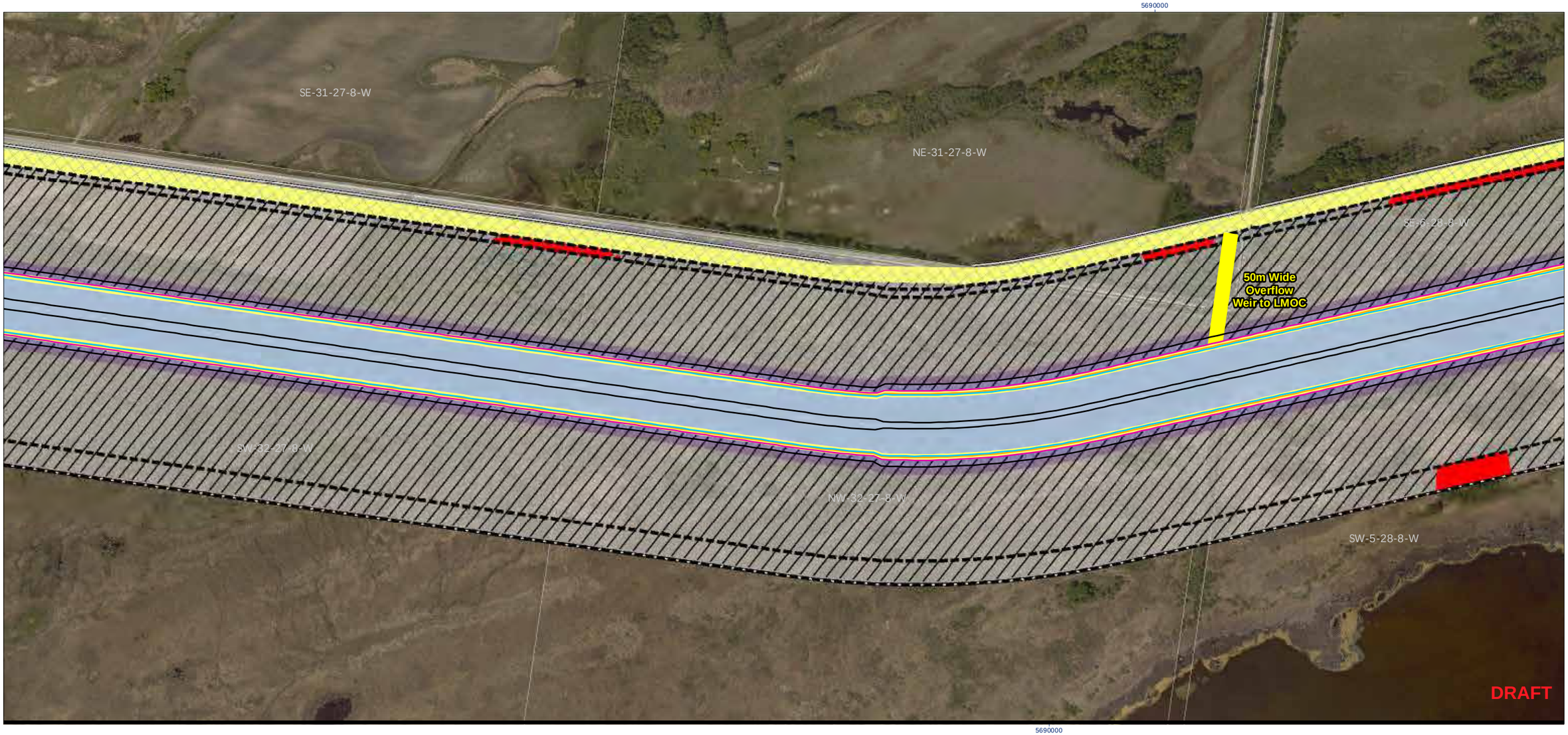
Client/Project
111475107 REVB
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

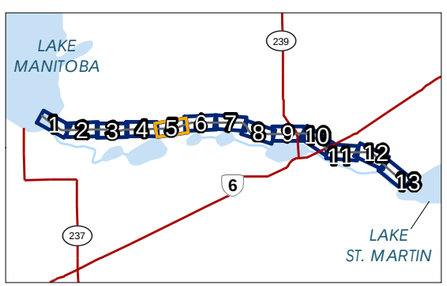
Figure No.
Figure 1- 4

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS\Project Folder\111475107_LakeManitobaOutlet\Arc\Map\RevegetationContrants Mapping\M_Revegetation_PrescriptionLocations_Manitoba_20200914.mxd Revised: 2020-09-14 By: ACampuzano





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI

*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer
- Potential Overflow Weir Location

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

Client/Project
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

111475107 REVB

Figure No.
Figure 1- 5

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS_Project_Folder\111475107_LakeManitoba\OutletAcrMap\Revegetation\Contents Mapping\MI_Revegetation_PrescriptionLocations_Manbook_20200914.mxd Revised: 2020-09-14 By: ACamundoto

530000

530000

SE-6-28-8-W

NE-6-28-8-W

SE-7-28-8-W

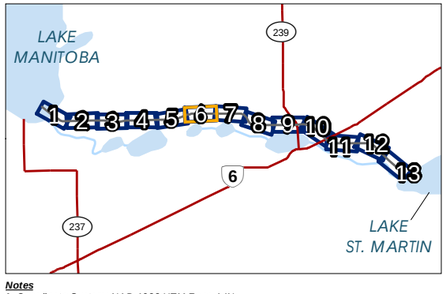
SW-5-28-8-W

NW-5-28-8-W

SW-8-28-8-W

WATER LAKE

DRAFT



Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres

(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

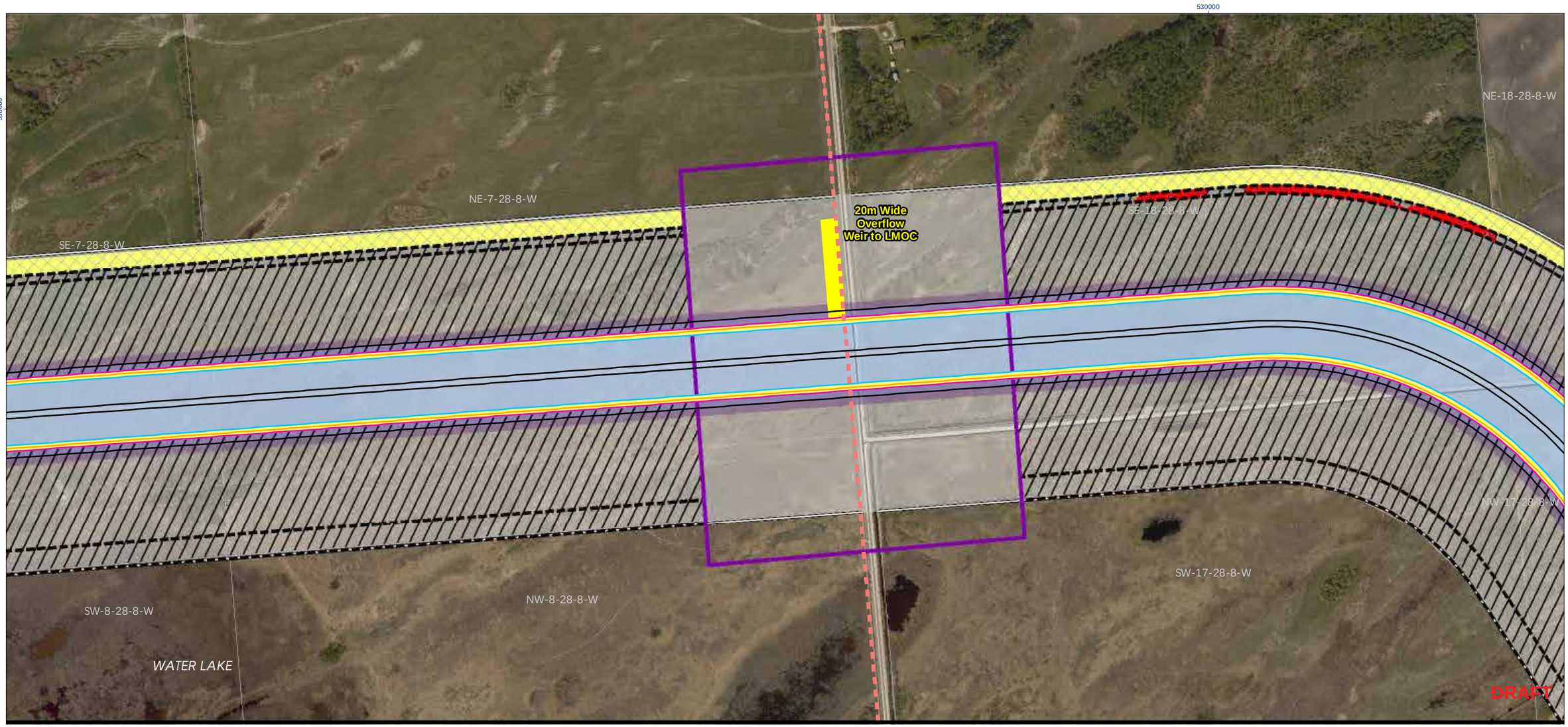
Client/Project
111475107 REVB
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

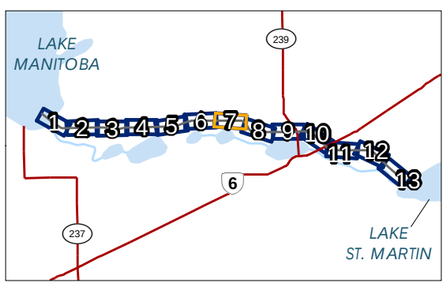
Figure No.
Figure 1- 6

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS_Project_Folder\111475107_LakeManitobaOutlet\ArcMap\RevegetationContracts Mapping\MI_RevegetationPrescriptionLocations_Mapbook_20200914.mxd Revised: 2020-09-14 By: ACamundoto





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI

*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer
- Potential Overflow Weir Location

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections
- Existing Transmission Line

Project Components
- Proposed Bridge
- Proposed PR 239 Realignment

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

Client/Project
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

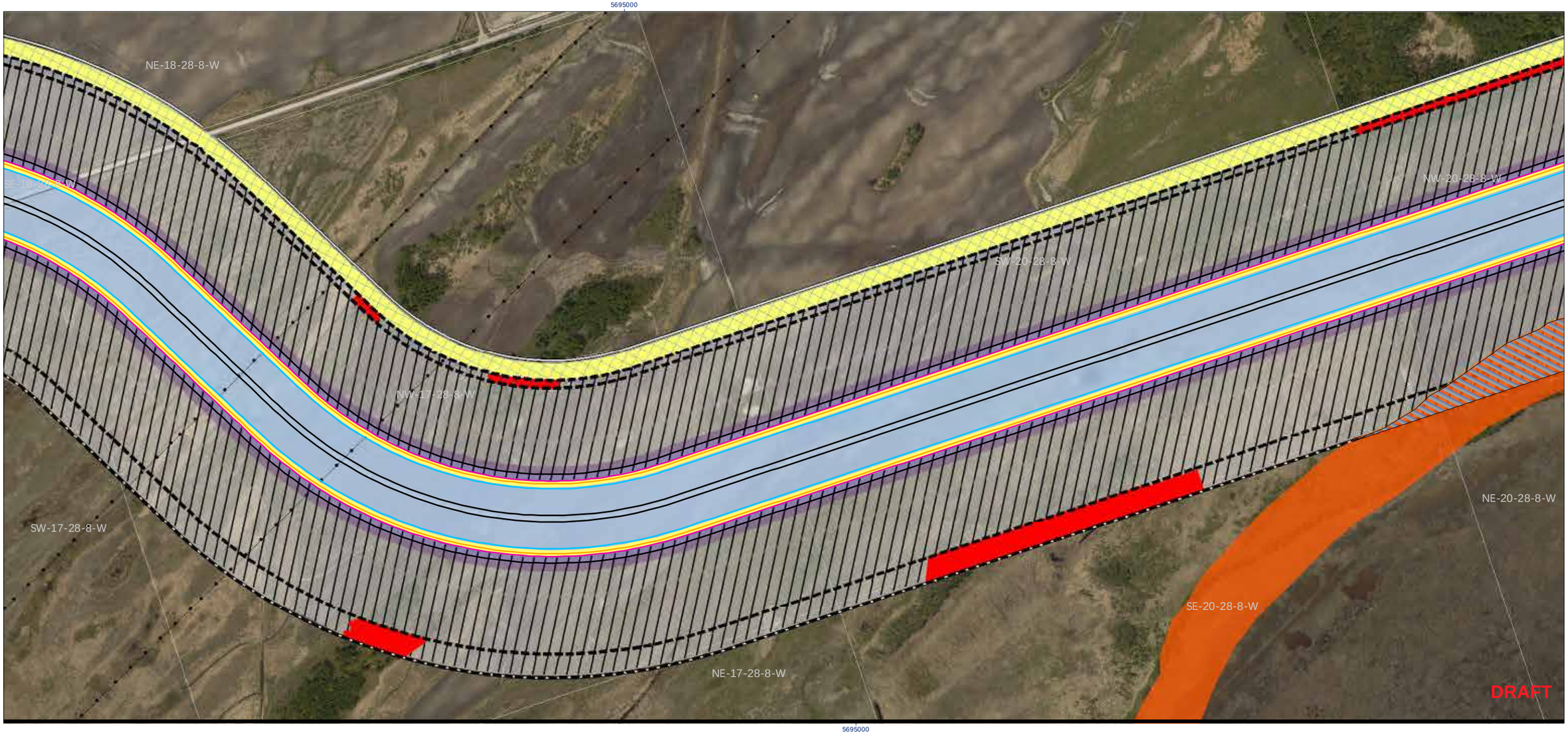
111475107 REVB

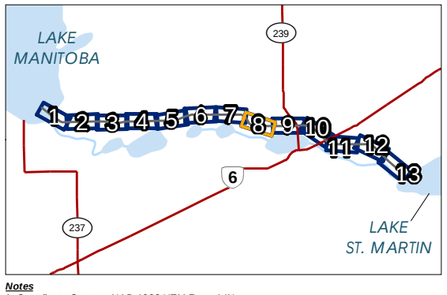
Figure No.
Figure 1- 7

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS_Project_Folder\111475107_LakeManitoba\Outlet\Arc\Map\Revegetation\Contronts Mapping\MI_Revegetation_PrescriptionLocations_Manbook_20200914.mxd Revised: 2020-09-14 By: ACamundoto





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI

*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Sensitive Sites
- Coarse Materials (Sands)

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections
- Existing Transmission Line

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)
- Erosion Control Mix

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres

(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

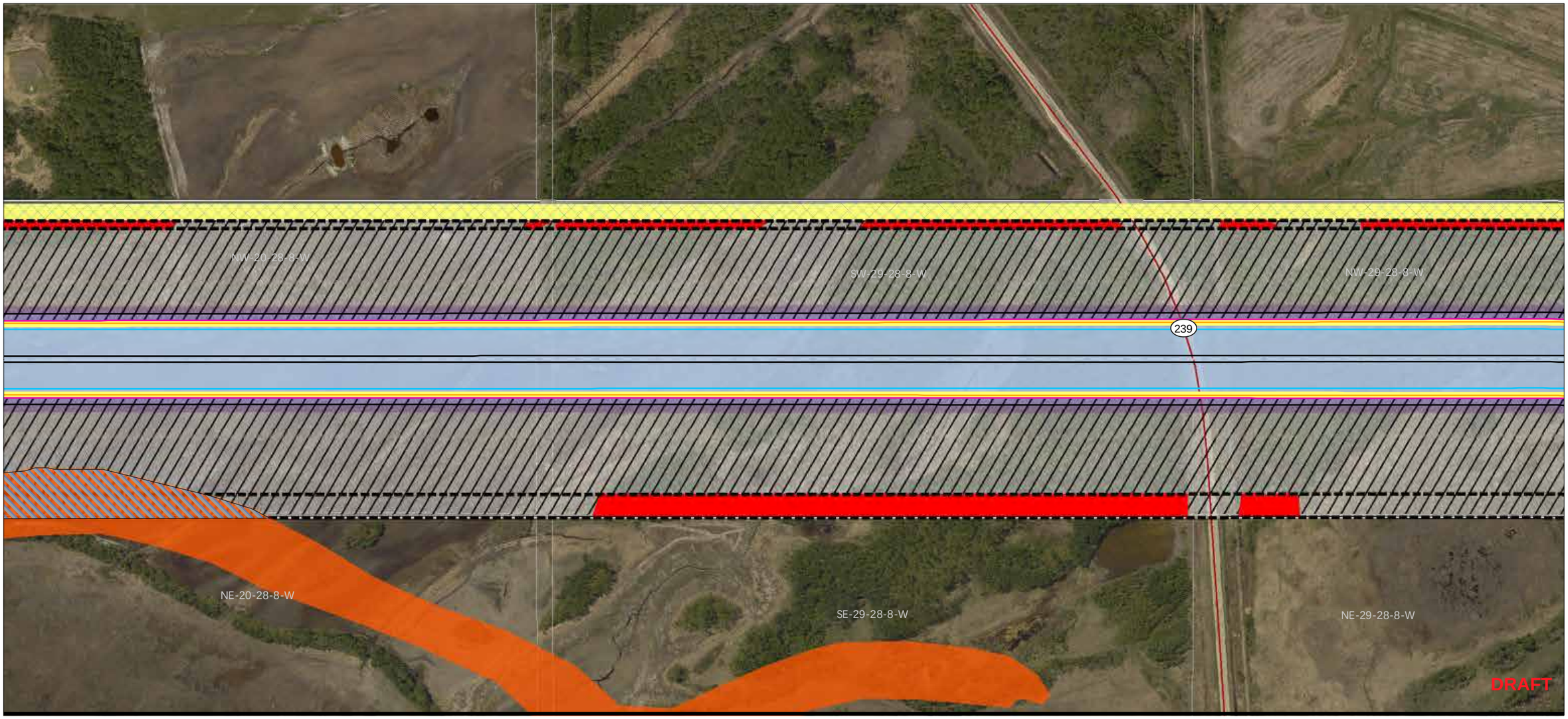
Client/Project
111475107 REVB
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

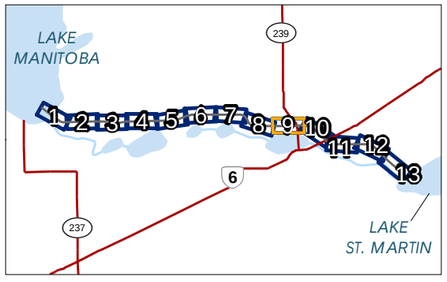
Figure No.
Figure 1- 8

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS_Project_Folder\111475107_LakeManitoba\OutletArcMap\RevegetationContraints Mapping\MI_Revegetation_PrescriptionLocations_Manbook_20200914.mxd Revised: 2020-09-14 By: ACamuccio





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Sensitive Sites
- Coarse Materials (Sands)

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)
- Erosion Control Mix

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

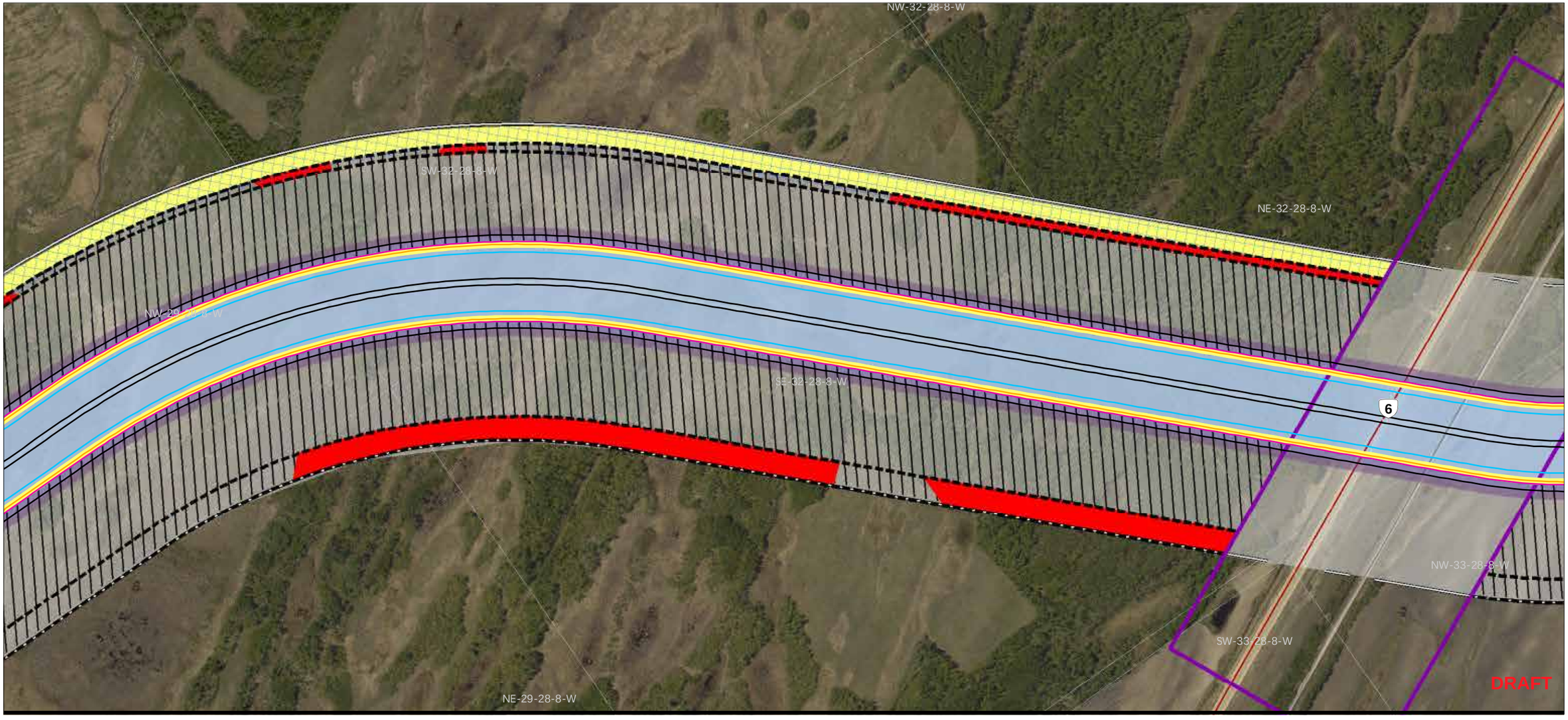
Client/Project
111475107 REVB
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

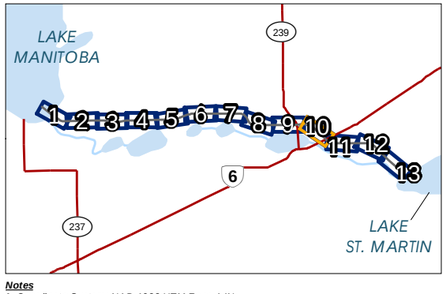
Figure No.
Figure 1- 9

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:_GIS_Project_Folder\111475107_LakeManitobaOutlet\ArcMap\RevegetationContraints.Mapping\M1_Revegetation_PrescriptionLocations_Mapbook_20200914.mxd Revised: 2020-09-14 By: ACampbell





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Project Components
- Proposed Bridge

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

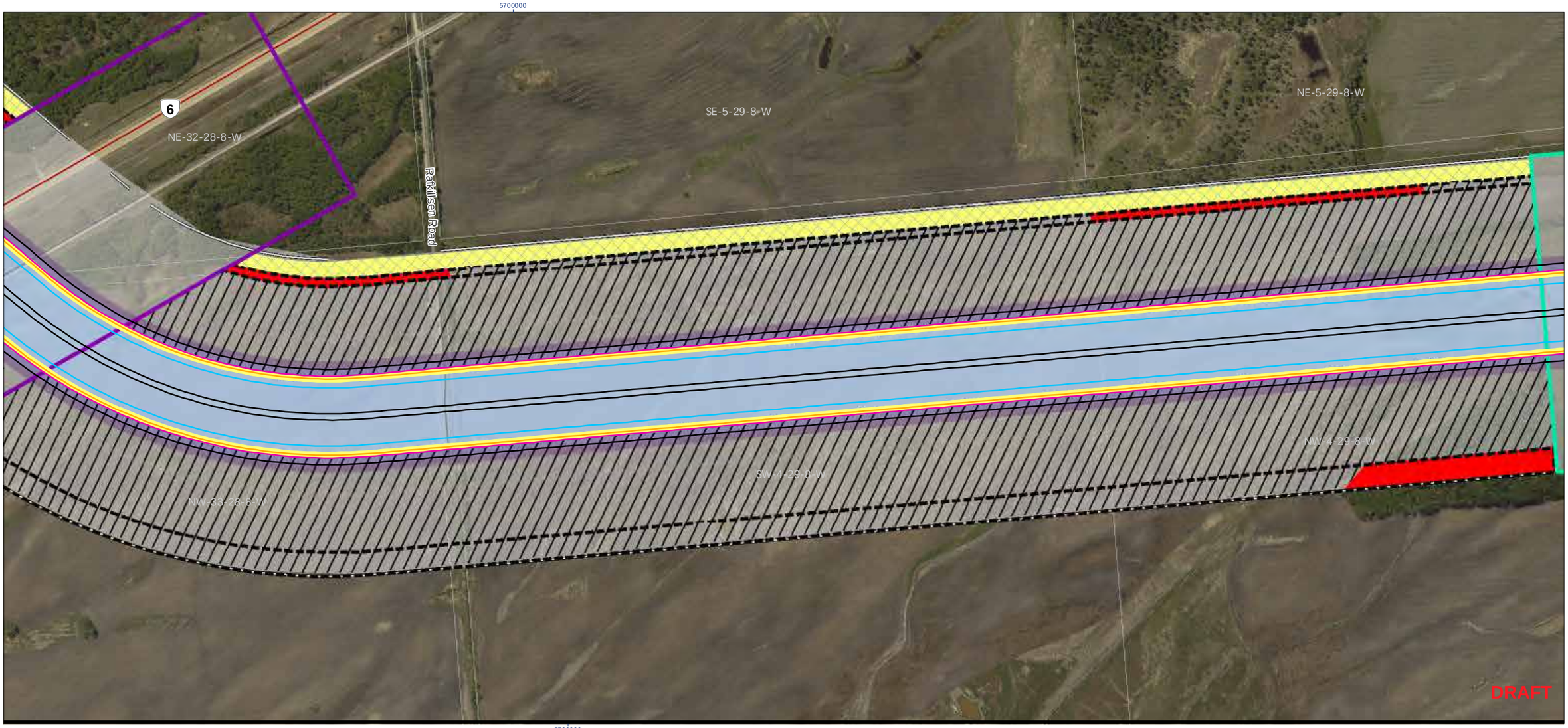
Client/Project
111475107 REVB
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

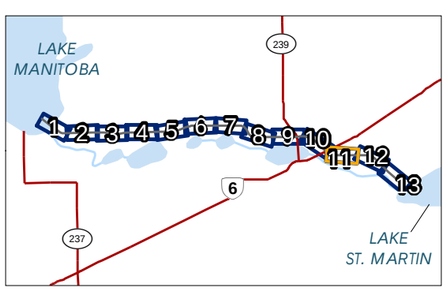
Figure No.
Figure 1- 10

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS_Project_Folder\111475107_LakeManitobaOutlet\Arc\Map\RevegetationContents Mapping\M_Revegetation_PrescriptionLocations_Mapbook_20200914.mxd Revised: 2020-09-14 By: ACamuccio





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI

*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Project Components
- Proposed Bridge
- Proposed Water Control Structure

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

Client/Project
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

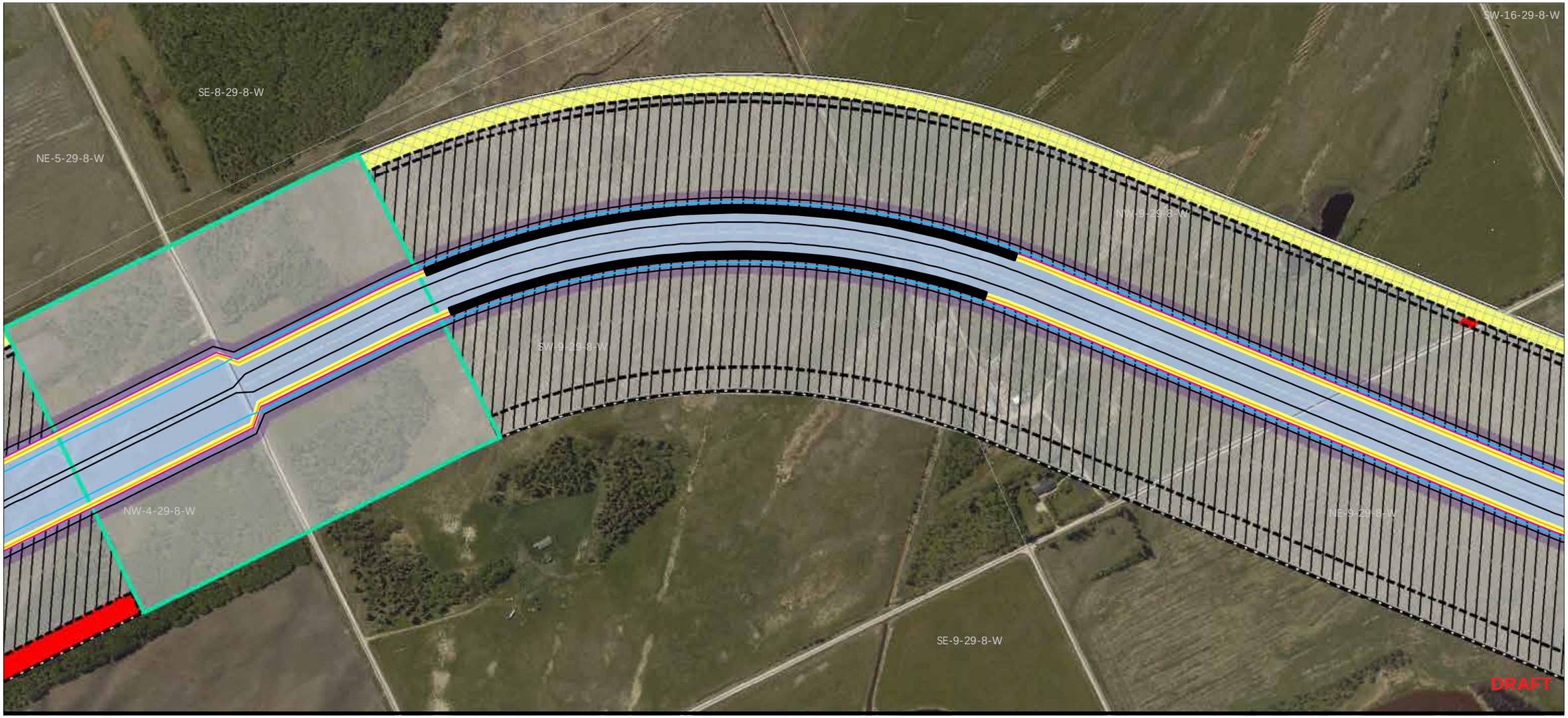
111475107 REVB

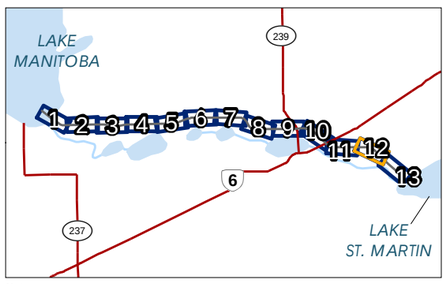
Figure No.
Figure 1- 11

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\...\GIS_Project_Folder\111475107_LakeManitobaOutlet\ArcMap\RevegetationConstraints Mapping\M_Revegetation_PrescriptionLocations_Manbook_20200914.mxd Revised: 2020-09-14 By: ACamuccio





Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections

Project Components
- Proposed Water Control Structure

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)
- Erosion Control (for wave action)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

Client/Project
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

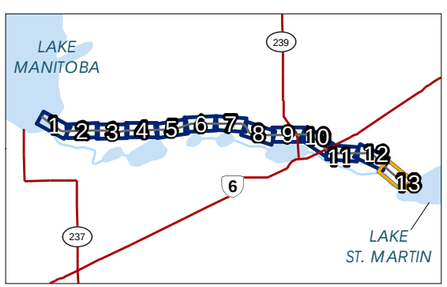
111475107 REVB

Figure No.
Figure 1- 12

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\GIS_Project_Folder\111475107_LakeManitobaOutlet\ArcMap\RevegetationConstraintsMapping\M_Revegetation_PrescriptionLocations_Manitoba_20200914.mxd Revised: 2020-09-14 By: ACamuccio



Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Stantec Consulting, Hatch, EcoLogic
3. Background: Air photo courtesy of MI
*Ground truthing required for confirmation of wetland areas (some wetlands on the map may not actually exist, or, some existing wetlands may not be identified on the map)

Legend

Latest Channel Design

Channel Design
- Top of Dike
- Invert

Water Levels
- Top Lake Level
- Bottom Lake Level
- Peak Flow

- Outside Drain - 30m buffer
- Topsoil Stockpile - Temporary Seeding Followed by Shrubland (RHWP Breeding Habitat) or Grassland
- Top of Dike buffer

Sensitive Sites
- Coarse Materials (Sands)

Original Channel
- Channel ROW Boundary
- Top of Channel
- Channel Centerline
- Channel / Drain Spoil Piles
- Channel
- Quarter Sections
- Outlet Channel

Prescription Application
- Channel and Outside Drain Wet/Dry
- Grassland
- Shrubland (RHWP Breeding Habitat)
- Shoreline Prescription (Sensitive Site)

Wet/Dry Prescription for the area between peak flow and bottom lake level, plus 1 m down from the bottom lake level

0 100 200 metres
(At original document size of 11x17)
1:5,000

N

Stantec

Project Location
Near Lake Manitoba & Lake St.Martin
Manitoba

Prepared by AC on 2020-09-14
TR by NT on 2020-09-14

Client/Project
Manitoba Infrastructure/Hatch Ltd.
Preliminary Engineering - Revegetation Management Plan for the Lake Manitoba Outlet Channel Project

111475107 REVB

Figure No.
Figure 1- 13

DRAFT - FOR DISCUSSION PURPOSES ONLY

Title
RVMP Revegetation Prescription Locations

G:\...\GIS_Project_Folder\111475107_LakeManitobaOutlet\ArcMap\RevegetationConstraints Mapping\M_Revegetation_PrescriptionLocations_Manbook_20200914.mxd Revised: 2020-09-14 By: ACampuzano

APPENDIX 2B

LMOC Revegetation Prescription Fact Sheets

Revegetation Prescription: Grassland

A mix of native and agronomic grasses on the spoil piles that are adjacent to farmland and within the assigned locations on RoW beyond the spoil piles.

Predicted Landuse	Hayland and support surrounding apiculture.

Site Preparation

Provide rough and loose soil placement. Apply 30 kg per ha seed mix through broadcast seeding. Spring planting. Required fertilizer application during broadcast seeding, 15-15-15 NPK.

Site information

Soil capping depth:	30 cm
Location on ROW:	KPs variable along full length of Channel ROW.
Landscape position:	On dikes and spoil of the channel and outside drain, and adjacent to farmer fields.

Management Considerations

On the dikes and spoils, limit tree growth through annual mowing. May require weed management.

Revegetation

Candidate Species

12% oats (*Avena sativa*)
15% fowl bluegrass (*Poa palustris*)
20% slender wheatgrass (*Elymus trachycaulus*)
20% tall wheatgrass (*Thinopyrum intermedium*)
20% sheep fescue (*Festuca ovina*)
10% timothy (*Phelum pretense*)
3% canada milk vetch (*Astragalus canadensis*)
Optional flowering species:
Monarda fistulosa (wild bergamot), *Rudbekia hirta* (black eyed susan), *Dalea purporea* (purple prairie clover)
Note: Species count and mix may vary depending on availability

Wildlife associations

Habitat Subtype: Prairie grassland.

Other associated species: Ground nesting birds including bobolink and short-eared owl, white tailed deer, butterflies.

Typical Drawing/Photograph

Revegetation Prescription: Erosion Control

Erosion control by seeding. Coco matting with seeding as an alternative.

Predicted Landuse	Recreational and other types of landuse covered under grassland, shoreline, and channel prescription fact sheets.

Site information

Soil capping depth: None unless decompaction not possible then 30 cm may be needed.

Location on ROW: (i) above water portion of the slopes of the channel and the slopes of the outside drain, along the slopes of the dikes and the channel and drain spoil piles, (ii) along the flat areas of the benches, top of dikes and channel, and top of drain spoil pile, and (iii) channel bends under potential wave action impact

Landscape position:

Site Preparation

If compaction density of the top 30-cm layer was below 1.55 g/cm^3 no site preparation needed. If compaction density is above 1.55 g/cm^3 the site prep (e.g. disking or cover soil placement) of the top 30 cm is required. Coco matting with seeding as an alternative. Jute netting/Erosion Control Blankets at the channel bends under potential wave action impact (See Channel Bends Revegetation Prescription).

Management Considerations

Compaction specification is needed in developing this prescription.

Initial candidate revegetation species

For seeding

Common Name (*Scientific Name*)	**% seed by weight**
Local spp.:	
• Canada bluejoint (*Calamagrostis canadensis*)	40
• Kentucky bluegrass (*Poa pratensis*)	30
• Fringed brome (*Bromus ciliolatus*)	30

Wildlife associations

Habitat Subtype: Prairie grassland and riparian
Other associated species: migratory birds, ungulates and furbearers

Example of Coco matting with grass seeding

Revegetation Prescription: Channel Bends

Jute netting and heavy seeding at channel bends

Predicted Landuse	Recreational, riparian habitat.

Site Preparation

See wet/dry prescription for site preparation, plus Jute netting in accordance with best management practices.

Site information

Soil capping depth:	None
Location on ROW:	2 channel bends just prior to the Lake MB and Lake St. Martin.
Landscape position:	Sloped bend within the area of revegetation.

Management Considerations

Jute netting install will require soil preparation (see attached diagram).

Initial candidate revegetation species

Wet/Dry Channel revegetation with Jutte Netting install

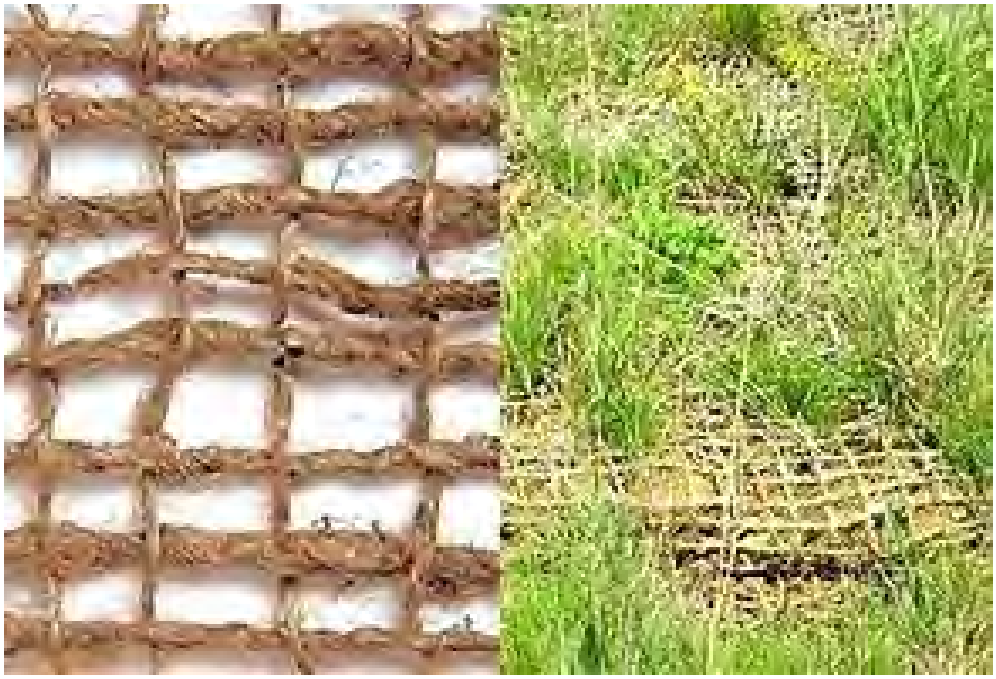
Install Jute Netting prior to seeding **Note: Species count and mix may vary depending on availability**	Common Name (Scientific Name): • Canada bluejoint (*Calamagrostis canadensis*) • Kentucky bluegrass (*Poa pratensis*) • Fringed brome (*Bromus ciliolatus*) • Hardstem bulrush (*Schoenoplectus acutus*)	% by weight 50 30 10 10

Wildlife associations

Habitat Subtype:

Other associated species: migratory birds, furbearers.

Example of Jute Netting with grass seeding



Revegetation Prescription: Shoreline

Revegetation of exposed mineral and organic soil surfaces along the shoreline located within the Right-of Way at Inlet and Outlet of the MI LMOC. Seeding and live staking using local plant species with brush layering depending on slope.

Predicted Landuse	Traditional, recreational, and wildlife habitat.

Site Preparation

If compaction density of the top 30-cm layer was below 1.55 g/cm^3 no site preparation needed. If compaction density is above 1.55 g/cm^3 p (e.g. disking or cover soil placement) of the top 30 cm is required. Spring planting.

Site information

Soil capping depth:	None.
Location on ROW:	Outlet is in Birch Bay in Lake St. Martin; Northeast of KP 250+00. Inlet is in Watchorn Bay in Lake Manitoba; Southwest of KP 20+00.
Landscape position:	At Watchorn Bay, shoreline (8 m back from the water's edge) and potential berms parallel to shoreline, if any. At Birch Bay, shoreline (10 m from the water's edge).

Management Considerations

Minimizing disturbance footprint. Armoring of the bottom of the inlet and outlet is recommended.

Initial candidate revegetation species

For live staking

Common (*Scientific Name*) (density)

Local willow spp.: (spacing - 50 x 50 cm2). Willow species considered for staking will depend on site soil conditions and include the following:

- Sandbar willow (*Salix exigua*)
- Beaked willow (*Salix bebbiana*)
- Hoary willow (*Salix candida*)
- Sandbar willow (*Salix exigua*)
- Slender willow (*Salix petiolaris*)

For seeding

Common (*Scientific Name*) (% seed by weight)

Local spp.:

- Canada bluejoint (*Calamagrostis canadensis*) (50%)
- Kentucky bluegrass (*Poa pratensis*) (40%)
- Narrow leaved cattail (*Typha angustifolia*) (10%)

For transplanting/plugging

Common (*Scientific Name*) (density)

Local spp.:

- Beaked sedge (*Carex utriculata*) (1 x 1 m^2)
- Tussock sedge (*Carex stricta*) (1 x 1 m^2)

Wildlife associations

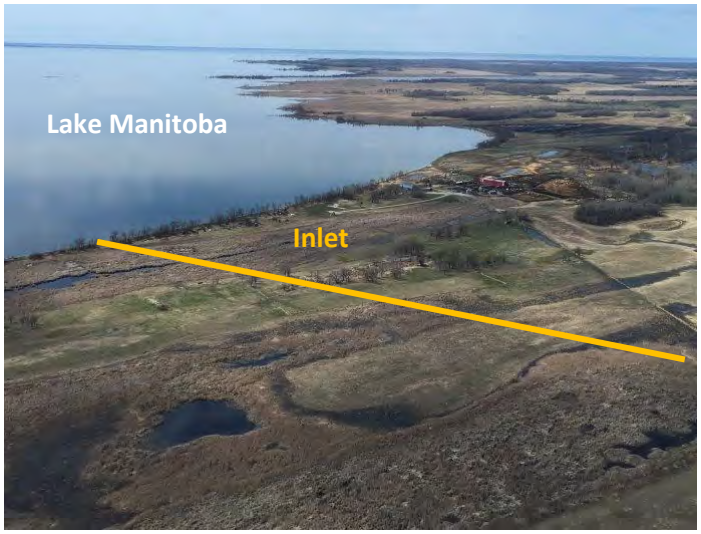
Habitat Subtype: At Watchorn Bay, shoreline habitat is composed of a compacted gravel – cobble – sand substrate with sparse (0% - 20% cover over >90% area)

Dense vegetation cover (mixture of long grasses, low shrubs and deciduous trees) is present along the extent of this berm, beyond which land has been developed for agricultural use.

At Birch Bay, shoreline habitat is composed of a compacted gravel-cobble substrate with scattered boulders with wetland habitat extending between 62 m and 127 m back from the shoreline.

Other associated species: migratory birds, amphibians, ungulates, furbearers

Typical Drawing/Photograph



Revegetation Prescription: Channel Wet/Dry

Seeding (possible jute mats with seeds) within the wet/dry area of the channel and outside drain slopes.

Predicted Land Use	Recreational, grassy riparian habitat.

Site information

Soil capping depth: None

Location on ROW: Along the length of the channel from Inlet to Outlet, and along the length of the Outside Drain.

Landscape position: Mid- channel

Site Preparation

If compaction density of the top 30-cm layer was below 1.55 g/cm^3 no site preparation would be needed. If compaction density is above 1.55 g/cm^3 the site prep (e.g., disking or cover soil placement) of the top 30 cm is required.

Management Considerations

If density of soil on the slope is greater than 1.55 g/cm^3 then soil surface would need to be loosened to provide a receptive seed bed. If compaction is above 1.8 g/cm^3 then non-vegetative methods of erosion control would be researched.

Compaction specification is needed in developing prescriptions.

Initial candidate revegetation species

For seeding

Common Name (*Scientific Name*)	**% seed by weight**
Local spp.:	
• Canada bluejoint (*Calamagrostis canadensis*)	40
• Kentucky bluegrass (*Poa pratensis*)	25
• Fringed brome (*Bromus ciliolatus*)	15
• Hardstem bulrush (*Schoenoplectus acutus*)	10

Wildlife associations

Habitat Subtype: Shrubby riparian.

Other associated species: Migratory birds, ungulates and furbearers.

Revegetation Prescription: Shrubland

A native shrub community that will buffer intersected forested parkland area along the edge of the ROW that support endangered woodpecker and/or whip-poor-will and other wildlife movement near the inlet and outlet structures (i.e., along lake shores). A dense herb and graminoid layer is included to suppress weeds.

Predicted Landuse	Forage and/or nesting habitat for wildlife that use forest edges (e.g., red-headed woodpecker, eastern whip-poor-will, white-tailed deer, elk), predator cover for wildlife moving along Lake Manitoba and Lake St. Martin shorelines.

Site information

Soil capping depth:	30 cm
Location on ROW:	KPs variable. Former soil stockpiles and edge of ROW.
Landscape position:	Dikes and along shoreline near inlet and outlet; areas where forest edges ROW, clearing along edge of forests with 50 m to 100 m width into the ROW.

Site Preparation

Provide rough and loose soil placement. Apply 30 kg per ha herb/graminoid seed mix through broadcast seeding. Potted live shrubs, or live stakes if available, should be planted at approximately 50 cm x 50 cm spacing (0.25m^2 density per ha). Spring seeding and planting. Required fertilizer application during broadcast seeding, 15-15-15 NPK.

Optional wildlife enhancements:

Snags

Locate salvaged dead or dying trees (minimum 20 cm diameter at breast height) up to 100m from edges of mature deciduous forest bisected by the ROW. Select sites on both sides (east and west) of the ROW for enhancements (erect 12-24 snags/ha).

Coarse woody debris (CWD)

Place 4 m piles of CWD in areas of shrubland, preferably two or three piles per acre, about 100 feet apart. Build on base of rocks to reduce decomposition rate if possible, and layer with bigger debris on bottom and finer materials on top.

Rock piles

Place 4 m piles of rocks and/or boulders in areas of shrubland, preferably two or three piles per acre, about 100 feet apart.

Management Considerations

May require weed management until ground cover establishes. As no seeding planned – erosion control if noticed after planting can be added at 10kg/ha application rate initially to allow shrubs to survive.

Revegetation

Candidate Species for Planting/Seeding

Scientific Name	Common Name	% seed by weight
Alnus viridis ssp. crispa	Green Alder	15
Cornus sericea ssp. sericea	Red Osier Dog Wood	15
Ribes americanum	Wild Black Currant	10
Rubus idaeus	Raspberry	5
Ribes lacustre	Black Gooseberry	5
Amelanchier alnifolia	Saskatoon	10
Corylus cornuta	Beaked Hazel	5
Elaeagnus commutata	Wolf willow	10
Symphoricarpos albus var. pauciflorus	Snowberry	15
Sheperdia argentea	Buffalo Berry	5

Note Target 1000 stems/ha – 50 cm spacing

Wildlife associations

Habitat Subtype: Riparian or transitional forest habitat; escape cover for small-bodied wildlife

Other associated species: migratory birds including species at risk, white-tailed deer, elk, furbearers, small mammals, amphibians, reptiles.

APPENDIX 3A

LSMOC Preliminary Revegetation Report

LAKE ST. MARTIN OUTLET CHANNEL:

PRELIMINARY REVEGETATION DESIGN REPORT

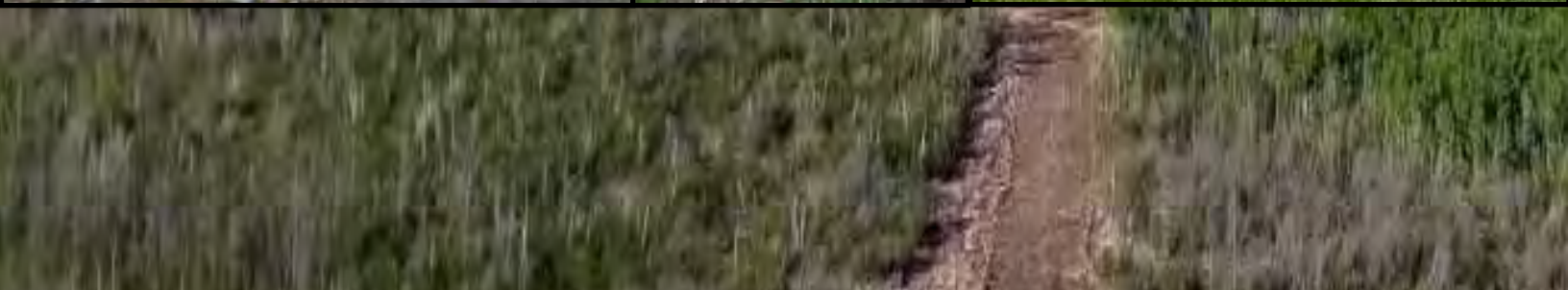
September 2020

Submitted to:

KGS GROUP

Prepared by:

SCATLIFF + MILLER + MURRAY



Front Photo: Aerial photo of Lake St. Martin Outlet Channel alignment, June 11th, 2019

Front Photo (inset): Lake St. Martin Emergency Outlet Channel – Reach 1 (left); Early grass seedling establishment (middle); Well established native grass planting on roadside ROW (right).

EXECUTIVE SUMMARY

Flooding throughout southern Manitoba during 2011 led the Province of Manitoba to construct the Lake St. Martin Emergency Outlet Channel (EOC), which included the Reach 1 and Reach 3 channels. While these channels served their initial purpose they were not intended to provide long-term permanent flood protection. Subsequently the Province is proceeding with the design and construction of a permanent flood relief channel connecting north basin of Lake St. Martin to Lake Winnipeg. This new permanent Lake St. Martin Outlet Channel (LSMOC) will be approximately 400m in width and will run 23.8 kilometers from the northeast shore of Lake St. Martin through low-lying upland landscape and connect to Lake Winnipeg immediately south of Willow Point.

It is expected that the project environmental license will stipulate that all disturbed sites associated with the project shall be revegetated with ecologically appropriate grass-based native vegetation in order to stabilize surface soils and limit the establishment of invasive weeds. The objective of this document is to provide a step-wise description of the preliminary planning considerations required to achieve a robust native grass planting in the LSMOC project area based on current understanding of revegetation conditions.

This document describes pre-plant site preparation requirements, planting considerations and scheduling, as well as construction and revegetation sequencing. Specifically, planning elements that are described include growth media preparation, integrated erosion control measures geared to large scale projects, seed mix design and seeding rate rationale, planting zones, planting methods, key dates and how revegetation measures may be coordinated. Native species and a selection of non-invasive tame species that are known to be suited to the region are identified and discussed herein.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Background

Flooding throughout southern Manitoba during 2011 led to water levels in Lake Manitoba and Lake St. Martin resulting in significant damage to hundreds of properties, restricted road access to several communities, and long-term evacuation of four First Nations communities in the vicinity of Lake St. Martin (LSM). As part of emergency relief measures, the Province of Manitoba, through Manitoba Infrastructure (MI), constructed the LSM Emergency Outlet Channel (EOC), which included the Reach 1 and Reach 3 channels (Figure 1).

Since construction of the EOC, the Province has needed to operate the Reach 1 channel in 2011-2012 and again in 2014, while Reach 3 has not been operated. While these channels served their designed purpose over the short term, they are not considered sufficient for long term, permanent flood protection of the area and the Province is proceeding with design and construction of the LSM Outlet Channel (LSMOC), a permanent flood relief channel connecting the north basin of Lake St. Martin Lake Winnipeg at Sturgeon Bay.

550000 555000 560000 565000 570000 575000 580000

5755000 5750000 5745000 5740000 5735000

Dauphin River

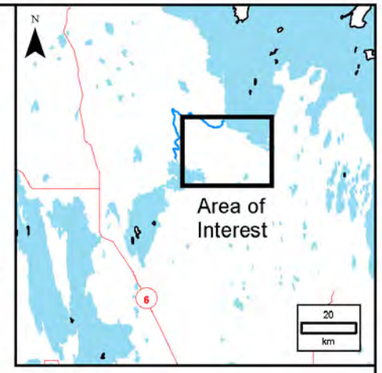
Lake Winnipeg

Buffalo Creek

Big Buffalo Lake

Little Buffalo Lake

Lake St. Martin



LEGEND:

- PDA
- LSMOC Alignment
- Reach 3 - Existing
- Reach 1 Channel - Existing
- Access Road
- Transmission Line

LAND COVER

- No Data
- Shadow
- Cloud
- Snow/Ice
- Rock/Rubble
- Exposed Land
- Water
- Shrub - Tall
- Shrub - Low
- Herb
- Bryoids
- Wetland - Treed
- Wetland - Shrub
- Wetland - Herb
- Coniferous - Dense
- Coniferous - Open
- Coniferous - Sparse
- Broadleaf - Dense
- Broadleaf - Open
- Broadleaf - Sparse
- Mixed Wood - Dense
- Mixed Wood - Open
- Mixed Wood - Sparse

1 0 1 2 3 4
Kilometres

SCALE: 1:100,000 METRIC 11"x17"

NO	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
X	20/08/28	ISSUED FOR REVIEW	XXX	XXX

REVISIONS / ISSUE

KGS GROUP

Manitoba Infrastructure

PRELIMINARY DESIGN OF THE LSM OUTLET CHANNEL PROJECT3

LAND COVER CLASSIFICATION FROM LAKE ST. MARTIN TO LAKE WINNIPEG

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

AUGUST 2020 | FIGURE 01 | REV: X

FileName: P:\Projects\2018\18-0300-005\Dwg\GIS\MXD\Working\Land_Cover\18-0300-005_Fig01_Land_Cover_Rev1.mxd
11"x17" PLOT SCALE 1:1

1.2 Project Description

The 23.8 kilometer LSMOC will run from the northeast shore of LSM through low-lying upland landscape and connect to Lake Winnipeg immediately south of Willow Point (Figure 1). A significant elevation change occurs along the alignment of the channel, dropping from an elevation of 242m at LSM to an elevation of 216m at Lake Winnipeg. Almost 5km of the new channel will overlap with the existing Reach 3 channel although substantial widening and redevelopment of this reach is anticipated.

The LSMOC project has an approximately 400m wide right-of-way (ROW) along the alignment. This ROW comprises the channel and dyke (~150m), a reclaimed spoil area (~200m), a construction road (~20m), as well as an outer drain (~30m) (Figure 2). Associated construction components that are not part of the revegetation scope of work for this project, include a permanent access road connecting the LSMOC to the abandoned Reach 1 channel as well as a proposed transmission line (~15km), and temporary winter access roads. At select locations along the channel (e.g. control structures) permanent erosion protection measures such as riprap or other hard armoring is anticipated and no revegetation treatment will be required.

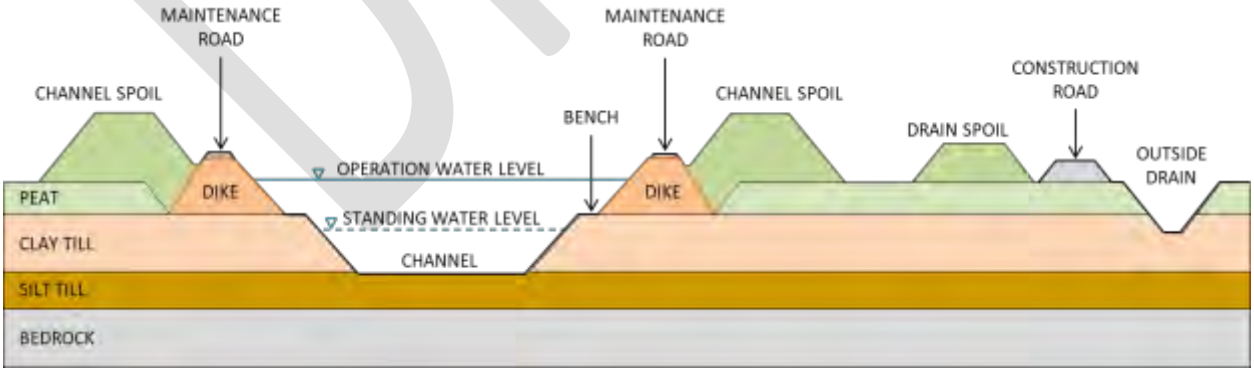


Figure 2. Typical right-of-way cross section for the Lake St. Martin Outlet Channel (KGS, 2019).

1.3 Ecological Context

The LSMOC project is situated in the Mid-Boreal Lowland Ecoregion of the Boreal Plains Ecozone. The Ecoregion is broadly characterized by extensive peatland cover interrupted by mixed softwood/hardwood plant communities where drainage and mineral soils allow (Smith *et al.*, 1998). The vegetation on the peatlands varies with peatland type. Bogs are generally characterized by stunted black spruce with ericaceous shrub and moss cover. Moss cover is often dominated by species of sphagnum. Fens are generally dominated by sedges and brown mosses and contain varying quantities of shrubs such as swamp birch and stunted tamarack trees where conditions permit. Upland cover can vary with drainage, soil texture and fire history. Black spruce is widespread, but following forest fires, jack pine and, to a lesser extent, trembling aspen, become major forest components (Smith *et al.*, 1998). Wet uplands have black spruce and moss vegetation with shrubs such as willow and alder. Table 1 provides a breakdown of all Land Cover and Forest Types represented throughout the project footprint (MLI, 2019).

Table 1. Manitoba Land Initiative forest cover types along the LSMOC project footprint.

COVER CLASSES	AREA (Ha)	COVER (%)
Water	4.4	0.5
Exposed Land	1.5	0.2
Wetland - Treed	35.5	4.0
Wetland - Shrub	483.7	54.4
Wetland - Herb	228.3	25.7
Coniferous - Dense	55.9	6.3
Coniferous - Open	6.8	0.8
Broadleaf - Dense	16.1	1.8
Broadleaf - Open	1.0	0.1
Mixed Wood - Dense	56.2	6.3

1.4 Rationale for Revegetation

Site naturalization and revegetation is an important and challenging component of the LSMOC project. The establishment of site appropriate, non-invasive perennial vegetation can serve to stabilize surface soils and protect against accelerated soil loss and erosion while limiting the establishment of non-native weedy plant species. Large linear infrastructure projects such as roads, transmission lines, and water diversion channels that connect otherwise separated landscapes can serve as conduits for the introduction of non-native and invasive plant species and can rapidly degrade local environments. Given the natural setting of the Project in addition to its large scope and scale, if site restoration and revegetation is not planned and implemented in a considerate and responsible fashion, its can have disproportionately high impact on the local and interconnected environments.

1.5 Revegetation Field Trials

Small scale revegetation field trials were conducted in 2019-2020 at Reach 1 of the LSM EOC. These trials were designed to evaluate the establishment and growth of native grass seedlings on the existing channel soils amended with different depths of organic soil (peat). The results of these trials are described in depth in Appendix 1 and will be used to inform and support revegetation methods described for active revegetation zones within the LSMOC ROW.

1.6 Goals and Objectives

The goal of this document is to provide preliminary planning information for revegetation of the LSMOC with site-appropriate, long-lived and ecologically appropriate species. This project features a number of challenges to revegetation, including the unpredictable duration and magnitude of flooding conditions along the channel. This document will outline the current understanding of the anticipated site conditions after construction and describe the recommended approach to revegetation.

The objective of this document is to provide a step-wise description of the required elements to undertake successful revegetation in the project area based on our current understanding of revegetation conditions. Preliminary revegetation design is divided into the following elements;

1) Preparation of the disturbed ROW for revegetation

2) Revegetation design and plant material sourcing

3) Scheduling

4) Construction sequencing

2.0 CURRENT AND ANTICIPATED SITE CONDITIONS

2.1 Revegetation Field Survey

A field survey was carried out in June 2019 to confirm the availability and suitability of soil resources for use in revegetating the LSMOC and to make note of invasive weeds that may be problematic to revegetation efforts. A total of twenty-six (26) sampling locations were distributed along the channel centerline representing nine land cover classes found within the LSMOC project area. Field observations of plant community cover were in-line with Manitoba Land Initiative (MLI) data with over 80% of the project area falling within the category of wetlands with deep organic soils. Analysis of the chemical properties of organics along the channel alignment revealed no apparent barriers to the growth and establishment of grass species that are appropriate for revegetating purposes within the LSMOC project area. That being said, these organic soils are characteristically low in plant available nutrients, and the revegetation design may need to account for improving soil fertility. Invasive weed encroachment was minimal and highly localized. Canada thistle and dandelion were encountered on two occasions; both cases occurred in the broadleaf tree MLI cover class. See Appendix 1 for further detail.

2.2 Channel Design Parameters (Anticipated)

2.2.1 Construction Overview

Construction of the Project is tentatively expected to occur over a period of approximately 2.5 to 3 years with approximately 1-2 years for post construction-related works, such as site clean-up, survey, and environmental offset works.

The proposed Project schedule includes the following major phases:

1. Construction will occur in the fall 2020 to spring/summer 2023
2. Operation and maintenance will start in the 2023 and continue indefinitely

Construction of the LSMOC is expected to generate approximately 450ha of exposed mineral subsoils (channel/dyke slopes, spoil piles made of mineral soil) which will require active revegetation treatments to establish deliverable cover vegetation. As the channel construction will take place over multiple years, revegetation works will be phased into the overall channel construction in order to minimize the exposure of channel slopes and hasten the channel revegetation. Once a segment of the channel is fully excavated and constructed, site preparation and soil placement for revegetation will be phased in at the earliest opportunity possible.

2.2.2 Base Materials (Subsoils)

The channel will be constructed through glacial till deposits leaving large areas of exposed subsoils following final grading. Clay deposits may be present in places along the channel, but are expected to be a minor component of the overall base material composition. Exposed glacial till will act as an important component of final seedbed conditions but due to deficiencies in organics and available nutrients they cannot be relied on solely to support perennial cover. Soil organic content is a vital constituent of growth media and when incorporated into subsoils, improves revegetation results by enhancing soil moisture efficiency, fertility and seedbed conditions.

2.2.2 Availability of Organics for Revegetation

Topsoil and available organics will be salvaged as part of the LSMOC construction work and used to amend existing glacial till subsoils during revegetation work. The preliminary design of the LSMOC anticipates excavating approximately 3M m^3 of peat, which is more than the quantity of organics required for revegetation as described in Section 3.1.1.

Soil analyses indicate that organics located in the project area pose no impediment for revegetation purposes. Revegetation trials undertaken on Reach 1 as part of 2019 site investigations support this assertion. These revegetation trials demonstrate that successful seedling establishment of key native grass species is achievable using organic amendments of 7.5cm and 15cm incorporated into local glacial till subsoil.

Organics situated at depths of >20cm or greater should be considered for use as a source of organics for revegetation purposes as these are more decomposed.

Material staging should be considered from the onset of construction to facilitate all phases of the Project, including site revegetation. Stockpiling and staging organics soils should occur outside of the area of active channel construction. Where space for material staging within the ROW is limited, alternative arrangements will be made. Greater detail on site specific material staging will be provided in the detailed design phase.

3.0 SITE PREPARATION FOR REVEGETATION

Anticipated site conditions following construction of the LSMOC have been described in Section 2.0. The exposed glacial till subsoils are deemed unsuitable for revegetation given their deficiency in plant available nutrients and organic matter. As such, in order to create conditions that will allow the establishment of a perennial groundcover, suitable quantities of organics (peat) must be integrated into the existing glacial till. The following section considers the planning elements necessary to create favorable site conditions for seedling establishment and the development of a long-lived perennial cover.

3.1 Organics Salvage, Stockpiling and Use

3.1.1 Quantity of Oorganics Required for Revegetation

Cover soils created by blending organic soil with mineral subsoils typically have a target ratio of between 50:50 and 70:30 (organics: subsoil). For perennial grass plantings it is recommended that up to 15cm of organics be integrated into subsoils while remaining within the target blend ratio (AEW, 2012). Quantity calculations need to account for an expected volume loss of up to 30% during salvage, storage and re-spreading organic soils.

Assuming 0.150m of peat is incorporated across this area, there is a requirement for up to 877,500m^3 of peat for revegetation purposes (including 30% expected loss). Given that there is an expected excavation volume of approximately 3M m^3 of peat, we anticipate a surplus of >2M m^3 of peat across the whole project ROW. The detailed design phase will consider methods and approaches to manage surplus peat quantities to mitigate any potential negative impacts of this excess material

3.1.2 Organics Handling and Management

Organic soils will be stripped and stockpiled early in site development during the winter construction season for use in site reclamation. The methods and sequence of organics salvage can vary and are generally determined by ease of access, which is in-

turn determined by weather conditions, depth of frost, and moisture content of the peat and underlying mineral soil layers. During organics salvage and stockpiling, the Contractor may need someone on site to identify soil types in order to handle and stockpile these materials appropriately. Alternatively, construction crews, including excavator operators will need to be sufficiently informed and trained on the specified approach to soil salvage.

Construction logistics and material staging must take into account the total area required for the stockpiling of organic soils that will be used in site revegetation. Stockpiles must be re-spread promptly to avoid degradation and loss of viability that can occur when organic soils are stockpiled for more than one winter. Stockpiled organic soils should be re-spread across the area to be revegetated as soon as the channel has been excavated, rough graded, and decompacted. If organic soils are expected to remain stockpiled for more than one month during the active growing season (May to October), these stockpiles must be managed to protect from erosion, weed establishment and degradation.

Organics should be staged strategically for to minimize the number of times machinery is required to travel over prepared sites. Organics should only be incorporated during appropriate weather conditions (i.e. not too wet, not frozen, and under appropriate wind conditions). Due to the low expected nutrient content of the peat, leaching from these stockpiles is not considered a concern. That said, stockpiles should be staged a minimum of 30m from the channel slopes to ensure any potential localized leaching has an opportunity to be bound in the mineral soils prior to reaching the channel.

Given that we are anticipating a significant surplus of organic soils, the project Erosion and Sediment Control Plan (ESCP) will provide additional detail on methods and approaches to managing organic soil erosion and movement.

Other general considerations for organic soil salvage and handling include:

- Coarse woody debris should be separated from organic stockpiles and disposed of prior to soil placement and integration. The Contract Tender will state that the Contractor will be responsible for appropriate wood waste management, but specify that woody debris cannot be chipped and mulched into the organics or across the revegetation area.

- Peat sources should be inspected for noxious weeds and either rejected if weeds are present, or undergo weed control prior to spreading. This may include weed control before stripping, and/or weed control on peat stockpiles. Pre-construction surveys will allow opportunities for in-situ inspection of the surface soils while construction monitoring will provide opportunities for inspection of stockpiled soils for use in revegetation.

- Organic stockpiles should be left in a 'rough and loose' condition to allow rainfall to infiltrate into the soil and prevent erosion from rainfall.

- Organic stockpile grades should be left no steeper than 4:1 to accommodate the potential for cover crop seeding as an erosion protection measure.

- Position stockpiles in a sheltered area away from active construction works (i.e. along a forests edge) to minimize exposure to wind erosion.

- Organic soil stockpiles that freeze overwinter may take a very long time to thaw in the spring because of the insulating effect of the material. Smaller stature stockpiles will thaw faster than larger stockpiles.

- Windrowing organics stockpiles to a height of roughly 2 meters facilitates ease of stockpile maintenance where organics are to be stockpiled for prolonged periods of time.

3.2 Base Material Preparation

3.2.1 Alleviation of Compaction

Subsoil compaction must be alleviated prior to the integration of organics. Doing so enables proper seeding depth, allows for better root penetration and enhances establishment and long-term survival of the planting. Areas that have been compacted through equipment traffic may require multiple passes, in multiple directions, to alleviate heavy compaction. Decompaction of the subsoils to a depth of 20 – 30cm prior to placing and incorporating the organics is recommended. Heavy equipment such as a bulldozer with ripper teeth or tandem discs and a tractor can be used to alleviate compaction.

3.2.2 Rill Repair

Rills that emerge prior to seeding and plant establishment will need to be repaired to allow for accurate and effective native grass seeding. Small rills in the base material that develop prior to decompaction will be sufficiently repaired during decompaction work, but if small rills are allowed to develop into larger rills or gullies, more effort will be required for repair. Small rills that develop after organic soil placement and incorporation, but prior to seeding can be repaired using harrows, chains or a toothed bucket on low-ground pressure equipment (e.g. tracked skid steer). Rills that emerge after seeding will need to be carefully monitored to determine if they should be repaired and reseeded immediately, or if a wait-and-see approach should be taken. In all cases, the cause/source of the active erosion that is leading to rill formation should be investigated and addressed, as needed, through light grading and earthworks, erosion control materials, or other actions.

3.3 Growth Media Preparation

3.3.1 Organic Soil Placement and Incorporation

Organics should be spread over decompacted subsoils using equipment and methodology that avoids compacting prepared ground. Strategic staging of organics stockpiles along the ROW will facilitate timely and efficient organics placement. Low

ground pressure equipment (e.g. small to medium wide base, wide blade, tracked bulldozer) with GPS linked grade control systems are well-suited to accurately spreading specific depths of organic soils prior to incorporation, provided existing rough grades are accurate. As described in Section 3.1.1, a depth of 10 – 15cm of organics should be placed across the project footprint in all areas that will be revegetated.

Once placed, organics should be incorporated into the mineral subsoils using discs to a depth of roughly 20 – 25cm. Other equipment such as field cultivators or an aggressive set of harrows may also be used for incorporating organics. This incorporation will result in a blended cover soil with an organics to mineral soil ratio within the target range. These conditions should provide suitable growth media conditions for seeding and establishment of a perennial grass groundcover. It is important that organic soils placed over the decompacted base material are not buried or blended too deeply, which could result in poor surface soil conditions and unsuitable seedbed characteristics.

3.3.2 Seedbed Preparation

Creating proper seedbed conditions is a crucial element of preparing site for seeding. Seedbed conditions must be smooth, level, firm and free of excessive woody debris in order to allow a seed drill to deliver seed at an accurate rate and depth. Firm seedbeds conserve moisture and ensure good seed-to-soil contact. The seedbed is considered firm enough when a person's footprint only penetrates 0.6 to 1.2cm deep. The surface should be free of rills and gullies and wherever possible, slopes should not exceed 4:1 to allow machinery to operate safely and properly.

The soil surface will require some level of conditioning after organic soils are placed and integrated to create seedbed conditions that will facilitate proper and consistent seed placement. Harrowing is generally sufficient to breakdown large chunks of soil creating a smooth level condition ideal for seeding. Harrowing may also serve to remove minor debris from the surface which could otherwise interfere with seed placement. In some cases, surface packing with a coil or roller packer may be required to create firm seedbed conditions after harrowing.

3.3.3 Fertilization and Irrigation

The Water Protection Act Nutrient Management Regulation restricts the application of nutrient within 35m of the LSMOC due to its proximity and connection to Lake Winnipeg. In marginal soil conditions, such as those anticipated along the constructed LSMOC a low rate phosphorous fertilizer banded into the soil during seeding can improve the rate of establishment and growth of perennial grass seedlings. For reference, a summary of soil analysis results obtained during the 2019 Field Investigations is provided in Appendix 1. To hasten early establishment of seeded grass cover, it is recommended to supply a low rate of phosphorous fertilizer to areas of the disturbed ROW that are being actively revegetated to bring the available phosphorous levels within the range of 4 – 10 ppm.

Once established, further application of nutrient is not anticipated. As such, other elements of the site naturalization and revegetation approach will be designed to alleviate long-term nutrient limitations. For example, cool season native grass species generally have greater nitrogen requirements than warm season species. Use of appropriate warm season grasses will reduce competition for nutrients and create a more sustainable perennial groundcover. Similarly, the inclusion of a site appropriate native nitrogen-fixing species, such as Canada milkvetch (*Astragalus canadensis*) in the designed seed mix can serve to improve soil fertility over time and yield a more sustainable long-term groundcover.

When native grass seed mixes are seeded following appropriate site preparation and seeding methods during the proper seeding window (see Section 4.4.5), irrigation is typically not needed for seedling establishment. When seeding takes place outside of the specified seeding window (after mid-June), or if unseasonable dry conditions occur throughout spring and early summer, irrigation may be required to ensure grass establishment. Site preparation techniques, such as leaving the soil in a somewhat rough condition, can help to trap moisture and improve seedling establishment. Likewise, the use of hydraulically applied wood fibre mulch can improve moisture retention and improve seedling establishment. When seeding outside of the specified seeding windows, the Contractor should be prepared to provide irrigation.

3.4 Erosion and Sediment Control

Erosion and sediment control is a major consideration in the construction and revegetation of the LSMOC. The existing Reach 1 and Reach 3 of the EOC provide evidence of the erosion that can be expected if channel side slopes are not secured with perennial vegetation. Perennial vegetation is considered a stable erosion protection measure once 75% live groundcover has been achieved. In order to achieve this level of consistent vegetative cover, temporary and alternative measures are needed to prevent soil loss and allow for establishing vegetation to take hold.

3.4.1 Site Preparation and Grading Approaches

Site preparation and grading approaches can be implemented to reduce the likelihood of soil erosion and sediment loss. For example, organic stockpiles may be windrowed strategically to control water runoff and reduce rill formation on the side slopes prior to soil placement and incorporation. Likewise, throughout the revegetation process surface conditions should be left in a rough, unfinished state to reduce overland water velocity and minimize erosion.

3.4.2 Temporary Cover Crops and Nurse Crops

Temporary cover crops and nurse crops are a cost-effective way to stabilize soils during periods of time where perennial vegetation has not been seeded or has not yet established sufficiently to provide soil protection. Cover crops are typically used in reclamation projects as a primary means of preserving and improving site and soil conditions prior to the establishment of perennial vegetation. In these cases, cover crops are seeded at, or near, a full field-rate to provide erosion control, competition against weeds, as well as other ancillary benefits to soil quality. Nurse crops on the other hand, are typically seeded at the same time as perennial vegetation, at a much lower rate, in order to improve growing conditions and facilitate establishment of the intended final vegetation cover. During the revegetation of the LSMOC, cover crops will be used to mitigate erosion risks in prepared soils that cannot be seeded to perennial cover due to the seasonal timing of soil preparation (i.e. during hot summer conditions). Likewise, nurse crops will be included within the seed mixes during all

perennial seeding activities.

Seeding of a perennial grass seed mix, particularly a native seed mix with a significant warm season grass species component should occur during a relatively tight seasonal window of time (described further in Section 4.4) from May through mid-June. Given the scope and scale of the LSMOC construction project, it is reasonable to expect that all site preparation and seeding work will not be completed within one seasonal seeding window. Areas that cannot be prepared and seeded within the May – mid June seeding window can still be prepared throughout the growing season, and once soil has been placed and incorporated, these areas can be protected by seeding an annual cereal crop like common oats (*Avena sativa*). Common oats may be seeded until mid- to late August, but late summer seeding may yield poor plant establishment due to high temperatures and low moisture availability. Seeding of an annual cover crop any later in the growing season is unlikely to produce sufficient biomass to provide any reliable erosion protection, and is therefore not recommended. Dormant seeding of a cover crop is not completely reliable, but certain cold hardy species and varieties can be dormant seeded. Considering the LSMOC project, if dormant seeding (after October 20th until frost prevents seed placement) is being considered, it may be more advantageous to proceed directly to seeding the perennial grass mix, rather than seeding an annual cover. In these cases, consideration must be given to seed mix design (some species do not establish well by dormant seeding), as well as site specific factors such as risk of erosion, likelihood of flooding, and spring site accessibility,

In some instances, measures should be taken to limit biomass production by planted cover crops. Excessive stems and stubble can interfere with proper seeding rate and seed placement during native seeding operations. Therefore, cover crops are generally either mowed to a height of 15 – 20 cm or are desiccated using herbicide roughly 6 – 8 weeks after planting (while 'in – boot' just prior to flowering). If timed properly, cover crop desiccation can be integrated into ongoing weed control efforts.

All perennial grass seed mixes should include an annual nurse crop component composed of an annual cereal crop like common oats, at a rate of approximately 5.6 – 8.9 kg/hectare when revegetating an erodible slope. The fast growing annual crop

species facilitate native grass seedling establishment by assisting in erosion protection during early establishment while also serving to improve soil conditions and competing with undesirable weed species. Nurse crop seeding rates must be designed to maximize their positive impact while making sure that they do not negatively impact perennial seedling establishment through competitive effects.

3.4.3 Erosion Control Materials/Products

The use of manufactured erosion control products to safeguard prepared sites from erosive forces may be required in certain circumstances. Given the large scale of the LSMOC, extensive use of erosion control products in all situations that typically necessitate them may be unrealistic. As such, manufactured erosion control products may be used strategically in areas that pose the greatest risk of erosion and where impacts of erosion are most detrimental. Steep and long slopes, pathways of directed surface runoff, and ditches and drains that receive high volumes and rapid velocities of surface water are candidate locations for installation of erosion control materials/products.

Use of rolled erosion control blanket (ECB) is costly and inefficient in large-scale work. Hydraulically applied wood fiber mulch products present an alternative because of the relative ease and speed of application, as well as their ability to provide good coverage on uneven surfaces. Strategic use of hydraulic mulches should not be ruled out as an erosion protection measure in areas that include steep slopes or where long slope runs may require supplemental erosion control. When used, hydraulically applied mulches should be applied immediately following seeding operations, prior to seed germination. Installation of any erosion control measures, including application rates, should follow manufactures specifications and industry standard best practices

Strategic use of straw waddles or silt fencing may also be considered during construction and revegetation of the LSMOC as sediment barriers or slope interrupters. These products are highly modular, easy to install under variable site and climatic conditions, and are capable of providing rapid control of sediment where there is a risk of discharge. These products can be particularly useful in slowing overland water flow along extensive slopes where concentrated water flow may result in rill formation. By

slowing the flow of surface run-off, the rate of sediment dislodgement and transportation can be reduced and plant establishment can be hastened.

3.5 Weed Control

Ordinarily, weed control is required when revegetating disturbed land with ground cover with an intended function (i.e.; erosion control, aesthetics, protection of adjacent rare habitat, etc.). This is especially true in areas where persistent weedy species have already established either on or near the site that is to undergo revegetation. In these cases, weed control is typically undertaken prior to planting (pre-plant weed control) and during the establishment of the planting (post-plant weed control). The duration and tactics involved in pre- and post-plant weed control measures varies with weed spectrum and level of infestation.

Where problematic weedy species are absent from landscapes prior to construction, which is often the case in remote wilderness sites like the LSMOC project area, the need for pre-plant weed control may be highly limited or altogether unnecessary. In these cases, the best approach is to take steps to ensure that weeds are not imported onto the site with machinery and equipment and to undertake proper revegetation measures on prepared sites as soon as possible. In this fashion, a desired grass planting on the LSMOC is more likely to establish properly without interference by weeds and become competitive against invasive plant species. For large multi-year construction projects, revegetation should be phased-in as sections of the project are completed to help prevent the establishment of weeds on disturbed sites. Monitoring for invasion and establishment of weed species during the construction phase of work is further described in the Vegetation Monitoring Plan. Monitoring will include both incidental observations during environmental monitoring as well as targeted surveys in locations of higher likelihood of invasion.

As noted above, the LSMOC project area is largely free of weed encroachment however Canada thistle (*Cirsium arvense*) dandelion (*Taraxacum officinale*) were found in two areas noted during the site investigations in June 2019. Specifically Canada thistle encroachment was noted within the first kilometer of the new LSMOC channel alignment. Dandelion was noted at approximately kilometer 3.8. In both cases, these

weeds occurred in mineral soil conditions associated with broadleaf treed areas. Mineral soil habitat is more favourable to the kinds of weeds that pose problems for establishing seeded grass stands. By comparison, the boreal wetland habitat that dominates the project area is considerably less hospitable to weeds. Canada thistle, in particular, is a highly problematic perennial weed that is aggressively rhizomatous and produces large quantities of viable seed. Species like thistle can rapidly spread and out-compete native seedlings. Salvaging and spreading soils containing the seeds and live roots of weeds like Canada thistle will stimulate the rapid regeneration and dispersal of this tier three noxious weed onto prepared areas.

To help avoid spreading broadleaf weeds that have been documented during site investigations, the following is recommended:

- Avoid stockpiling and using soils with a history of weed colonization. Nearby soils free of weed species should be used instead. Given the expected surplus of suitable organic material, no additional excavation should be required to avoid weed contaminated soils.

- When soils with a history of weeds must be used as growth media, project managers should direct environmental monitors to inspect stockpiles for weed regeneration and undertake appropriate weed control measures, including herbicide applications where required.

In spite of these precautions invasive weed species may still become a problem to planting establishment. Some weeds, as mentioned, have the potential to spread and infest large areas in a very short period of times. Normally an infestation of Canada thistle or other broadleaf weeds can be avoided with timely monitoring and corrective measures early in the construction phase. The following practices are strongly recommended:

- Ensure that all machinery mobilized to the project site has been thoroughly washed to minimize importing weed seeds from other sites.

- All disturbed sites in the project footprint should be regularly monitored for

weed encroachment by individuals that can identify plant species and make best practice weed control recommendations.

- When invasive weed species are documented in the project footprint, a timely and appropriate weed control response should be undertaken to control the weed infestation at its onset, before it becomes a larger issue.

4.0 PLANTING CONSIDERATIONS

Planting considerations include; design of revegetation zones and corresponding plant species, plant and seed procurement, quantity requirements, installation methodology, and weed control.

4.1 Revegetation Design

Changes in vegetation patterns seen in natural areas are reflective of changing environmental conditions (soils, slope, access to water, duration of flooding, etc.). Revegetation design for the LSMOC will mimic natural landscapes and incorporate plant species suited to the varying environmental conditions present within the disturbed ROW.

4.1.1 Revegetation Zones and Plant Species

Revegetation areas along the ROW should be divided into two planting zones, the lower berm zone and the upland berm zone. These zones are defined largely by an anticipated gradient in moisture availability from the uplands to the side slopes (Figure 2). These zones reflect patterns seen in natural communities but are also influenced by the potential for inundation during future channel operation. It is expected that there will be significant overlap in species selected for each zone but additional species that are suited to anticipated site conditions will be adjusted.

Upland Berm Zone

The upland berm zone (UBZ) includes sites that will regularly be subjected to drought conditions during dry summer months. In extreme wet conditions these sites may also experience flooding that will typically not exceed three to four days. Species planted in the UBZ will include drought tolerant native grasses well-suited to upland sites and local climatic conditions. Several species in this mix will also have a degree of flood tolerance to account for flooding potential.

Lower Berm Zone

The lower berm zone (LBZ) includes channel and drain side-slopes that will be periodically flooded during heavy rainfall periods and channel operation. In times of water deficit, the LBZ may also be subjected to extended periods of drought. To account for these moisture variations, the seed mix in the LBZ will be designed using species capable of tolerating inundation as well as those adapted to drought conditions.

Vegetation Cover and Channel Operation

Flooding, rather than drought, is perhaps the most challenging constraint to establishing permanent grass cover on the LSMOC. The duration, frequency, timing and magnitude of channel operation will affect the health and rigor of all planted species. From year to year, plant cover surviving prolonged flooding will require an adequate period of time to recover between flood events and replenish root reserves. Late season flood events are likely more difficult for vegetation to endure than prolonged spring flooding. Prolonged channel operation in the LBZ environment may result in periods of inundation that exceed the inherent flood tolerance of species planted on the side-slopes. In this scenario, vegetation die-off will leave gaps in plant cover, the extent of which will depend on the timing and duration of inundated conditions and recovery periods between flood events.

Post Channel Operation Monitoring

Following the operation of the channel, a site investigation should be undertaken to document site conditions as well as the inundation tolerances among the planted native grass species. Areas where vegetation die-off is substantial may warrant remedial action, including seedbed conditioning and reseeding. If certain grass species are documented to better withstand channel operation than other planted species, remedial seed mixes can be adjusted to include higher rates of the successful species.

4.2 Plant Material Procurement

Commercially sourced native grass seed will serve as the primary component of all seed mixes employed during LSMOC revegetation work. Commercially sourced seed should be certified. Seed lot certificates displaying seed quality data should be reviewed by a native revegetation specialist prior to purchasing seed. Seed certificates should display, at a minimum, seed % purity, weed seed content per 25mg sample, % germ or tetrazolium test results as well as cultivar information. All seed purchased for the project should be adapted to the regional climate of the project area. Seed lot point-of-origin should be reviewed by a native grass revegetation specialist. Given the substantial quantity of native grass seed required for site revegetation, seed procurement should be initiated well in advance of anticipated seeding dates to ensure access to high quality seed lots that meet standards for weed seed content and percent purity. Given the large seed needs for the LSMOC Project, seed procurement should begin > 1 year in advance of anticipated seeding dates.

Areas that persistently hold water can be challenging to revegetate efficiently by seeding. As an alternative method, these areas may be revegetated using live-rooted propagules transplanted from within the LSMOC project area. This method of planting is not considered to be a primary means of revegetation at LSMOC but certain areas may warrant it as a consideration. As an example, this revegetation treatment could be applied to areas immediately upstream of drop structures where water levels are expected to be consistently high. The detailed design process will investigate if, and where this treatment could be valuable and delineate these locations along the LSMOC ROW. Depending on the expected hydrologic conditions, emergent macrophytes or wet meadow vegetation may be suitable for use. Propagule harvest sites should be assessed by a revegetation specialist to ensure that the donor material is appropriate to the anticipated planting conditions.

4.3 Seed Mix Design and Seeding Rates

Upper berm and lower berm seed mixes will contain a balanced mix of early establishing species and long-lived species, as well as tufted and rhizomatous species. Doing so promotes early growth and long term competitiveness in seeded grass stands. Candidate species for seeding at LSMOC are listed in Table 2. Non-invasive tame species that are considered suitable for revegetating at LSMOC are listed in Table 3. When designing the seed mixes, care will be taken to avoid overrepresentation of certain species that are aggressively rhizomatous, or those with highly competitive seedling vigor. When seeded at too high a rate, these species can out-compete certain long-lived species that may have weaker seedlings but when established, are critical to the long-term performance of the planting.

Table 2. Relevant attributes of native grass species that may be used in LSMOC ROW revegetation.

					Chemistry			Zone***		Growth Habit				Life History			Seral Stage		
Scientific Name	Common Name	C3/C4*	Variety	Origin	E.C. (dS m^{-1})**	Salinity Tolerance	pH Range	Upland Berm	Lower Berm	Rhizomatous	Creeping	Sod Former	Bunch	Annual	Biennial	Perennial	Early	Mid	Late
Agrostis scabra	Rough hairgrass	C3	Common	Parkland Prairie	< 4	low	weakly acidic – weakly basic						●			●	●	●	
Andropogon gerardii	Big bluestem	C4	Bison	North Dakota	< 4	low	neutral – weakly basic				●		●			●		●	●
Astragalus canadensis	Canada milkvetch	C3	Common	Manitoba	N/A	none	weakly acidic – weakly basic				●					●	●	●	
Beckmannia syzigachne	Sloughgrass	C3	Common	Manitoba	N/A	medium	weakly acidic – weakly basic						●		●		●		
Bouteloua gracilis	Blue grama	C4	Badlands	North Dakota	< 4	none	neutral – weakly basic				●		●			●		●	●
Bromus anomalus	Nodding brome	C3	Common	Manitoba	N/A	low	weakly acidic – weakly basic						●			●	●	●	
Bromus ciliatus	Fringed brome	C3	Common	Manitoba	< 4	none	weakly acidic – weakly basic						●			●	●	●	
Deschampsia caespitosa	Tufted hairgrass	C3	Nortran	Alaska	N/A	low	highly acidic – weakly basic						●			●	●	●	●
Elymus canadensis	Canada wildrye	C3	Mandan	North Dakota	< 4	low	weakly acidic – weakly basic						●			●	●		
Elymus dasystachyum	Northern wheatgrass	C3	Polar	Western Prairies	< 8	low	weakly acidic – mod. basic			●		●				●		●	●
			Elbee	Saskatchewan	< 8	low	weakly acidic – mod. basic			●		●				●		●	●
Elymus innovatus	Hairy wildrye	C3	Common	Manitoba	< 4	none	weakly acidic – weakly basic				●					●	●	●	
Elymus trachycaulus var. *subsecundus*	Awned wheatgrass	C3	Spring	Southern Prairies	< 4	none	weakly acidic – weakly basic						●			●	●		
			Hillcrest	Alberta	< 4	none	weakly acidic – weakly basic						●			●	●		
Elymus trachycaulus var. *trachycaulus*	Slender wheatgrass	C3	Common	Saskatchewan	< 16	high	weakly acidic – strongly basic						●			●	●		
Elymus virginicum	Virginia wildrye	C3	Common	Minnesota	< 4	none	weakly acidic – weakly basic						●			●	●	●	
*Glyceria grandis*****	Tall manna grass	C3	Common	Manitoba	N/A	none	weakly acidic – mod. basic				●					●	●		
*Juncus arcticus*****	Alpine rush	C3	Common	Manitoba	N/A	medium	weakly acidic – strongly basic			●						●	●	●	●
Koeleria macrantha	June grass	C3	Common	Manitoba	< 4	none	neutral – weakly basic						●			●		●	●
Nassella viridula	Green needle grass	C3	Lodorm	North Dakota	< 4	none	neutral – weakly basic						●			●		●	●
			Mallard	Manitoba	< 4	none	neutral – weakly basic						●			●		●	●
Panicum virgatum	Switchgrass	C4	Dacotah	Manitoba	< 4	medium	neutral – weakly basic						●			●		●	●
Pascopyron smithii	Western wheatgrass	C3	W.R. Poole	MB, SK, AB	< 16	high	weakly acidic – mod. basic			●		●				●	●	●	●
			Rodan	North Dakota	< 16	high	weakly acidic – mod. basic			●		●				●	●	●	●
Poa palustris	Fowl bluegrass	C3	Common	Manitoba	N/A	medium	mod. acidic – weakly basic						●			●		●	●
Puccinellia nuttalliana	Nuttall's alkali grass	C3	Common	Manitoba	< 33	high	weakly acidic – mod. basic						●			●		●	●
Schizachyrium scoparium	Little bluestem	C4	Badlands	North Dakota	< 4	none	neutral – weakly basic						●			●		●	●
*Scholochloa festucacea*****	Whitetop	C3	Common	Manitoba	N/A	low–medium	weakly acidic – weakly basic			●						●	●	●	●
*Sparganium eurycarpum*****	Bur reed	C3	Common	Manitoba	N/A	none	weakly acidic – weakly basic			●						●		●	●
*Spartina pectinata*****	Cord grass	C4	Red River	North Dakota	< 4	none	neutral – weakly basic			●	●	●				●		●	●

* C3 denotes cool season and C4 denotes warm season.

** E.C. refers to electrical conductivity, used here as an indication of salt tolerance.

***Indicates expected suitability for use in different active revegetation zones of the LSMOC ROW – final seed mixes to be determined in detailed design.

**** For consideration in ditches and drains.

Notes: Commercial seed availability and quality (purity and germination) may vary from year to year.

Table 3. Relevant attributes of non-native grass species that may be used in LSMOC revegetation.

			Chemistry			Zone		Growth Habit				Life History			Seral Stage		
Scientific Name	Common Name*	C3/C4*	E.C. (dS m^{-1})**	Salinity Tolerance	pH Range	Upper Berm	Lower Berm	Rhizomatous	Creeping	Sod Forming	Bunch	Annual	Biennial	Perennial	Early	Mid	Late
Thinopyrum ponticum	Tall wheatgrass	C3	< 16	high	neutral - alkaline						●			●	●	●	
Dactylis glomeratus	Orchard grass	C3	4-8	low	mod. acidic - neutral						●			●	●		
Agrostis stolonifera	Redtop	C3	< 16	high	weakly acidic - strongly basic					●	●			●	●	●	●
Phleum pratense	Timothy	C3	< 4	low	mod. acidic - slightly basic						●			●	●	●	●
Festuca sp	Fescues	C3	4-8	low	weakly acidic - strongly basic				●		●			●	●	●	●
Medicago sativa	Alfalfa	C3	4-8	low	neutral - alkaline						●			●	●		

* C3 denote cool season species; C4 denotes warm sesason species.

**E.C. refers to electrical conductivity, used here as an indication of salt tolerance.

***Indicates expected suitability for use in different active revegetation zones of the LSMOC ROW - final seed mixes to be determined in detailed design.

Note: Commercial seed availability and quality (purity and germination) may vary from year to year.

Seeding rates will be determined on the basis of pure live seed. It has been found repeatedly that seeding at a proper rate promotes the survival and establishment of all species components in a seed mix and makes for a stronger, more competitive planting in the long-term. Percent-based seed mixes do not adequately account for individual species growth attributes or seed size. This tends to result in excessively high seeding rates and imbalanced seed mix characteristics. Seeding at too high a rate for example, results in excessive intra- and inter-species competition which in turn causes the failure of many key species in a mix to establish. Grass mixes seeded at too high a rate either fail to establish or are dominated by one or two species with competitive seedlings but poor long-term competitiveness. In both cases these stands tend to collapse into weed infestation in the relative short-term.

4.4 Planting (Seed Mix Installation)

4.4.1 Drill Seeding

The Truax native grass seed drill has proven to be the best method for seeding multi-species native grass mixes. The equipment and various internal mechanisms have been optimized to ensure even and consistent placement of native seeds at the appropriate depth. Seedbed preparation activities along the channel alignment are directed at achieving site conditions best suited to drill operation.

- Truax native seed drills can be run as several setups including; on a tractor with a three point hitch, towed as a trailer (end-wheel drive) or mounted to the front of a skidsteer. The three point hitch and skidsteer mounted options provide increased maneuverability and accuracy when seeding irregular shaped areas like forest edges or lay down sites. Larger Truax drills run as an end wheel drive trailer setup can be employed on long straight-away sections of the LSMOC right-of-way, maximizing seeding efficiency.

- Truax drills employed on the LSMOC ROW should be equipped with 'trash plows' for seeding in areas where excessive cover crop residue may be present on the soil surface.

- Ideally, Truax drills are run on slopes no steeper than 4:1 for safe operation. This may preclude drill operation on some parts of the channel side slopes where harrow-broadcast-harrow seeding becomes the preferred option for safety reasons.

- Drill seeding should only be undertaken on smooth, firm, level ground free of excessive debris to ensure the accurate delivery of seed to the proper depth.

4.4.2 Harrow-Broadcast-Harrow Seeding

In the harrow-broadcast-harrow (HBH) seeding method, an initial pass over the seedbed is made with harrows in order to roughen the soil surface, allowing for better seed-soil contact. In a second pass, a broadcaster (ex. fertilizer spreader) distributes seed over the area at a specified rate. The broadcast seeding pass is followed by a final harrow pass that incorporates the seed into the soil.

- The primary disadvantage of HBH seeding is the fact that it uses a minimum of twice the amount of seed as drill seeding because not all of the broadcasted seed will become embedded in the soil following the final harrow pass. Therefore, seeding rates are doubled (2x the drill rate) to account for approximately 50% of the broadcasted seed usually being left at the soil surface where the chances of germination and establishment are greatly decreased.

- Another disadvantage of HBH seeding is harrow passes over a prepared seedbed may be impaired by cover crop residues clogging equipment during scarification. In places where cover crops have been seeded as a form of erosion protection, drill seeding with trash plows should be the primary method of seed installation.

- Harrow-broadcast-harrow seeding is highly effective when undertaken with equipment that is stable on slopes steeper than 4:1. In these instances, harrows

may run offset and downslope of the machinery pulling it. On slopes greater than 2.5:1, harrows are less effective unless downward force is applied.

4.4.3 Hydro-Seeding

Hydro-seeding should be regarded only as a last resort option and where other seeding methods are not feasible. Hydro-seeding typically does not provide the necessary seed-to-soil contact to promote reliable seed germination and seedling survival across prepared sites. Hydro-seeded sites are prone to uneven germination rates, uneven species germination, bare areas, and weed encroachment.

4.4.4 Erosion Control Measures

Erosive forces that could disturb and displace surface soils and planted seed must be mitigated during early plant establishment in order to hasten site revegetation. Low cost options such as site grading measures and cover crops (described in Section 3.4) will be implemented throughout the site, while critical areas with a high probability of accelerated erosion may warrant the application of manufactured erosion control products.

In large scale revegetation projects that feature steep or long slopes and highly erodible soils, rolled erosion control products can be costly and relatively ineffective. An attractive alternative to rolled erosion control products are hydraulically applied wood fiber mulches. These products provide similar project benefits which include:

- Can be applied more quickly than conventional ECB and provides superior direct soil coverage and protection.
- Covers irregular soil surfaces better than conventional ECB (i.e. small rock or woody debris at the surface will not interfere with its function).
- There is no need to remove the product once applied to seeded areas.
- Wood fiber mulch products are weed seed free and biodegradable.

4.4.5 Timing of Seeding

Native grass seeding

The recommended native grass seeding windows should be closely followed to achieve best results. Cool season native seed mixes should be sown in the early spring as soon as conditions allow, until June 15th. Warm season mixes can be seeded from late May 20 to June 15. This seeding window gives establishing grasses access to spring moisture which greatly enhances the establishment of seedlings. Seeding native grasses after mid-June exposes seedlings to periods of summer moisture deficit which can be detrimental to the establishing grasses.

A dormant seeding window occurs after October 20th until frost or snow inhibits normal seed placement. Dormant seeding is ideal for cool season grass species but does not accommodate warm season grass species which have seedlings that are sensitive to spring frosts.

Due to the slightly shorter growing season in the project area, it is recommended that seeding be undertaken at the earliest possible opportunities within the recommended seeding windows. Seeding early in the recommended seeding windows, as opposed to waiting until the end of the window, helps to safe-guard planting success against uncharacteristic weather such as the early on-set of drought conditions.

Cover crop seeding

As previously noted, erosion control cover crops can be seeded throughout the growing season, up until August 15th, but as summer progresses the germination of seeded annual cover becomes dependant on getting a well-timed rainfall, typically, within two weeks of seeding. Cover crops are most reliably established when seeded between mid-April and mid-August.

4.5 Propagule Plantings

While not considered to be a primary revegetation technique at the LSMOC, the possibility of using wetland propagules to revegetate specific sites may be appropriate in certain circumstances and should be considered as the LSMOC

revegetation design evolves.

When planning to undertake propagule plantings it is recommended that the following be considered;

- Excavation, hauling and placement of propagules as well as the excavation of planting beds and trenches are best undertaken in early winter – late spring in frozen conditions (late November – early March).

- Planting beds or trenches can be amended with additional soil to prepare the site. This would require minor additional sub-cutting to accommodate organics placement.

- Propagules of emergent species cannot be planted deeper than 45 cm below anticipated water levels. Some propagule plantings may be placed at the toe of the slope.

4.6 Weed Control

It is recommended that MI be prepared to undertake weed control during the planting year. As previously noted the project is considered to be largely free of weeds therefore planting should be phased-in as soon as possible on prepared sites rather than delay and increase the chances of weeds establishing prior to seeding. Early establishment of desirable cover, prior to weed infiltration, will be an important part of the overall revegetation process

As noted, dandelion and Canada thistle were documented in deciduous treed cover during site investigations. There is significant potential for these species to establish and proliferate during the planting phase of the LSMOC project especially if organics in these areas are stockpiled and distributed onto prepared grades for revegetation purposes. These species, particularly Canada thistle, will interfere with short-term and long-term planting objectives and without early control can quickly become a severe infestation. Unless adequate weed control measures can be made available during construction and revegetation, it is strongly recommended that organics not be used

for the purpose of amending soils, from sites where invasive weeds have been documented. The requirement for large scale weed control measures can often be minimized through the early detection and subsequent prompt control of invasive weeds. Weed control efficacy is best achieved at the early onset of encroachment.

4.6.1 Coordination of Weed Control in Seeding Year

A weed control strategy on a project of this scale is influenced by construction and planting schedules, existing weed spectrum, as well as seedling leaf-stage development within a seeded area. A project specific integrated weed control strategy should be developed with consideration given to weed management best practices. When employing the use of herbicide for weed control, the following points should be considered;

- In-crop herbicide applications can only be undertaken after grass seedlings have reached the two to three leaf stage (typically late-June to early July depending on date of seeding and prevailing weather conditions).
- Non-selective herbicides cannot be applied after native seedling emergence.
- Only prescribed rates of broadleaf herbicide should be applied where native seeding has been undertaken.
- Where a localized weed encroachment is detected, MI should be prepared to undertake an appropriately timed herbicide application on up to three occasions during the growing season.

5.0 SEQUENCING OF SITE PREPARATION AND REVEGETATION

Due to the seasonal nature of revegetation work, start-up time for site preparation and seeding affects how revegetation activities unfold in a given year. Site preparation and planting activities are highly integrated and are sensitive to time of growing season. Subsequently, missing key dates for completion of various elements may set the project behind schedule for up to one year and may result in additional project costs associated with the introduction of cover crops or other temporary erosion control measures. Additional time contingency planning will be required. Staging of sufficient machinery and organics prior to, or during, construction will be critical to overall success of revegetation.

5.1 Peat Extraction and Stockpiling

Peat and organic soil extraction is anticipated to occur during the initial channel construction contract. Equipment will access designated peat borrow sites in frozen conditions to allow for efficient extraction of the material which can then be windrowed in the ROW. See Section 3.0 for further discussion on organics sourcing, handling, management and integration.

5.2 Overview of Preliminary Revegetation Plan

Each of the required steps for revegetation will unfold as a tightly coordinated series of '*passes*'. To make the most efficient use of seeding opportunities and to minimize exposure of prepared sites to further erosion, ground that is prepared should be seeded as soon as possible, ideally within 24 hours. It is therefore essential that all required equipment, personnel and soil resources be mobilized and coordinated before work commences.

The sequence of passes takes place in the following order after final grading has been achieved:

FIRST PASS: Decompaction

- Decompaction will be required if subsoils are left in a compacted state following scheduled construction.

SECOND PASS: Organics placement

- Stockpiled organics can be staged adjacent the work site and placed/spread onto decompacted subsoils.

THIRD PASS: Organics integration and seedbed conditioning

- Organics are harrowed into decompacted subsoils to the appropriate depth.
- Harrow passes break up soil clumps following organics integration.
- More than one pass with harrows may be required to achieve a level seedbed.

FOURTH PASS: Seeding permanent cover

- Native grasses may be seeded from May – mid June or from October 20th – early November, depending on prevailing weather conditions and timing of site preparation.

FIFTH PASS: Seeding cover crop

- Once the seeding window for permanent cover has past, cover crop seeding can take place from April – August 15th.
- Areas seeded only with a cover crop will be revisited at the earliest permanent cover seeding window.

PROPAGULE PLACEMENT:

- Propagule, if required, is generally undertaken in the late-fall throughout winter.

The rate of site preparation (i.e. decompaction, organics placement and incorporation, as well as seedbed conditioning) will depend on the amount and type of resources (equipment and personnel) dedicated to this work. Site preparation works can be accomplished outside of the seeding window for perennial vegetation (early spring until mid-June and after mid-October). Ideally areas that are prepared are seeded to perennial cover as soon as possible to minimize their exposure and risk of erosion. Typically, approximately 2-5ha can be prepared per day under favorable conditions. The detailed design phase of this project will provide a more accurate estimate for rate of site preparation, informed by a more complete understanding of the overall contracting approach for the project.

The more site preparation work that can be accomplished leading up to the spring seeding window, the more area can be seeded to perennial cover in a given year. Every effort should be given to maximizing the amount of continuous area that is prepared for seeding ahead of early May. Provided sites have been suitably prepared for seeding, 8-16ha can realistically be drill seeded per day (assuming 10hr day). Seeding efficiency is maximized by employing large scale equipment and by ensuring large continuous tracts of seedable area is prepared ahead of seeding. Reduced efficiency should be expected when seeding steep slopes, wet areas, and forest edges as these areas will require special attention to ensure accurate seeding. Experienced staff should be on hand to assist with coordination and quality control oversight during all seeding.

6.0 REFERENCE

Alberta Environment and Water. 2012. Best Management Practices for Conservation of Reclamation Materials in the Mineable Oil Sands Region of Alberta. Prepared by MacKenzie, D. for the Terrestrial Subgroup, Best Management Practices Task Group of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, AB. March 9, 2011.

KGS Group Consulting Engineers. 2019. Lake St. Martin Outlet Channel Preliminary Design Report. Draft_REV A. KGS Group 18-0300-005. Pp. 75.

Manitoba Land Initiative. 2001. Core Maps – Data warehouse; accessed via: http://mli2.gov.mb.ca/mli_data/index.html

Government of Manitoba. "2001. Her Majesty the Queen in Right of Manitoba, as represented by the Minister of Conservation. All rights reserved."

Smith, R.E., H. Veldhuis, G.F. Mills, R.G. Eilers, W.R. Fraser, and G.W. Lelyk. 1998. Terrestrial Ecozones, Ecoregions, and Ecodistricts, An Ecological Stratification of Manitoba's Landscapes. Technical Bulletin 98-9E. Land Resource Unit, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada, Winnipeg, Manitoba. Pp. 324.

APPENDIX 1

LAKE ST. MARTIN OUTLET CHANNEL

PRELIMINARY REVEGETATION DESIGN:

REVEGETATION SITE INVESTIGATIONS REPORT

Submitted to:

KGS GROUP

Prepared by:

SCATLIFF + MILLER + MURRAY

Front Photo: Aerial photo of Lake St. Martin Outlet Channel alignment, June 11th, 2019

Front Photo (inset): Reach 1 LSMEOC revegetation trials; Plot #2, September 23rd, 2019

EXECUTIVE SUMMARY

Field investigations were undertaken in 2019 by Scatliff+Miller+Murray Inc. (SMM) revegetation biologists as part of the overall Lake St. Martin Outlet Channel (LSMOC) Preliminary Naturalization Revegetation Plan. These investigations focussed on the availability and suitability of in-situ growth media resources within the LSMOC project area, some of which will be stockpiled for use during site revegetation. The field investigations consisted of two parts:

1. Field Survey - along the LSMOC Alignment
2. Revegetation Trials - on the existing Reach 1 Emergency Outlet Channel

The Field Survey was carried out primarily to confirm the availability and suitability of existing soil resources for use in revegetation of the LSMOC and to make note of invasive weeds. A total of twenty-six (26) sampling locations were distributed along the channel centerline to represent nine Land Resources Inventory (LRI) cover classes found within the LSMOC project area. Field observations of plant community cover were in line with expectations, with over 80% of the project area falling within the category of wetlands with deep organic soils. Analysis of the chemical properties of organic soils along the LSMOC alignment revealed no apparent barriers to the growth and establishment of grass species that are appropriate for revegetating purposes within the LSMOC project area. Invasive weed encroachment was minimal and highly localized. Canada thistle and dandelion were encountered on two occasions.

Revegetation trials were carried out on the existing Reach 1 to assess seedling establishment with and without salvaged organics. Establishment of a site-appropriate, grass-based native seed mix was tested in exposed till amended with 7.5cm (3'') and 15cm (6'') of salvaged organics. Glacial till sub-soils within the trial plots were decompacted to 15-20 cm prior to incorporating organics. Seedling establishment was also tested in a control treatment with no amendments but which was similarly decompacted. Seedling establishment was successful for both 7.5 cm and 15 cm organic amendment treatments. Seedling establishment on control plots was weak and, overall, did not meet the required performance criteria that has proven to be

effective in establishing long-lived grass stands. The 7.5cm amendment is considered here as the minimum condition required for successful short term seedling establishment. That being said, with the expectation that the LSMOC will experience periods of moisture limitation and drought, a 15cm depth of organic soil is recommended for the long term sustainability of revegetation efforts, rather than the minimum 7.5cm organic soil depth.

Analysis of the organics that were salvaged for Revegetation Trials were found to be comparable, both in texture and in chemical properties, to organics soils on the LSMOC alignment. The results of the vegetation trials suggest that the use of salvaged organic soil resources on the LSMOC alignment pose no barriers to revegetation objectives. The use of soils that are salvaged in areas where Canada thistle and dandelion were present is likely to cause proliferation of these weeds. Canada thistle is considered especially problematic for the establishment and long-term quality of seeded grass stands. It is recommended that soils likely to contain the seed bank and live roots of these weeds should either not be used, or a targeted weed control program be implemented as part of the channel revegetation phase.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Field investigations were undertaken by Scatliff+Miller+Murray Inc. (SMM) revegetation biologists as part of the LSMOC Preliminary Naturalization Revegetation Plan. Channel revegetation is described in the *Lake Manitoba and Lake St. Martin Outlet Channels Project Environmental Impact Statement* (EIS) (Manitoba Sustainable Development, 2019) as a major construction component aimed at mitigating channel surface erosion and colonization by invasive species. The intent of the field investigations was to assess opportunities or constraints in the existing bio-physical environment to channel revegetation within the LSMOC. The main purpose of these investigations was to determine the suitability of growth media resources for revegetation and to help determine the quantity of organic soils required to meet revegetation objectives.

Topsoil and organics will be salvaged and stockpiled as part of the channel construction phase. Stockpiled soils will then be deployed as part of the revegetation phase to create a suitable growth medium for the establishment of a perennial grass cover. Soil organics will be essential for the purpose of revegetation on the LSMOC as most graded areas will be composed of deep glacial till subsoils. Glacial till subsoils in the project area are comprised of a mix of coarse material and mineral fines (sand, silt and clay fractions). These mineral fractions are important components of a functioning growth media, but lack organic content and fertility. Gaining a better understanding of the chemical and physical nature of salvageable organics, as well as the quantities required to suitably amend subsoils will directly inform revegetation planning going forward.

The presence of invasive weed species in the project area prior to construction is considered to be an important factor for the establishment of desirable vegetation during the project revegetation phase. Salvaged soils contaminated with weed seeds and live roots will result in significant weed regeneration when these soils are used for growth media purposes and may confound revegetation efforts. The majority of the project area is largely undisturbed and unsuitable to weed species considered to be most problematic in seeded perennial grass stands. Nonetheless the presence of

weeds along the channel alignment was included as part of the field investigation for consideration during revegetation design and planning.

The revegetation field investigations consisted of two parts;

1. Field Survey of the LSMOC Alignment
2. Revegetation Trials

The Field Survey was carried out primarily to confirm the availability and suitability of soil resources for use in revegetating the LSMOC. Revegetation Trials were carried out on the existing Reach 1 to assess seedling establishment using salvaged organics that are comparable to soil resources on the LSMOC. The following sections describe the ecological context of the project area, outline the methodologies used, and describe the findings of the revegetation field investigations.

1.1 Ecological Context

The LSMOC project is situated in the Mid-Boreal Lowland Ecoregion of the Boreal Plains Ecozone. The Ecoregion is broadly characterized by extensive peatland cover interrupted by mixed softwood/hardwood plant communities where drainage and mineral soils allow (Smith et al., 1998). The vegetation on the peatlands varies with peatland type. Bogs are generally characterized by stunted black spruce with ericaceous shrub and mosses cover. Moss cover is often dominated by species of sphagnum. Fens are generally dominated by sedges and brown mosses and contain varying quantities of shrubs such as swamp birch and stunted tamarack trees where conditions permit. Upland cover can vary with drainage, soil texture and fire history. Black spruce is widespread, but following forest fires, jack pine and, to a lesser extent, trembling aspen, become major forest components (Smith et al., 1998). Wet uplands have black spruce and moss vegetation with shrubs such as willow and alder.

The LSMOC is 23.8km in length with a 400m right of way with the inlet situated at Lake St. Martin and the outlet at Lake Winnipeg (Figure 1). The overall area of the project is approximately 890 ha. The major land cover classes, as well as their total area and relative contribution to the overall project area are shown in Table 1.

During construction of the LSMOC, tree clearing, soil stripping, excavation, soil handling and stockpiling will take place. Following final grading it is anticipated that the areas to be revegetated will be composed primarily of exposed glacial till along with a mixture of other subsoil material. Glacial till is generally low in organics, fertility and biological processes and is not considered to be a suitable growth media for revegetation. Stockpiled organic soils will be used to amend exposed subsoils to create a suitable growth medium for the timely establishment of seeded native grass cover.

Table 1: Land resources inventory cover classes and proportional cover within the LSMOC right of way.

COVER CLASSES	AREA (Ha)	COVER (%)
Water	4.4	0.5
Exposed Land	1.5	0.2
Wetland – Treed	35.5	4.0
Wetland – Shrub	483.7	54.4
Wetland – Herb	228.3	25.7
Coniferous – Dense	55.9	6.3
Coniferous – Open	6.8	0.8
Broadleaf – Dense	16.1	1.8
Broadleaf – Open	1.0	0.1
Mixed Wood – Dense	56.2	6.3

FileName: P:\Projects\2018\18-0300-005\Dwg\GIS\MXD\Preliminary_Naturalization_Revegetation_Plan\RevA\18-0300-005_Fig01_v2.mxd
11"x17" PLOT SCALE 1:1

555000 560000 565000 570000 575000

5750000 5745000 5740000

N W E S

Lake Winnipeg

Buffalo Creek

Big Buffalo Lake

Little Buffalo Lake

Lake St. Martin

0+000 1+000 2+000 3+000 4+000 5+000 6+000 7+000 8+000 9+000 10+000 11+000 12+000 13+000 14+000 15+000 16+000 17+000 18+000 19+000 20+000 21+000 22+000 23+000 24+000

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

LEGEND:

- Soil Sample Location
- Classification Site
- Reach 1 Channel – Existing
- LSMOC Alignment
- Access Road
- Alignment Corridor (400 m)

LAND COVER

- No Data
- Shadow
- Cloud
- Snow/Ice
- Rock/Rubble
- Exposed Land
- Water
- Shrub – Tall
- Shrub – Low
- Herb
- Bryoids
- Wetland – Treed
- Wetland – Shrub
- Wetland – Herb
- Coniferous – Dense
- Coniferous – Open
- Coniferous – Sparse
- Broadleaf – Dense
- Broadleaf – Open
- Broadleaf – Sparse
- Mixed Wood – Dense
- Mixed Wood – Open
- Mixed Wood – Sparse

1 0 1 2 3
Kilometres

2.0 REVEGETATION FIELD SURVEY

2.1 Methods

The revegetation field survey of the LSMOC alignment was conducted by SMM revegetation biologists on June 11th and 12th, 2019, mainly within a 20m wide cleared area along the channel centerline. The survey was conducted on foot with transportation provided by helicopter.

A total of twenty-six (26) sampling locations were situated along the LSMOC centerline (Figure 1). Cover class information was obtained from the Provincial Land Resource Inventory (LRI) Land Use / Land Cover Landsat TM Maps (Gov. MB, 2001). Using ArcMap GIS software, survey locations were distributed roughly proportionally among the various LRI cover classes. At each sampling location, general vegetation cover observations were documented to confirm the major LRI vegetation cover types intersecting the LSMOC alignment. Land vegetation cover is considered to be a good indicator of soil conditions given the relationship between soil and drainage and the dominant plant community. Therefore cover type was linked to soil information to help extrapolate information gained from soil samples on the availability of soil resources throughout the project area. Any evidence of weedy or otherwise invasive plant species were also documented and given a UTM waypoint to mark locations.

Soil samples were taken at all sampling locations. The frequency and distribution of soil sampling was designed to proportionally represent existing cover classes depicted within the 400 meter wide LSMOC right-of-way (ROW). Soil sampling protocol for each sampling site was to obtain separate samples at depths of 0 – 15cm, 15 – 30cm and 30 – 45cm. Samples consisted of a minimum of three (3) cups of organics or mineral soils at each depth. Samples were stored in a freezer following field collections prior to being submitted for laboratory analysis. A subset of samples, representing major cover types were analysed for characteristics that are important for establishing native grass-based seed mixes. Chemical parameters that were analysed included organic content, pH, electrical conductivity and macro-nutrients such as phosphorus and nitrogen.

2.2 Results

2.2.1 General Land Cover Observations

Field observations of dominant vegetation cover/structure, for the most part, supported LRI cover classes. Survey vegetation data and representative photography of each sample location are provided in Appendix 1. Visually distinguishing between the various broadleaf cover classes *('Broadleaf Open', 'Broadleaf Dense' and 'Mixedwood Dense')* was difficult, and subsequently, these classes were consolidated into a new category; '*Broadleaf Treed*', for the purposes of this report.

The vegetation cover was native and characteristic of undisturbed landscape across all land cover classes. Observations were taken from the narrow clearing along the centerline of the LSMOC with occasional short forays into adjacent sites. Ground cover along the clearing was generally intact with a minimum of disturbance save for the removal of tree cover. Only occasionally was exposed mineral soil encountered and this was usually where aspen was encountered were surface organics were relatively thin compared with wetland soils.

2.2.2 Invasive Weed Species

Broadleaf weeds were encountered at two (2) locations. In both circumstances a small number of specimens were encountered on mineral soils within broadleaf treed areas. Roughly fifteen (15) Canada thistle (*Cirsium arvense*) plants were encountered within a cleared trembling aspen stand, on the channel center line, within one (1) kilometer of the inlet at Lake St. Martin (Sampling Location # 25). Dandelions were seen in a similar environment at Sampling Location #4. Exposed upland mineral soils are generally more prone to weed encroachment than wetland soils encountered in the region.

2.2.3 Soils

Soil samples were taken at all 26 sampling sites. Frost was encountered at 20 – 30cm in wetland and coniferous sites. Therefore soil sampling was mostly restricted to the 0 – 15cm and 15 – 30cm depths in these areas. Frost was absent from upland mineral soils associated with aspen cover and generally better drainage conditions. In these

areas field personnel were also able to obtain soil samples from the 30 – 45 cm depths.

A sample of exposed glacial till at the 0 – 15cm depth was taken from an embankment on a segment of Reach 3 that will be modified and integrated in to the LSMOC alignment. The assumption was made that the embankment was nearly entirely composed of excavated and graded till therefore it was deemed to be unnecessary to obtain deeper samples from 15 – 30cm and 30 – 40cm soil depths.

To minimize unnecessary duplication of soil testing and associated costs, a subset of soil samples representing major cover types was submitted for further analysis. Table 2 shows the distribution of the number of sampling sites that were submitted across representative cover classes. Soil samples from a total of fifteen (15) sites were submitted for laboratory analysis. A summary of relevant soil parameters for revegetation are provided in Appendix 2. Generally all sampled soils were found to be significantly more fertile than glacial till. Mineral soils were encountered only in cover classes containing deciduous forest cover types. All other soils were organic in nature. Soil pH and electrical conductivity were generally found to be within the environmental tolerance ranges of most grass species being considered for revegetation within the project area.

Table 2: Soil sampling summary table showing number of sampling locations by cover class.

COVER CLASSES	AREA (Ha)	COVER (%)	SOIL SAMPLING LOCATIONS
Exposed Land	1.5	0.2	1
Wetland – Treed	35.5	4.0	1
Wetland – Shrub	483.7	54.4	3
Wetland – Herb/Bryoid	228.3	25.7	4
Coniferous – Dense	55.9	6.3	1
Coniferous – Open	6.8	0.8	2
Broadleaf – Treed	56.2	6.3	3

3.0 REVEGETATION FIELD TRIALS

3.1 Methods

The experimental trials were conducted at Reach 1 of the Lake St. Martin Emergency Outlet Channel, at the north shore of Lake St. Martin, Manitoba (UTM 14U 554037 5740386) (Figure 1). The study site is located within the Interlake Plain Ecoregion of the Boreal Plains Ecozone (Smith et al., 1998). Mean annual precipitation ranges from approximately 500 to 525mm and experiences highly variable year-to-year precipitation rates.

The Emergency Outlet Channel was constructed in 2011 in order to provide emergency reduction to lake levels caused by flood water diversion in southern Manitoba. This channel reach was operated from 2011 to 2012 and again from 2014 to 2015. Existing soil conditions are described as un-vegetated glacial till exposed at the time of channel construction (i.e. base material). Soils are moderately alkaline (pH > 8), non-saline (EC < 1dS/m), lack soil organic matter (< 1.0%) and are infertile (N < 4ppm; P < 2ppm; K < 130ppm). Site soils have experienced variable levels of erosion and compaction since their construction, largely attributable to their position on site (i.e channel side slopes vs. terrace/bench).

The vegetation trials follow a split plot design and were replicated three times. The experimental variable being tested was rate of organic soil application and the study evaluated three application rates – 15cm (6''), 7.5cm (3''), and 0cm (no soil amendment). All other aspects of the revegetation approach were kept consistent between subplots, including method of base material decompaction, seedbed preparation, seeding, and plot maintenance.

An initial site investigation was conducted in late May 2019 in order to locate suitable sources of organic soils to use in the trials, as well as to confirm existing site conditions and finalize trial logistics and experimental set-up methodologies (Appendix 3 - Photo Array 1). During this site investigation, several potential sources of salvageable organics were located along the edge of the forest. These potential

sources were sampled and soil samples were submitted for analysis at Farmer's Edge Laboratories, in Winnipeg, MB. Ultimately, a source on the south side of the channel, approximately 600 – 700m east of the constructed weir at the inlet was selected for use in the trials based on the soil quantity and quality, as well as its relative proximity to the channel inlet (Figure 2).

Vegetation trial plots measured 2.5m by 9m and were sub-divided into three sub-plots (each measuring 2.5m by 3m) each of which received one of the three experimental treatments (15cm, 7.5cm, or 0cm organic soil amendment) (Figure 3). All vegetation trial plots were set up on June 3rd and June 4th, 2019. Trial plot set-up followed the following steps (Appendix 3 - Photo Array 2):

1. Plots were sited, measured and marked with corner posts;
2. Plots were decompacted to approximately 15 – 20cm manually using a pick-axe;
3. Organic soil was dug and hauled to decompacted plots using a wheel-barrow with a known volume/capacity;
4. The requisite volume of organic soil was placed and spread over the applicable treatment with bow rakes;
5. Placed soils were lightly blended into the decompacted till using pitch forks;
6. The plot seedbeds were prepared by raking the surface level with bow rakes;
7. Seed was broadcast across the plot using a push-broadcaster that had been calibrated to the desired seeding rate – the native grass seed mix and seeding rate is shown in Table 3;
8. Plots were lightly raked once more to incorporate the seed into the surface of the soil;
9. Animal exclusion measures were installed (chicken wire fencing and jute string and flagging tape).

Site inspections were conducted throughout the growing season to document plant establishment and growth. During each inspection, plots were surveyed by randomly placing a 0.1 m^2 quadrat five times in each sub-plot and collecting plant growth data within each quadrat. Quadrat drops avoided the outer 60cm of the plots to limit any potentially confounding edge effect on vegetation establishment. Plant measures

documented included seedling density (oat seedlings and native grass seedlings) and growth stage (including height and leaf stage), as well as the presence of un-seeded vegetation. General observations on plant growth, stress, and soil conditions were made during each site inspection and conditions were documented with photography (Appendix 3 – Photo Arrays 3-5).

The seeding rate was determined on the basis of pure live seed. The seed mix is shown below in Table 3. Oats were also included in the seed mix as a quick growing temporary nurse crop while the seed mix is establishing.

Table 3: Native grass seed mix and commercial lot numbers for revegetation trials.

Species	**PLS Seeding Rate** (kg/ha)	**Lot #**
Switchgrass	1.7	SG-18-801
Western wheatgrass	0.8	H4-16-87101 (504801)
Northern wheatgrass	0.8	514773
Rough hairgrass	0.2	171438219
Canada wildrye	1.1	504738
Big bluestem	2.8	BBS-18-18
Nodding brome	1.7	1801 (504447)
Slender wheatgrass	0.8	18-0028 (504775)
Canada milkvetch	0.2	----
Total	**10.1**	

Figure 2: Approximate location and position of trial plot replicates on Reach 1 of the Emergency Outlet Channel.

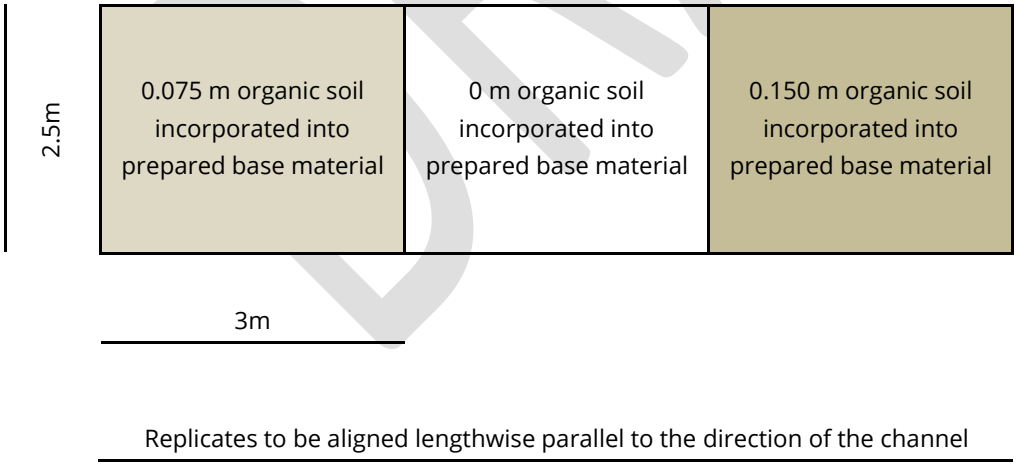


Figure 3: Plot configuration showing all three treatments and orientation of plots parallel to the channel alignment.

3.2 Results and Observations

While the target native grass seedling density of > 6 seedlings per 0.1m^2 was achieved in all three experimental treatments (Table 4), the required density of seedlings at the critical 4-leaf stage at the time of the final inspection was met only in the amended plots. Seedlings in the 'no soil' treatment were immature, stunted, and stressed, and failed to meet the minimum density of seedling at the required leaf stage in nearly all samples. Seedlings in the no-soil treatment are not expected to over-winter successfully or develop into a perennial groundcover capable of satisfying the revegetation objectives of mitigating surface erosion and weed establishment. Achieving the target seedling density, regardless of depth of soil placement, confirms that the site and seedbed preparation as well as seeding methods are appropriate for early grass establishment under the conditions at the LSMOC. However, growth rate and maturation (measured here as leaf stage), as well as observations on plant stress, are more important metrics to evaluate the success and long-term viability of the native grass planting.

Table 4: End-of-season summary data showing density and maturity measures.

	Average Oat Seedlings Density (#)	Average Native Grass Seedlings Density (#)	Average Native Grass Seedling Leaf Stage	Samples Meeting Criteria for Successful Establishment
15cm Soil Depth	4.9	10.0	≥4	80%
7.5cm Soil Depth	5.8	14.7	≥4	80%
0cm Soil Depth	5.2	8.9	<4	20%

Native grass seedling rate of growth and development was directly related to organic soil application rate. The 15cm soil application rate was characterized by robust and mature native grass seedlings, while the 0cm soil application rate treatments were characterized by small, stunted native grass seedlings at a younger leaf stage. The 7.5cm soil application rate treatment was characteristically intermediate between the 0cm and 15cm treatments. This relationship between soil depth and grass seedling growth rate was likewise evident looking at the oat nurse crop. Nurse crop biomass, based on visual assessment, was noticeably less in 0cm amendments than that in both 7.5 and 15cm amendments, and nurse crop plants were most robust in 15cm amended plots.

Native grass seedlings established within the 0cm organic soil amendment treatment appeared very stunted and stressed as compared to the treatments that received organic soil amendment. These seedlings were small and less mature than other treatments and showed signs of stress including change in coloration (red pigment in leaves) as well as leaf tip necrosis. These seedlings are likely to suffer increased rates of mortality during the winter because of their stunted and stressed state. This treatment does not meet our criteria for successful plant establishment and serves to illustrate the importance of organic soil application in site revegetation.
While the native grass seedling density was comparable between all three soil depth treatments, a high degree of within- and between-plot variation was evident. For one, the plot that was positioned in the centre of the channel bench/terrace was characterized by notably higher seedling densities than the other two replicates that were positioned on either side of this plot (Appendix 4). During summer site investigations it was noted that after rainfall water was ponding near this centre plot, while no surface water was observed around the other two plots. While this condition was not evident during trial plot set-up, it suggests that drainage in this portion of the site is being impeded, leading to increased moisture availability for the seeded native grass mix. The improved moisture availability in this area resulted in seedling densities that were on average two-times greater than that documented in the other two replicates. This condition is likely the result of this area having been used as an access road during channel construction and operation, leading to compaction and low rates of internal drainage.

Likewise, within sub-plots, regardless of soil depth treatment, the documented seedling densities varied considerably. For example, during the September 23rd site visit, seedling density in the 7.5cm soil depth treatment varied from as high as 23 to as low as 4 seedling per 0.1m^2 (Appendix 4). The observed high variability in seedling density across the revegetation trails can be attributed to a number of factors, most notably the small scale of the plots, the manual seeding operations, the somewhat rough and irregular nature of the soil surface at the time of seeding, as well as the randomness of quadrat placement. In larger scale applications using conventional field operations a more consistent level of plant establishment is typically achieved owing to greater precision in seedbed preparation and seeding rate calibration. Generally, given the study design, the variability in seedling numbers is considered to be reasonable and within the expected range.

4.0 DISCUSSION - IMPLICATIONS FOR PROJECT REVEGETATION

4.1 Field Survey

Over 80% of the LSMOC project footprint traverses land cover types that are characterized by organic soils of varying depths. Geotechnical soil test logs can provide a better quantification of available organics at specific locations along the channel alignment, and should be used in detailed design to provide direction on construction staging and sequencing with respect to organic soil stockpiling. That being said, based on the ubiquity of organic soils throughout the project footprint, our expectation is that this important revegetation resource will not be a limiting factor in successful site revegetation.

The reasons that certain parts of the alignment may lack the required quantities of salvageable organics vary. For example, soils in areas where invasive weeds were encountered should not be used unless sufficient weed control resources are made available during the project construction and revegetation phases. Also, a large quantity of soil organics attached to plant roots may be lost during grubbing and tree disposal. These scenarios are more like to occur on mineral soils, which incidentally are associated with hardwood cover on the alignment. Given that mineral soil conditions appear relatively uncommon on the project alignment, any additional organics can theoretically be sourced from nearby adjacent sites where the thickness and overall coverage of organic material may be found in excess.

The general lack of non-native plant species observed throughout the project footprint is not surprising given the undeveloped and undisturbed nature of the existing landscape. The presence of Canada thistle near the inlet location is notable and should be addressed as soon as possible to ensure this Tier 3 Noxious Weed does not have the opportunity to spread and degrade the quality of adjacent landscapes and site soils. By selectively avoiding re-use of site soils that have a history of weed establishment, we can confidently accelerate the typical revegetation sequence and potentially save costs associated with extensive pre-plant weed control operations. To preserve the integrity of the site in the interim, and leading up to revegetation work, it

is recommended that best practices to avoid weed seed importation be followed (e.g. clean all equipment before mobilizing to site).

4.2 Revegetation Trials

The revegetation of disturbed sites is often limited as a result of soil related factors such as soil compaction and moisture limitation due to a lack of soil organic matter and structure. Reclamation of disturbed soils devoid of structure or organic matter can be accomplished through the amendment of soils with an organic material, mechanical preparation and seeding a site appropriate long lived vegetative cover. The Revegetation Trials at the Emergency Outlet Channel have served to confirm the suitability of the local organic soil type for use in future revegetation of the LSMOC, and has provided valuable information relating to the quantity of soils required to achieve target and minimal establishment of native grass seedlings.

The results from the Revegetation Trials 2019 field season suggest that target mature (4-leaf stage) native seedling densities can reliably be achieved in a situation closely analogous to the anticipated site conditions along the LSMOC. The revegetation conditions at Reach 1 are very similar to those expected at the LSMOC, just as the soil characteristics of the organic soils used in the Revegetation Trials are very similar to those organic soils characterized along the LSMOC alignment. While trial plots were set-up manually using low-cost materials and a small scale, the methods are easily achievable at the field scale using commonly available heavy equipment and standard agronomic practices.

The ability of native grass seedlings to successfully over-winter and establish as a perennial groundcover is strongly related to maturity (measured here as leaf stage) at end of the growing season. A standard criterion for end of season establishment of native grass seedlings is the 4-leaf stage. With no organic soil application, only 20% of the sample quadrats achieved this maturity, while at the 7.5cm rate and at the 15cm rate, 80% of the sample quadrats had successfully reached this growth stage.

It should be noted that the provision of a higher rate of organic soils (i.e. 15cm) will impart the grass stand with a greater resilience to adverse climatic conditions,

particularly periods of drought or low precipitation. Given that current climate models suggest that we will experience less predictable precipitation rates over the coming decades – with heavier rainfall during some months and dramatic reduction in rainfall during other months – providing a greater depth of organics during revegetation of the LSMOC is highly recommended.

It should also be noted that these revegetation trials illustrate the importance of seeding date on native grass establishment. Despite very low rainfall throughout the growing season, native grass seedlings establishment was predictable and reliable, comfortably achieving target seedling densities. Had seeding occurred later in the spring/summer, we expect that moisture limitation would have reduced grass establishment and growth.

Finally, these trial results would be greatly strengthened by follow-up investigations conducted in the 2020 growing season. The highly exposed nature of the channel will create harsh conditions for the young seedlings, and evaluating their ability to over-winter will inform the overall strategy for revegetation. Additionally, it should be noted that because of the lack of fertility of the subsoils, long term plant growth may become limited over time, resulting in decreased growth in grassy cover. Monitoring these plots for a second growing season will provide insight into their capability to accumulate biomass under low-nutrient conditions.

5.0 REFERENCES

Government of Manitoba. 2001. Manitoba land initiative – Core Maps – Data warehouse http://mli2.gov.mb.ca/mli_data/index.html
"2001. Her Majesty the Queen in Right of Manitoba, as represented by the Minister of Conservation. All rights reserved."

Smith, R.E., H. Veldhuis, G.F. Mills, R.G. Eilers, W.R. Fraser, and G.W. Lelyk. 1998. Terrestrial Ecozones, Ecoregions, and Ecodistricts, An Ecological Stratification of Manitoba's Landscapes. Technical Bulletin 98-9E. Land Resource Unit, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada, Winnipeg, Manitoba. Pp. 324.

APPENDIX 1 - Lake St. Martin Outlet Channel revegetation Survey Observations

Sample Location Waypoint 1

Survey Data	Observations
Cover Classification	Wetland Herb
Forest Description	Sparse black spruce clusters
Shrub Description	Sparse bog birch, tamarack saplings
Groundcover Description	Sedge spp., pitcher plant
Soils Description	0-30cm - Sedge peat; frozen at 30cm
Notes	

Sample Location Waypoint 2

Survey Data	Observations
Cover Classification	Coniferous Dense
Forest Description	Black spruce > 70%; Tamarack regen ~20%
Shrub Description	Labrador tea and poplar
Groundcover Description	Bluejoint, marsh marigold, raspberry, colts foot, blueberry
Soils Description	Sphagnum moss (0-10''); frozen at 10-12''
Notes	Woody debris ~5%

Sample Location Waypoint 3

Survey Data	Observations
Cover Classification	Wetland Herb
Forest Description	Black spruce and poplar – small clusters
Shrub Description	Bog birch – clusters
Groundcover Description	Sedge spp., pitcher plant, buck bean; sphagnum dominant
Soils Description	Sedge peat (0–14''); frozen at 14''
Notes	

Sample Location Waypoint 4

Survey Data	Observations
Cover Classification	Broadleaf Treed (aspen forest, couple conifers V9)
Forest Description	Trembling aspen 75%; Balsam poplar 5–10%; willow and tamarack sporadic
Shrub Description	Willow sp. ~40%
Groundcover Description	Bluejoint regen, some willow, lots of small seedlings; sparse regen on centre line; dandelion at forest edge
Soils Description	Clay loam (6–8''); grey clay (8–24'')
Notes	3 samples taken; dark clay loam near surface, grey silty clay below, roots throughout; few stones at surface

Sample Location Waypoint 5

Survey Data	Observations
Cover Classification	Wetland Herb
Forest Description	None
Shrub Description	Sporadic bog birch
Groundcover Description	Sedge spp.
Soils Description	Organic, sedge peat
Notes	Water table at surface; sample from top 15''

Sample Location Waypoint 6

Survey Data	Observations
Cover Classification	Wetland Shrub (edge of Wetland Herb)
Forest Description	Black spruce and tamarack clusters
Shrub Description	Bog birch, tamarack and black spruce; denser as you reach forest edge, sparse throughout
Groundcover Description	Sedge spp., pitcher plant, bog rosemary, Labrador tea
Soils Description	Organic 0-14''; frozen at 14''
Notes	Water table within 10'' of surface

Sample Location Waypoint 7

Survey Data	Observations
Cover Classification	Wetland Shrub
Forest Description	Tamarack, Jack pine, black spruce – young; couple Jack pine out of place; productive
Shrub Description	Spruce, tamarack, bog birch
Groundcover Description	Sphagnum cover 100%, sedge spp., bog rosemary, Labrador tea
Soils Description	Organic soil; brown sphagnum 0-9'', frozen at 9''
Notes	Water table near frozen layer

Sample Location Waypoint 8

Survey Data	Observations
Cover Classification	Wetland Shrub
Forest Description	Tamarack, black spruce; young coniferous forest V32
Shrub Description	Willow sp., tamarack, spruce, poplar, Labrador tea
Groundcover Description	Sphagnum ~100%; Labrador tea
Soils Description	Sphagnum peat 0-6'', frozen at 6''
Notes	

Sample Location Waypoint 9

Survey Data	Observations
Cover Classification	Wetland Shrub
Forest Description	Tamarack, black spruce; young forest regen, some older BS and tamarack in distance
Shrub Description	Black spruce, tamarack, Labrador tea, dense shrubs in forest
Groundcover Description	Sedge spp., bog birch
Soils Description	Brown peat (0-4''); black peat (4-6''); frozen peat at 6''
Notes	2 samples taken

Sample Location Waypoint 10

Survey Data	Observations
Cover Classification	Shrub Tall
Forest Description	Black spruce and tamarack; sporadic older trees but mostly mid-aged
Shrub Description	Black spruce, tamarack, Labrador tea, dense shrubs in forest
Groundcover Description	Very little regen from clearing
Soils Description	Brown peat (0-4''); black peat (4-6''), frozen peat at 6''
Notes	Consistent with WPT018

Sample Location Waypoint 11

Survey Data	Observations
Cover Classification	Coniferous Open
Forest Description	Black spruce and tamarack
Shrub Description	Black spruce and tamarack
Groundcover Description	Bog laurel, Labrador tea, moss and lichen; no regen from clearing
Soils Description	Dark peat (0-10''); frozen at 10''
Notes	

Sample Location Waypoint 12

Survey Data	Observations
Cover Classification	Wetland Treed or Wetland Shrub
Forest Description	Black spruce; trees all dead oy dying
Shrub Description	Bog birch, tamarack, cattail throughout
Groundcover Description	Cattail, sedge, marsh marigold, bog rosemary, buck bean
Soils Description	Organic, black peat on top then brown below
Notes	Frozen at 18''

Sample Location Waypoint 13

Survey Data	Observations
Cover Classification	Wetland Shrub
Forest Description	Tamarack, black spruce – sporadic in clusters
Shrub Description	Bog birch
Groundcover Description	Phragmites, cattail, sedge, equisetum, bog rosemary, colt's foots
Soils Description	Black peat to 10–12'' then frozen
Notes	

Sample Location Waypoint 14

Survey Data	Observations
Cover Classification	Wetland Herb
Forest Description	None; small pockets of black spruce/tamarack
Shrub Description	Small patches of bog birch
Groundcover Description	Sedge spp., pitcher plant
Soils Description	Black sedge peat 0–6''; brown sedge peat 6–12''; frozen at 12''
Notes	Anaerobic; water table 4'' below surface

Sample Location Waypoint 15

Survey Data	Observations
Cover Classification	Wetland Herb
Forest Description	Clumps of black spruce around
Shrub Description	Sporadic bog birch around
Groundcover Description	Sedge spp., pitcher plant
Soils Description	Black peat 0-6''; brown sedge peat 6-12''; frozen at 12''
Notes	Water table 4'' below surface

Sample Location Waypoint 16

Survey Data	Observations
Cover Classification	Wetland Herb
Forest Description	Shrubby willow cover
Shrub Description	Willow sp., some poplar, young black spruce
Groundcover Description	Raspberry, horsetail, bluejoint, Solomon seal, marsh marigold, colts foot, mertensia, fireweed
Soils Description	Black peat 0-24''; frost at 24''
Notes	Water table at 12-14''; 3 samples taken

Sample Location Waypoint 17

Survey Data	Observations
Cover Classification	Coniferous Sparse
Forest Description	Young conifer forest, tamarack, black spruce, 1 Jack pine
Shrub Description	Bog birch and conifer regen; bog laurel and rosemary
Groundcover Description	Bog rosemary, Solomon seal, sphagnum, bluejoint, pitcher plant, cloudberry
Soils Description	Sphagnum at surface, black peat 0-12''; frost at 12''
Notes	No standing water but frozen layer saturated

Sample Location Waypoint 18

Survey Data	Observations
Cover Classification	Wetland Herb
Forest Description	None
Shrub Description	Sporadic bog birch around
Groundcover Description	Sedge spp., buck bean, horsetail
Soils Description	Sedge peat throughout; darker 0-6''; brown/tan 6-12''; frost at 12''
Notes	Water table around 6'' below surface

Sample Location Waypoint 19

Survey Data	Observations
Cover Classification	Wetland Shrub – Mixedwood Forest
Forest Description	Shrubby mixedwood forest; black spruce, balsam poplar, young Jack pine
Shrub Description	Willow, bog birch, Jack pine, Labrador tea
Groundcover Description	Lichen, Labrador tea, bog rosemary, bearberry, andromeda
Soils Description	Dark brown peat 0-14''; frost at 14''
Notes	No water table encountered

Sample Location Waypoint 20

Survey Data	Observations
Cover Classification	Wetland Shrub
Forest Description	Young coniferous forest with patches of bog birch; Jack pine, tamarack, black spruce
Shrub Description	Bog birch, conifer saplings, Labrador tea
Groundcover Description	Sedge spp., sphagnum
Soils Description	Black peat 0-6'', black/brown mixture 6-12''; frozen around 12''
Notes	No water table encountered

Sample Location Waypoint 21

Survey Data	Observations
Cover Classification	Broadleaf Treed
Forest Description	Trembling aspen 75%; Balsam poplar 5-10%; willow and tamarack sporadic
Shrub Description	Willow sp. ~40%
Groundcover Description	Bluejoint regen, some willow, lots of small seedlings; sparse regen on centre line; dandelion at forest edge
Soils Description	Clay loam (6-8''); grey clay (8-24'')
Notes	3 samples taken; dark clay loam near surface, grey silty clay below, roots throughout; few stones at surface

Sample Location Waypoint 22

Survey Data	Observations
Cover Classification	Wetland Treed
Forest Description	Black spruce/tamarack forest cover, young
Shrub Description	Alder, poplar, tamarack, bog birch
Groundcover Description	Phragmites, sedge spp., raspberry, Labrador tea
Soils Description	Black peat 0-8''; frost at 8''; saturated but no water table
Notes	None

Sample Location Waypoint 23

Survey Data	Observations
Cover Classification	Wetland Shrub
Forest Description	No forest canopy; sporadic tamarack and black spruce
Shrub Description	Lots of bog birch, tamarack and poplar regen, willow
Groundcover Description	Sphagnum, Labrador tea, bog rosemary; brown sphagnum at surface in places
Soils Description	Black peat 0-6''; brown peat 6-8''; frost at 8''
Notes	Brown thrasher

Sample Location Waypoint 24

Survey Data	Observations
Cover Classification	Broadleaf Dense
Forest Description	Poplar stand – cleared; all trembling aspen and balsam poplar
Shrub Description	Shrub poor; some willow and poplar regen – very sparse
Groundcover Description	Rich groundcover; bluejoint, lily of the valley, strawberry, rose, sarsaparilla, current, gallium, starflower, palmate coltsfoot, honeysuckle, Solomon's seal, wintergreen, bishops cap, alder-leaved buckthorn
Soils Description	Clay loam 0-6"; greying clay 6-10"; 10-24" grey clay
Notes	No water table hit, no frost hit

Sample Location Waypoint 25

Survey Data	Observations
Cover Classification	Wetland Shrub
Forest Description	Sporadic poplar with lots of snags
Shrub Description	Willow; aspen regen
Groundcover Description	Bluejoint
Soils Description	Organic 0-4''; dark clay loam 4-12''; grey clay 12''+ very heavy
Notes	Quite a bit of Canada thistle right at the inlet

Sample Location Waypoint 26 – Lake St. Martin Outlet Channel Reach 3 (existing channel)

Survey Data	Observations
Cover Classification	N/A – Disturbed
Forest Description	No mature trees
Shrub Description	Minor deciduous regeneration – poplar
Groundcover Description	Sedge, clover, cattail, saltgrass
Soils Description	Exposed till
Notes	More regrowth and less erosion than Reach 1; lots of geese; less erosion; channel has not been operated.

APPENDIX 2 - Lake St. Martin Outlet Channel Field Survey Soil Sample Analysis

LRI Cover Class	Locations	Sampling Depth (cm)	pH	EC (mS/cm)	Phosphorous (mg/L)	Nitrate N (mg/L)	Organic Matter (%)	Texture / Soil Type
Exposed	26	0 – 15	8.4	0.167	0.89	0.24	81	Loamy till, with a mixture of coarse gravel
Wetland Herb	3, 14 , 15, 17 and 11	0 – 15	7.0 – 7.5	0.111 – 0.245	1.5 – 30	1.6 – 7.1	75 – 88	Organic
		15 – 30	7.0–7.5	0.061 – 0.096	1.5 – 10	2.0 – 3.5	84 – 87	Organic
Coniferous Dense	2	0 – 15	7	0.245	30	7.1	75	Organic
Coniferous Open	11 and 17	0 – 15	6.9 – 7.3	0.106 – 0.113	15 – 30	3.6 – 8.7	73 – 79	Organic
		15 – 30	7.1 – 7.3	0.111 – 0.311	11	3.8 – 8.2	72 – 78	Organic
Wetland Shrub	5, 13 and 20	0 – 15	7.6 – 8.0	0.124 – 0.280	11–12	2.3 – 15.0	75 – 79	Organic
		15 – 30	7.5 – 7.9	0.156 – 0.254	3.3 – 7.3	5.0 – 23.0	73 – 77	Organic
Wetland Treed	22	0 – 15	7.6	0.117	11	3	79	Organic
		15 – 30	8.2	0.262	22	0.58	4.6	N/A
Broadleaf Tree	4, 21 and 24	0 – 15	7.6 – 7.9	0.149 – 0.257	2.4 – 15	0.49 – 17.0	6.9 – 9.2	Organic – Mineral Clay
		15 – 30	7.8 – 8.2	0.220 – 0.755	3.1 – 9.8	0.58 – 0.84	2.8 – 4.6	Mineral Clay
		30 – 60	8.2 – 8.6	0.220 – 1.90	3.4 – 4.6	0.39 – 1.40	1.2 – 2.3	Mineral Clay

APPENDIX 3 - Revegetation Trials Photo Log

Photo Array 1: Site reconnaissance – organic soils (peat) were located in multiple locations along Reach 1 along the forest edge; representative samples were collected and submitted for laboratory analysis; a suitable organics source was selected based on available quantity, soil quality, and proximity to a suitable trial location.

Photo Array 2: Trial Set-up (June 3rd and 4th, 2019) - Plots were decompacted to 0.30m using a pick axe; organics were dug, hauled and placed on appropriate sub-plots; organics were spread and blended into the decompacted till; animal exclusion measures were installed; grasses were seeded on following site preparation.

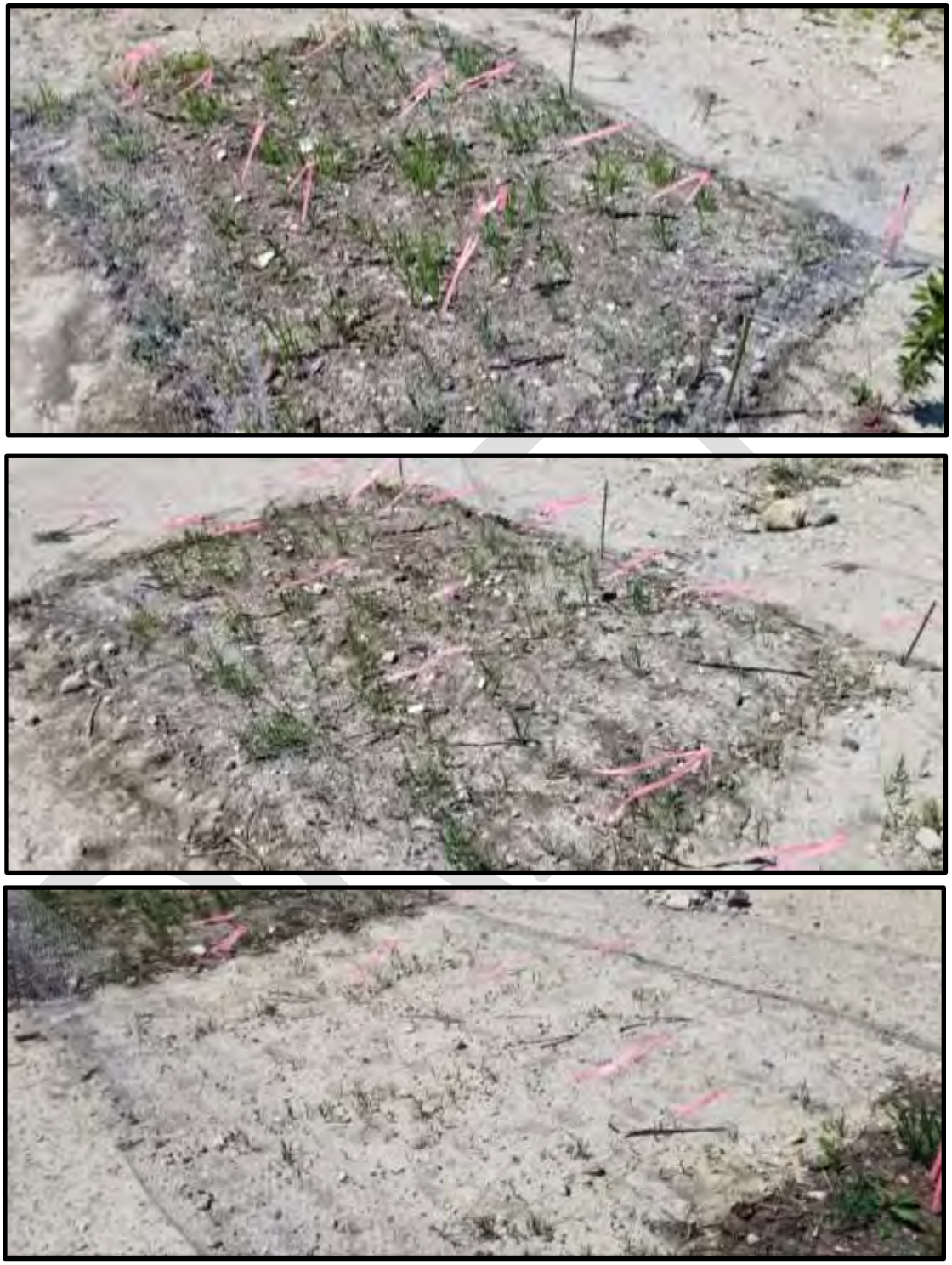


Photo Array 3: Site Inspection (July 10th, 2019) – Showing early summer plant growth in the 0.15 m (top), 0.075 m (middle), and 0 m (bottom) organics depth treatments – Note seedlings visible are oat nurse crop, at this point in the summer native grass seedlings are very small and difficult to pick out in these photographs.

Photo Array 4: Site Inspection – August 8th, 2019 – Showing summer plant growth – 0.15 m organics depth (top), 0.075 m organics depth (middle), 0 m organics applied (bottom).

Photo Array 5: Site Inspection – August 8th, 2019 – Showing relative grass growth between treatments (top) and native seedling health and vigour in 0.15 m depth of organics treatment (middle) and no organic amendment treatment (bottom).

Photo Array 6: Site Inspection (September 23rd, 2019) – Showing late summer plant growth – 0.15 m organics depth (top), 0.075 m organics depth (middle), 0 m organics applied (bottom).

APPENDIX 4 - end-of-season revegetation trials field data

Upper Slope Plot	Sample #	Oat Seedlings (#)	Total Native Grass Seedlings (#)	Native Grass Seedling Leaf Stage (avg.)	Meets Criteria for Successful Establishment (y/n)
15cm soil	**1**	4	4	>4	No
15cm soil	**2**	8	4	>4	No
15cm soil	**3**	6	7	>4	Yes
15cm soil	**4**	6	12	>4	Yes
15cm soil	**5**	5	11	>4	Yes
	avg	**5.8**	**7.6**	**>4**	**60%**
	stdev	**1.48**	**3.78**		
7.5cm soil	**1**	7	7	>4	Yes
7.5cm soil	**2**	9	13	>4	Yes
7.5cm soil	**3**	8	9	>4	Yes
7.5cm soil	**4**	5	12	3 to 4	Yes
7.5cm soil	**5**	7	10	>4	Yes
	avg	**7.2**	**10.2**	**>4**	**100%**
	stdev	**1.48**	**2.39**		
No soil	**1**	2	6	3 to 4	No
No soil	**2**	4	4	3	No
No soil	**3**	4	10	3	No
No soil	**4**	5	5	3	No
No soil	**5**	5	12	3 to 4	Yes
	avg	**4**	**7.4**	**<4**	**20%**
	stdev	**1.22**	**3.44**		

Middle Plot	Sample #	Oat Seedlings (#)	Total Native Grass Seedlings (#)	Native Grass Seedling Leaf Stage (avg.)	Meets Criteria for Successful Establishment (y/n)
15cm soil	**1**	2	19	3 to 4	Yes
15cm soil	**2**	5	18	3 to 4	Yes
15cm soil	**3**	7	14	4 or >4	Yes
15cm soil	**4**	3	14	4 or >4	Yes
15cm soil	**5**	8	13	4 or >4	Yes
	avg	**5**	**15.6**	**4**	**100%**
	stdev	**2.55**	**2.70**		
7.5cm soil	**1**	3	15	4 or >4	No
7.5cm soil	**2**	5	17	>4	No
7.5cm soil	**3**	8	19	3 to 4	Yes
7.5cm soil	**4**	4	22	3 to 4	Yes
7.5cm soil	**5**	3	25	3 to 4	Yes
	avg	**4.6**	**19.6**	**4**	**60%**
	stdev	**2.07**	**3.97**		
No soil	**1**	4	16	2 to 3	No
No soil	**2**	11	8	2 to 4	No
No soil	**3**	4	15	3 to 5	Yes
No soil	**4**	11	12	2 to 4	Yes
No soil	**5**	9	18	2 to 4	No
	avg	**7.8**	**13.8**	**3**	**40%**
	stdev	**3.56**	**3.90**		

Lower Slope Plot	Sample #	Oat Seedlings (#)	Total Native Grass Seedlings (#)	Native Grass Seedling Leaf Stage (avg.)	Meets Criteria for Successful Establishment (y/n)
15cm soil	**1**	4	10	>4	Yes
15cm soil	**2**	3	6	>4	Yes
15cm soil	**3**	4	9	>4	Yes
15cm soil	**4**	4	2	>4	No
15cm soil	**5**	5	7	>4	Yes
	avg	**4**	**6.8**	**>4**	**80%**
	stdev	**0.71**	**3.11**		
7.5cm soil	**1**	5	23	>4	Yes
7.5cm soil	**2**	6	15	>4	Yes
7.5cm soil	**3**	5	14	>4	Yes
7.5cm soil	**4**	7	15	4	Yes
7.5cm soil	**5**	5	4	4	No
	avg	**5.6**	**14.2**	**>4**	**80%**
	stdev	**0.89**	**6.76**		
No soil	**1**	3	4	3	No
No soil	**2**	4	5	3	No
No soil	**3**	4	4	3	No
No soil	**4**	4	6	4	No
No soil	**5**	4	8	4	No
	avg	**3.8**	**5.4**	**<4**	**0%**
	stdev	**0.45**	**1.67**		

APPENDIX 3B

LSMOC Candidate Grass Species Attributes Tables

Table 3B-1: List of Commercially Available Seed Suitable to the Lake St. Martin Region

					Chemistry			Zone***		Growth Habit				Life History			Seral Stage		
Scientific Name	Common Name	C3/C4*	Variety	Origin	E.C. (dS m^{-1})**	Salinity Tolerance	pH Range	Upland Berm	Lower Slope	Rhizomatous	Creeping	Sod Former	Bunch	Annual	Biennial	Perennial	Early	Mid	Late
Agrostis scabra	Rough hairgrass	C3	Common	Parkland Prairie	< 4	low	weakly acidic - weakly basic		●				●			●	●	●	
Andropogon gerardii	Big bluestem	C4	Bison	North Dakota	< 4	low	neutral - weakly basic				●		●			●		●	●
Astragalus canadensis	Canada milkvetch	C3	Common	Manitoba	N/A	none	weakly acidic - weakly basic		●		●					●	●	●	
Beckmannia syzigachne	Sloughgrass	C3	Common	Manitoba	N/A	medium	weakly acidic - weakly basic		●				●		●		●		
Bouteloua gracilis	Blue grama	C4	Badlands	North Dakota	< 4	none	neutral - weakly basic				●		●			●		●	●
Bromus anomalus	Nodding brome	C3	Common	Manitoba	N/A	low	weakly acidic - weakly basic		●				●			●	●	●	
Bromus ciliatus	Fringed brome	C3	Common	Manitoba	< 4	none	weakly acidic - weakly basic		●				●			●	●	●	
Deschampsia caespitosa	Tufted hairgrass	C3	Nortran	Alaska	N/A	low	highly acidic - weakly basic		●				●			●	●	●	●
Elymus canadensis	Canada wildrye	C3	Mandan	North Dakota	< 4	low	weakly acidic - weakly basic		●				●			●	●		
Elymus dasystachyum	Northern wheatgrass	C3	Polar	Western Prairies	< 8	low	weakly acidic - mod. basic		●	●		●				●		●	●
			Elbee	Saskatchewan	< 8	low	weakly acidic - mod. basic		●	●		●				●		●	●
Elymus innovatus	Hairy wildrye	C3	Common	Manitoba	< 4	none	weakly acidic - weakly basic		●		●					●	●	●	
Elymus trachycaulus var. *subsecundus*	Awned wheatgrass	C3	Spring	Southern Prairies	< 4	none	weakly acidic - weakly basic		●				●			●	●		
			Hillcrest	Alberta	< 4	none	weakly acidic - weakly basic						●			●	●		
Elymus trachycaulus var. *trachycaulus*	Slender wheatgrass	C3	Common	Saskatchewan	< 16	high	weakly acidic - strongly basic		●				●			●	●		
Elymus virginicum	Virginia wildrye	C3	Common	Minnesota	< 4	none	weakly acidic - weakly basic		●				●			●	●	●	
*Glyceria grandis***	Tall manna grass	C3	Common	Manitoba	N/A	none	weakly acidic - mod. basic		●		●					●	●		
*Juncus arcticus****	Alpine rush	C3	Common	Manitoba	N/A	medium	weakly acidic - strongly basic		●	●						●	●	●	●
Koeleria macrantha	June grass	C3	Common	Manitoba	< 4	none	neutral - weakly basic						●			●		●	●
Nassella viridula	Green needle grass	C3	Lodorm	North Dakota	< 4	none	neutral - weakly basic						●			●		●	●
			Mallard	Manitoba	< 4	none	neutral - weakly basic						●			●		●	●
Panicum virgatum	Switchgrass	C4	Dacotah	Manitoba	< 4	medium	neutral - weakly basic		●				●			●		●	●
Pascopyron smithii	Western wheatgrass	C3	W.R. Poole	MB, SK, AB	< 16	high	weakly acidic - mod. basic		●	●		●				●	●	●	●
			Rodan	North Dakota	< 16	high	weakly acidic - mod. basic		●	●		●				●	●	●	●
Poa palustris	Fowl bluegrass	C3	Common	Manitoba	N/A	medium	mod. acidic - weakly basic		●				●			●		●	●
Puccinellia nuttalliana	Nuttall's alkali grass	C3	Common	Manitoba	< 33	high	weakly acidic - mod. basic		●				●			●		●	●
Schizachyrium scoparium	Little bluestem	C4	Badlands	North Dakota	< 4	none	neutral - weakly basic						●			●		●	●
*Scholochloa festucacea****	Whitetop	C3	Common	Manitoba	N/A	low-medium	weakly acidic - weakly basic		●	●						●	●	●	●
*Sparganium eurycarpum****	Bur reed	C3	Common	Manitoba	N/A	none	weakly acidic - weakly basic		●	●						●		●	●
*Spartina pectinata****	Cord grass	C4	Red River	North Dakota	< 4	none	neutral - weakly basic		●	●	●	●				●		●	●

* C3 denotes cool season and C4 denotes warm season.

** E.C. refers to electrical conductivity, used here as an indication of salt tolerance.

***Indicates expected suitability for use in different active revegetation zones of the LSMOC ROW - final seed mixes to be determined in detailed design.

**** For consideration in ditches and drains.

Note: Commercial seed availability and quality (purity and germination) may vary from year to year.

Table 3B-2: Non-exhaustive List of Tame Grass Species Suitable For Use in Lake St. Martin Outlet Channel Revegetation

			Chemistry			Zone		Growth Habit				Life History			Seral Stage		
Scientific Name	**Common Name***	**C3/C4***	**E.C. (dS m^{-1})****	**Salinity Tolerance**	**pH Range**	**Upland Berm**	**Lower Slope**	**Rhizomatous**	**Creeping**	**Sod Forming**	**Bunch**	**Annual**	**Biennial**	**Perennial**	**Early**	**Mid**	**Late**
Thinopyrum ponticum	Tall wheatgrass	C3	< 16	high	neutral - alkaline						●			●	●	●	
Dactylis glomeratus	Orchard grass	C3	4-8	low	mod. acidic - neutral						●			●	●		
Agrostis stolonifera	Redtop	C3	< 16	high	weakly acidic - strongly basic					●	●			●	●	●	●
Phleum pratense	Timothy	C3	< 4	low	mod. acidic - slightly basic						●			●	●	●	●
Festuca sp	Fescues	C3	4-8	low	weakly acidic - strongly basic				●		●			●	●	●	●
Medicago sativa	Alfalfa	C3	4-8	low	neutral - alkaline						●			●	●		

*C3 denote cool season species; C4 denotes warm season species.

**E.C. refers to electrical conductivity, used here as an indication of salt tolerance.

***Indicates expected suitability for use in different active revegetation zones of the LSMOC ROW - final seed mixes to be determined in detailed design.

Note: Commercial seed availability and quality (purity and germination) may vary from year to year.