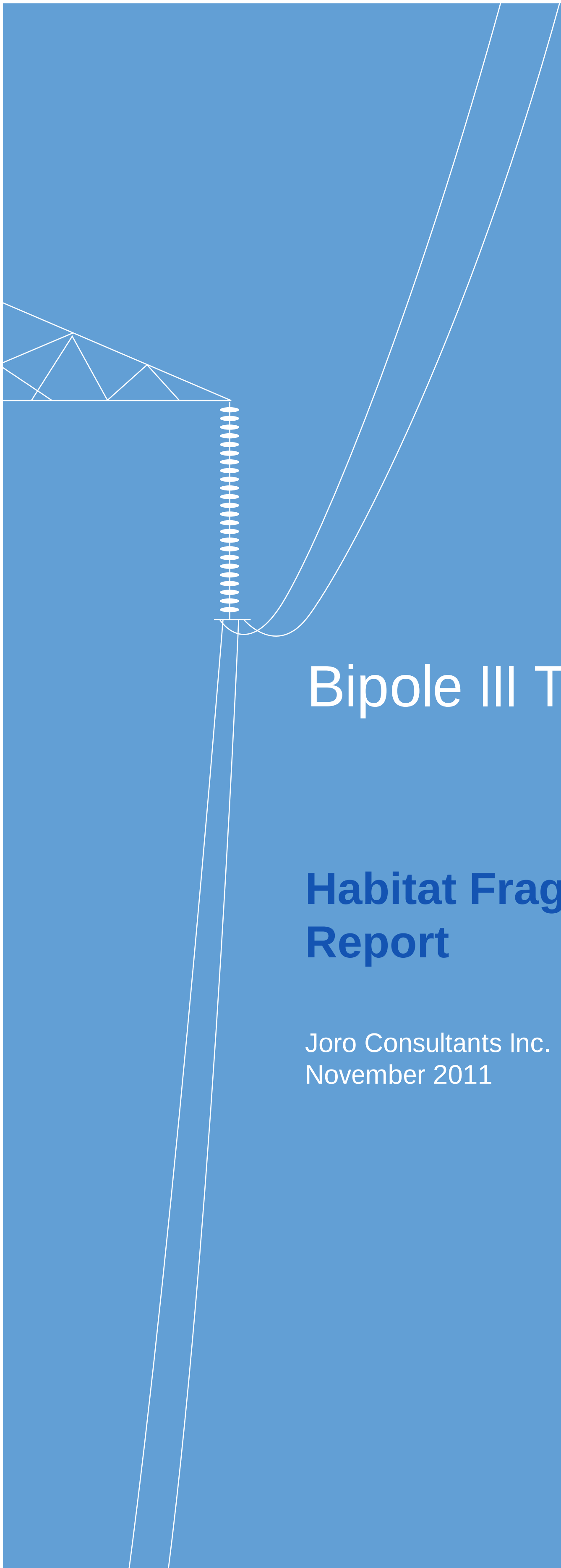

Bipole III Transmission Project

Habitat Fragmentation Technical Report

Joro Consultants Inc.
November 2011

Manitoba Hydro

Bipole III Transmission Project:

Fragmentation Technical Report

Prepared by: Joro Consultants Inc.

Prepared for: Manitoba Hydro

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1.0 INTRODUCTION

1.1 Purpose

Manitoba Hydro is proposing to develop a new 500 kilovolt (kV) high voltage direct current (HVdc) transmission line, known as Bipole III (hereon referred to as the Project), on the west side of Manitoba. Approximately 75% of Manitoba Hydro's generating capacity is delivered to southern Manitoba via the existing HVdc Interlake corridor, which is shared by the Bipole I and II transmission lines. Due to the heavy reliance on one transmission corridor and a single converter station in the south (Dorsey), the system is vulnerable to extensive power outages from severe weather (e.g., major ice storms, extreme wind events, tornados), fires, or other events.

Habitat fragmentation is the change in configuration of habitat as habitat cover decreases (Grossman et al., 2008). Effects of fragmentation include increased forest edge, reduced forest interior habitat, and increased isolation of forest patches. The effect of landscape fragmentation on a variety of wildlife species has been documented, with species such as caribou being notably susceptible (Dyer et al., 2001; Courbin et al., 2009). The impact of the direct habitat loss from the removal of vegetation along a Right-of-way (ROW) is minor relative to the indirect effects, including alteration of predator-prey dynamics, influx of competition and disease, and increased mortality by humans due to ease of access. The Final Preferred Route (FPR) for the Project traverses through a landscape with variable degrees of corridor development and density, from large contiguous forests to an urban-agricultural matrix. The potential effects of fragmentation are greatest where the landscape is largely untouched and the relative impact presented by the FPR along its length was assessed to identify these areas. Due to the potential effects of fragmentation on wildlife movement and habitat use, it is important to have an understanding of the extent of fragmentation that will be created by the Project.

This report features an overview of fragmentation that may potentially result from the Project's construction and its projected environmental effects. The interactions between fragmentation and Valued Environmental Components (VECs) are considered in this report, complementing the detailed assessment of the effects of the Project on VECs (caribou, moose, birds, etc.) which are

available in the *Bipole III- Mammal Technical Report* (Joro Consultants Inc. and WRCS, 2011), *Bipole III- Birds Technical Report* (WRCS, 2011) and *Bipole III- Caribou Technical Report* (Joro Consultants Inc., 2011).

2.0 METHODOLOGY

In order to assess the effects of fragmentation on VECs in the Project Local Study Area, a combination of desktop studies and Geographic Information Systems (GIS) analysis were used as well as a review of peer-reviewed literature on the effects of fragmentation on the biophysical environment and its components. Specific analysis involved calculating the density of existing linear features within the FPR 3 mile corridor (Local Study Area) and assessing the degree of intersection with intact and un-fragmented forest. The cumulative fragmentation potential was assessed as a function of the FPR intersecting areas already impacted by linear development versus remote and un-fragmented habitat.

2.1 Literature Review

The literature review process surveyed academic literature and reports on fragmentation and its effects. This investigation provided a knowledge base regarding issues surrounding habitat fragmentation, with particular focus on the responses of species that occur in and around the Project's FPR. The results of the literature review are described in Section 3.1.

2.2 GIS Analysis

Fragmentation on the landscape can be described as the division of large habitat blocks into smaller habitat areas, which often results from the development of linear corridors, including transmission lines and associated access corridors (Jalkotzy et al., 1997). The relative effects of fragmentation along the FPR were quantified based on the length of existing route and future linear features anticipated in the Local Study Area. The two aspects studied were the existing density of access corridors along the FPR and the habitat intersection of the FPR itself. While fragmentation is most often quantified by measuring habitat patch area across the landscape (Wilcove et al., 1986; Saunders et al., 1991; Dyer et al., 2001), a linear approach was developed to assess the relative impact of a single feature (the FPR) rather than the more general comparison of landscape disturbance regimes commonly used. With respect to the potential effects arising from access routes associated with the Wuskwatim Transmission Line, an assessment was conducted evaluating construction access routes along Wuskwatim Transmission Line. This analysis is included in this report as a Case Study to assist in assessing the effects of HVdc construction and operation (See Appendix A).

2.2.1 Existing Access Density

Existing access within the Local Study Area was measured using existing linear feature shapefile data including roads, transmission line ROWs, rail lines, forestry cut blocks, and access routes. These layers were supplemented with extensive digitizing of recent digital ortho-imagery to ensure data was accurate and up to date. Due to variation in the FPR location relative to the current ortho-imagery, a 2.5 km diameter buffer was applied to the FPR. All linear features within this area were digitized and separated from the overall dataset to represent the degree of access development (roads, transmission lines, and other anthropogenic linear features) near the FPR. At regular intervals of 1 km along the FPR, 2.5 km circles were generated and the length of access was measured within each circle. The length of access was divided by the area of the circle to determine density of access at regular intervals along the line.

To illustrate the varying degrees of access density along the FPR, a density weighted buffer was drawn at each measurement interval, using the formula [r = 1250 + (density*2)]. These buffers were then merged into a single new buffer for the entire length of the FPR that widened and narrowed with changes in density (Map 1). Access density at each interval was summarized across the landscape by using ecoregion boundaries to broadly describe trends in different areas.

2.2.2 Expected Access

The degree of potential fragmentation caused the FPR itself on intact forest habitat was assessed and summarized by ecoregion. This assessment compared the total length of the FPR in each ecoregion with the length passing through contiguous forest stands (Map 2). For the purpose of this project, a spatial ecological GIS layer was specifically developed for the Project and was termed the Landcover Classification of Canada, Enhanced for Bipole (LCCEB). A full description of the LCCEB layer can be found in the *Bipole III- Mammal Technical Report* (Joro Consultants Inc. and WRCS, 2011). Forest stands were described as LCCEB broadleaf, coniferous, and mixedwood covertypes (covertype codes 210-232). Contiguous forest was identified by merging all the above LCCEB forest covertypes in a GIS environment. The proportion of line passing through these intact forest patches was calculated to quantify the amount of habitat fragmentation that would occur in each ecoregion upon clearing of the FPR.

3.0 ENVIRONMENTAL ASSESSMENT

3.1 Effects of Fragmentation Identified From Literature

Habitat fragmentation is most often defined as a process in which a large area of habitat is converted into a number of smaller patches, isolated from one other by a matrix of habitats unlike the original (Wilcove et al., 1986). Habitat loss is generally associated with habitat fragmentation and is implicated as the leading cause of the extinction of species (Dyer et al., 2001). There are many documented effects of fragmentation, including increased edge, reduced forest interior habitat, and increased isolation of forest patches (Saunders et al., 1991; Dyer et al., 2001). Fragmentation generally results in the production of a series of remnant vegetation patches surrounded by a system of different vegetation types and land uses (Saunders et al., 1991). The size, shape, and position of remnant habitat patches on the landscape will influence not only physical changes to the environment, but biological changes as well (Saunders et al., 1991). Such changes can include altered microclimate, reduction of available habitat, and isolation of remnant habitats from other remaining habitats.

In addition to effects on habitat structure and interactions, fragmentation can affect species richness, population abundance, growth rates, species distribution, genetic diversity, and biodiversity (Fahrig, 2003). Habitat loss has also been shown to specifically reduce trophic chain length, to alter species interactions, predation rate, and foraging behaviour, as well as affect the breeding and dispersal success of various species (Fahrig, 2003).

There are circumstances where some species may persist, and in some cases, flourish in newly created habitat patches. For example, species considered 'habitat generalists', such as white-tailed deer (*Odocoileus virginianus*), can survive in small habitat patches by using resources from the differing surrounding patches (Andren, 1994). Habitat generalists differ from 'habitat specialists', such as woodland caribou (*Rangifer tarandus caribou*), who have specific habitat requirements. If the only available habitat patches do not meet the requirements of the habitat specialist, the species may become extirpated from the area. It has also been suggested that in some cases, species diversity across a landscape may increase when new patches of habitat are created within the contiguous habitat, since new species may be found in newly created habitats (Andren, 1994). It is primarily habitat generalists that benefit, whereas other species tend to experience population reduction (Fahrig, 2003).

Resource and habitat management has become a strong focus of resource users and stakeholders due to habitat fragmentation and the associated number of potentially negative effects that fragmentation can have on populations of native species. Management of fragmentation has two basic components. Firstly, the newly fragmented system and/or the internal dynamics of the remnant system must be managed. Secondly, the external influences on the new system must be considered (Saunders et al., 1991). In the context of a large transmission project, such as the Project, this results in the required management of flora and fauna of the remaining habitat patches after development and management/mitigation of ongoing disturbances (i.e. construction and vehicle access) and direct/indirect effects of the project on flora and fauna of the remaining habitat patches. Most impacts on remnant habitat patches originate from surrounding landscapes, resulting in difficulty in management of remaining patches of native vegetation. Generally speaking, scale is important, and a landscape approach to management is essential for management of fragmented habitats, since remnant patches of habitat can collectively serve to represent a complete system overall for more mobile species using the area (Saunders et al., 1991).

The vast majority of fragmentation literature shows that habitat loss has negative effects on the species inhabiting an area. This implies that one of the most important questions for protecting species within an area is "How much habitat is enough?" (Fahrig, 2003). Many species co-exist in a given area and require different habitat types in different amounts. Therefore, conservation of any species in a given area requires identifying which species are most vulnerable to habitat loss (Fahrig, 2003) and estimating the minimum habitat required for persistence of the most vulnerable species for a given habitat type (Fahrig, 2003). In many cases in Manitoba, woodland caribou are used as an indicator for determining the effects of fragmentation on habitat due to the fact that they are extremely sensitive to the effects of fragmentation (Fahrig, 2003).

Forest fragmentation can affect predator-prey interactions, making it essential to understand the direct and indirect impacts of habitat fragmentation on woodland caribou as well as the predators with which caribou interact. One of the largest causes of caribou habitat loss in the boreal forest is fragmentation due to forest harvesting (Courbin et al., 2009). Fragmentation of the boreal forest and avoidance of disturbances has the potential to concentrate caribou into progressively smaller areas of remaining habitat, which can make caribou more vulnerable to predation and human hunting (Dyer et al., 2001; Courbin et al., 2009). During the last century, the southern limit of semi-continuous caribou distribution has retracted northward in Canada, with this northward recession of caribou distribution following the advancing forest harvest front (Thomas, 1995; Vors et al., 2007; Courbin et al., 2009). Habitat loss can have an even greater impact on caribou when habitat loss occurs in an area of critical value, such as winter habitat or calving grounds (Wedeles and Damme, 1995). In addition to habitat loss, human disturbances or fragmentation of the forest which allows the co-occurrence of deer and caribou can lead to the spread of parasites and disease. White-tailed deer are carriers of meningeal worm (*Parelaphostrongylus tenuis*) but are not affected by this parasite. Habitat alteration and linear development may increase risk of infection for moose (*Alces alces*) and caribou, both species who are fatally vulnerable to this same parasite (Manitoba Conservation, 2005). Habitat fragmentation is generally understood to have negative effects on caribou populations as it may result in habitat loss, increase disturbance resulting in decreased calf survival, and increase mortality through predation.

Responses to the effects of fragmentation vary by species. Moose have been found to avoid habitat in the vicinity of roads because of human activity, which is most evident in hunted populations (Jalkotzky, 1997). Despite these negative effects, it has been cited that the creation of linear corridors may also be considered a habitat enhancement if they serve as travel corridors for moose in otherwise unsuitable habitat (Jalkotzky, 1997). In addition, the creation of edges can encourage the growth of shrubs and preferred browse species for moose. However, moose have been found to respond on an individual basis to habitat fragmentation (Jalkotzky, 1997). Thus, linear corridors, such as transmission line ROWs may create or remove habitat for moose depending on the habitat types being traversed and degree of distribution to individuals in the area.

Reaction of medium sized mammals/carnivores to the creation of linear features also varies by species; however, most negative effects in response to the creation of linear corridors are related to increases in human disturbance rather than avoidance of the project area. It has been found that in the case of wolverine (*Gulo gulo*), human disturbance at natal den sites may cause den abandonment during noise-intensive activities, such as construction (Jalkotzky, 1997). Forest fragmentation also does not favor American marten (*Martes americana*) (Kurki et al., 1998). Marten have been shown to avoid crossing open areas and are sensitive to immediate effects from even small disturbances (Forsey and Baggs, 2001). Increased road access facilitating industrial and recreational activities contributes to effects of fragmentation of marten population, which indirectly contributes to increased trapping success through increase wilderness access (Webb and Boyce, 2009).

Direct mortality has been documented among many medium-sized carnivore species as a result of linear developments (roads), with most direct mortalities associated with vehicle collisions. Most indirect mortalities occurred as a result of human access along roads and other linear developments via hunting and/or trapping (Jalkotzky, 1997).

3.2 Results of GIS Analyses

Overall, the 1,384 km length of the FPR passed through 480 km (34.7%) of forest landscape, as identified through the merging of LCCEB forest covertypes (Section 2.2). Mean access density across all ecoregions was 573 m/km^2 (Table 1a: Metrics quantifying existing fragmentation along the FPRa). A visual analysis of access density along the FPR revealed notable differences between the northern and southern portions of the route. The FPR north of the Red Deer Lake/Swan River area was characterized by occasional high access density areas and large low access density contiguous forest. The FPR to the south of Red Deer Lake/Swan River showed a consistently moderate density of access routes and less interception of the ROW with contiguous forest habitat (Map 3).

Table 1a: Metrics quantifying existing fragmentation along the FPR relative to expected fragmentation values following ROW construction.

Ecoregion	Section length (km)	Length of section intercepting forest (km)	Percentage of segment intercepting forest	Length of access within 2.5km buffer (km)	Average density of access (m/km^2)
Aspen Parkland	3.7	3.1	84.0	12.9	642.9
Churchill River Upland	104.7	73.0	69.7	205.1	390.7
Hayes River Upland	304.2	158.2	52.0	679.5	445.6
Hudson Bay Lowland	58.7	18.2	31.0	17.1	58.8
Interlake Plain	188.8	68.7	36.4	1,058.2	1,119.8
Lake Manitoba Plain	452.2	78.5	17.4	1,808.3	800.1
Mid-Boreal Lowland	267.5	80.1	30.0	1,504.5	1,127.0
Selwyn Lake Upland	4.7	0.0	0.0	0.0	0.0
Total	**1,384.4**	**479.7**	**34.7**	**5,285.5**	**573.1**

Exceptions to these trends included ecoregions with very little intersection with the FPR. The Aspen Parkland Ecoregion showed high forest intercept (84%) and moderate access density (642 m/km^2), but had only 3.7 km of intersection with the FPR. The Selwyn Lake Uplands only contained 4.2 km of FPR length, all of which occurred in non-forested areas (mainly shrub and wetland) with no access development.

4.0 CONCLUSIONS

With 34.7% of the total FPR traversing forested landscape, effects of fragmentation in forested habitat must be considered when planning mitigation for the Project. The greatest proportion of intersection between the transmission line and intact forest patches occurred in the Aspen Parkland (84% of 3.4 km), Churchill River Upland (69.7% of 104.7 km), and Hayes River Upland (52% of 304.2 km) Ecoregions. Hayes River Upland, Mid-Boreal Lowlands, and Lake Manitoba Plains were found to be the ecoregions with the longest length of ROW intercepting forest, with 158.2 km, 80.1 km, and 78.5 km of forest intersected, respectively. With an average length of access of 5,285.5 km along the 2.5 km transmission line buffer and an average access density of 573 m/ km^2, there is a potential for access to contribute to the effects of habitat fragmentation. Based on effects described in Appendix A (Wuskwatim Access Case Study), possible effects of habitat fragmentation arising from access roads should also be considered in environmental planning and mitigation (where applicable).

Given that many wildlife species, including woodland caribou, are sensitive to habitat fragmentation and the associated effects of habitat fragmentation (including increased grey wolf (*Canis lupus*) presence, edge effects, and increased public access to forested areas), habitat fragmentation is considered a strong negative effect. Given that woodland caribou are generally considered to be an umbrella species (Hannon and McCallum, 2004), this negative impact is assumed to carry over to other mammal species whose home ranges overlap with these ecoregions and the project area, including wolverine, marten, black bear (*Ursus americanus*), and elk (*Cervus canadensis*). For more in depth detail regarding other affected species, please see the *Bipole III- Mammals Technical Report* (Joro Consultants Inc. and WRCS, 2011).

Mitigation measures for the effects of fragmentation are limited, with the majority of mitigation measures existing at the planning and routing stage of the project. As stated in Jalkotzy et al. (1997) development and disturbance corridors have their greatest effects at the landscape level, thus it is appropriate that the most effective measures to mitigate the effects of these corridors should occur at the same scale. Regional planning, coordination between industries and projects occurring within ecoregions, and cumulative effects addressing habitat fragmentation are the strongest measures to taken to avoid/mitigate the effects of fragmentation (Jalkotzy et al., 1997). For management of fragmentation past the planning stage of a project, maintenance of travel corridors, habitat patches, intensive management of remaining habitat at the landscape scale, and management for edge effects are key factors. Consideration of species composition, species at risk (such as woodland caribou), and landscape ecology are also key requirements for proper planning and management. These management strategies vary according to species; for details of specific management strategies, please see the *Bipole III- Mammal Technical Report* (Joro Consultants Inc., 2011), *Bipole III- Birds Technical Report* (WRCS, 2011), and *Bipole III- Caribou Technical Report* (Joro and WRCS, 2011).

When considering large-scale corridor projects, such as the Project, fragmentation is frequently an inevitable consequence. The Project will consist of a 1,384.4 km linear corridor, with the corridor intercepting a total of 479.7 km of forest across eight ecoregions. The potential adverse effects of fragmentation within the project area will vary across affected species in the area, but overall effects are assumed to have potential negative effects on individuals and populations of mammal species at varying degrees. Mitigation measures include intensive management and monitoring of flora and fauna species within the area and regional planning for future projects occurring within the area.

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6.0 APPENDICES

Appendix A: Case Study - Wuskwatim Access Analysis

Joro Consultants Inc. discussed and presented information on construction access at the September 7, 2010 Biophysical Team meeting. As a result, at a subsequent Biophysical Team Meeting (November 4, 2010), Joro was asked to conduct an assessment of possible access effects associated with various terrain types to determine the extent of extra clearing and access as well as to assist in assessing the impacts of the HVdc construction and operation activities. The results of this evaluation are outlined below. The evaluation was not intended as a comprehensive analysis of the entire Wuskwatim Transmission Line (T-Line). Rather, it was an assessment to determine the next steps in evaluating construction access, given this was a regulatory issue during the Wuskwatim T-Line construction process.

Background

While access route construction is known to have negative environmental impacts, including habitat fragmentation (McLoughlin, 1979; Golder Associates, 2011; Public Service Commission of Wisconsin, 2011), the relative effects of clearing for access routes in relation to right-of-ways (ROW) has not been well studied. To assess the potential impacts of access routes within the Bipole III Transmission Project 3-Mile Corridor relative to those of the ROW, the Wuskwatim T-Line was used as a case study for a comparison between total ROW and access length.

Methodology

To assess the impacts of access routes in a variety of habitats, four sections of the Wuskwatim T-Line were selected in the vicinity of Dyce Lake, Wekusko Lake, Wuskwatim Lake, and a boggy area south of Wuskwatim Lake (Map 1). Each section was 15 km in length and intersected a different vegetative cover type. Selected dominant cover types for assessed sections included coniferous forest (LCCEB covertype codes 210-213), wetland (codes 80-83), mixed wood forest (codes 230-233); the final section intersected mixed coniferous forest and wetland. Cover types were identified using the LCCEB (Joro, 2009).

To delineate access routes along each 15 km section, existing linework obtained from Manitoba Hydro was supplemented with digitized linework based on a combination high-resolution ortho-imagery flown for the Bipole III Preliminary Preferred Route (PPR) (for the portions of the Wuskwatim T-Line that paralleled the PPR) and pre-construction aerial photography flown along the Wuskwatim T-Line. Access routes were assessed within a 3-mile buffer (1.5 miles on each side) of the Wuskwatim T-line centreline. The total length (km) of access routes along each 15 km section was summed and the access length percentage of 15 km was calculated.

Results and Discussion

The length of access routes ranged from 0-5.5 km for assessed sections (Table 6a), with a mean access length of 2.7 km/15 km of T-Line, representing 12.4% of 15 km. The greatest length of access routes, 36% of 15 km, was seen in the Dyce Lake area, while no access routes were identified in the bog section south of Wuskwatim Lake. As access length was variable between sections, further assessment is needed to determine whether access length is correlated with vegetation cover type.

Table 6a. Length and proportion of access routes in relation to selected 15 km sections of the Wuskwatim Transmission Line ROW.

Segment Location	Dominant cover type	Length of T-Line (km)	Length of Access Routes (km)	Access Route Percentage of T-line Length
Dyce Lake	Coniferous forest/wetland	15	5.5	36.5
Wuskwatim Lake	Coniferous forest	15	3.3	22.4
Bog core	Wetland	15	0	0
Wekusko Lake	Mixedwood forest	15	1.9	12.4
Mean		**15**	**2.7**	**17.8**

Further study is needed to determine whether access routes typically comprise a large proportion of total T-Line clearing; however, given the considerable length added to T-Line clearing for access routes (up to 36%) found in this preliminary analysis, access routes should be considered in environmental effects assessments.

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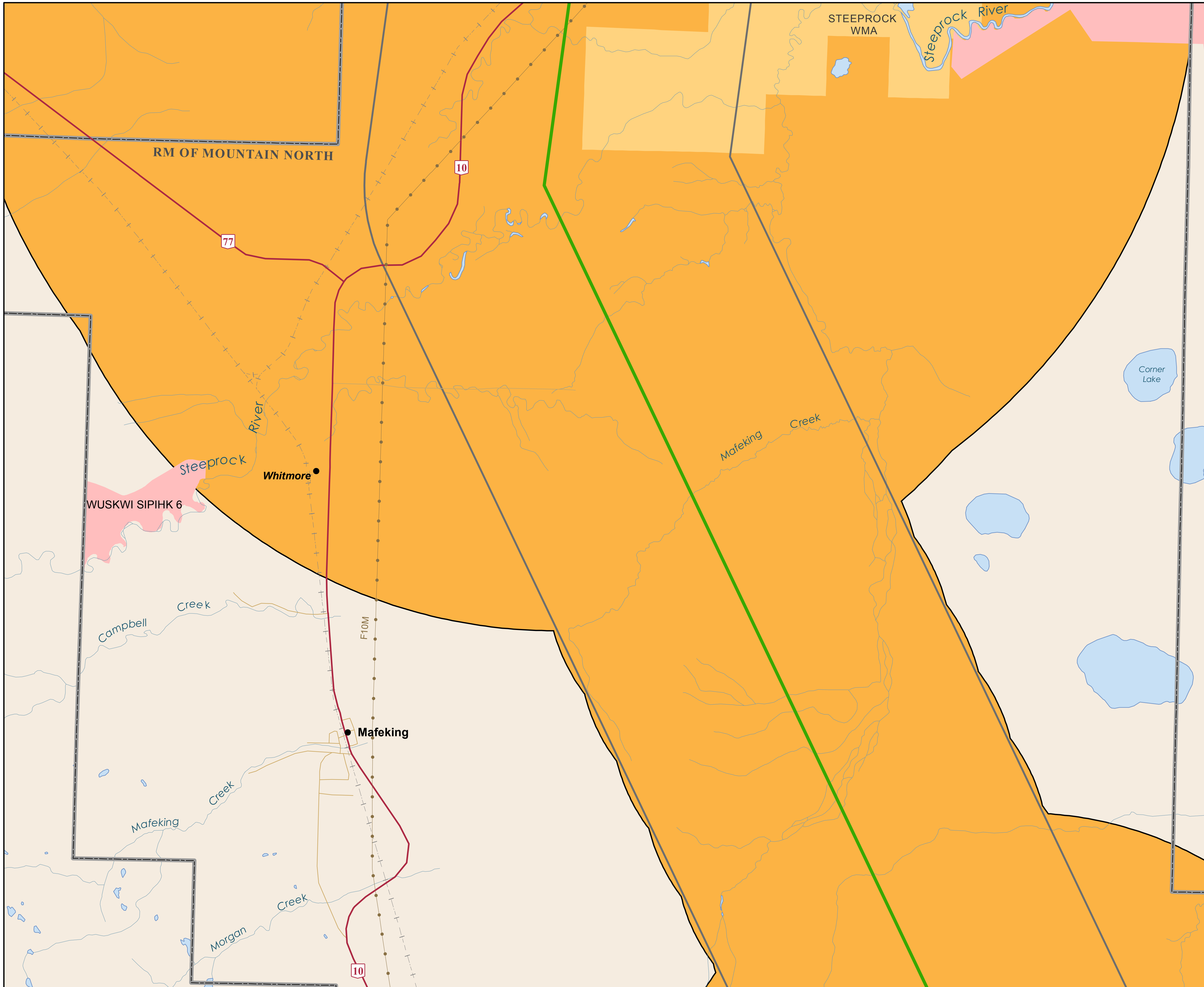

Manitoba Hydro

Bipole III Transmission Project

Project Infrastructure

Final Preferred Route

Local Study Area

Infrastructure

Transmission Line

Access Density

Weighted Density Buffer

Landbase

Community

Rural Municipality

First Nation

Provincial Highway

Provincial Road

Road (Other)

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, MMM, Stantec, ProvMB, Joro
Date Created: July 06, 2011

N

0 0.5 1 Kilometres

0 0.5 1 Miles

1:50,000

Access Density

Buffer of Final Preferred Route, Width Weighted By Density Of Access Corridors

Map 1

Manitoba Hydro

Bipole III Transmission Project

Project Infrastructure
- Final Preferred Route
- Local Study Area

Infrastructure
- Transmission Line

Forest Cover
- Forest Intercept of Final Preferred Route
- Forest Cover

Landbase
- Community

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, MMM, Stantec, ProvMB, Joro
Date Created: July 06, 2011

N

0 0.5 1 Kilometres

0 0.5 1 Miles

1:50,000

Forest Interception

Final Preferred Route and LCCEB Forest Cover Classes

Map 2

Manitoba Hydro

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, MMM, Stantec, ProvMB, NRCAN, Joro
Date Created: June 24, 2011

0 25 50 Kilometres

0 25 50 Miles

N

1:2,500,000

Linear Feature Density Buffer

Width of Buffer Weighted to Density of Access Along The Final Preferred Route

Map 3