Canadian toads require sandy habitats for hibernation since they are weak burrowers. Habitats in the Boreal Mixedwood generally associated with sandy or coarse textured soils include:

- Lichen – jack pine (a1);
- Blueberry – jack pine/aspen (b1);
- Blueberry – aspen (white birch) (b2);
- Blueberry – aspen/white spruce (b3);
- Blueberry – white spruce/jack pine (b4); and
- Labrador tea – mesic jack pine/black spruce (c1) ecosite phases.

There are some slight differences in ecosite phases between the Boreal Mixedwood and Lower Boreal Highlands. Ecosite phases in the Lower Boreal Highlands generally associated with sandy or coarse textured soils include:

- Bearberry – jack pine (a1);
- Blueberry – jack pine/aspen (b1);
- Blueberry – aspen (b2);
- Blueberry – aspen/white spruce (b3); and
- Labrador tea – mesic jack pine/black spruce (c1).

Soils were mapped only within the North American leases so the assessment of impacts to hibernating habitat was confined to that area. Within the North American leases, suitable hibernating soils include the Mildred and Firebag soil units (Hodgson 2007, pers. comm.). The Mildred soils unit is a Dystric Brunisol, developed on deep outwash sands and typically associated with a and b ecosites. The Firebag soils unit is an Eluviated Dystric Brunisol, developed on very coarse glaciofluvial deposits and is also typically associated with a and b ecosites.

At baseline, there are approximately 15,244 ha of potential hibernating habitat within the North American lease (Figure 11.5-37). This represents only 13.7% of the area. At baseline, the habitat suitability model calculated 17.3% of the LSA as high quality habitat. Although only one toad survey was conducted in the LSA, the absence of toads may be attributable to the amount of over-wintering habitat combined with the amount of high quality habitat available. However, it is uncertain whether or not toads are present in the LSA.

The Project is predicted to clear less than 1% (646 ha) of the potential hibernating habitat within the North American leases (Figure 11.6-38). With this loss in hibernating habitat, it is predicted that less than 1% of the Canadian toad population in the North American leases will be impacted through direct mortality as a result of clearing during winter. At application, the effect of these mortalities is expected to be local in extent, low in magnitude and isolated in frequency since mortality will occur during clearing. This is classified as a low impact; however, the confidence in this rating is moderate since the extent of the population in the LSA cannot be determined based on a single survey.

At closure, Canadian toad hibernating habitat is expected to return to baseline conditions and therefore, there should be no residual impact.

Impacts resulting from other sources of mortality are predicted to be low. The affect of traffic on toad mortality is difficult to assess since there is no information on the toad population within the LSA. As stated earlier, no Canadian toads were found during the toad survey and no breeding wetlands were found. Mortality resulting from acidification of wetlands due to Project emissions is not expected to occur, since acidifying emissions from the Project are not expected to increase potential acid input (PAI) above the critical load level of wetlands in the LSA (Volume 2, Section 2 and Volume 3, Section 7).

11.6.4.4 Black Bear, Moose and Woodland Caribou

Potential Impacts

Large mammal roadkills (particularly black bear, moose and caribou) were used to assess the potential for direct Project-related wildlife mortality. Large mammals are particularly susceptible to highway mortality because of their large spatial needs that require individuals to regularly cross roads (Trombulak and Frissell, 2000). However, a wide diversity of wildlife species are killed on a variety of roads under a range of different conditions (Evink et al., 1996; Jalkotzy et al., 1997; Foreman et al., 2003). Typically, wildlife collisions occur at night and during spring and fall and are most pronounced on sections of roads that intersect a movement corridor or important habitat patch (Forman et al., 2003). Wildlife may also be attracted to roads by forage conditions along the road edge or by salt applied to remedy icing conditions during winter (Forman et al., 2003). Divided highways with large traffic volumes (≥10,000 average annual daily traffic) are known to act as barriers to some wildlife species and as sources of mortality to most or all species of wildlife (Beringer et al., 1990; Forman et al., 2003). Some lower traffic volume highways have proportionally lower barrier and mortality effects. Smaller roads with relatively low traffic volumes (e.g., 5–100 vehicles per day) may not inhibit wildlife movements and are rarely associated with wildlife collisions (Beringer et al., 1990; Forman et al., 2003).

Residual Impacts

Based on the available roadkill data from the region, there were 545 wildlife mortalities along Highway 63 between 2001 and 2005 (Table 11.6-18 and Table 11.6-19). Deer (white-tailed and mule) and moose comprised 92% ($n = 500$) of reported roadkill, at 70.5% and 21.5% of all wildlife mortalities respectively ($n = 383$ and 117). Other species included wolf (1.3%; $n = 7$), black bear (0.9%; $n = 5$), coyote (0.6%; $n = 3$) and caribou (0.2%; $n = 2$) and 25 unidentified roadkills (4.6%). On Highway 881 from the Highway 63 turn-off to Lac La Biche, a total of 184 wildlife mortalities from 2000 to 2005 were recorded (Table 11.6-19). Deer (white-tailed and mule) are the most commonly reported and account for 79.3% of all wildlife mortalities ($n = 146$). Other species include moose (6.0%; $n = 11$), horse (0.5%; $n = 1$) and 25 unidentified wildlife species (14.1%).

Local traffic data was used to assess trends in wildlife mortality along regional highways (Table 11.6-20). Where mortalities have increased with increasing traffic volumes, there is a positive correlation between the total number of mortalities and traffic volume (Highway 63, $r = 0.79$, $P = 0.12$, $F = 4.75$, d.f = 4; Highway 881, $r = 0.48$, $P = 0.33$, $F = 1.20$, d.f. = 4) (Figure 11.6-39 and Figure 11.6-40). It is not known on what particular sections of highway these mortalities occurred. A much stronger correlation of the number of wildlife mortalities is obtained when pooling the traffic volumes from both Highways 63 and 881 ($r = 0.96$, $P < 0.001$, $F = 100.4$, d.f. = 10). Overall, increased traffic on Highways 63 and 881 will lead to increased mortality of large mammals, including black bear, moose, deer and perhaps caribou. This trend is due to collective growth of industry in this area. The exact impact that this will have on local wildlife populations is uncertain, since there are no accurate population numbers of moose, black bear and caribou. Known recorded wildlife mortality records of large animals were only those that resulted in reported motor vehicle accidents. A large number of wildlife mortalities go unreported, as systematic roadkill surveys have not been conducted (Nietvelt, 2003; Lee et al., 2006).

At application, it is expected that the Project will add a maximum increase of 12% in traffic (Conklin to Javier). Given the strong correlation with wildlife mortalities and traffic volume, this may result in a 12% increase in large mammal mortalities. These mortalities will likely be primarily deer and moose. Impacts to moose are expected to be low for the following reasons:

- Moose populations in the region are stable and not limiting (Charest, 2005; Todd Powell, pers. comm. 2007);
- While the absolute number of moose mortalities on these highways are unknown, and the reported figures are considered a minimum, at present time an additional 12% increase in road mortalities may be sustained by the current moose population; and
- Assuming that the three moose mortalities reported in 2005 on Highway 881 only 20% of what actually occurs, the Project will result in a total of two additional moose mortalities a year.

There is uncertainty in this assessment, as the moose total mortality rate in the region is unknown, and systematic road mortality surveys are not currently being conducted. However, ASRD do conduct regular population surveys for moose, and North American is currently monitoring moose in the region. Moose are particularly susceptible to road mortalities, and these trends can be assessed over time.

Impacts to black bear are also considered to of low magnitude, as black bears are likely to avoid high volume highways, and have relatively low occurrence in the road mortality records. Black bear population in the region are also not limiting.

Impacts to caribou are expected to be moderate, as their populations are limiting, unlike moose and black bear. Vehicle-caused mortality to the current caribou population may be additive and not compensatory, especially female mortalities. However, there is high uncertainty in this assessment, as caribou have low occurrence in the road mortality records, and the contribution of road mortalities to the total mortality rate is uncertain. However, North American is currently monitoring caribou in the region that will help detect changes in the caribou population over time.

Table 11.6-18 Known Wildlife Mortalities Due to Traffic on Highway 63 from 2001–2005

Species	2001	2002	2003	2004	2005	Total	Percent
Black bear	2	1	1	1		5	0.9
Coyote			2		1	3	0.6
Wolf	2		1	3	1	7	1.3
Caribou	1					1	0.2
Deer	66	64	71	91	91	383	70.5
Moose	17	16	25	34	25	117	21.5
Owl		1				1	0.2
Porcupine					1	1	0.2
Unknown species	2	4	2	1	16	25	4.6
TOTAL	**90**	**86**	**102**	**130**	**135**	**543**	**100.0**

2000 to 2004 data from Alberta Government (Infrastructure and Transportation).

Table 11.6-19 Known Wildlife Mortalities Due to Traffic on Highway 881 During the Period from 2000–2005

Species	2000	2001	2002	2003	2004	2005	Total	Percent
Bear								0.0
Coyote								0.0
Wolf								0.0
Caribou								0.0
Deer spp.	9	25		39	36	37	146	79.3
Moose		3		2	3	3	11	6.0
Horse	1						1	0.5
Unknown species			25			1	26	14.1
Grand Total	**10**	**28**	**25**	**41**	**39**	**41**	**184**	**100.0**

2000 to 2004 data from Alberta Government (Infrastructure and Transportation).

Table 11.6-20 Average Annual Daily Traffic Volume on Highways Used by the Project (± standard error)

Highway	2000	2001	2002	2003	2004	2005	2006
63	3,430.0 ± 456.3	4,277.0 ± 577.1	4,400.0 ± 585.9	4,613.0 ± 609.9	4,603.0 ± 193.8	5,540.0 ± 211.7	7,070 ± 305.1
881	840.5 ± 76.4	813.3 ± 97.0	815.2 ± 97.7	833.9 ± 100.3	999.6 ± 130.4	1,741.9 ± 232.3	2,322.2 ± 284

N/A – Data not available.

Source: Government of Alberta 2007.

11.6.5 Indirect Mortality

11.6.5.1 Potential Impacts

Potential impacts to black bear, moose and caribou from indirect mortality risks associated with the Project development and activities were qualitatively assessed within the RSA. Three sources of indirect mortality risks were fundamental for evaluating potential impacts. They are risks resulting from anthropogenic disturbances, hunting harvest, and predation. These three factors are predominant to this assessment given:

- Exposure of these species to increased levels of anthropogenic disturbances (stresses) that may occur during Project development and or during regular maintenance and operational activities of associated infrastructure;
- Increased exposure of these species to increased illegal and legal hunting harvest resulting from human access that is provided by Project development; and
- The potential to expose these species to increased levels of predation by displacing them from habitats that provide security from predators and or by attracting predators to these prey species through Project developments.

Black bear, moose and caribou populations are known to be both sensitive and vulnerable to these influences.

A qualitative discussion on the potential indirect mortality risks associated with the Project development and activities is provided separately for each of the species: black bear, moose and caribou.

11.6.5.2 Mitigation

In order to reduce the potential of indirect mortality, North American will implement the following mitigation measures:

- Optimize the Project footprint;
- Integrate Project developments with other existing and/or proposed land use activities in the area to minimize new disturbance, density of linear features and cumulative habitat loss, including the use of existing access or utility corridors where practicable;
- Optimize linear corridor widths;
- Prohibit employees and contractors from hunting, fishing or carrying firearms within the lease;
- Work with the Alberta Caribou Committee to help identify and minimize impacts on caribou; and
- Limit off-road access, where practicable, by rolling back debris and ongoing reclamation near the intersection of linear disturbances.

11.6.5.3 Residual Impacts

Black Bear

The primary issue of concern for black bear in relation to indirect mortality risks is increased exposure of black bears to illegal and legal hunting harvest resulting from Project development and activities. Increased exposure of black bears to hunter harvest is of concern for two primary reasons in relation to Project developments and activities:

- The Project will result in an increase in linear features and roads that provide additional hunter access into the area; and
- Black bears may become attracted to industrial footprints (especially garbage and waste disposal areas) where they are more susceptible to human caused mortality.

The residual impact on indirect mortality risks to black bears is expected to be of low magnitude during the application conditions of the Project, due to:

- Black bears are relatively abundant in the area;
- Project personnel will be restricted from carrying firearms and hunting on Project roads;
- Waste disposal and bear management program will be implemented to mitigate anthropogenic attractions for black bears resulting from the Project; and
- The relative increase in linear feature access within the RSA (beyond existing linear feature access) from Project development will be relatively minimal.

During the Project application phase approximately 435 km of linear features will be added to the RSA. However, there is approximately 8,220 km of existing linear features in the RSA at baseline condition. The Project will thus contribute only a 6% (approximate) addition to the existing linear features within RSA, during Project application. This may result in a localized effect to the regional black bear population.

At closure, the impacts are expected to be reversible as road and seismic access will be reclaimed and Project related influences will no longer exist. As such, no long term residual impacts are predicted.

The confidence rating in these predictions is considered moderate. The mortality risks related to black bears are well known. Moreover, black bear populations in the area are likely not limiting, and there are effective and well known mitigation strategies in place for this species. The Project will provide only a limited and localized relative increase in hunter access within the RSA.

Moose

Moose populations may potentially be affected by increased levels of mortality indirectly resulting from Project activities and developments. Of primary concern are the effects of animal stress resulting from Project activities (blasting, helicopters, human presence) on moose health and recruitment, the effects of increased levels of moose hunting harvest, and increased levels of predation resulting from increased predator efficiency and presence in the RSA.

The residual impact on indirect mortality risks to moose is expected to be of low magnitude during the application conditions of the Project for:

- Regional moose populations in the area are stable (Charest, 2005);
- The relative increase in linear feature access within the RSA (beyond existing linear feature access) from Project development is relatively minimal; and
- Project mitigation, including access management measures and hunting restrictions for Project staff on site, will be in place.

The effect of increased levels of moose hunting harvest indirectly influencing the regional moose population is expected to be minimal. The existing linear feature and access routes in the area are extensive (approximately 8,220 km in the RSA). The Project is expected to provide an additional 435 km of linear features in the RSA during the application conditions. Hunter access will thus increase in some areas and moose hunter success may increase in those areas, as well. However, this may only result in a localized effect to the larger regional moose population.

The potential effects of increased mortality risk which may indirectly result from increased levels of animal stress and or from increased levels of predation on moose is of moderate concern but is unknown (there is uncertainty in evaluation of these effects). As such North American, is monitoring moose, caribou and wolves in the area using scat detection surveys to evaluate animal presence, physiological stress (hormone analysis), and population levels (using DNA mark-recapture analysis). This ongoing monitoring program will provide a tool for detecting impacts and hopefully allowing them to be mitigated proactively.

At closure, impacts are expected to be reversible, as road and seismic access will be regenerated. No long term residual impact is predicted beyond Project closure.

The confidence rating in these predictions is considered moderate since:

- Moose populations in the area are not limiting;
- There are effective and well known mitigation strategies in place;
- The Project will provide only a limited and localized relative increase in regional hunter access; and
- An innovative monitoring program is being conducted to support the proactive mitigation of Project effects.

Woodland Caribou

Studies suggest that caribou populations on the East Side of the Athabasca River are declining (McLoughlin et al., 2003; Alberta Woodland Caribou Recovery Team, 2005). However there is uncertainty in the mechanisms that may be causing such declines (Canadian Association of Petroleum Producers, 2005).

Within the RSA, caribou populations may potentially be affected by increased levels of mortality indirectly resulting from Project activities and developments. Of primary concern are the effects of animal stress resulting from Project activities (seismic blasting, helicopters, human presence) on caribou health and recruitment, the effects of increased levels of hunting harvest on caribou populations, and increased levels of predation resulting from increased predator efficiency and densities in the RSA. Collectively, these indirect mortality factors have been suggested as the proximate causes that may be contributing to the declining caribou populations in the area, with current research identifying concerns related to calf mortality (death in the first year of life; Canadian Association of Petroleum Producers, 2005; Alberta Caribou Recovery Team, 2005).

At application, the Project is predicted to have a low contribution to caribou mortality in the RSA resulting from hunter harvest, for the following reasons:

- There is no non-native hunting of caribou permitted in Alberta;
- Poaching is not thought to be a strong contributor to caribou mortality in the area, accounting for approximately 8% of all known caribou mortalities in Alberta (McLoughlin et al., 2003); and
- Project mitigation includes firearm restrictions for Project staff and access management measures to reduce the potential for wildlife hunting impacts indirectly resulting from Project developments or activities.

At application, the potential effects of increased caribou mortality risk which may indirectly result from increased levels of animal stress and or from increased levels of predation is of greatest concern. However, there is a great deal of uncertainty in evaluation of the indirect effects on caribou mortality risk. The Project will lead to increased levels of human presence and industrial activities in the RSA (seismic activities, helicopter and vehicle traffic, construction of infrastructures, and etc.). The Project will also contribute to an increase in linear features in the RSA. The effects of increased linear features and project developments may indirectly increase wolf predation on caribou in the following ways:

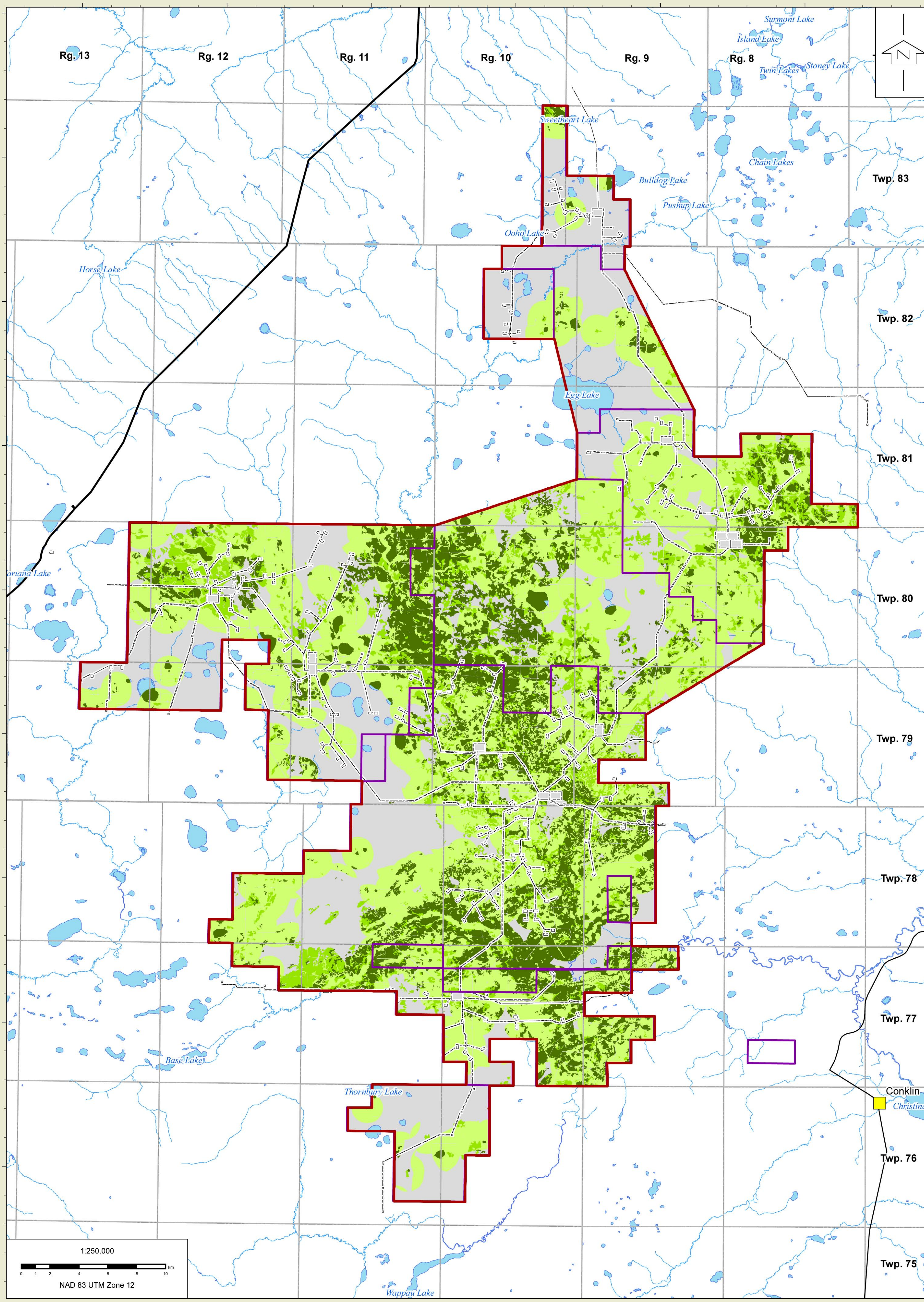
- Linear developments within caribou range increase wolf predation rates through increased mobility and line-of-sight (James, 1999); and

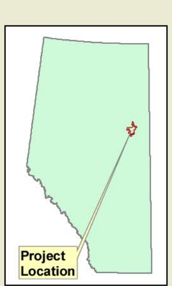
- Vegetation clearing and alteration may improve the habitat suitability for other wolf primary prey species like deer and moose on caribou ranges (Alberta Caribou Recovery Team, 2005). Increased abundances of primary prey within caribou ranges combined with improved access, may result in more predators on caribou range and an increased level of caribou mortality risk (James et al., 2004).

The effects of increased levels of anthropogenic disturbances may indirectly increase caribou mortality. Seismic activities, helicopter and vehicle traffic, construction of infrastructures, etc., may lead to increased levels of animal stress. Such stresses may distract normal animal behaviours (foraging, resting) and lead to reduced animal health. These stress concerns are of particular concern for pregnant and birthing female caribou and juveniles (Bradshaw et al., 1997). Increased levels of caribou stress may indirectly contribute to reduced caribou health and increased levels of mortality, particularly among juveniles and less vigorous individuals.

At closure, impacts are expected to be reversible to some degree, as road and seismic access will be regenerated. Only a low magnitude of long term residual impact is predicted beyond Project closure. Long term impacts may result from potential improvements to the habitat suitability for other primary prey species of wolves on caribou ranges (e.g., other primary prey species like deer and moose).

The impact of the Project on the caribou population is predicted as a medium magnitude impact. Consistent with current research on the causes of suggested caribou population declines in the area, there is a high level of uncertainty in this prediction and assessment. As such, North American is monitoring moose, caribou and wolves in the area using scat detection surveys to evaluate animal presence, physiological stress (hormone analysis), and population levels (using DNA mark-recapture analysis). It is anticipated that this ongoing monitoring program will provide a tool for detecting impacts and hopefully allowing them to be mitigated proactively.





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- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR CANADIAN TOAD AT APPLICATION IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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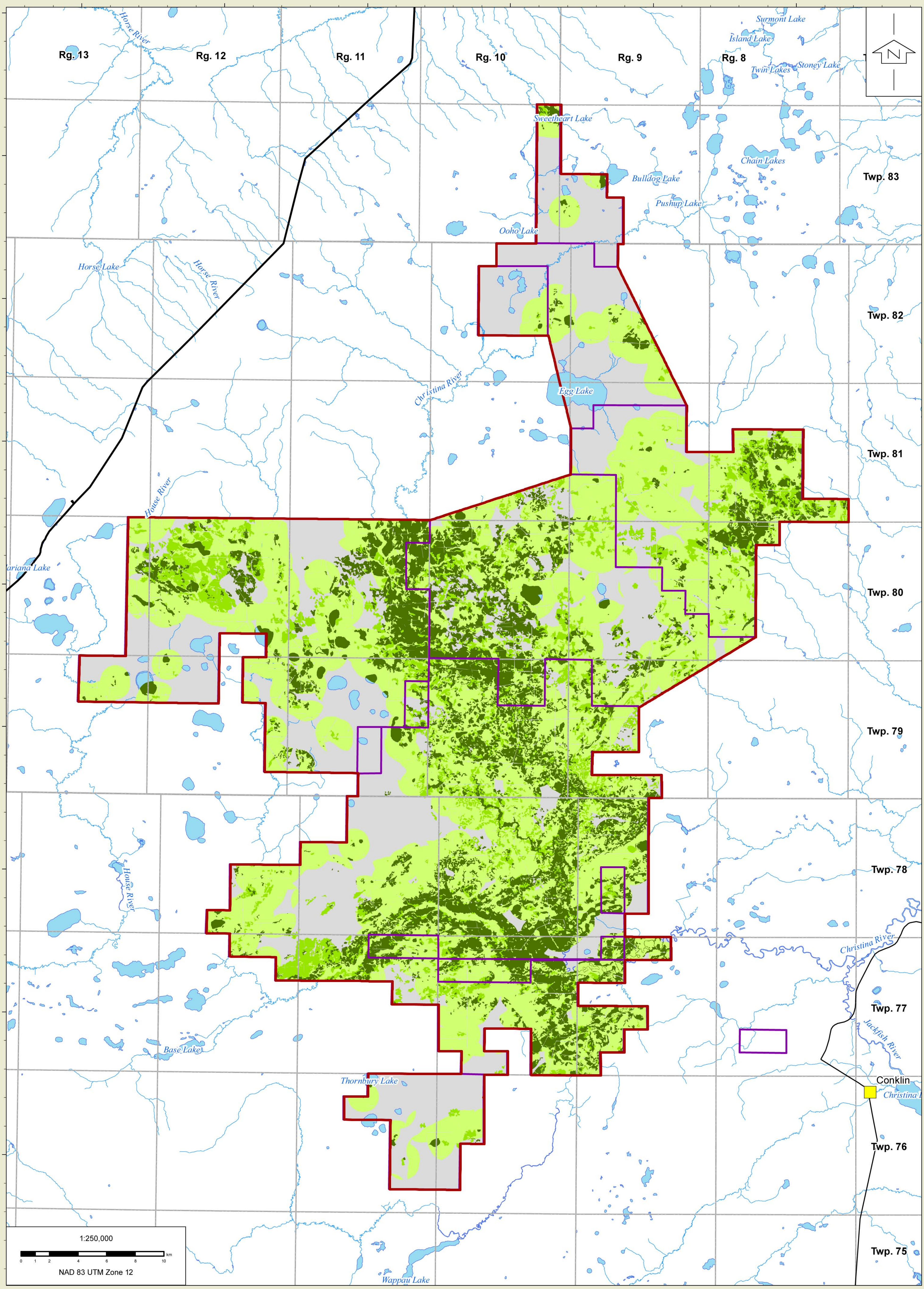

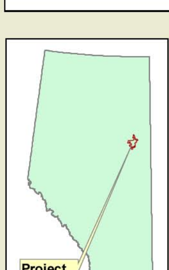

Legend

- North American Wildlife LSA
- North American Lease
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR CANADIAN TOAD AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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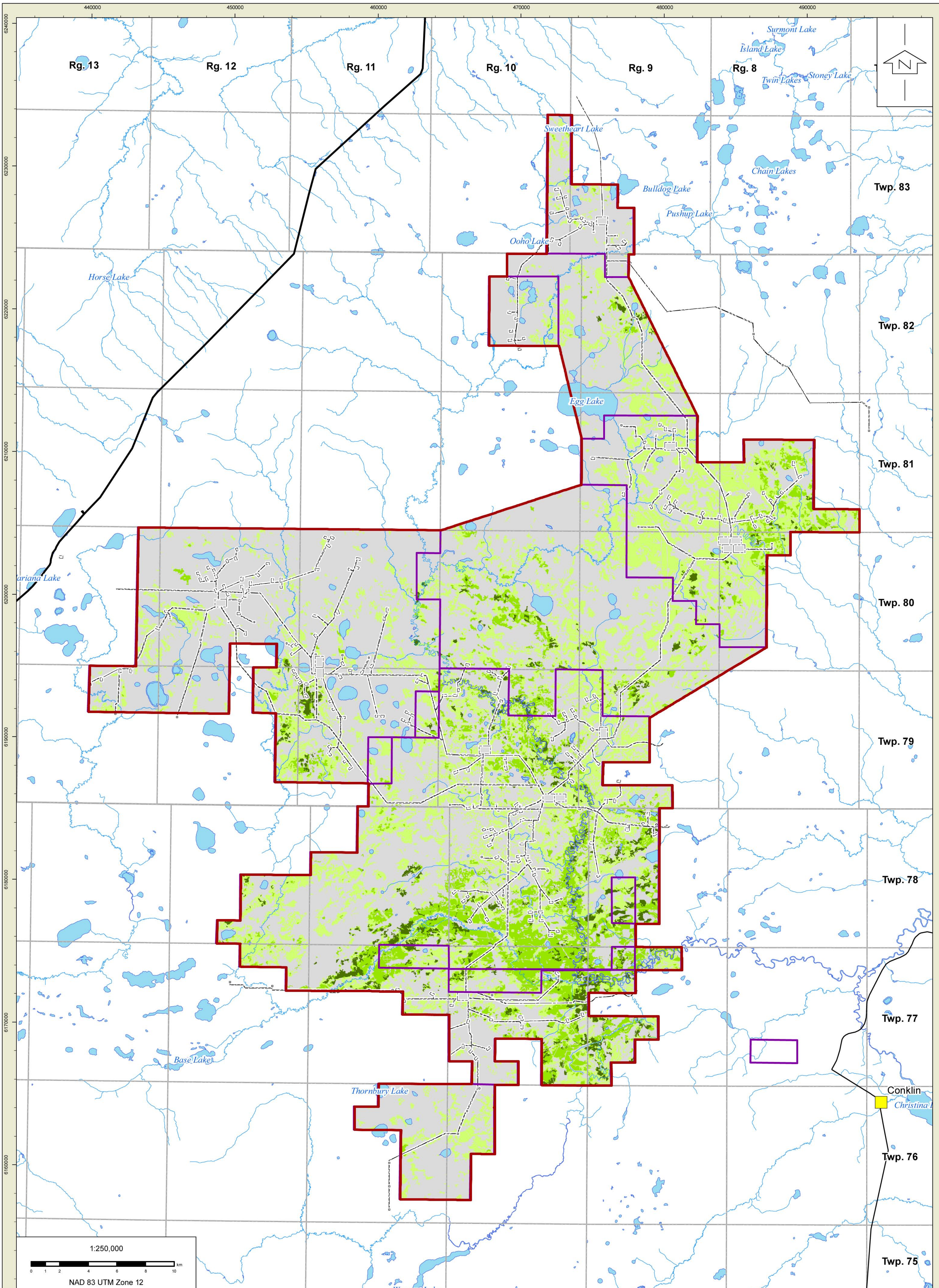

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- North American Wildlife LSA
- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR NORTHERN GOSHAWK AT APPLICATION IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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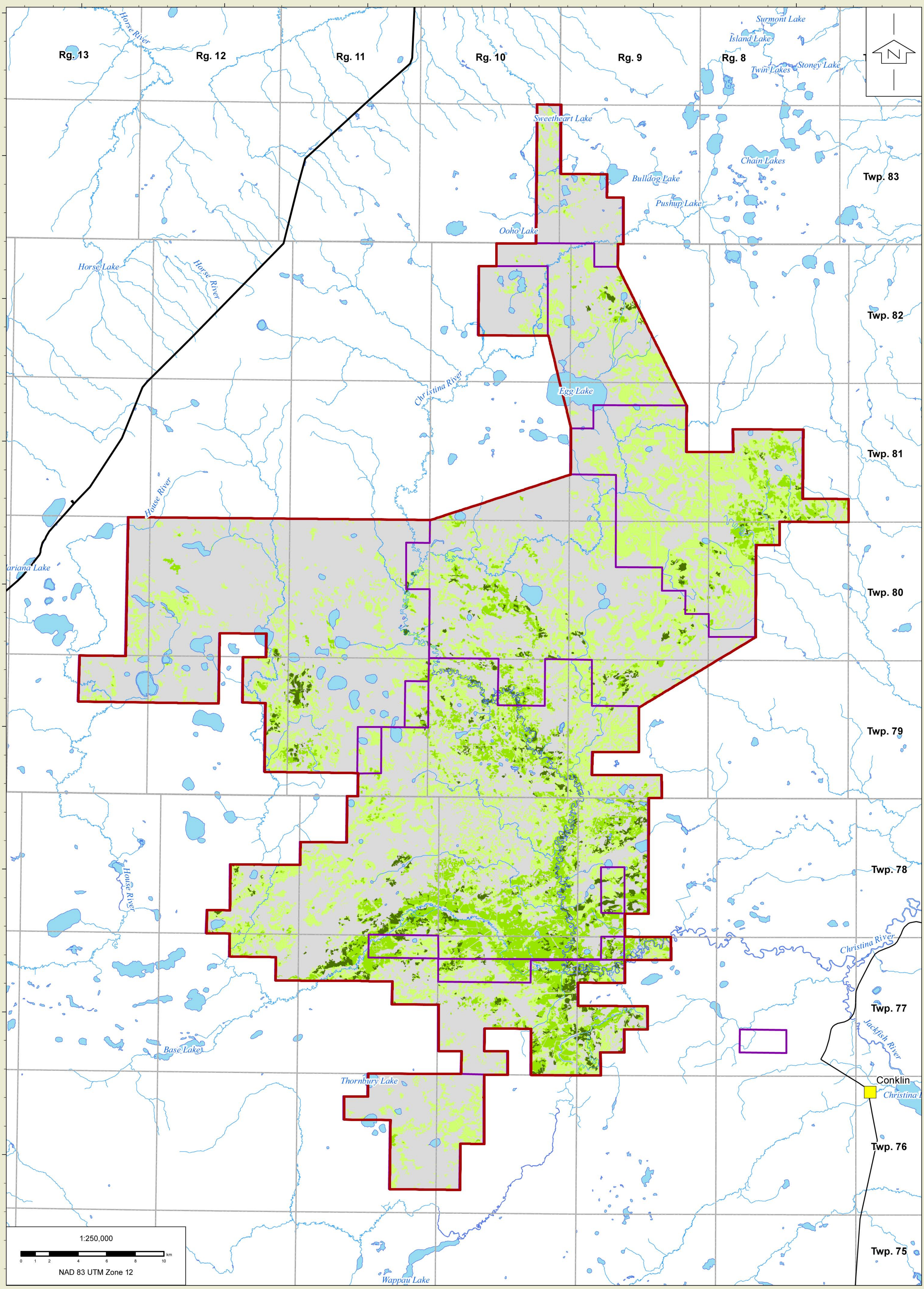

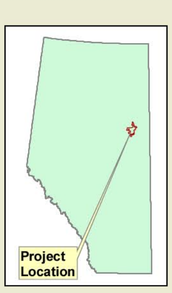

Legend

- North American Wildlife LSA
- North American Lease
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR NORTHERN GOSHAWK AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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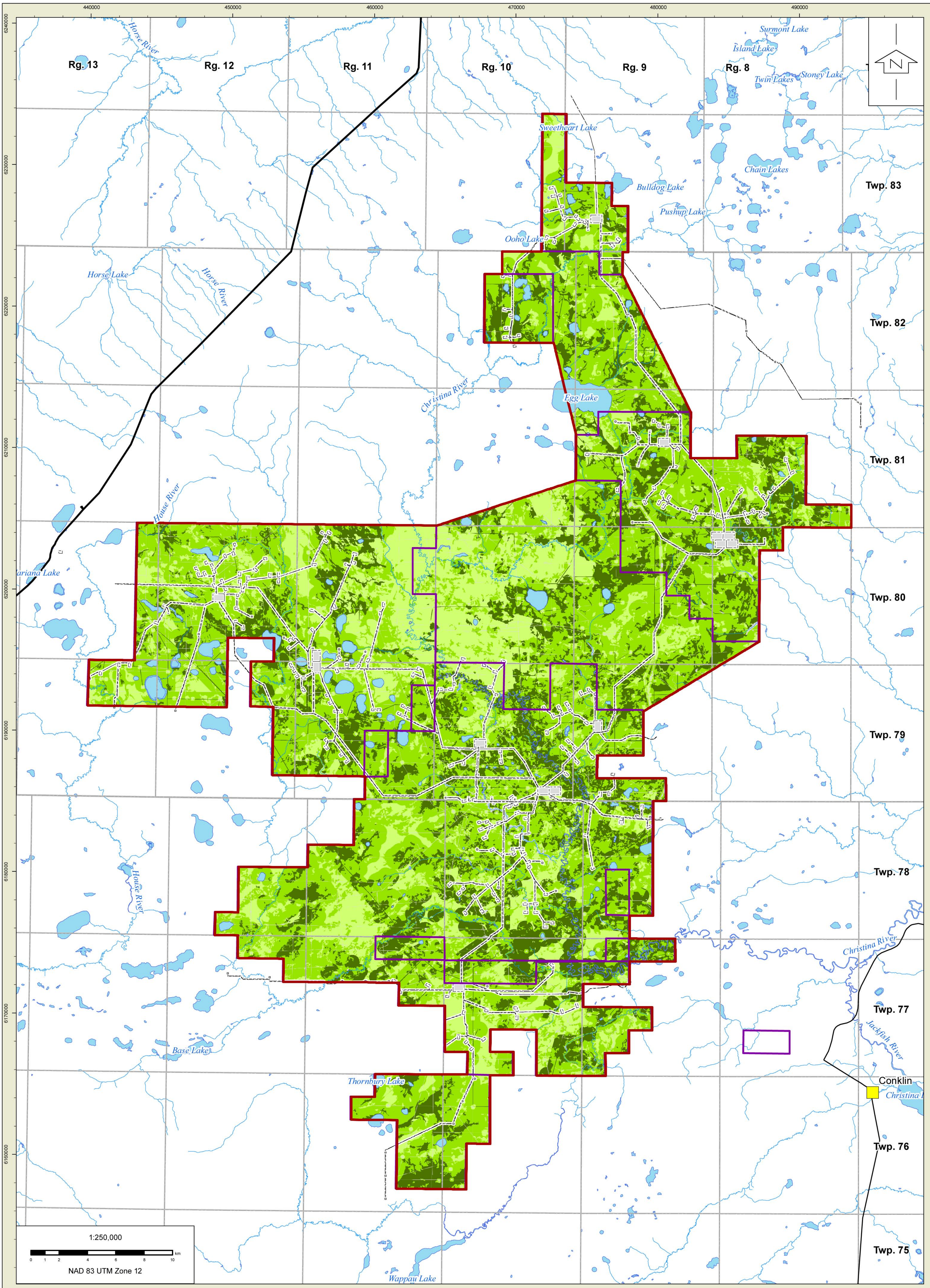

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HABITAT SUITABILITY FOR GREAT GRAY OWL AT APPLICATION IN THE LSA

Approved:	Revision Date:
RL	June 14, 2007

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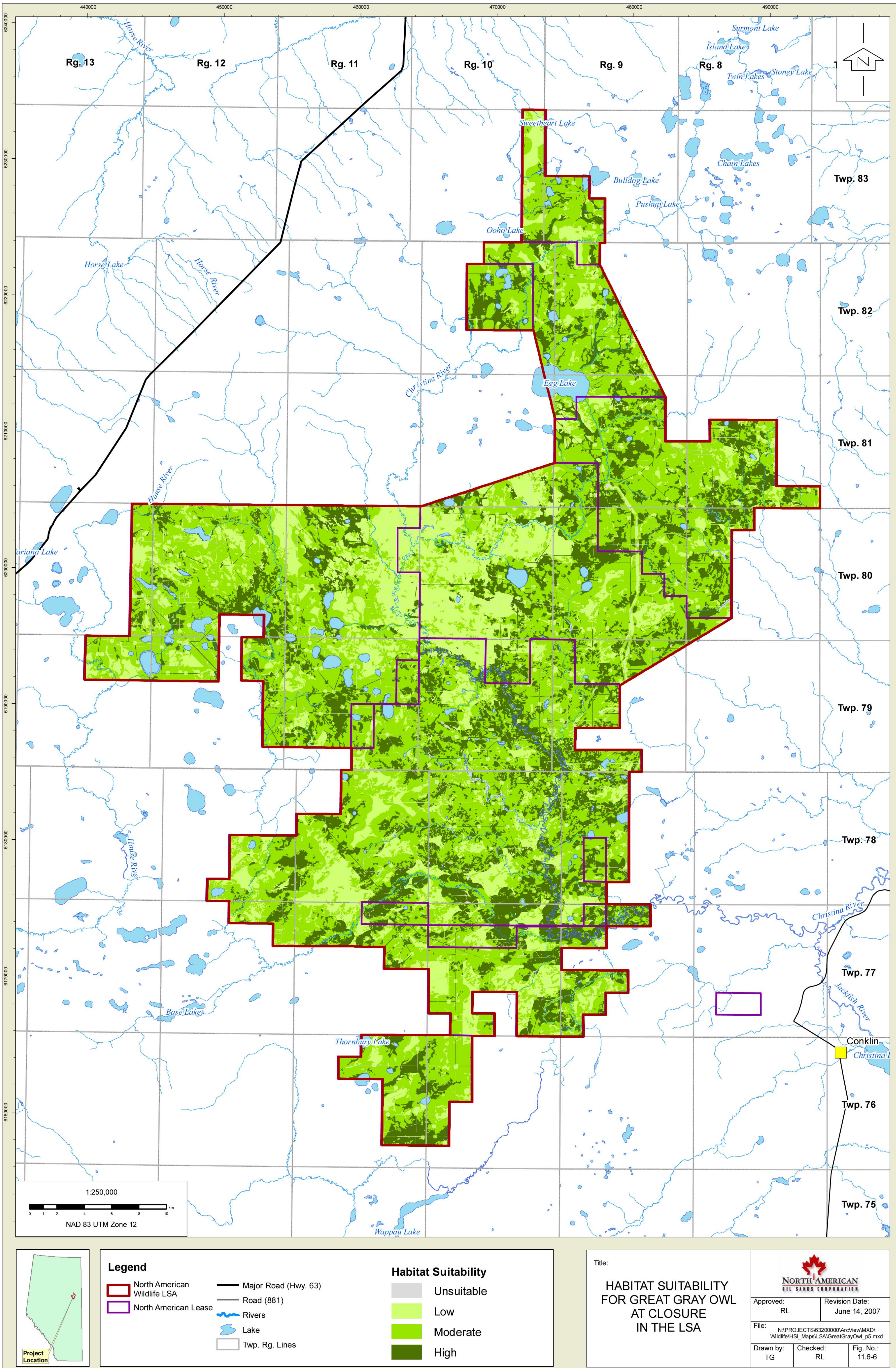

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North American Lease
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR GREAT GRAY OWL AT CLOSURE IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
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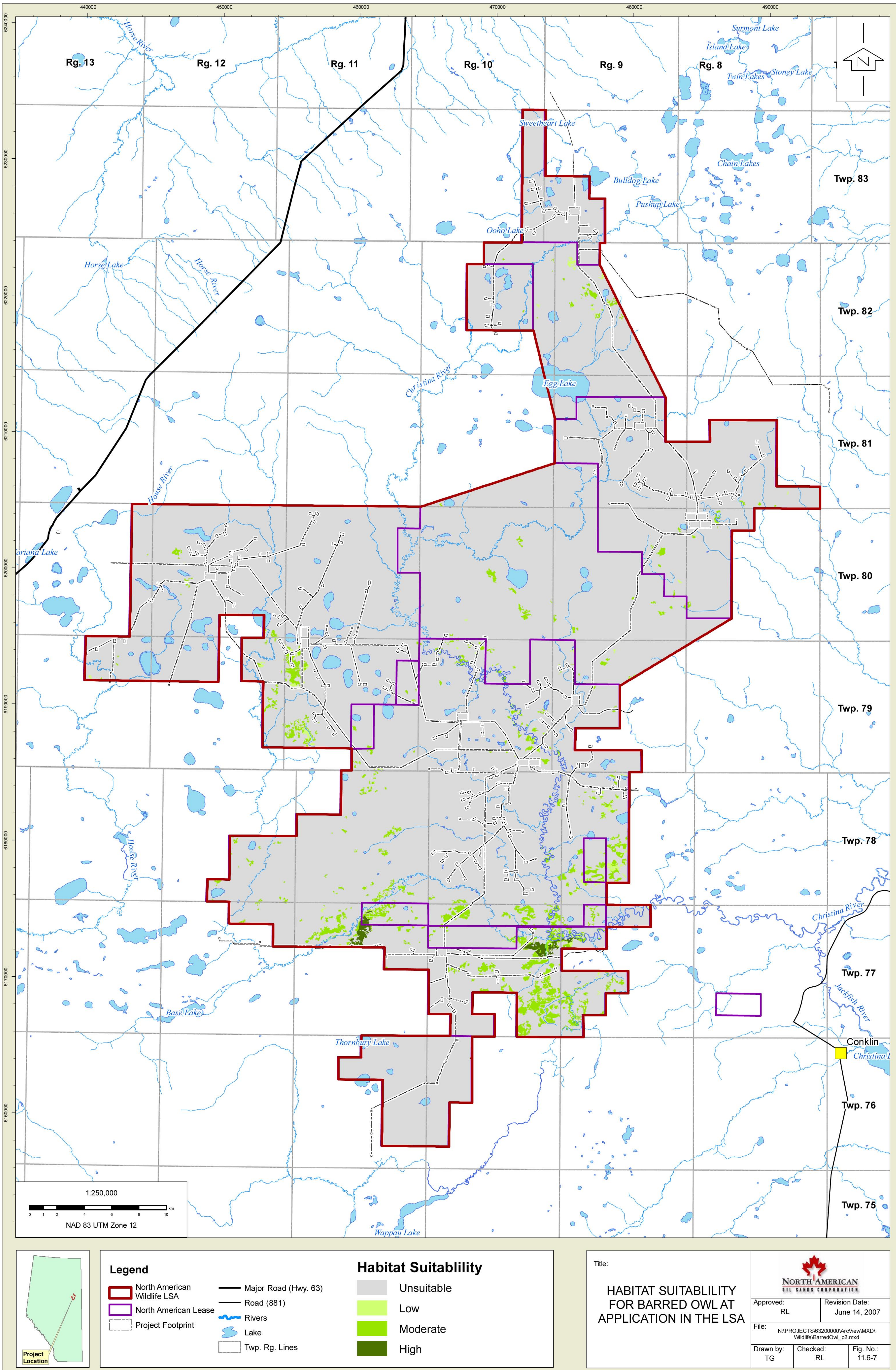
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Project Location
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Project Footprint
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Road (881)
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Lake
Twp. Rg. Lines
Habitat Suitablility
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABLILITY FOR BARRED OWL AT APPLICATION IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
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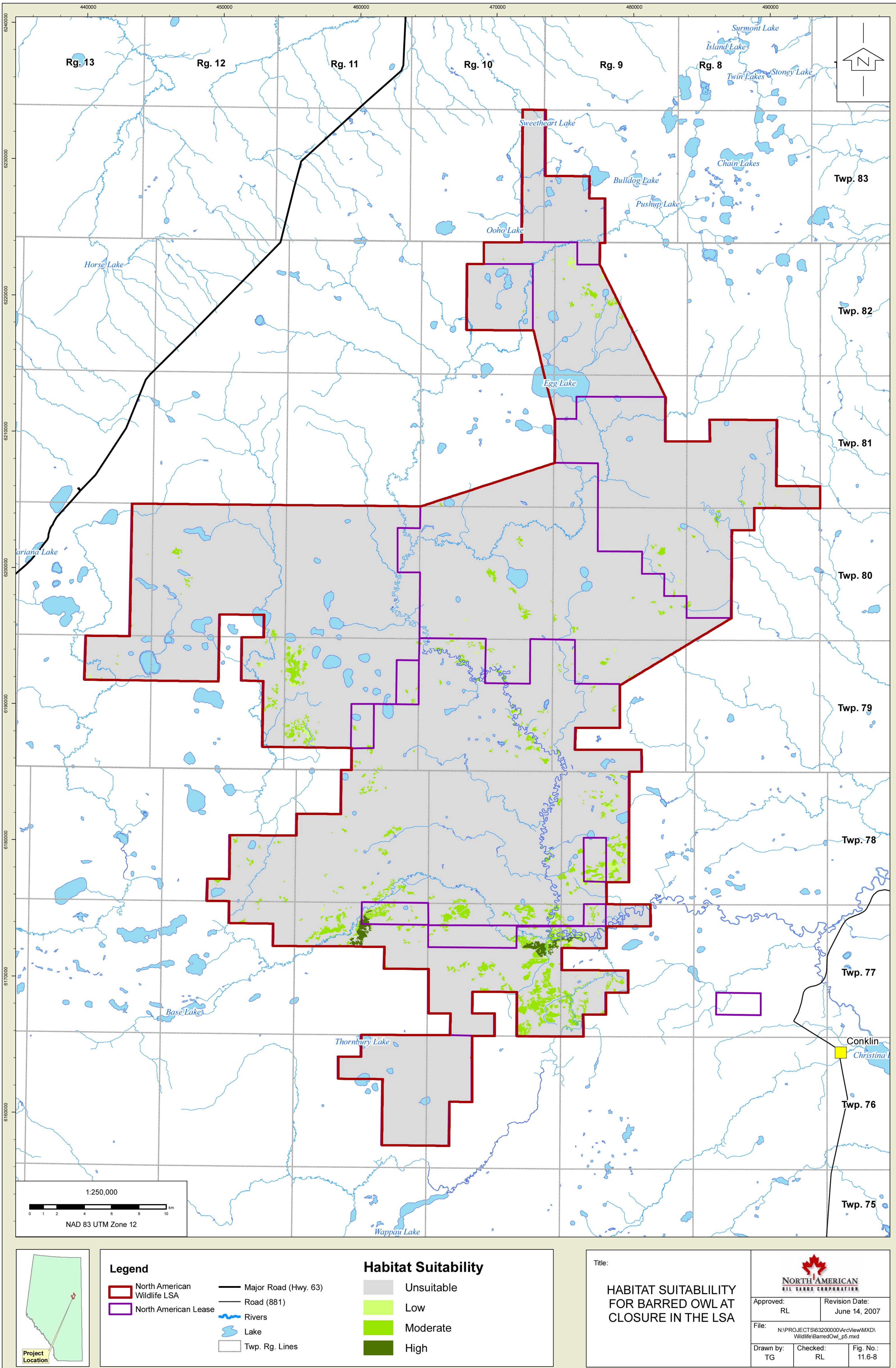

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Surmont Lake
Island Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Chain Lakes
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Base Lake
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Project Location
Legend
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North American Lease
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABLILITY FOR BARRED OWL AT CLOSURE IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
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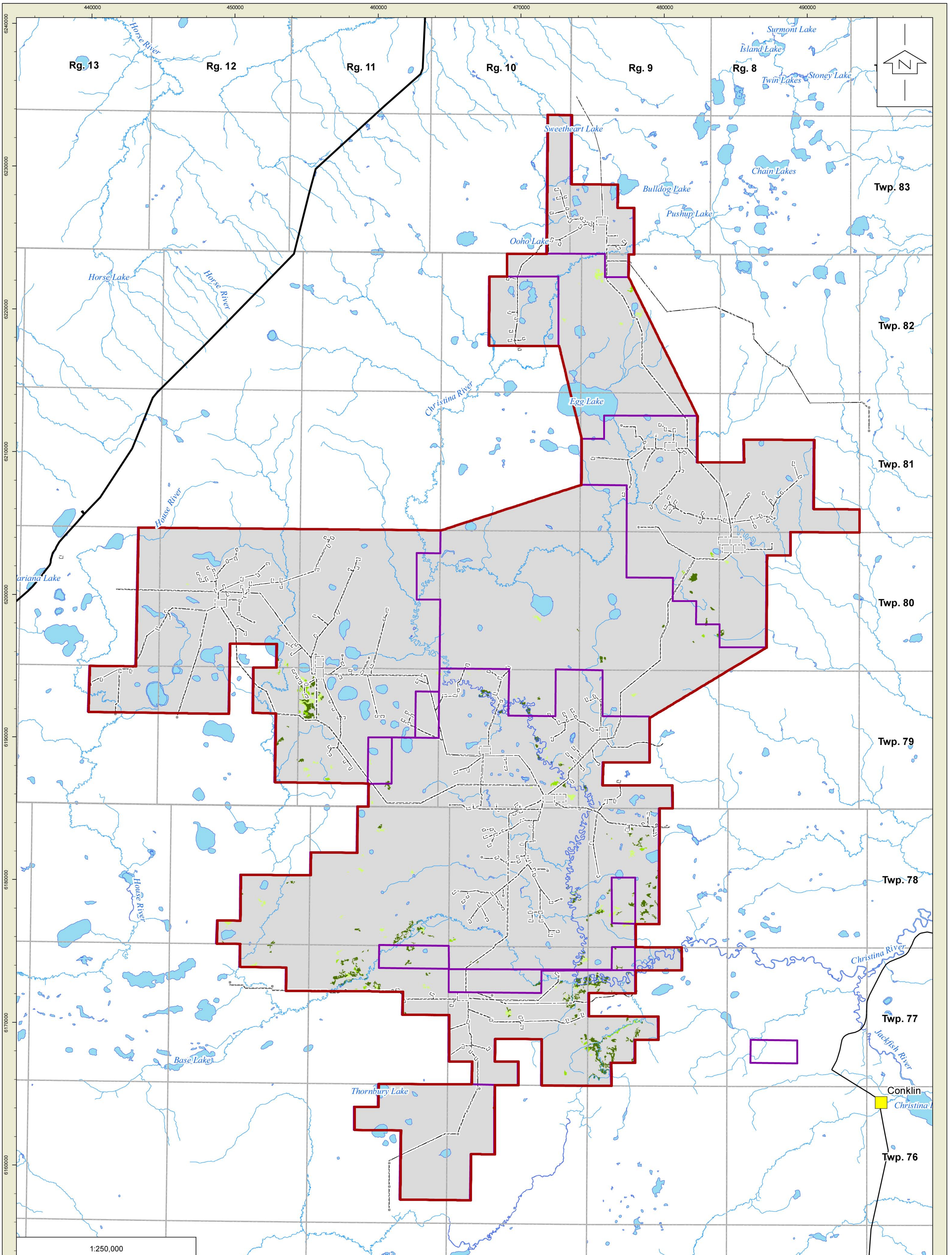
Drawn by: TG
Checked: RL
Fig. No.: 11.6-8



Legend

- North American Wildlife LSA
- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

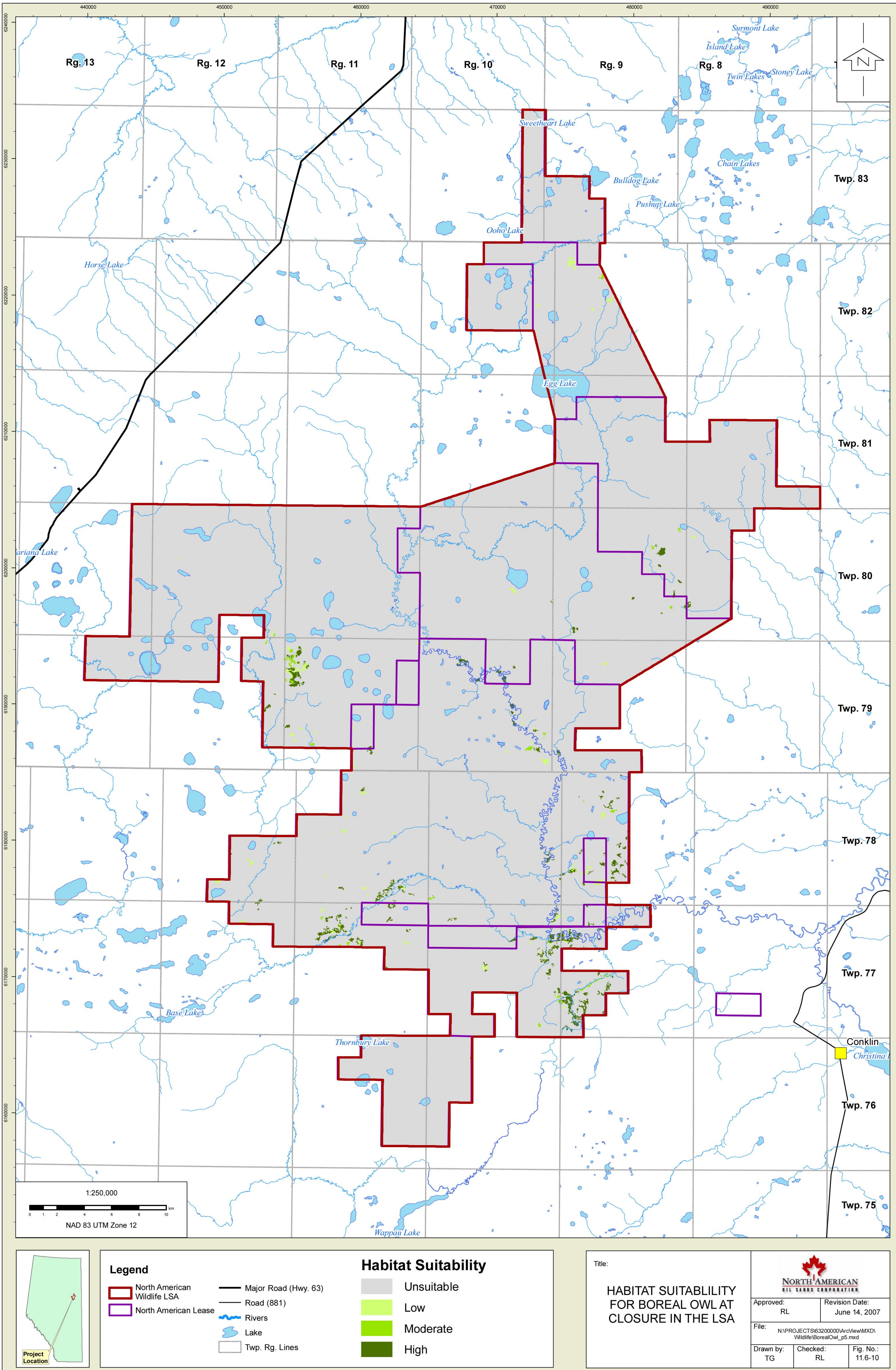
HABITAT SUITABLILITY FOR BOREAL OWL AT APPLICATION IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\BorealOwl_p2.mxd

Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-9



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Surmont Lake
Island Lake
Twin Lakes
Stoney Lake
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Horse Lake
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Mariana Lake
Base Lake
Thornbury Lake
Wappau Lake
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Christina L
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km
NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABLILITY FOR BOREAL OWL AT CLOSURE IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\BorealOwl_p5.mxd
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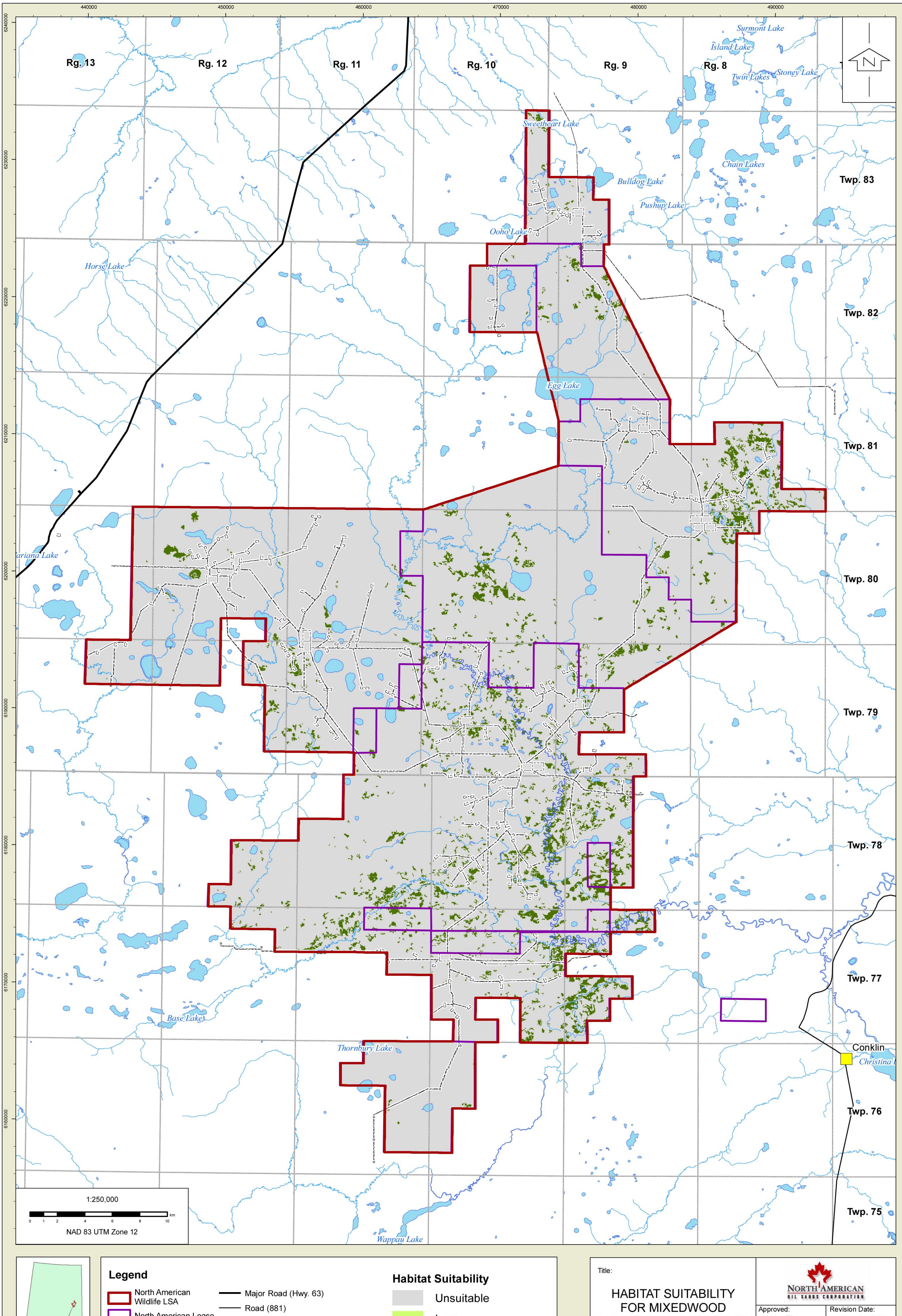
Checked: RL
Fig. No.: 11.6-10

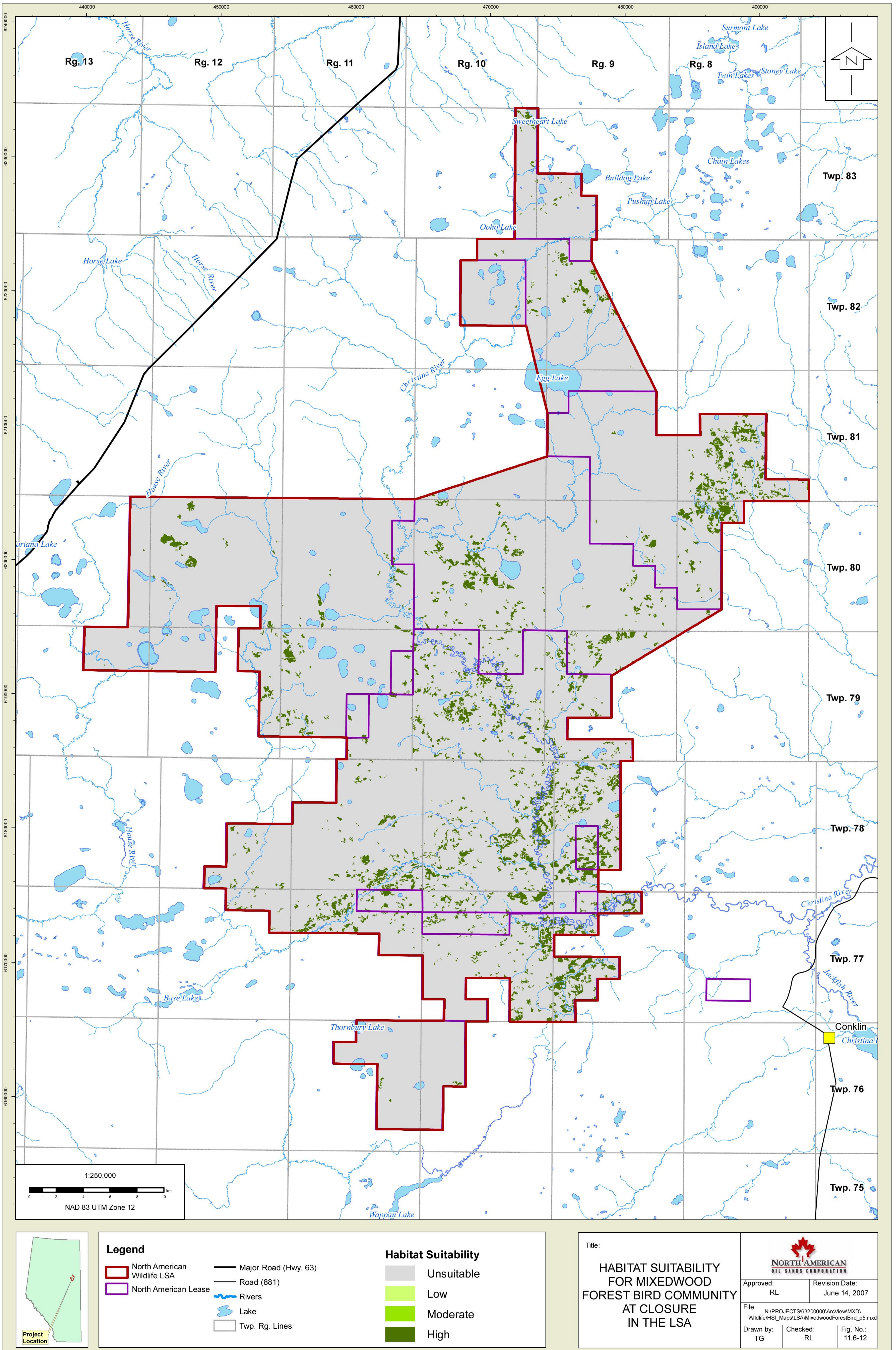


Title:

HABITAT SUITABILITY FOR MIXEDWOOD FOREST BIRD COMMUNITY AT APPLICATION IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:	
RL	June 14, 2007	
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\MixedwoodForestBird_p2.mxd		
Drawn by: TG	Checked: RL	Fig. No.: 11.6-11



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Island Lake
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Stoney Lake
Sweetheart Lake
Chain Lakes
Bulldog Lake
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Ooho Lake
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Christina River
Base Lake
Thornbury Lake
Wappau Lake
Jackfish River
Conklin
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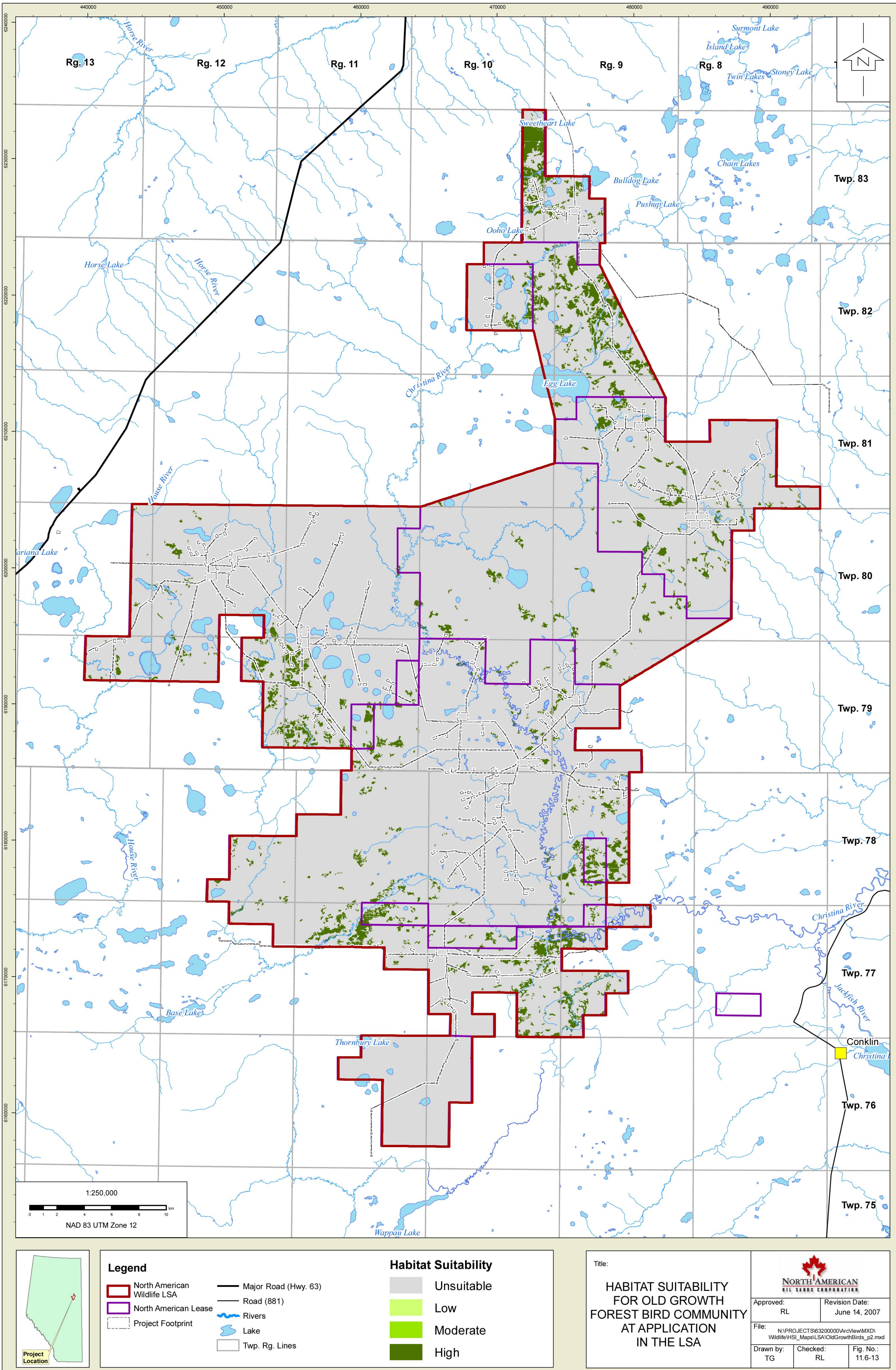
NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR MIXEDWOOD FOREST BIRD COMMUNITY AT CLOSURE IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\MixedwoodForestBird_p5.mxd
Drawn by: TG
Checked: RL
Fig. No.: 11.6-12



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Bulldog Lake
Pushup Lake
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Christina River
House River
Mariana Lake
Base Lake
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NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Project Footprint
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR OLD GROWTH FOREST BIRD COMMUNITY AT APPLICATION IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\OldGrowthBirds_p2.mxd
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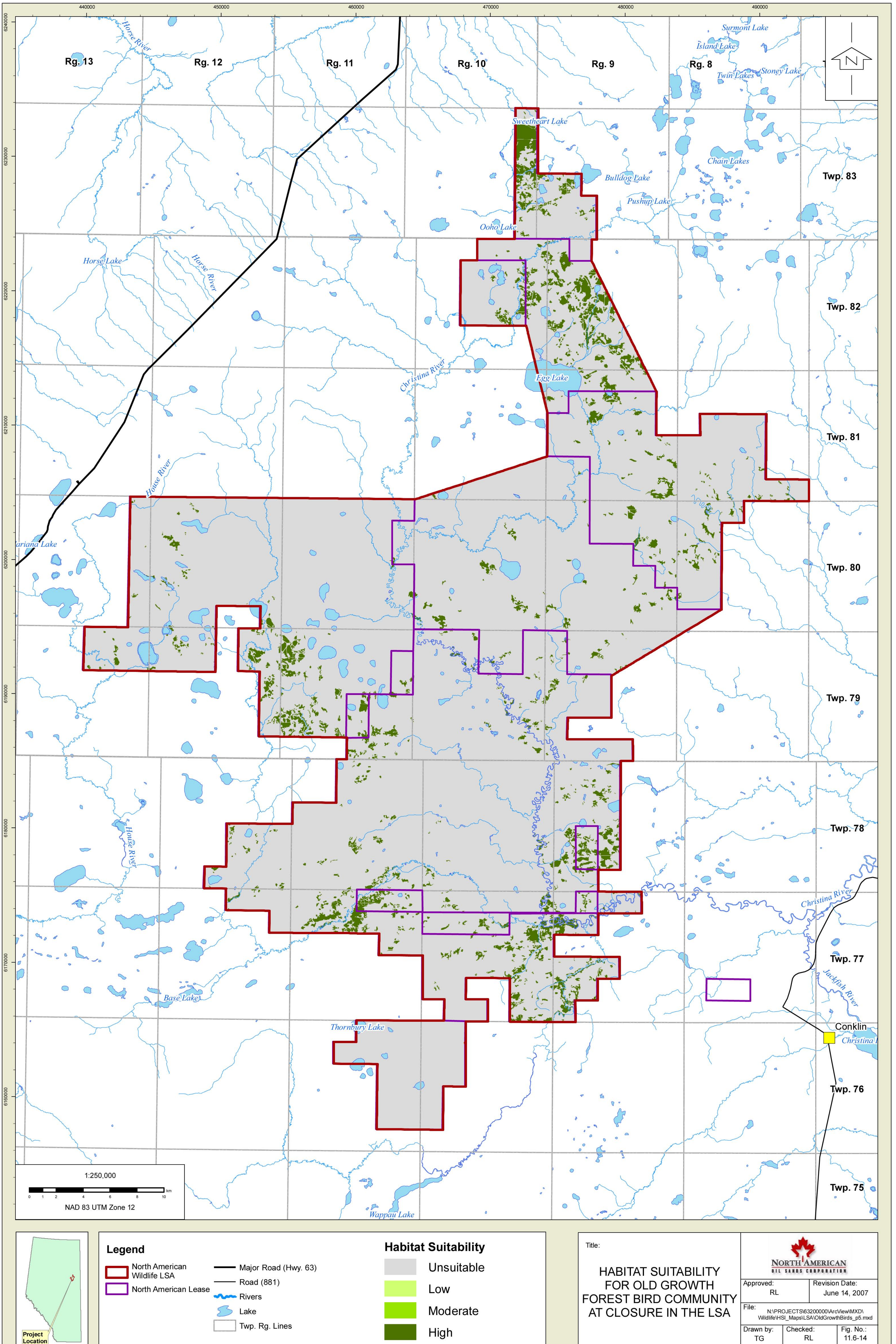
Checked: RL
Fig. No.: 11.6-13



Title:

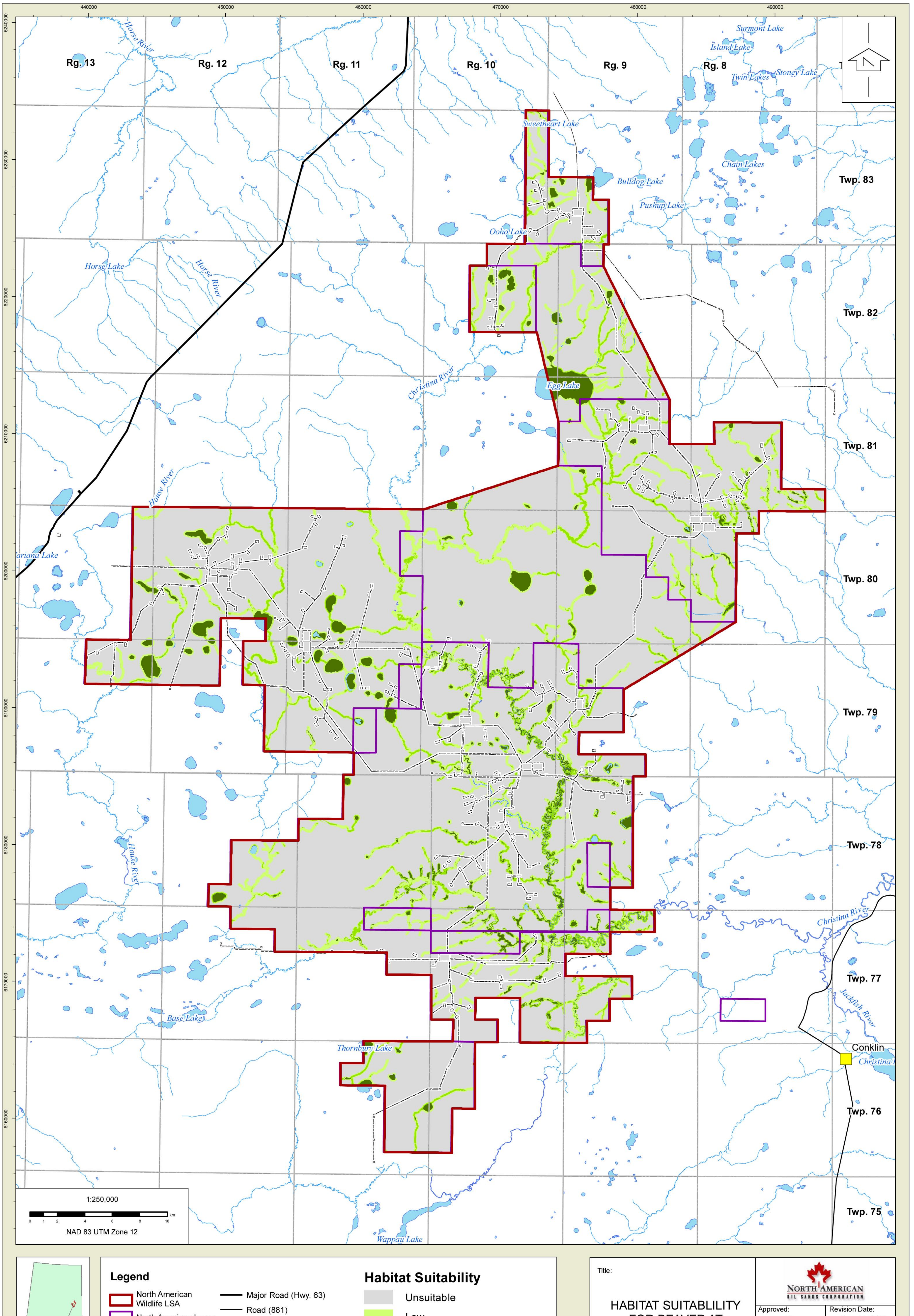
HABITAT SUITABILITY FOR OLD GROWTH FOREST BIRD COMMUNITY AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\OldGrowthBirds_p5.mxd

Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-14



Title:

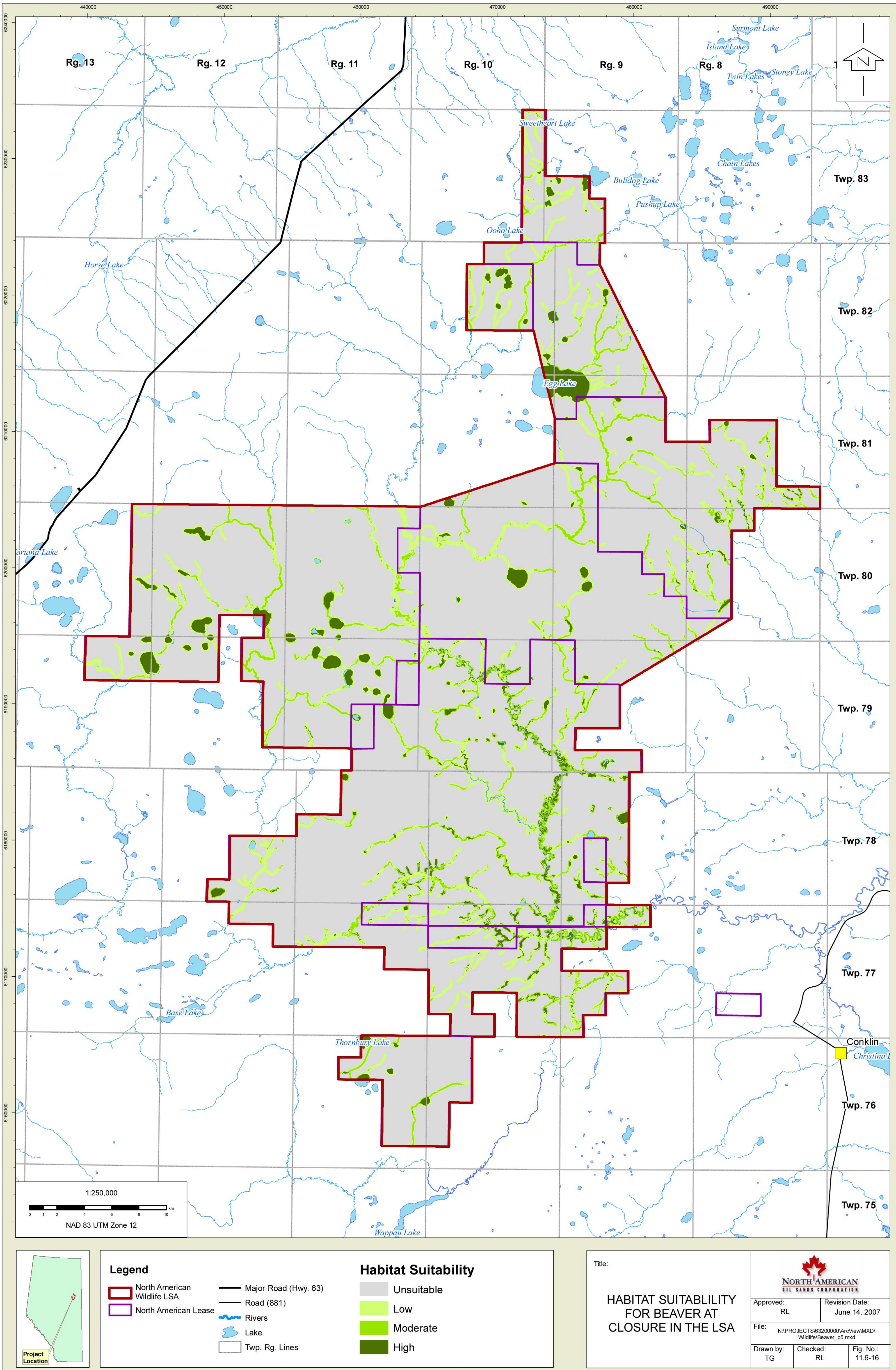
HABITAT SUITABLILITY FOR BEAVER AT APPLICATION IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\Beaver_p2.mxd

Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-15



Title:

HABITAT SUITABLILITY FOR BEAVER AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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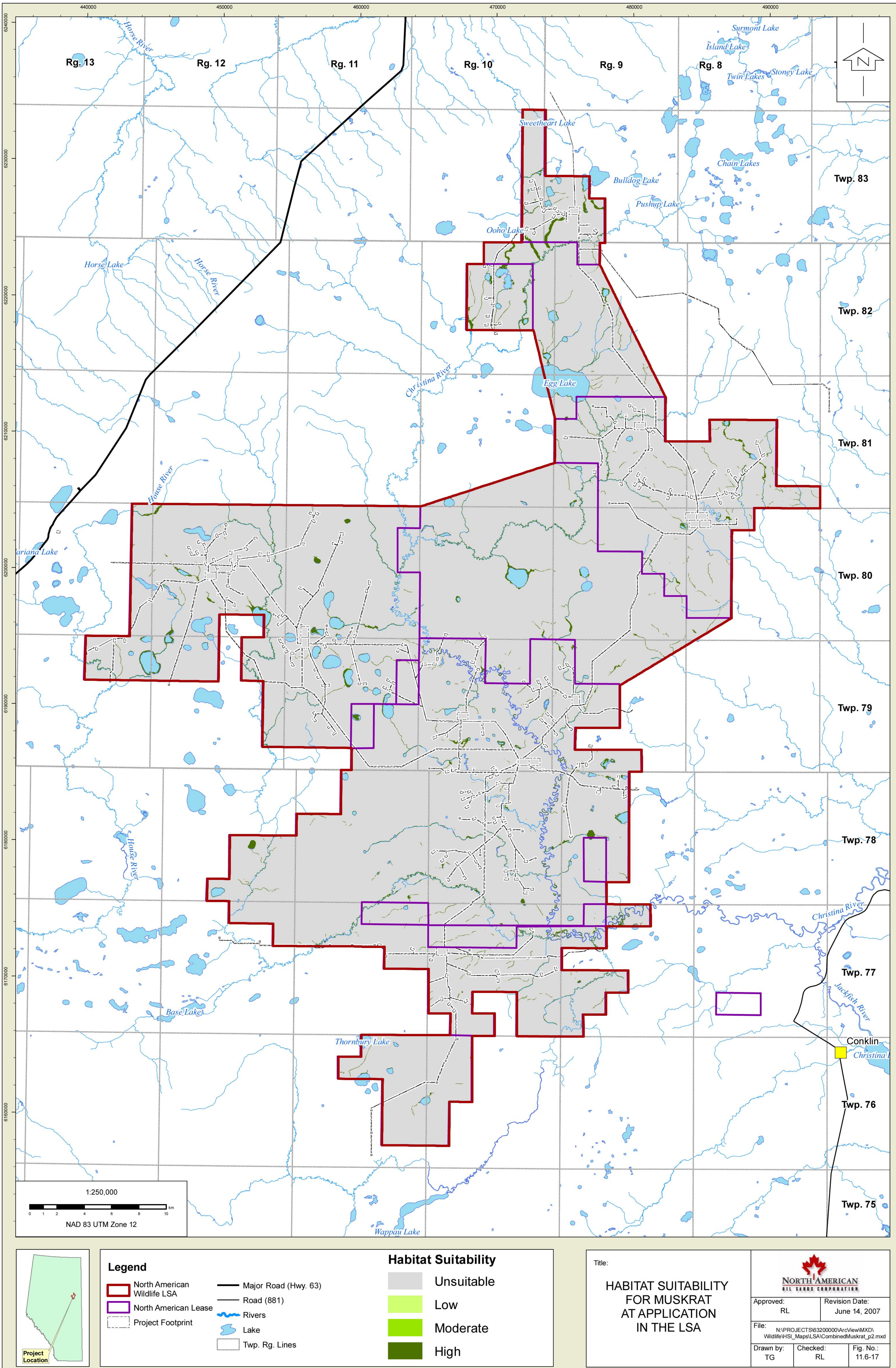
Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-16



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Surmont Lake
Island Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Chain Lakes
Bulldog Lake
Pushup Lake
Ooho Lake
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Christina River
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Base Lake
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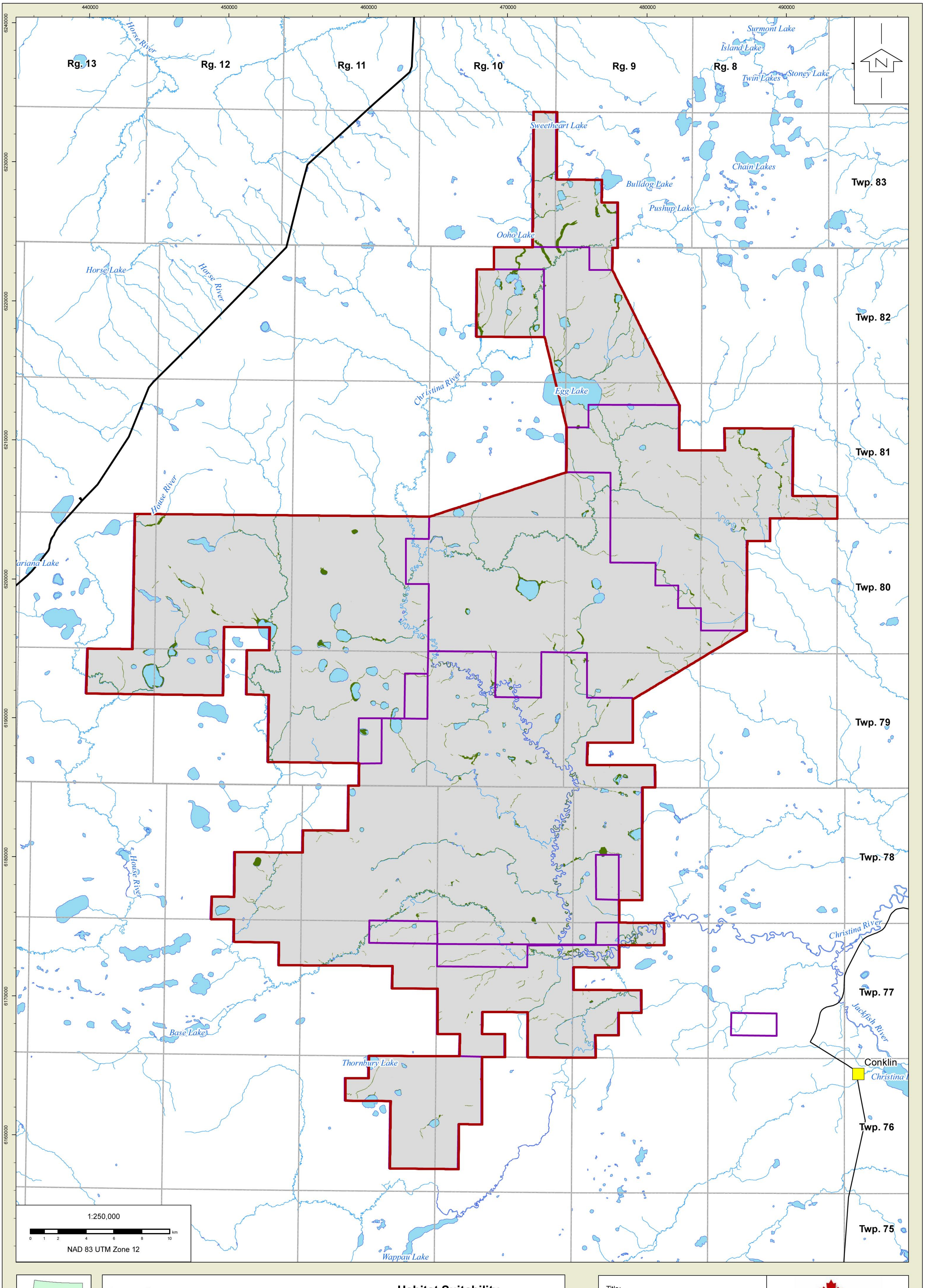
NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Project Footprint
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR MUSKRAT AT APPLICATION IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\CombinedMuskrat_p2.mxd
Drawn by: TG
Checked: RL
Fig. No.: 11.6-17



Legend

- North American Wildlife LSA
- North American Lease
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

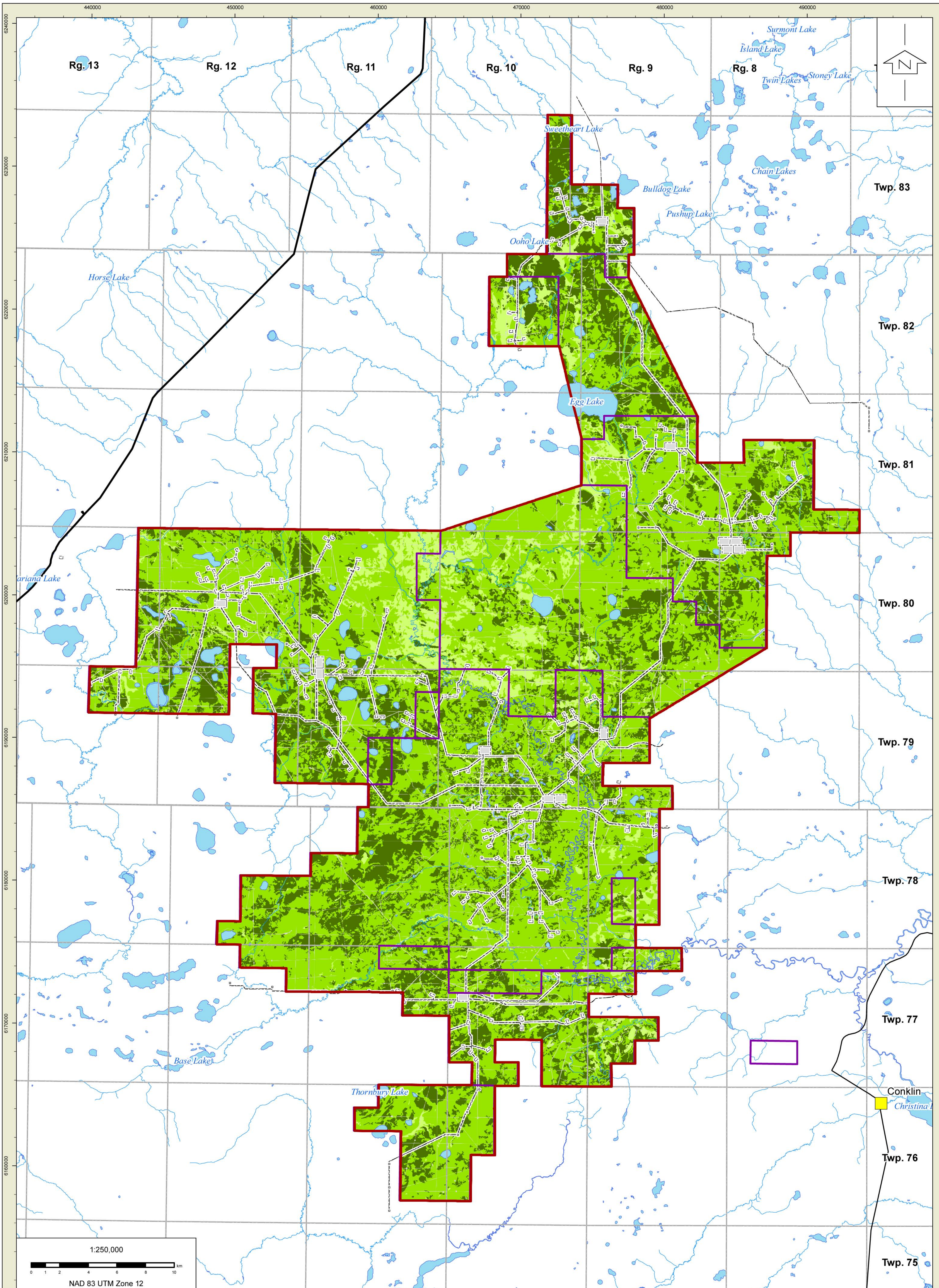
- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR MUSKRAT AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:	
RL	June 14, 2007	
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\CombinedMuskrat_p5.mxd		
Drawn by: TG	Checked: RL	Fig. No.: 11.6-18



Project Location

Legend

- North American Wildlife LSA
- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR FISHER AT APPLICATION IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\Fisher_p2.mxd

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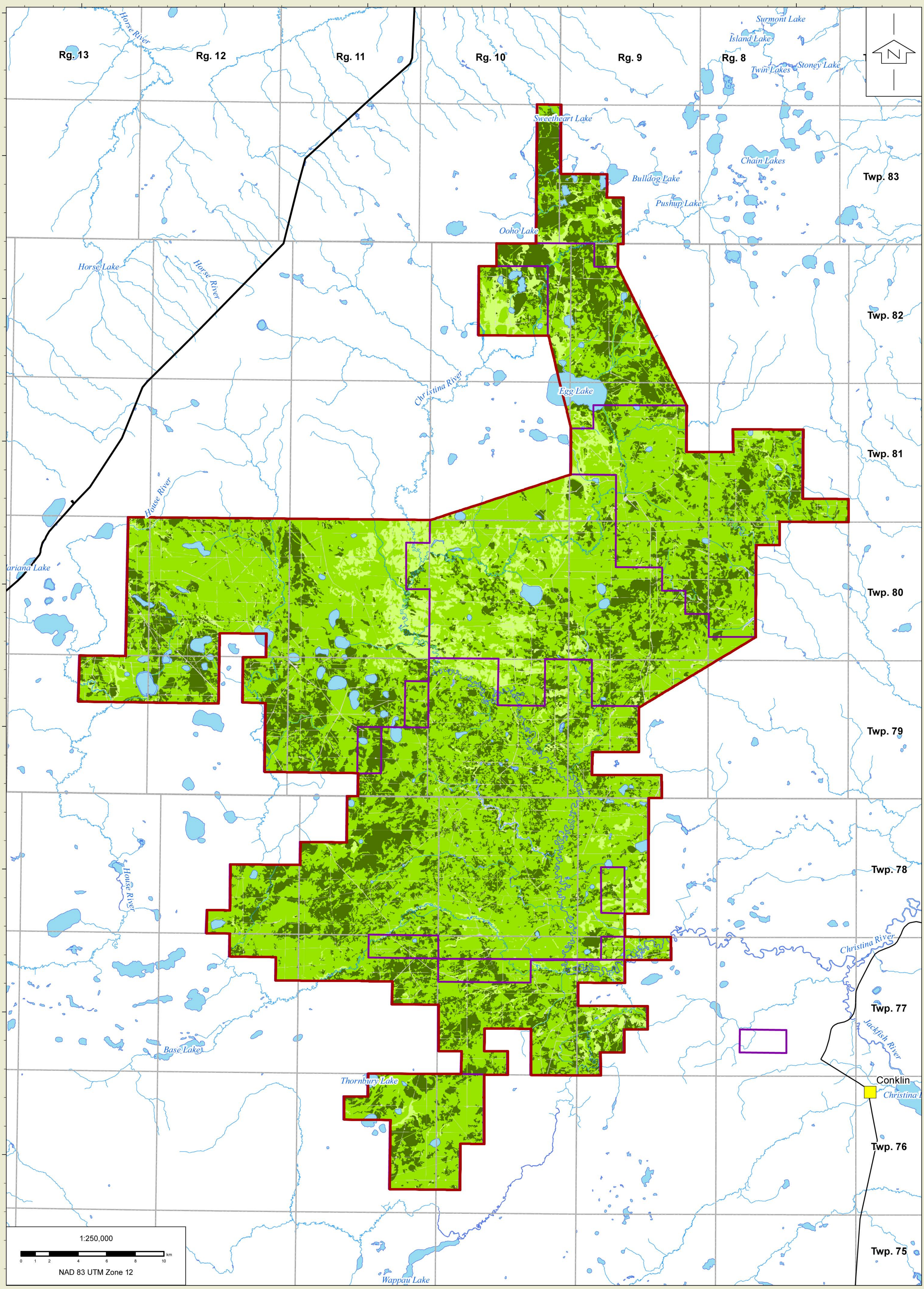
TG	RL	11.6-19



Legend

- North American Wildlife LSA
- North American Lease
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR FISHER AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\Fisher_p5.mxd

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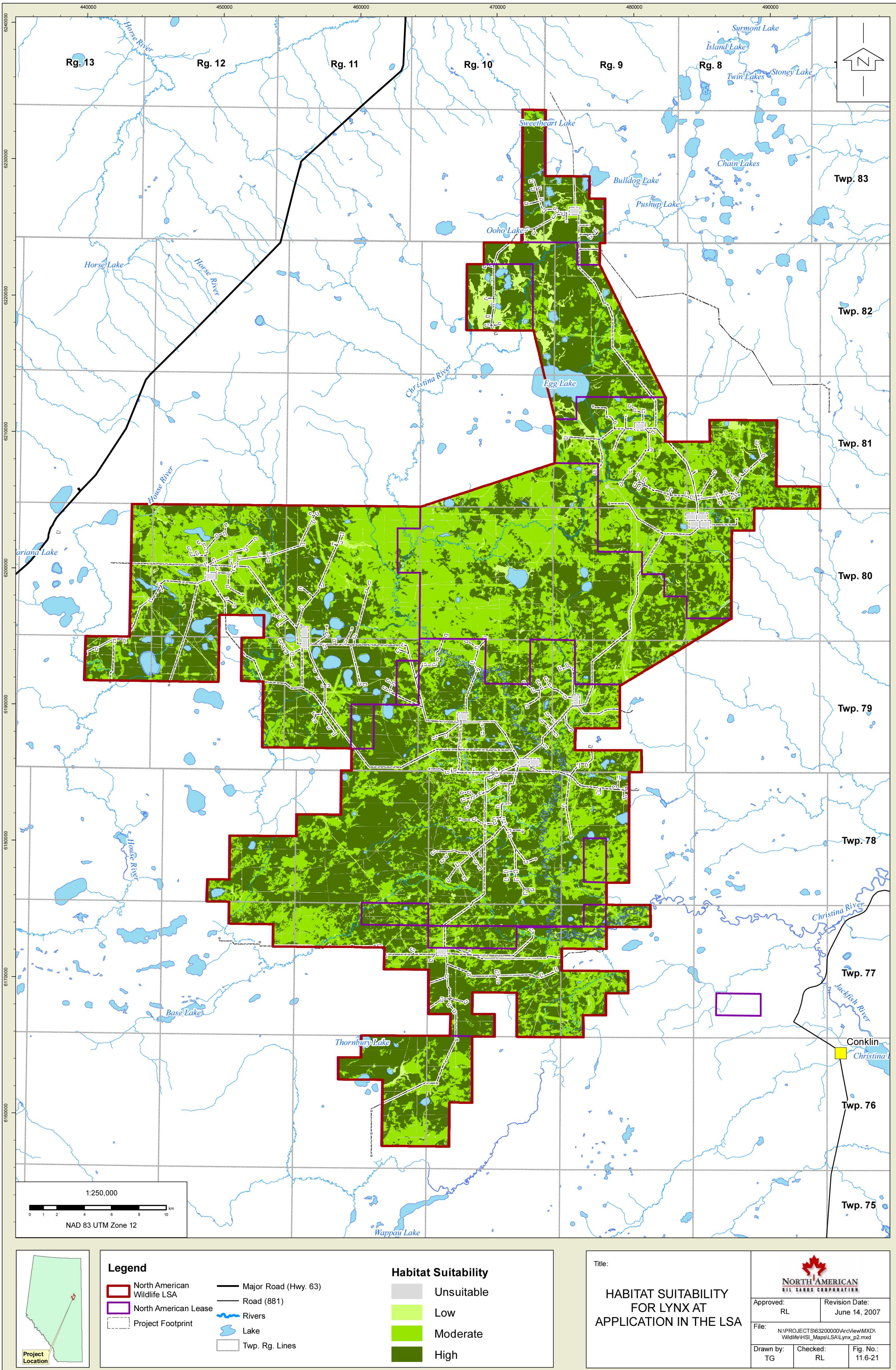
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Horse Lake
Surmont Lake
Island Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Chain Lakes
Bulldog Lake
Pushup Lake
Ooho Lake
Egg Lake
Christina River
Jackfish River
Base Lake
Thornbury Lake
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NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Project Footprint
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR LYNX AT APPLICATION IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\Lynx_p2.mxd
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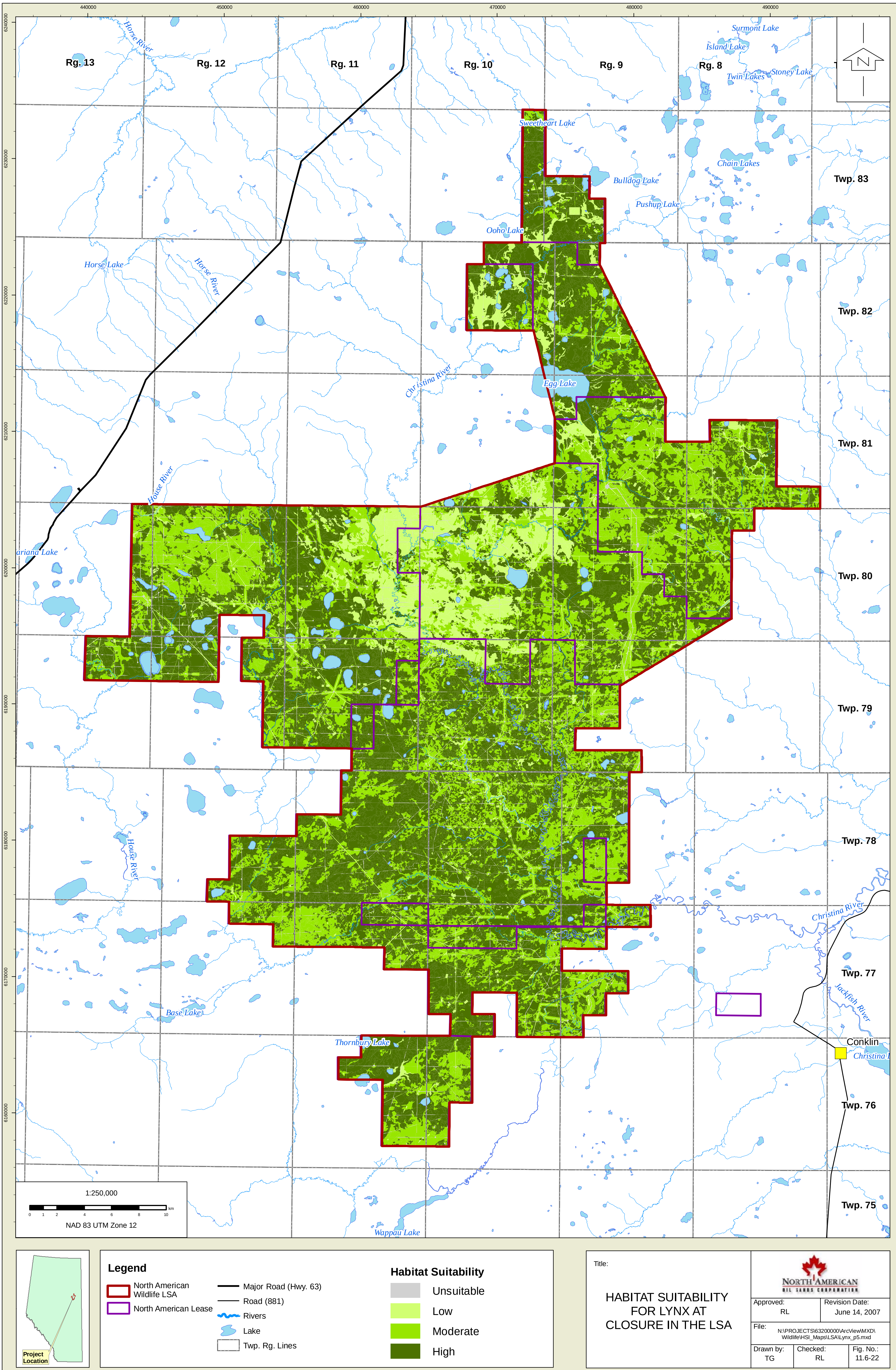
Checked: RL
Fig. No.: 11.6-21



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Sweetheart Lake
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Bulldog Lake
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Egg Lake
Christina River
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Thornbury Lake
Jackfish River
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NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR LYNX AT CLOSURE IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved:
RL
Revision Date:
June 14, 2007
File:
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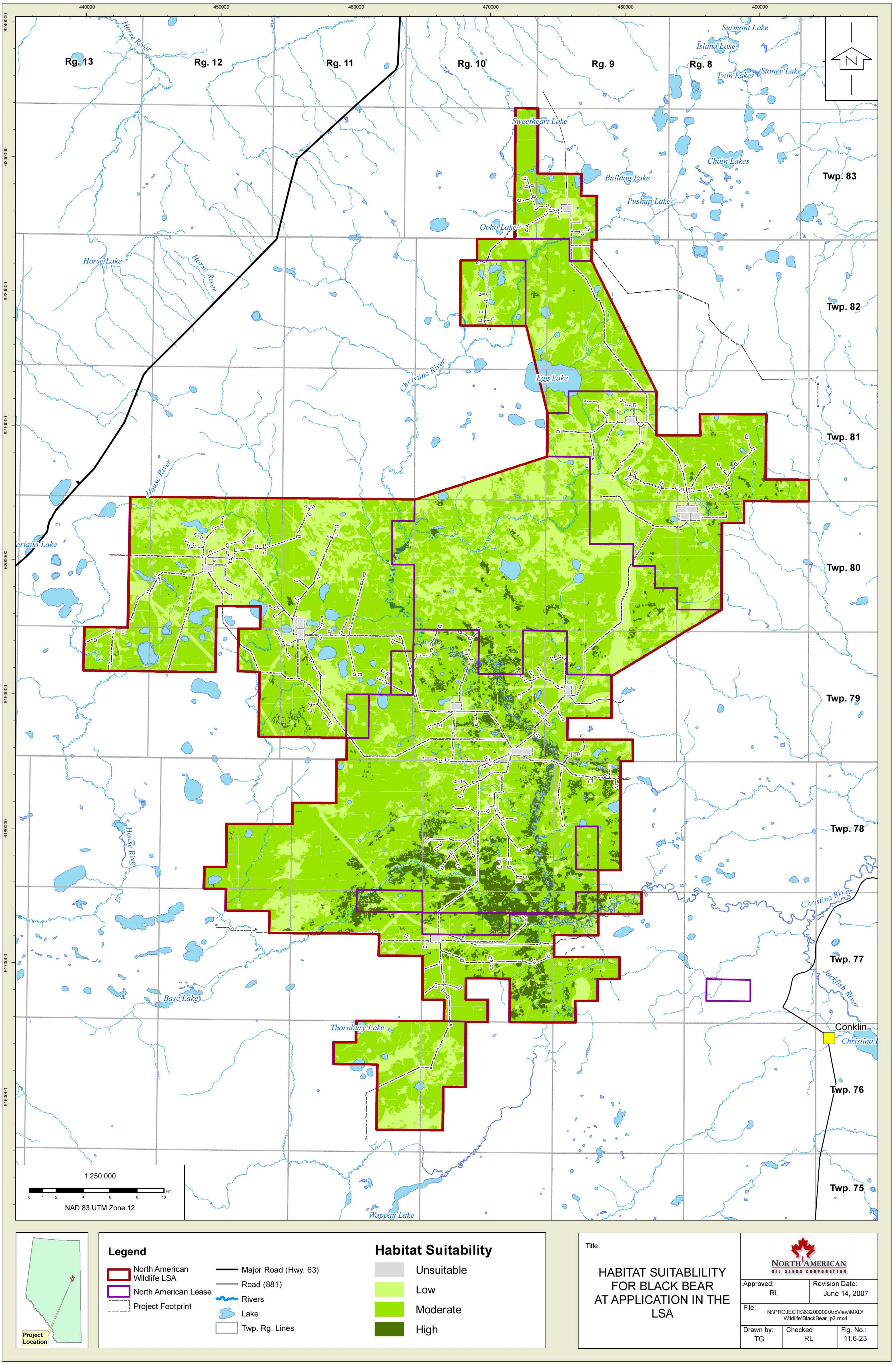
Fig. No.:
11.6-22



Title:

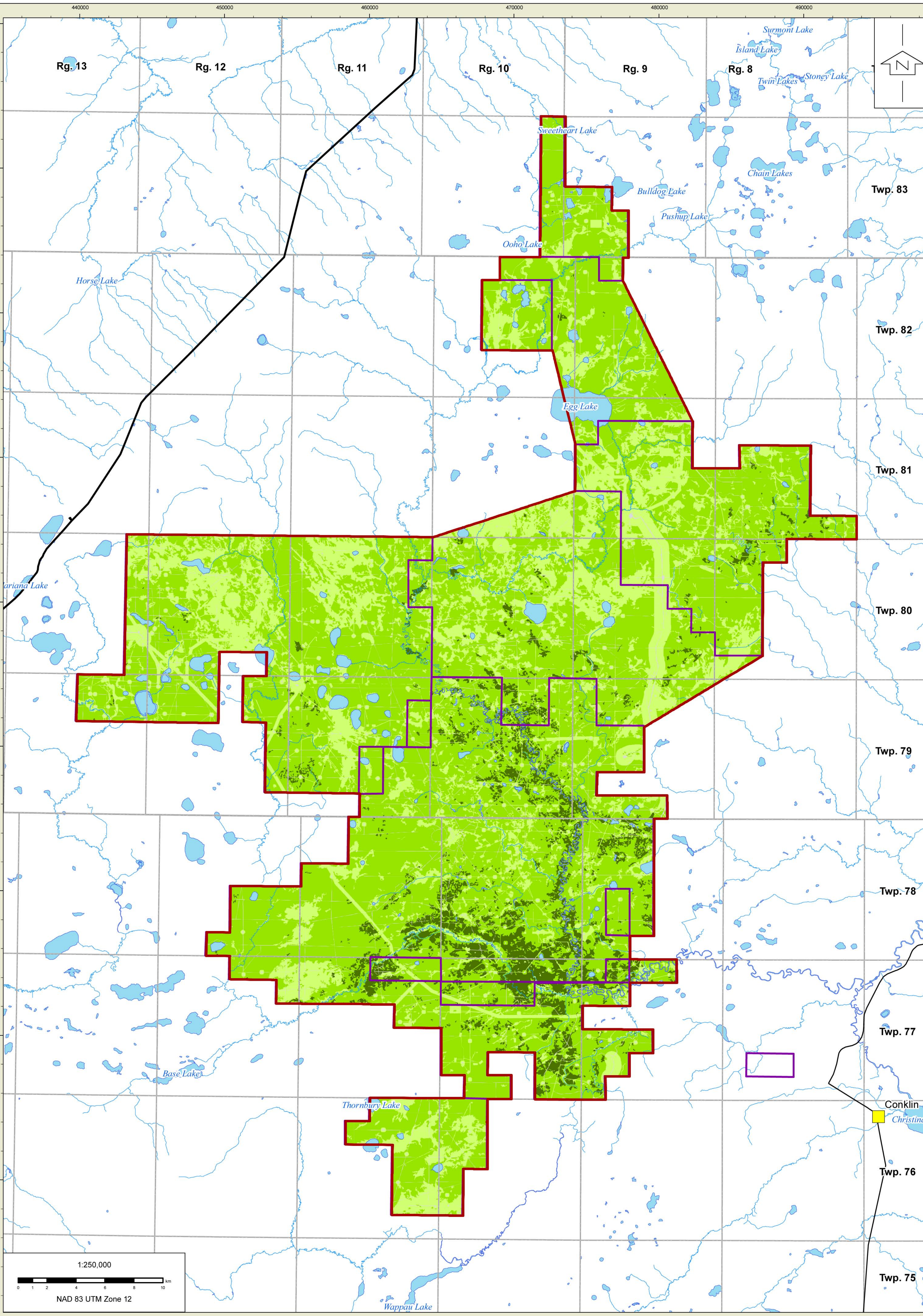
HABITAT SUITABLILITY FOR BLACK BEAR AT APPLICATION IN THE LSA

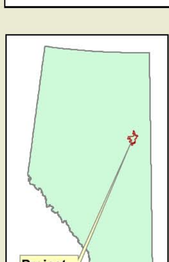
NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\BlackBear_p2.mxd

Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-23





Legend

- North American Wildlife LSA
- North American Lease
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABLILITY FOR BLACK BEAR AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:	
RL	June 14, 2007	
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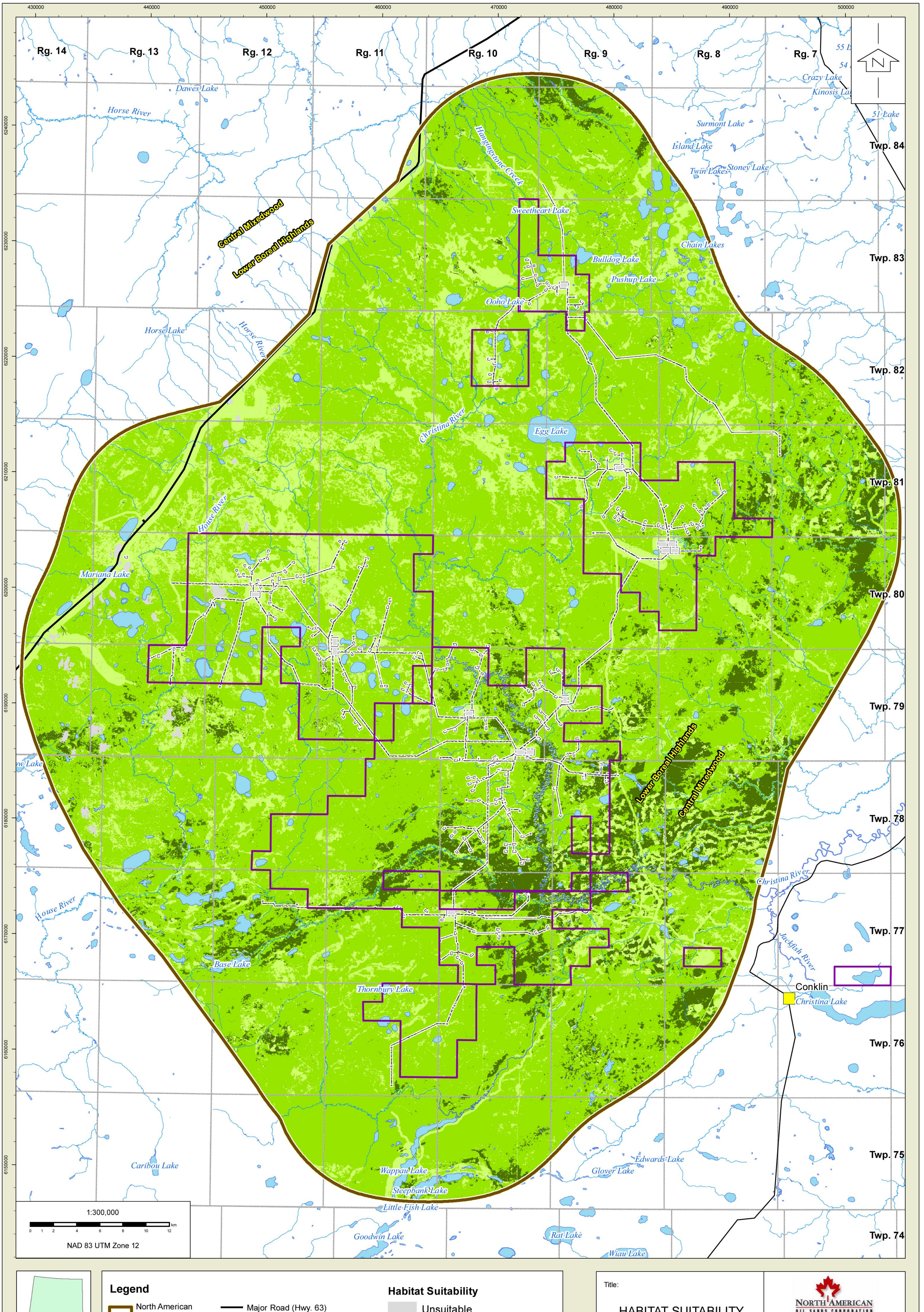


Legend

- North American Wildlife RSA
- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

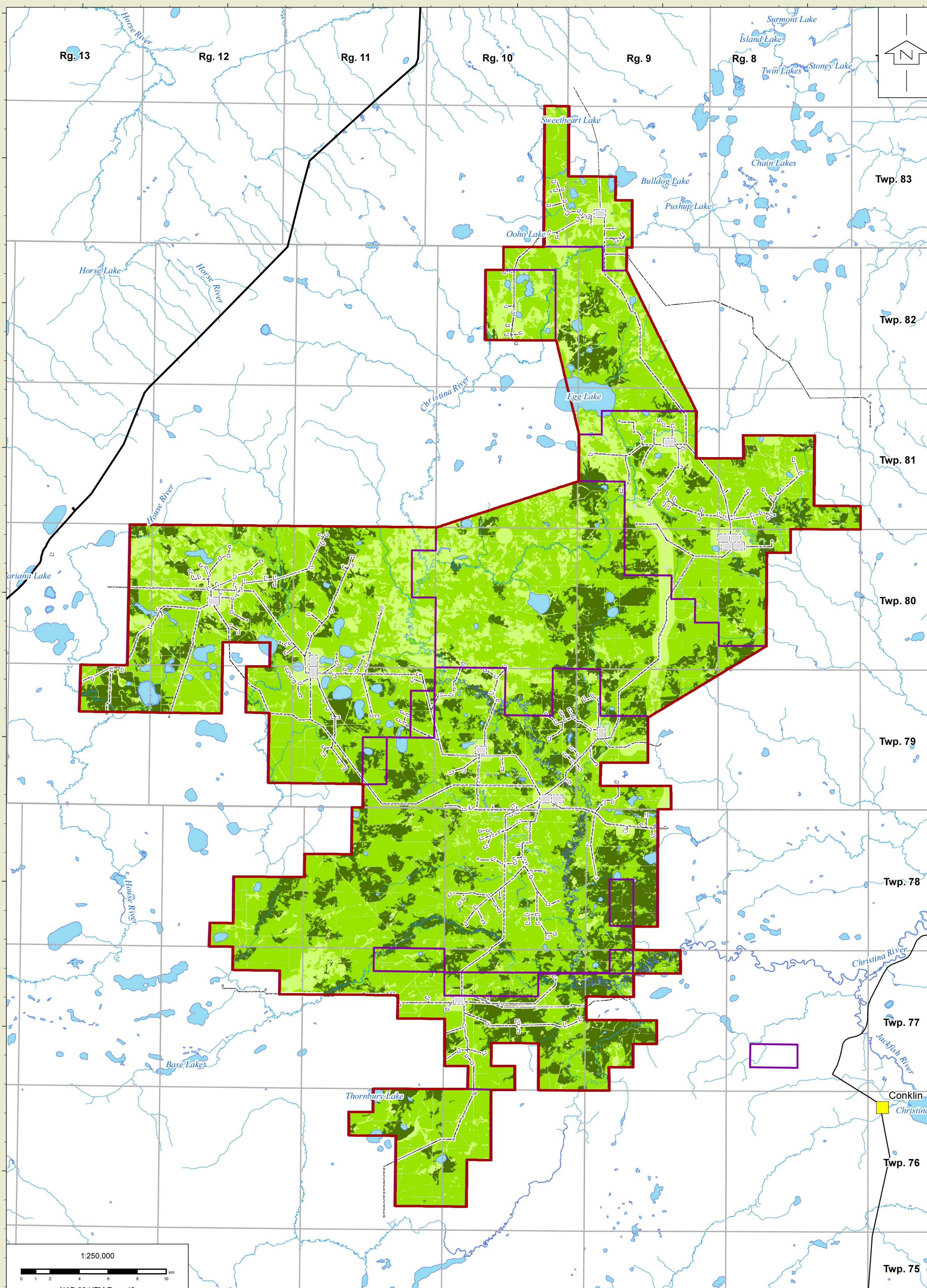
Title:

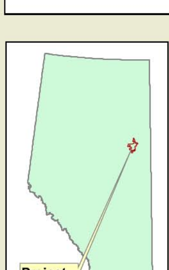
HABITAT SUITABILITY FOR BLACK BEAR AT APPLICATION IN THE RSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved: RL	Revision Date: June 14, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\RSA\BlackBear_p2.mxd	

Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-25





Legend

- North American Wildlife LSA
- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

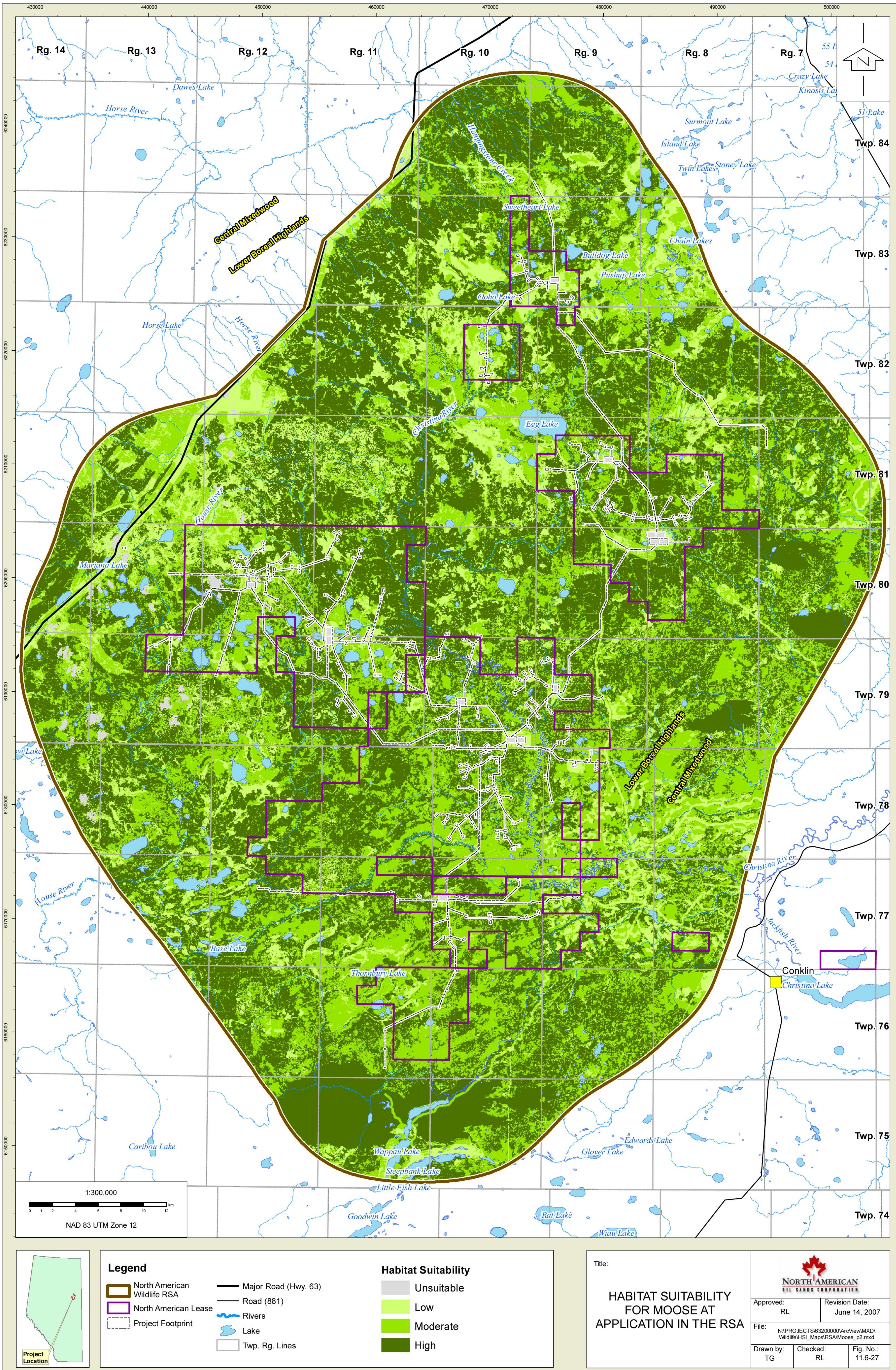
HABITAT SUITABILITY FOR MOOSE AT APPLICATION IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\Moose_p2.mxd

Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-26



Title:

HABITAT SUITABILITY FOR MOOSE AT APPLICATION IN THE RSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\RSA\Moose_p2.mxd

Drawn by:	Checked:	Fig. No.:
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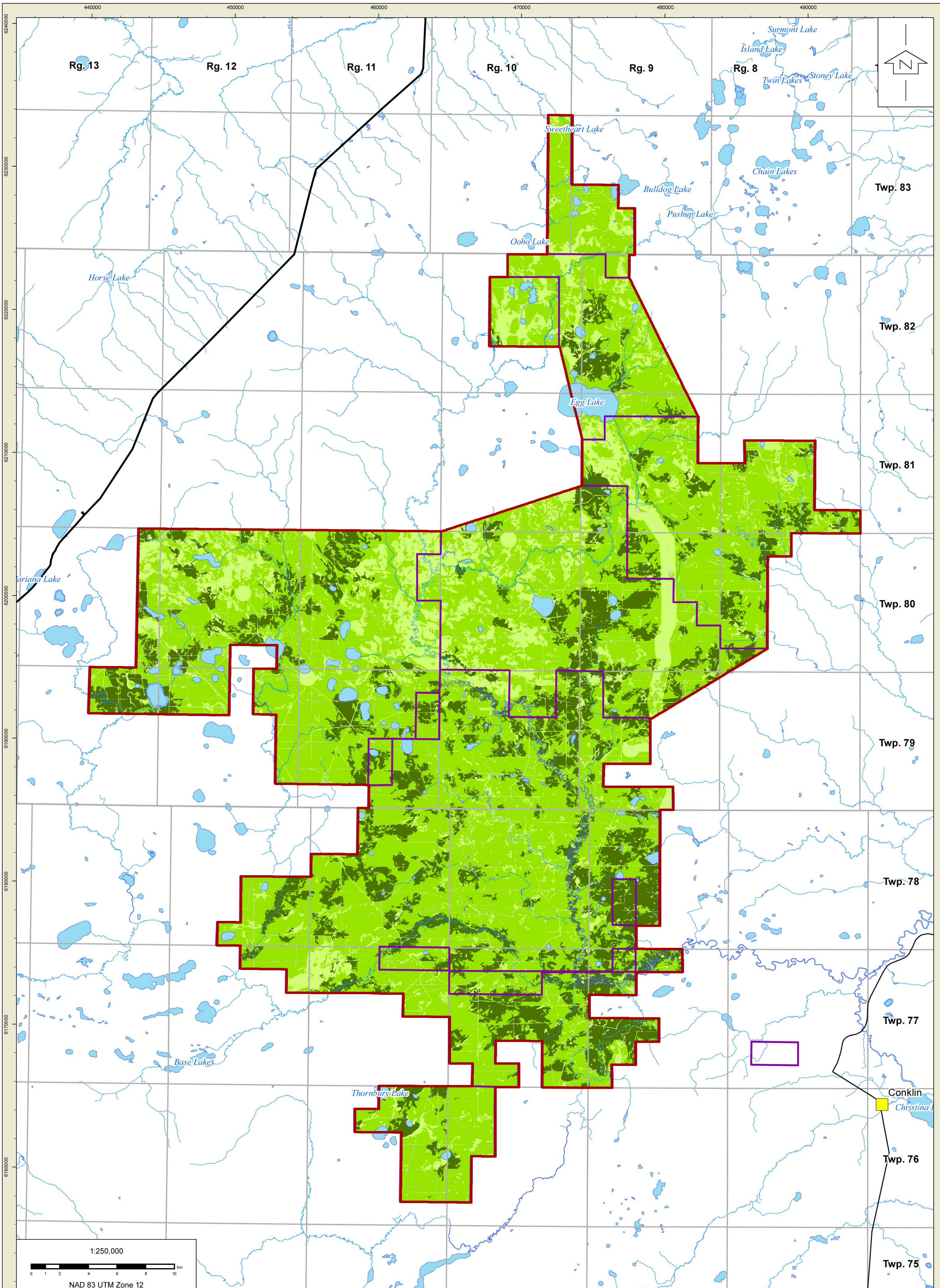

Project Location

Legend

- North American Wildlife LSA
- North American Lease
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR MOOSE AT CLOSURE IN THE LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\LSA\Moose_p5.mxd

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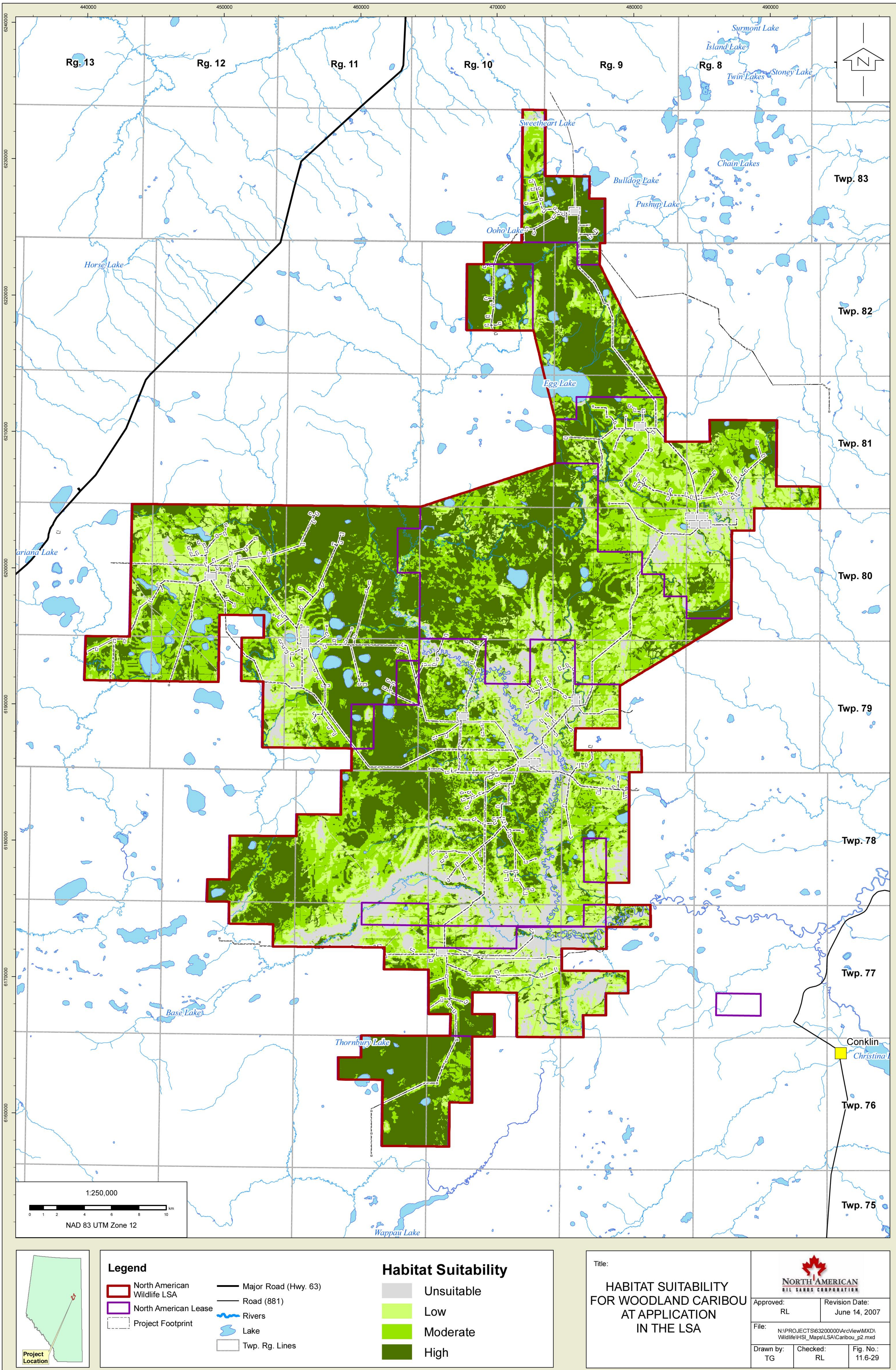

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Mariana Lake
Base Lake
Thornbury Lake
Wappau Lake
Conklin
Christina L
N
1:250,000
0 1 2 4 6 8 10
km
NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Project Footprint
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR WOODLAND CARIBOU AT APPLICATION IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
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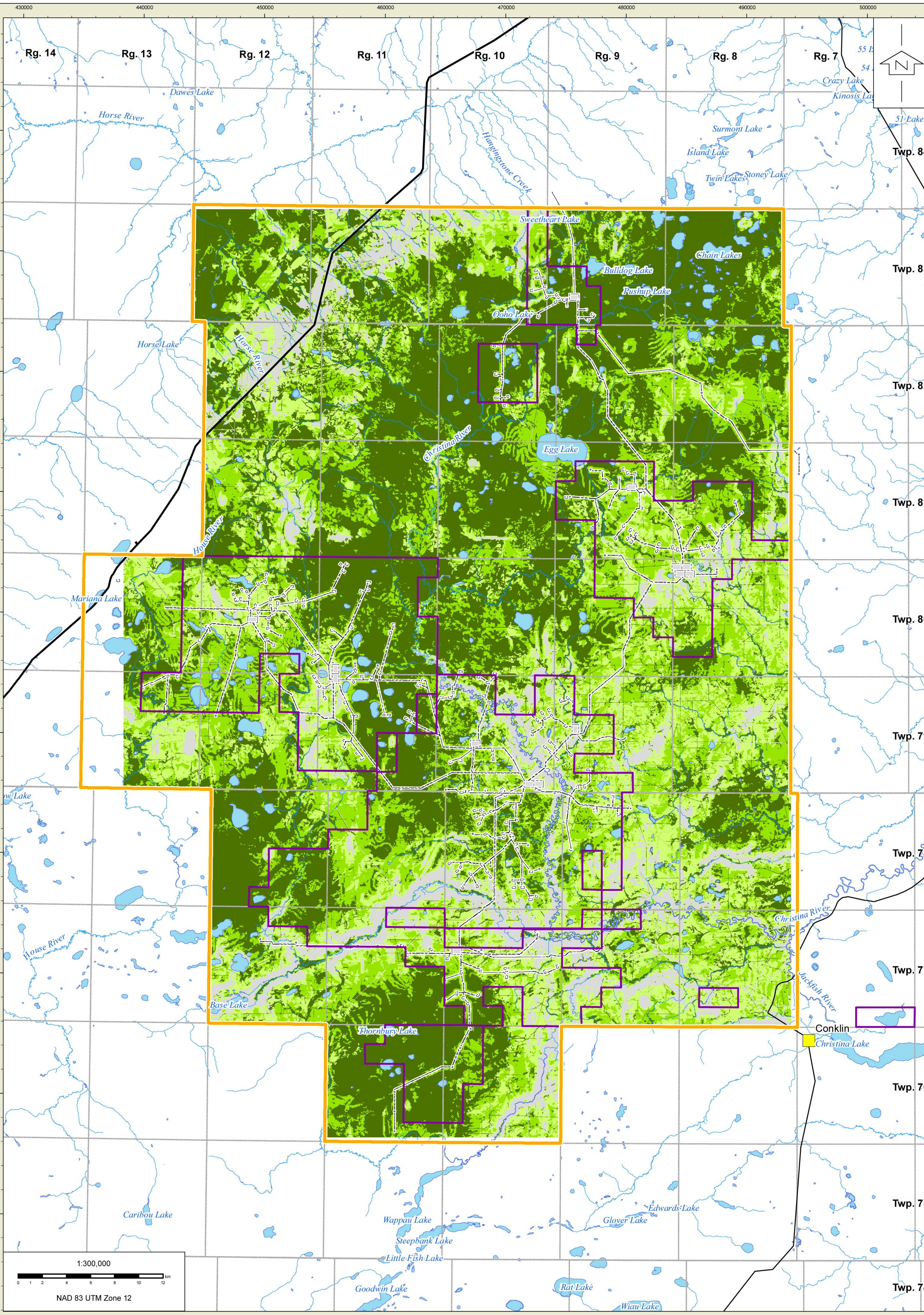
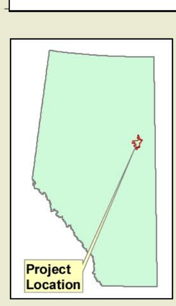
Checked: RL
Fig. No.: 11.6-29





Legend

- North American Caribou RSA
- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Title:

HABITAT SUITABILITY FOR WOODLAND CARIBOU AT APPLICATION IN THE CARIBOU REGIONAL STUDY AREA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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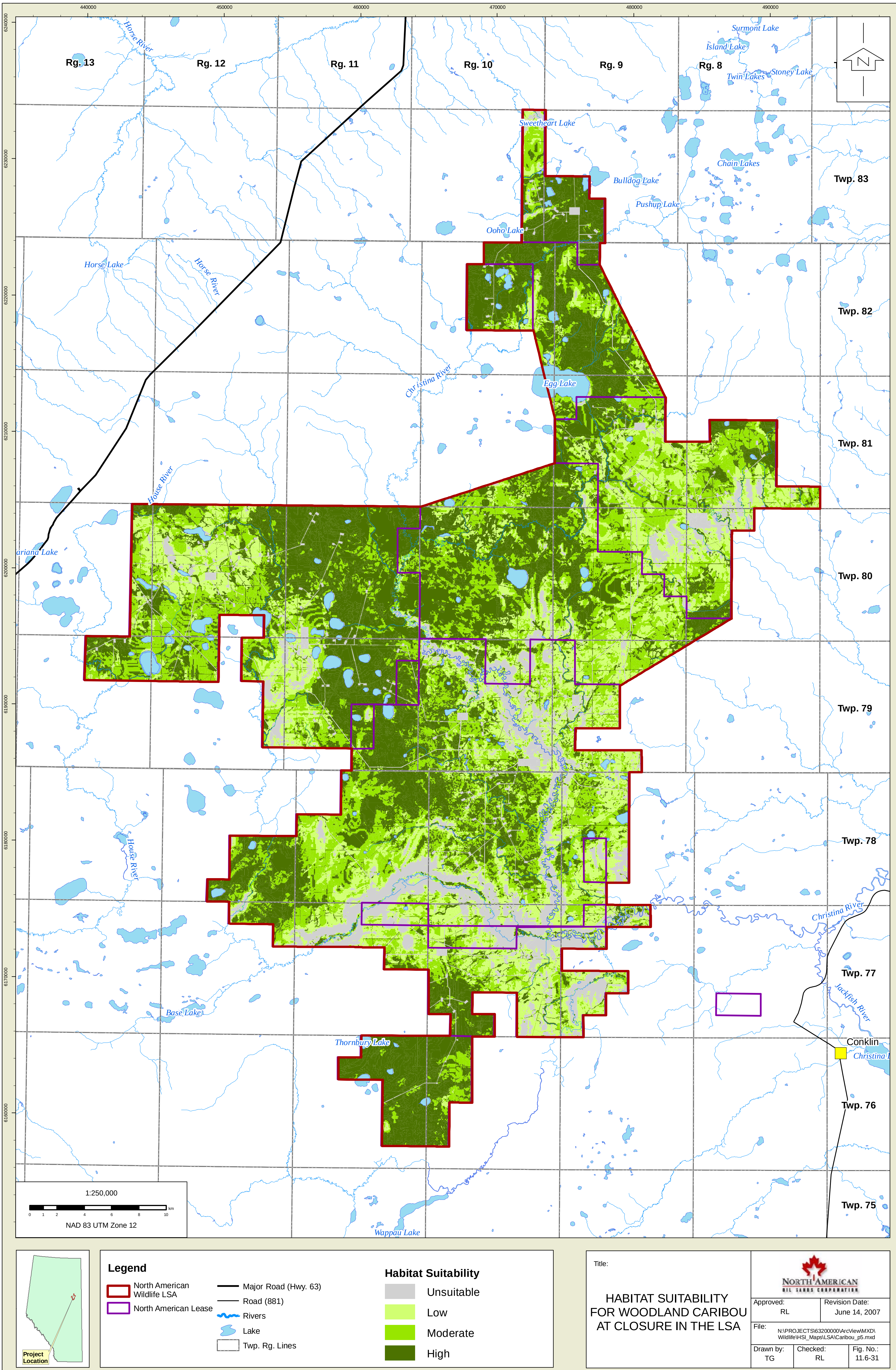
Rg. 13
Rg. 12
Rg. 11
Rg. 10
Rg. 9
Rg. 8
Twp. 83
Twp. 82
Twp. 81
Twp. 80
Twp. 79
Twp. 78
Twp. 77
Twp. 76
Twp. 75
Surmont Lake
Island Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Chain Lakes
Bulldog Lake
Pushup Lake
Ooho Lake
Horse Lake
Horse River
Egg Lake
Christina River
House River
Mariana Lake
Base Lake
Thornbury Lake
Wappau Lake
Jackfish River
Conklin
1:250,000
NAD 83 UTM Zone 12
Project Location
Legend
North American Wildlife LSA
North American Lease
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR WOODLAND CARIBOU AT CLOSURE IN THE LSA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
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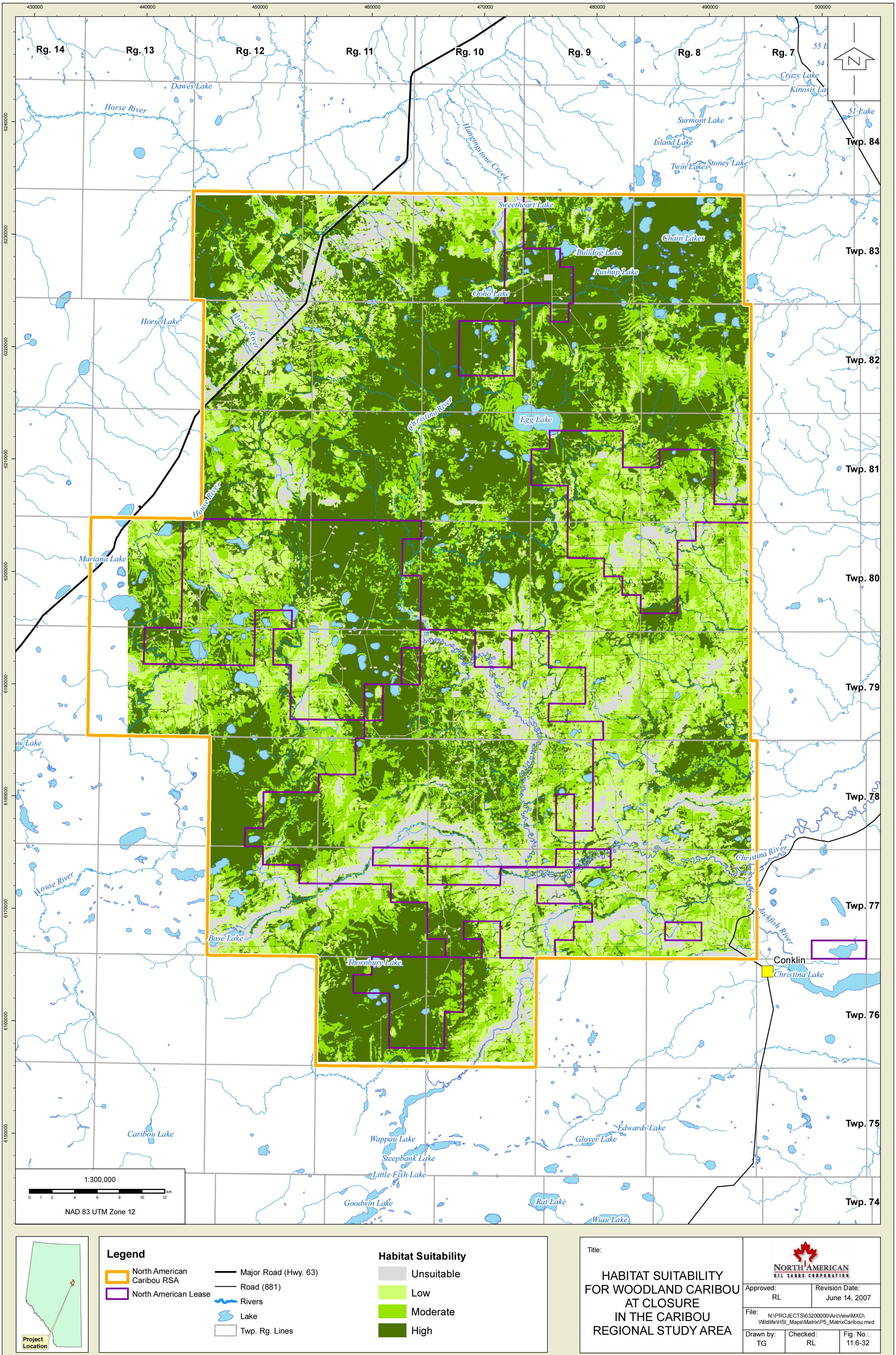
Fig. No.: 11.6-31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Twp. 81
Twp. 80
Twp. 79
Twp. 78
Twp. 77
Twp. 76
Twp. 75
Twp. 74
430000
440000
450000
460000
470000
480000
490000
500000
6240000
6230000
6220000
6210000
6200000
6190000
6180000
6170000
6160000
6150000
Dawes Lake
Horse River
Hangingstone Creek
Crazy Lake
Kinosis Lake
51 Lake
Surmont Lake
Island Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Chain Lakes
Bulldog Lake
Pushup Lake
Ooho Lake
Horse Lake
Christina River
Egg Lake
House River
Mariana Lake
House River
Base Lake
Thornbury Lake
Jackfish River
Conklin
Christina Lake
Caribou Lake
Wappau Lake
Steepbank Lake
Little Fish Lake
Goodwin Lake
Rat Lake
Wiau Lake
Glover Lake
Edwards Lake
1:300,000
0 1 2 4 6 8 10 12 km
NAD 83 UTM Zone 12
Project Location
Legend
North American Caribou RSA
North American Lease
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Title:
HABITAT SUITABILITY FOR WOODLAND CARIBOU AT CLOSURE IN THE CARIBOU REGIONAL STUDY AREA
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
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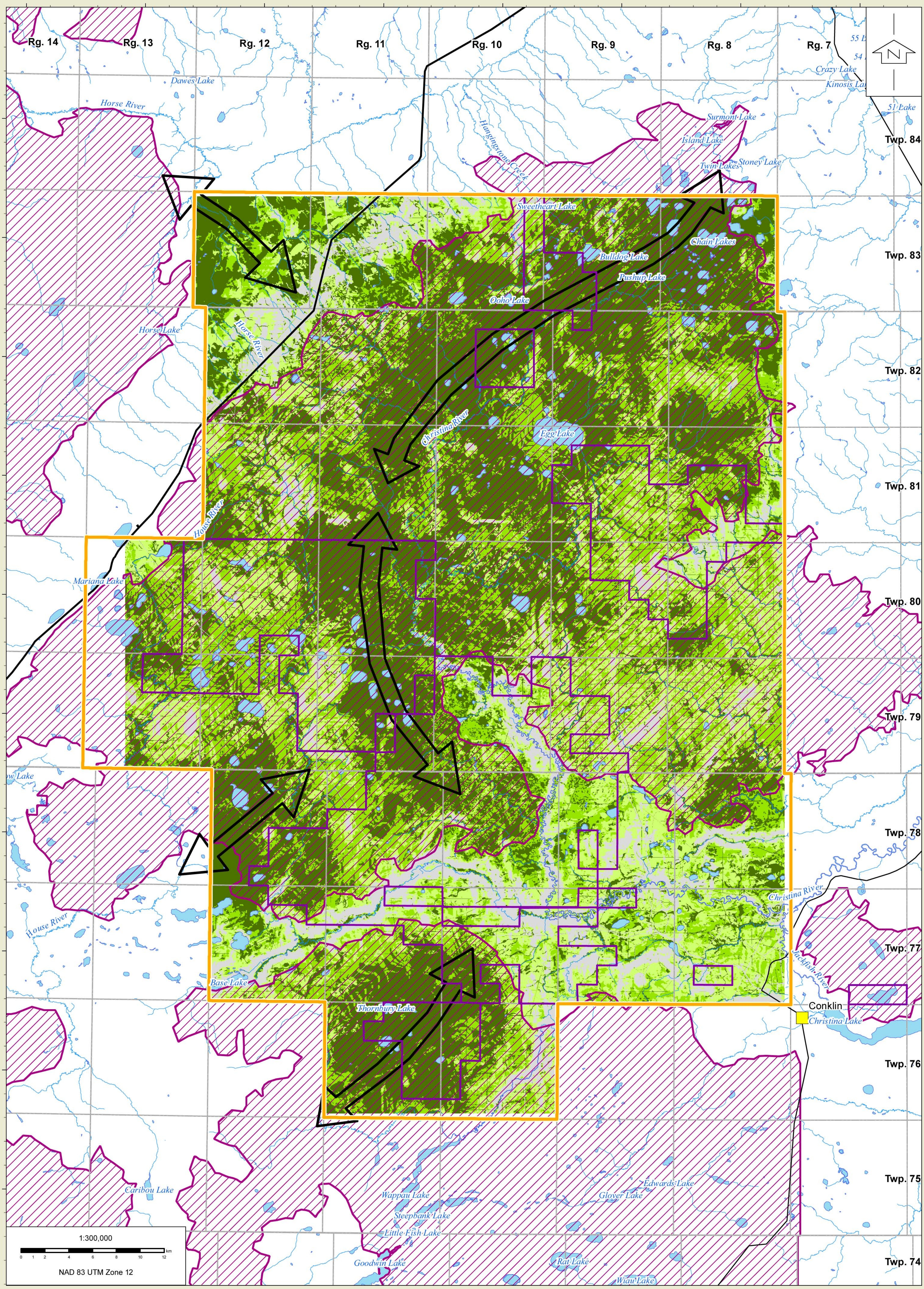
Fig. No.: 11.6-32



Project Location

Legend

- North American Caribou RSA
- North American Lease
- Caribou Range
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Hypothetical Connectivity

Title:

HYPOTHETICAL HABITAT CONNECTIVITY FOR WOODLAND CARIBOU AT BASELINE IN THE CARIBOU REGIONAL STUDY AREA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\Connectivity\Caribou_Hypothetical_Connectivity.mxd

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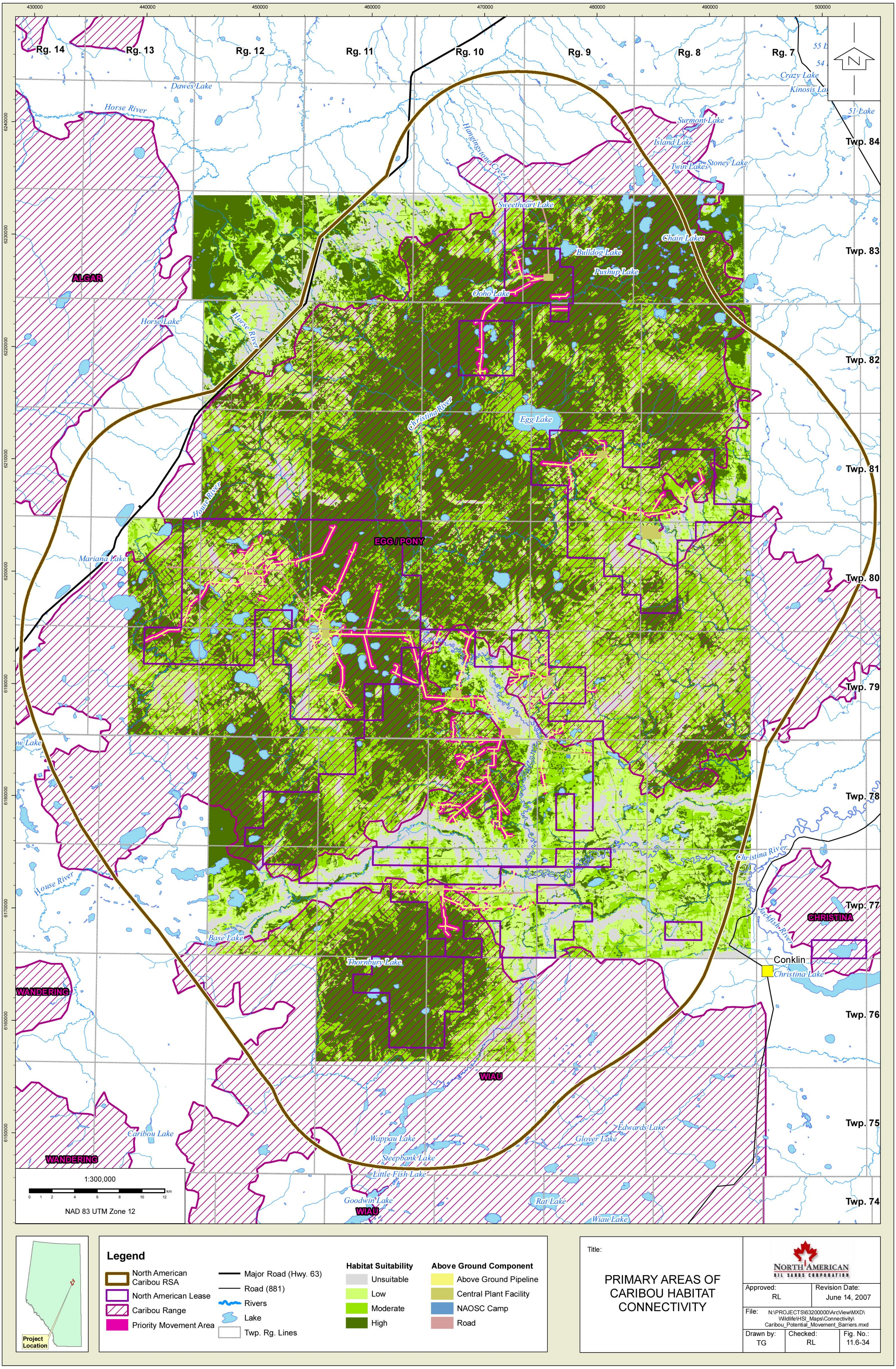
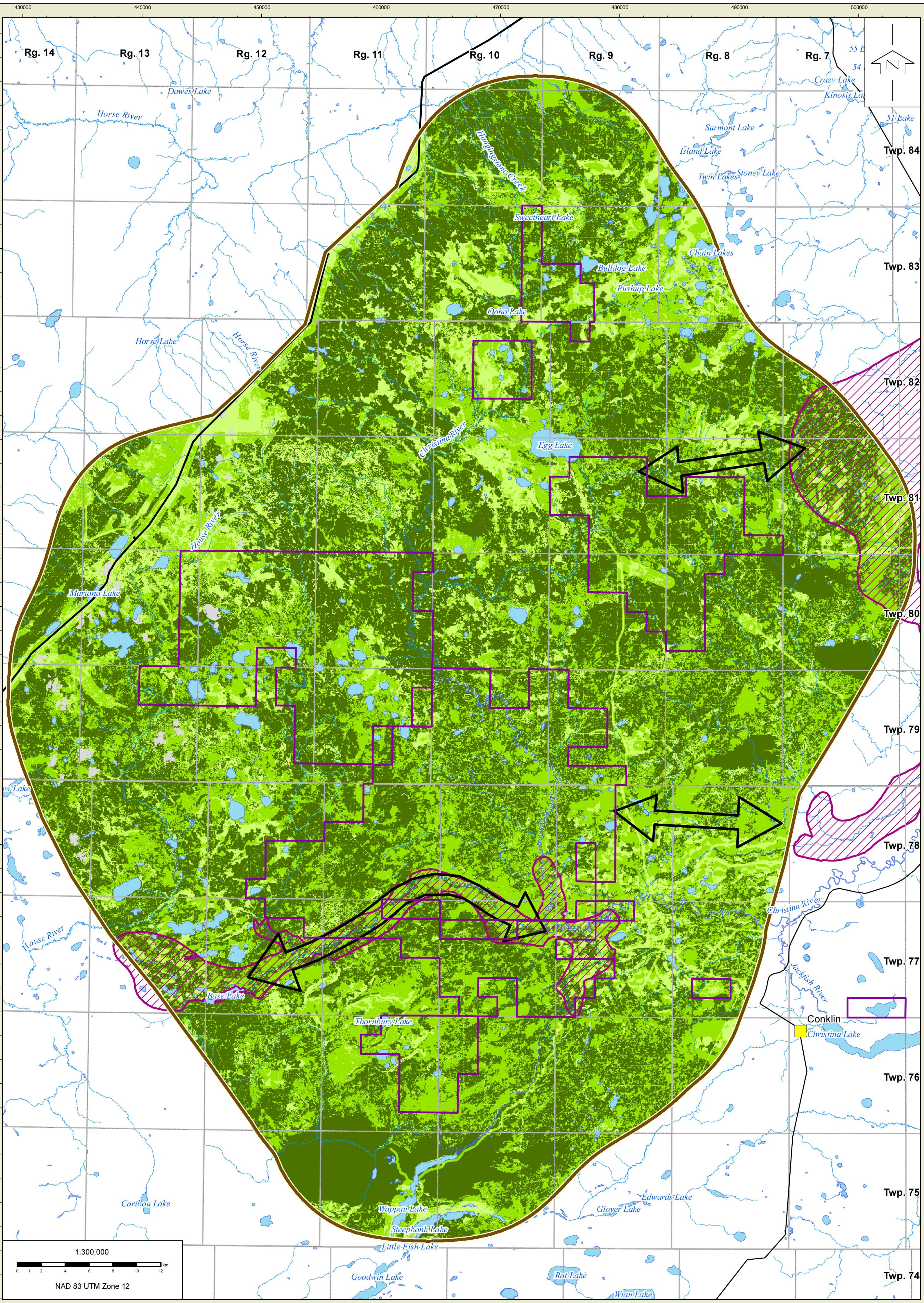


Rg. 14
Rg. 13
Rg. 12
Rg. 11
Rg. 10
Rg. 9
Rg. 8
Rg. 7
Twp. 84
Twp. 83
Twp. 82
Twp. 81
Twp. 80
Twp. 79
Twp. 78
Twp. 77
Twp. 76
Twp. 75
Twp. 74
430000
440000
450000
460000
470000
480000
490000
500000
ALGAR
EGG / PONY
CHRISTINA
WANDERING
WIAU
Dawes Lake
Horse River
Hangingstone Creek
Crazy Lake
Kinosis Lake
51 Lake
Surmont Lake
Island Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Chain Lakes
Bulldog Lake
Pushup Lake
Ooho Lake
Horse Lake
Egg Lake
Christina River
Mariana Lake
House River
Base Lake
Thornbury Lake
Conklin
Christina Lake
Jackfish River
Caribou Lake
Wappau Lake
Steepbank Lake
Little Fish Lake
Edwards Lake
Glover Lake
Goodwin Lake
Rat Lake
Wiau Lake
1:300,000
NAD 83 UTM Zone 12
Project Location
Legend
North American Caribou RSA
North American Lease
Caribou Range
Priority Movement Area
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Habitat Suitability
Unsuitable
Low
Moderate
High
Above Ground Component
Above Ground Pipeline
Central Plant Facility
NAOSC Camp
Road
Title:
PRIMARY AREAS OF CARIBOU HABITAT CONNECTIVITY
NORTH AMERICAN OIL SANDS CORPORATION
Approved: RL
Revision Date: June 14, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\Connectivity\Caribou_Potential_Movement_Barriers.mxd
Drawn by: TG
Checked: RL
Fig. No.: 11.6-34



Project Location

Legend

- North American Wildlife RSA
- North American Lease
- Key Moose Zone
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Hypothetical Connectivity

Title:

HYPOTHETICAL HABITAT CONNECTIVITY FOR MOOSE AT BASELINE IN THE REGIONAL STUDY AREA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

File: N:\PROJECTS\63200000\ArcView\MXD\Wildlife\HSI_Maps\Connectivity\Moose_Hypothetical_Connectivity.mxd

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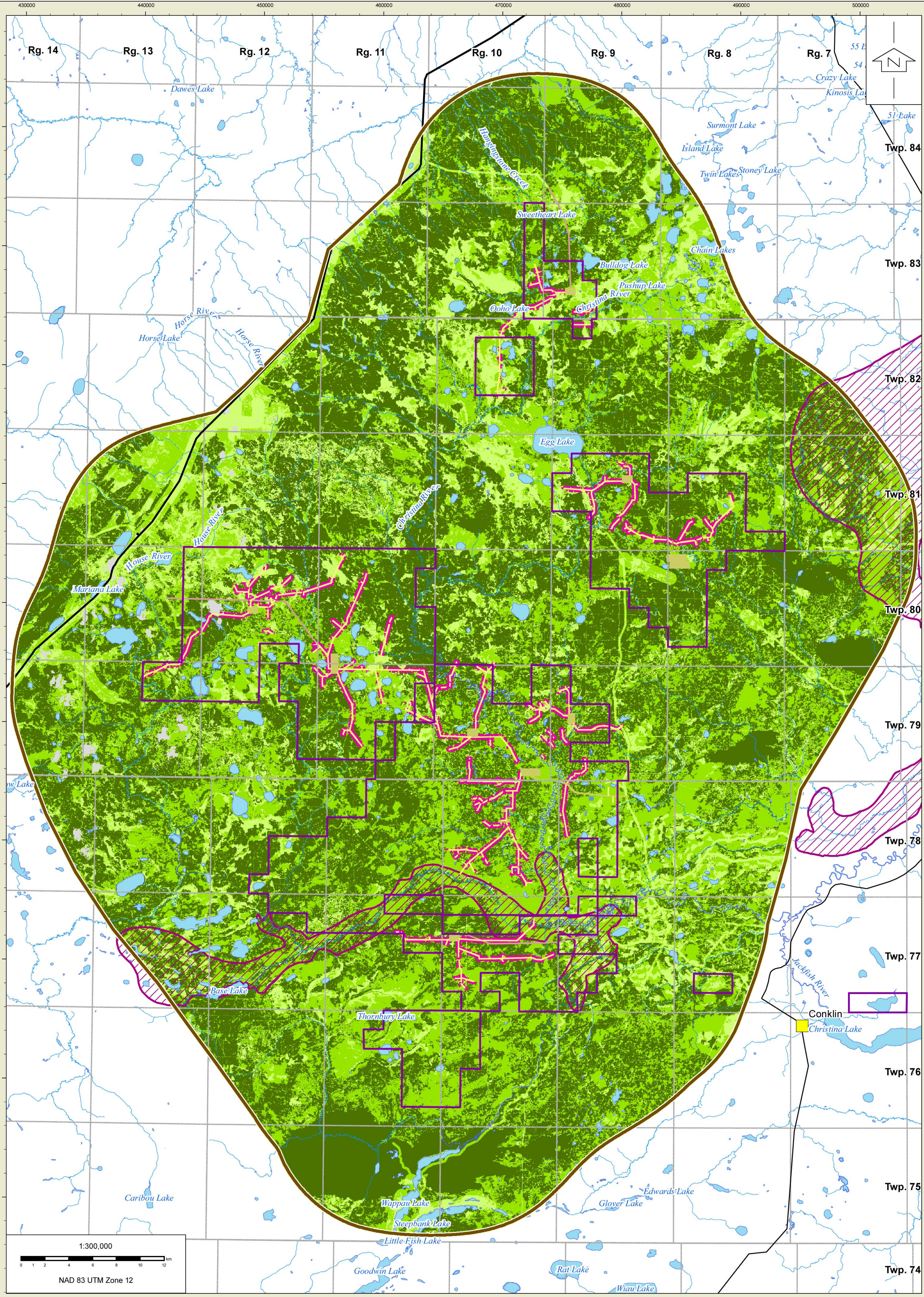
TG	RL	11.6-35



Legend

- North American Wildlife RSA
- North American Lease
- Key Moose Zone
- Priority Movement Area
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Habitat Suitability

- Unsuitable
- Low
- Moderate
- High

Above Ground Component

- Above Ground Pipeline
- Central Plant Facility
- NAOSC Camp
- Road

Title:

PRIMARY AREAS OF MOOSE HABITAT CONNECTIVITY

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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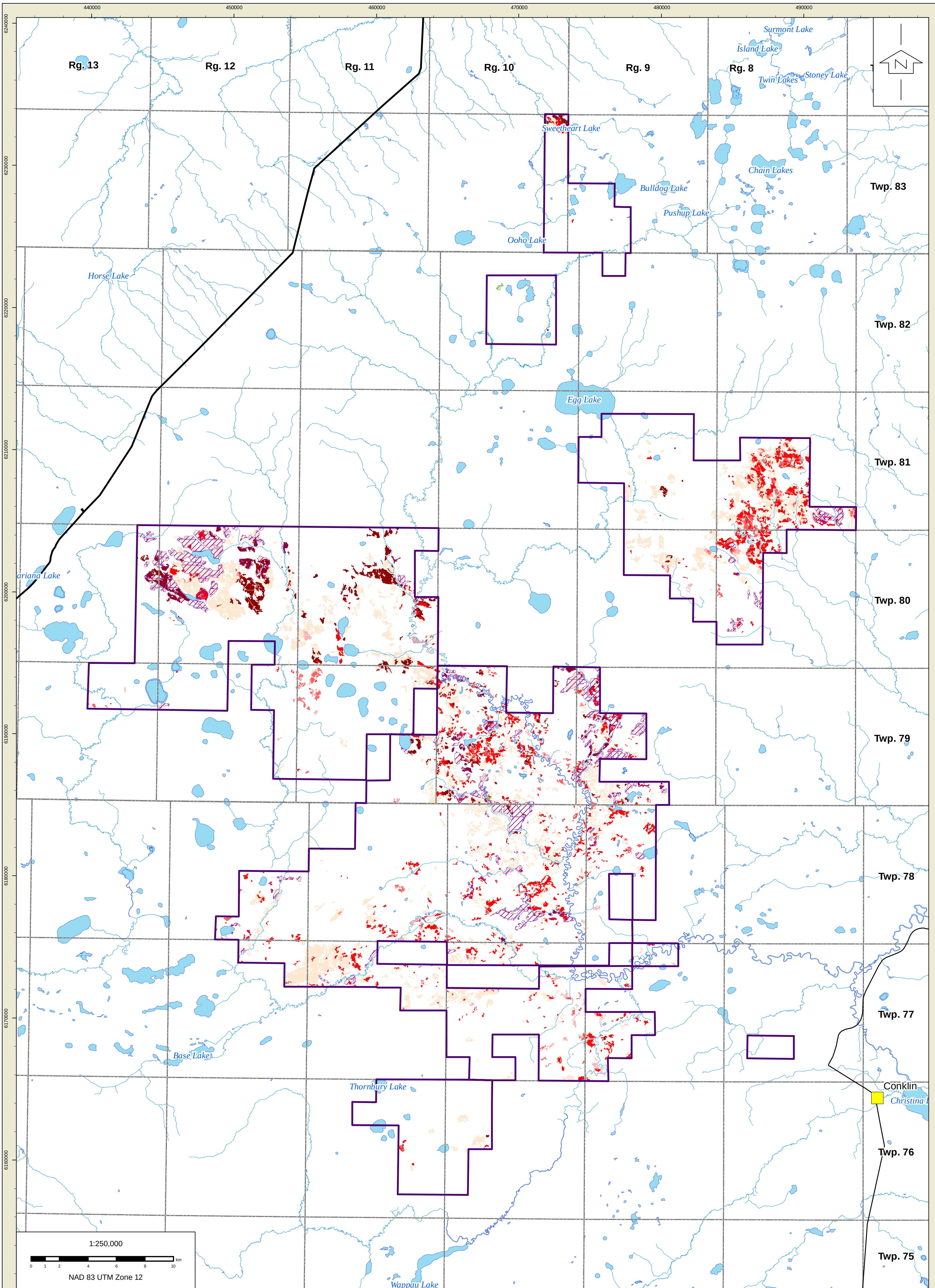

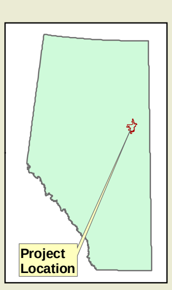

Legend

- North American Lease
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Toad Hibernating Habitat

Ecophase
- a1 - lichen Pj
- b1 - blueberry Pj-Aw
- b2 - blueberry Aw (Bw)
- b3 - blueberry Aw-Sw
- b4 - blueberry Sw-Pj
- c1 - Labrador tea-mesic Pj-Sb

Sandy Soils
- Firebag
- Mildred

Title:

SUITABLE HIBERNATING HABITAT FOR CANADIAN TOAD AT BASELINE WITHIN THE NAOSC LEASES

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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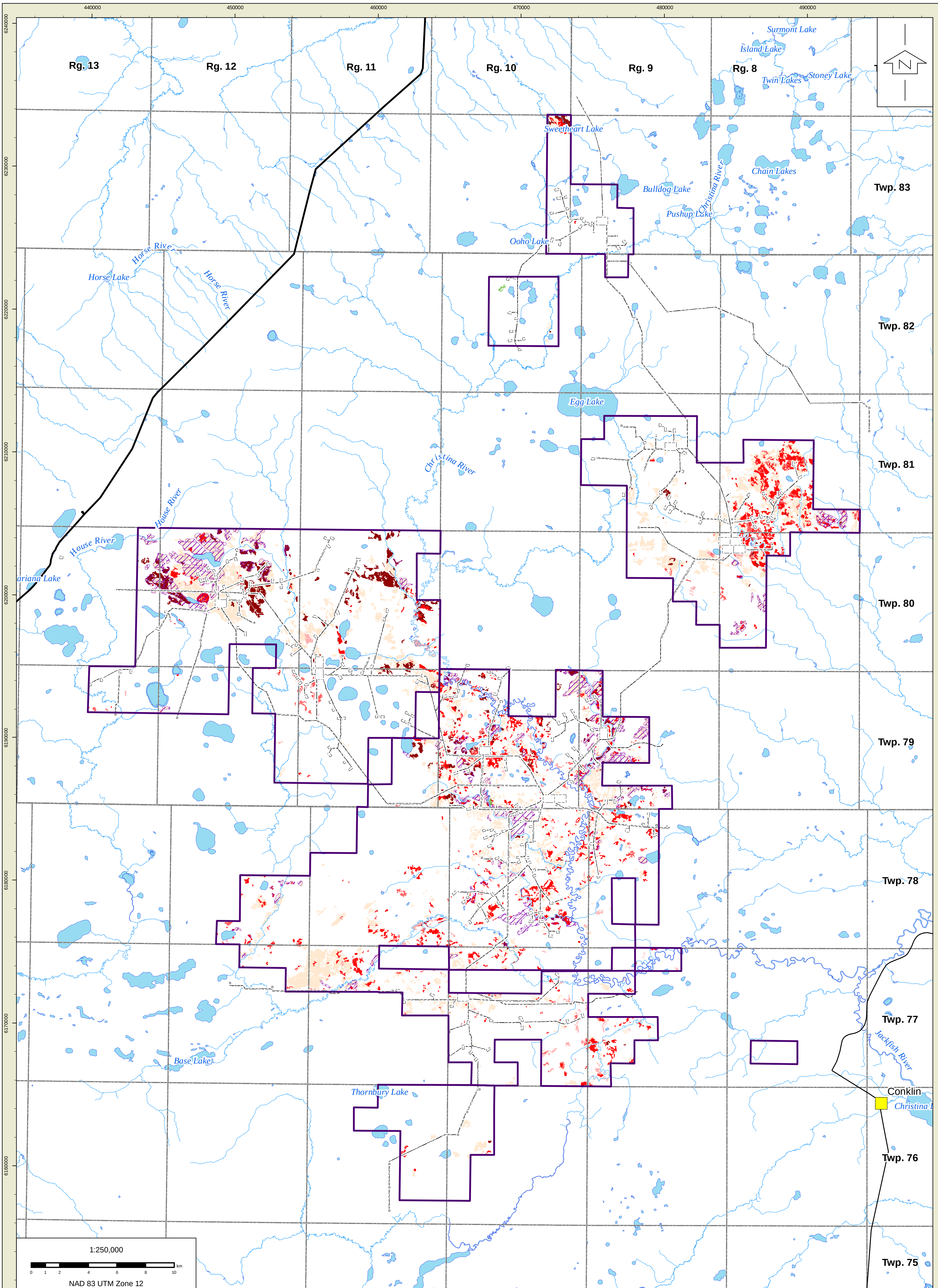
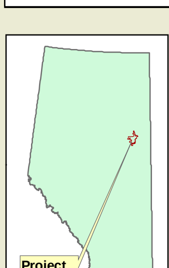
TG	RL	11.6-37





Legend

- North American Lease
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Toad Hibernating Habitat

Ecophase

- a1 - lichen Pj
- b1 - blueberry Pj-Aw
- b2 - blueberry Aw (Bw)
- b3 - blueberry Aw-Sw
- b4 - blueberry Sw-Pj
- c1 - Labrador tea-mesic Pj-Sb

Sandy Soils

- Firebag
- Mildred

Title:

SUITABLE HIBERNATING HABITAT FOR CANADIAN TOAD AT APPLICATION WITHIN THE NAOSC LEASES

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
RL	June 14, 2007

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Drawn by:	Checked:	Fig. No.:
TG	RL	11.6-38

Figure 11.6-39 Highway 881 Average Annual Daily Traffic (AADT) from 2000–2006 Compared to Total Wildlife Mortalities (using data from Government of Alberta 2000–2004)

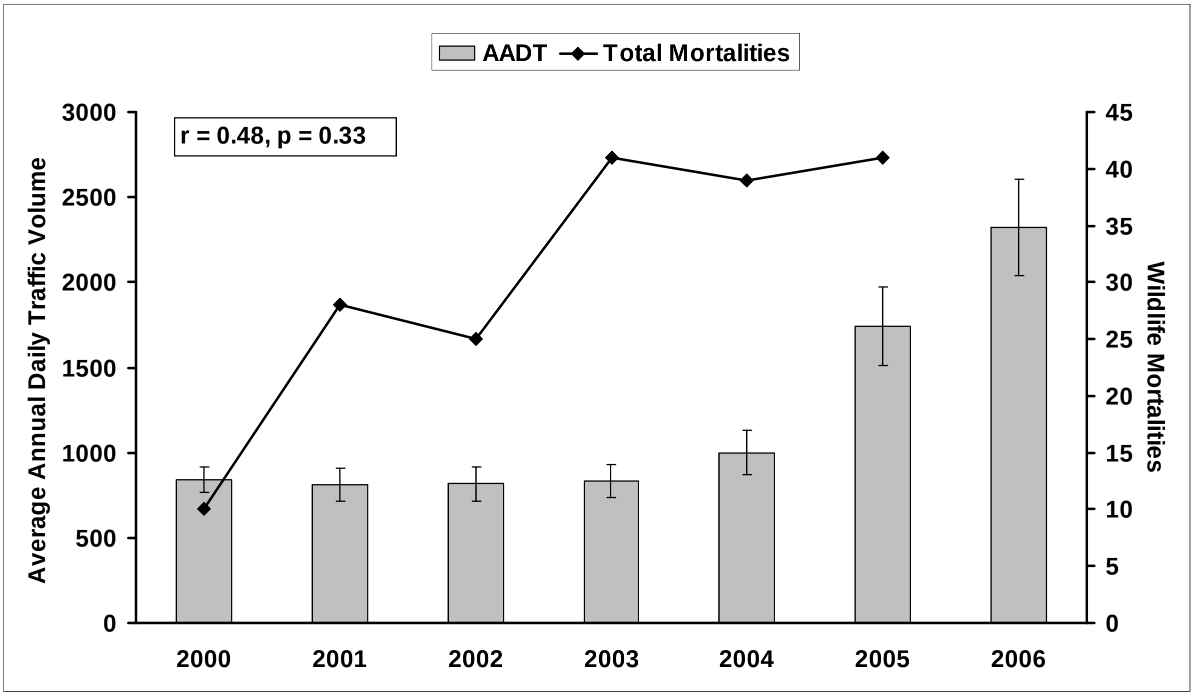
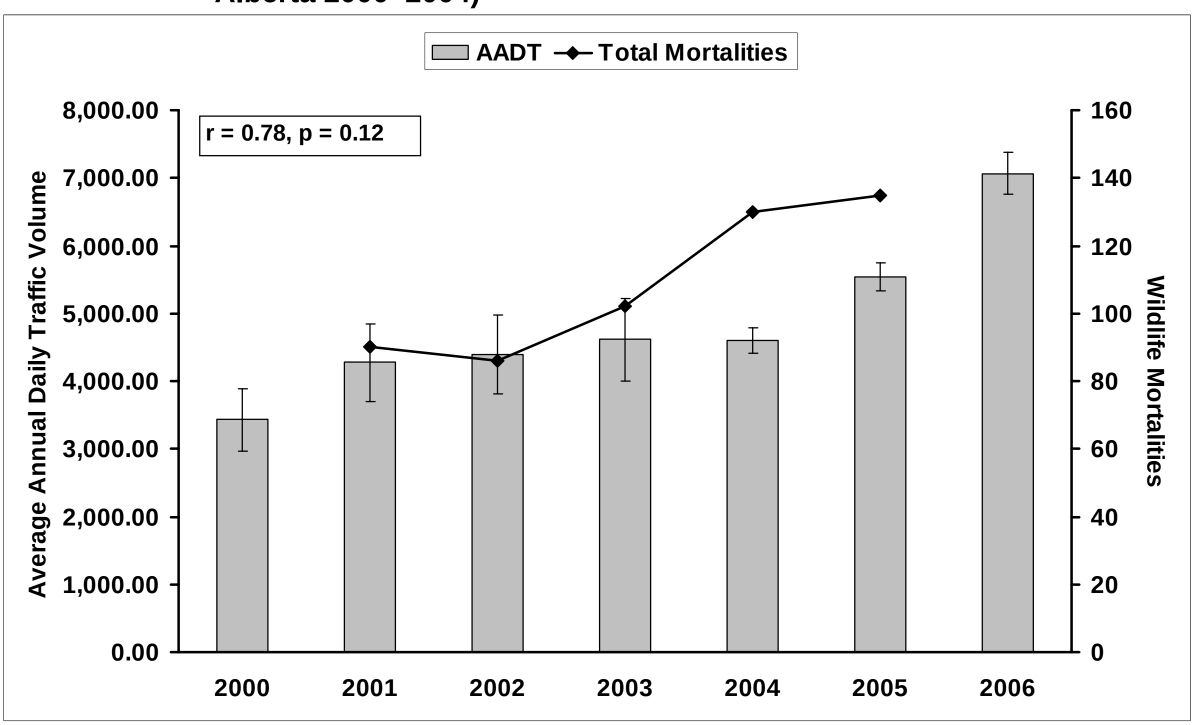


Figure 11.6-40 Highway 63 Average Annual Daily Traffic (AADT) from 2000–2006 Compared to Total Wildlife Mortalities (using data from Government of Alberta 2000–2004)



11.7 Cumulative Effects Assessment

A cumulative effects assessment (CEA) considers the impacts of the Project with other existing, approved, planned and potential projects in the region that overlap temporally and spatially. These projects are listed in Volume 2, Section 1 and include other planned or existing oil and gas facilities, forest harvesting, recreational activity and road construction (possible connector highway and bypass between Highway 63 and Highway 881).

At the time of this assessment, there were no publicly announced future oil sands developments identified in the RSA. Future industrial activities within the RSA are predicted to include exploration for oil and gas, seismic activity and forest harvesting however quantitative details (or footprints) of these future activities and associated developments are not available to North American. As such a qualitative CEA was conducted for wildlife.

For the purposes of the cumulative effects assessment, the following assumptions have been made:

- Wildlife mitigation, and reclamation methods will be similar to those identified by North American;
- Wildlife monitoring will be used to assess the effectiveness of mitigation measures;
- End land use targets for the planned and proposed projects will be similar to North American's; and
- Properly located and constructed wildlife crossing structures are a successful form of mitigation for wildlife movement.

Based on these assumptions, potential impacts and mitigation measures in the cumulative case are anticipated to be similar to those discussed in the application case. Therefore, the residual cumulative impact rating to wildlife, at closure, is predicted to be negligible to low as in the application case. The confidence of the CEA predictions is lowered by the uncertainty of future project timing and details.

11.8 Follow-up and Monitoring

Monitoring of wildlife is planned to assess the effectiveness of mitigation measures and to detect Project related impacts so they may be mitigated proactively. North American intends to work with ASRD and to participate in initiatives like the Alberta Biodiversity Monitoring Initiative, to enhance and develop regional wildlife monitoring strategies in the area. North American has initiated and funded a scat detection monitoring program in association with the University of Washington to assess changes in the abundance, distribution and physiological health of caribou, wolf, and moose in the region. North American plans to continue the scat detection monitoring program in collaboration with ASRD and other regional stakeholders in the area.

11.9 Summary

The application and closure phases of the Project will impact wildlife habitat availability and habitat connectivity in the area. The Project may also lead to direct and indirect mortality risks for wildlife (Table 11.9-1).

Wildlife field surveys were conducted in 2006 and 2007 to collect baseline information from within the assessment study areas. Surveys conducted in the LSA included a scat collection program (for caribou, moose and wolves), winter track count, bat survey, barred owl survey, a breeding bird survey, and a Canadian toad survey. Winter track count and breeding bird survey data from other projects in the region, including the Nexen Cottonwood and the Nexen/OPTI Long Lake South projects, were combined with the Project data to create a regional dataset.

Impacts on habitat availability were assessed for 14 wildlife indicators (or groups of indicators) within the LSA. These indicators included Canadian toad, northern goshawk, great gray owl, barred owl, boreal owl, mixed-wood forest bird community, old-growth forest bird community, beaver, muskrat, fisher, lynx, black bear, moose and caribou. The Project application scenario is predicted to reduce habitat availability in the LSA for these indicators. It is predicted that there will be declines in habitat availability ranging from 0.2% to 5.7% (low to moderate impacts) at application. At closure, habitat availability is predicted to be recovered or partially recovered for all indicators.

Impacts on habitat availability were assessed for three wildlife indicators in the RSA. These indicator species include black bear, moose and caribou. A resource selection model was derived from the locations of caribou scat collected in the RSA and was then used for this assessment. The predicted regional impacts are of either negligible or low magnitude for all three indicators during the application and closure phases of the Project.

Habitat connectivity was assessed by identifying key areas where aboveground pipelines intersect highly suitable habitats for caribou and moose. Impacts at application were considered low magnitude impacts given the proposed Project mitigation. This mitigation will include development of wildlife crossing structures (over and underpasses) for aboveground pipelines that will support habitat connectivity at both local and regional scales.

Direct mortality was assessed for Canadian toads by examining impacts to hibernating habitat (sandy soils). It is estimated that there will be a less than 1% decline in the Canadian toad population at application, a low magnitude impact. Direct mortality risk was also assessed for black bear, moose and caribou based on increasing traffic volumes which may result from the Project. The impacts of traffic related mortality risks are predicted as a low to moderate magnitude impact for these indicator species.

Potential impacts to black bear, moose, and caribou from indirect mortality risks associated with the Project development and activities were qualitatively assessed within the RSA. Three sources of indirect mortality risk were used to evaluate impacts, including risks resulting from: anthropogenic disturbances (stress), hunting harvest, and predation. Low magnitude impacts were assessed for black bear and moose given the proposed mitigation. A medium magnitude impact was assessed for caribou.

Future projects planned within the RSA, including exploration for oil and gas, seismic activity and forest harvesting, could contribute to cumulative impacts on wildlife in the region. However, footprint related details for such projects had not been developed or released at the time of this assessment, so it was not possible to conduct a cumulative effects analysis for wildlife.

Prediction confidence describes the certainty of the effect assessment and considers data quality, rigor of the assessment and measurement approach, and or the certainty of prescribed mitigation measures. There is a low level of confidence in the predicted assessment for indirect and direct mortality risks to caribou given a high level of uncertainty in the abundance of the regional caribou population and the proposed mitigation measures. As such, North American is monitoring moose, caribou and wolves in the area using scat detection surveys to evaluate animal presence, physiological stress (hormone analysis), and population levels (using DNA mark-recapture analysis). It is anticipated that this ongoing monitoring program will provide a tool for detecting impacts and hopefully allowing them to be mitigated proactively.

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Table 11.9-1 Final Impact Rating Summary for Project Effects

Indicator	Direction of Impact	Extent of Impact	Magnitude of Impact	Duration of Impact	Frequency of Occurrence of Impact	Permanence of Impact	Level of Confidence	Environmental Impact at Application	Environmental Impact at Closure
Habitat Availability & Reduced Habitat Effectiveness									
Canadian Toad	Negative	Sub-regional	Moderate	Long term	Continuous	Reversible	Moderate	Moderate	Negligible
Northern Goshawk	Negative	Sub-regional	Moderate	Long term	Continuous	Reversible	Moderate	Moderate	Low
Great Gray Owl	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Barred Owl	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Low
Boreal Owl	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Low
Mixedwood Forest Bird Community	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Old growth Forest Bird Community	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Low
Beaver	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Muskrat	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Low
Fisher	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Lynx	Negative	Sub-regional	Moderate	Long term	Continuous	Reversible	Moderate	Moderate	Negligible
Black Bear	Negative	Sub-regional	Moderate	Long term	Continuous	Reversible	Moderate	Moderate	Negligible
Black Bear Regional Assessment	Negative	Regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Moose	Negative	Sub-regional	Moderate	Long term	Continuous	Reversible	Moderate	Moderate	Negligible
Moose Regional Assessment	Negative	Regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Woodland Caribou	Negative	Sub-regional	Moderate	Long term	Continuous	Reversible	Moderate	Moderate	Negligible
Woodland Caribou Regional Assessment	Negative	Regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Habitat Connectivity									
Moose	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Woodland Caribou	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible

Indicator	Direction of Impact	Extent of Impact	Magnitude of Impact	Duration of Impact	Frequency of Occurrence of Impact	Permanence of Impact	Level of Confidence	Environmental Impact at Application	Environmental Impact at Closure
Direct Mortality									
Canadian Toad	Negative	Sub-regional	Low	Long term	Isolated	Reversible	Moderate	Low	Negligible
Moose	Negative	Sub-regional	Low	Long term	Continuous	Irreversible	Low	Low	Negligible
Black Bear	Negative	Sub-regional	Low	Long term	Continuous	Irreversible	Moderate	Low	Negligible
Woodland Caribou	Negative	Sub-regional	Low	Long term	Continuous	Irreversible	Low	Low	Negligible
Indirect Mortality									
Black Bear	Negative	Regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Moose	Negative	Regional	Low	Long term	Continuous	Reversible	Moderate	Low	Negligible
Woodland Caribou	Negative	Regional	Moderate	Long term	Continuous	Reversible	Low	Moderate	Negligible
Wildlife Health	Negative	Regional	Low	Long term	Continuous	Reversible	Moderate	Negligible	Negligible

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11.10.2 Personal Communications

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12 BIODIVERSITY

12.1 Introduction

Biodiversity is defined in the Canadian Biodiversity Strategy (Environment Canada, 1995) as "the variety of species and ecosystems on Earth and the ecological processes of which they are a part." It is described as encompassing all levels of ecological organization including ecosystem and habitat diversity, species diversity and genetic diversity.

Concern for biodiversity is based on the ecological, spiritual and cultural values placed on landscapes and organisms (Environment Canada, 1995). Habitats and the organisms that occupy them provide ecological services to human societies. Biodiversity is also considered important because ecosystems and species are interdependent. All species that are found within a certain habitat can be assumed to contribute to the character of that habitat. Moreover, the welfare of one species is dependent upon that of others, and the extirpation of species can lead to a loss of ecosystem services.

The maintenance of existing diversity is generally considered to be more important than the promotion of diversity. Activities that disturb the landscape can result in an increase in the diversity of habitat types. This may be accompanied by the establishment of species that were not previously present, including invasive species. Even if diversity increases, these outcomes are not usually desirable.

This section provides an analysis of baseline biodiversity conditions in the local study area (LSA) and the regional study area (RSA) for the Project. Baseline data are used as the basis of an assessment of the impact of the Project on habitat richness, species diversity and habitat fragmentation during Project construction and operation and after Project closure and reclamation. The potential for cumulative effects on biodiversity from the Project and other nearby oil and gas operations is also evaluated. These assessments are consistent with the requirements presented in the TOR (Volume 2, Appendix 1A) and initiatives outlined by the Alberta Government (AEP, 1998).

12.2 Issues and Assessment Criteria

Biodiversity issues considered in this assessment follow the TOR provided to assess the Project (Volume 2, Appendix 1A). These issues are consistent with those identified in other EIAs for oil and gas projects in Alberta, the goals outlined in the Canadian Biodiversity Strategy (Environment Canada, 1995) and the Alberta Government's Initiatives Supporting the Canadian Biodiversity Strategy (AEP, 1998). Issues of concern with respect to biodiversity include:

- Reductions in landscape diversity through elimination of habitat;
- Reduction in habitat suitability for resident species through fragmentation or reductions in habitat availability;
- Local extinction of species; and
- Reduction in the ecological, spiritual and cultural value of landscapes and species.

12.3 Assessment Boundaries

12.3.1 Local Study Area

The LSA has been established to assess effects of the Project at a local scale. The rationale used in setting the boundaries included consideration of vegetation, wildlife and biodiversity components of this EIA. The LSA boundaries were delineated (Figure 12.3-1) to encompass lands owned by North American in the following areas:

- Township 76, Ranges 10 and 11(or portions thereof)
- Township 77, Ranges 9 to 12 (or portions thereof)
- Township 78, Ranges 9 to 12 (or portions thereof)
- Township 79, Ranges 9 to 13 (or portions thereof)
- Township 80, Ranges 8 to 13 (or portions thereof)
- Township 81, Ranges 8 to 10 (or portions thereof)
- Township 82, Ranges 9 and 10 (or portions thereof)
- Township 83, Ranges 9 and 10 (or portions thereof)

Lands within the delineated LSA not owned by North American were also included.

The LSA is 145,351 ha in area.

For this assessment, the biodiversity LSA is identical to that defined for the Vegetation assessment of this EIA (Volume 4, Section 10). Site selection for the Project footprint began in 2005 and has continued as the Project design has evolved. Soil and vegetation sampling was initiated in 2005 based on preliminary geological results and the North American land holdings at the time. Preliminary facility placements were based on:

- Maximizing resource recovery;
- Terrain (i.e., upland locations were preferred as were locations with minimal change in topography, thereby reducing need for cut and fill); and
- Avoiding open water bodies and defined water course channels (having defined bed and bank material).

Initial geological resource mapping, as defined in 2006, was used to further refine the 2006 vegetation study design and to establish the vegetation LSA boundaries. North American acquired over 50 townships of Alberta Vegetation Inventory/Ecological Land Classification (AVI/ELC) data for the Project to map vegetation in all lease areas. As the LSA was being defined, the development of the Project footprint was still in preliminary stages. Plans for utility ROWs connecting North American's leases were conceptual; the precise location of the ROWs was not defined. Therefore, vegetation on lands between the leases was also mapped.

The lease boundary and interconnecting lands encompasses almost 16 townships of land. Consideration was given to reducing the LSA size to reduce the dilution effect on assessed impact of such a large LSA; however, insufficient engineering was available to eliminate any of these lands from potential development.

Since the initial selection of the LSA, North American has continued to refine the footprint layout based on a constraints mapping approach to avoid sensitive areas within the lease boundaries. North American made modifications to the footprint layout based on information acquired from the geological data collection, hydrogeological data, aquatics, soils and vegetation surveys conducted in 2005 and 2006 combined with the AVI/ELC mapping, survey imagery (i.e., still photography images, aerial video, line scans and LiDAR, including topography).

As the Project footprint was further refined, several changes were made. North American examined each development area to determine the best well trajectories, giving consideration to variability in oil/water contact, reservoir quality, and character differences in the channels. Options for well pair placements in the channel trends considered non-reservoir shale plugs and various types of potential thief zones. Two SAGD pads were moved outside of the North American lease lands; however, well trajectories were designed to drain the resources from within the leases. Engineering and hydrogeologic assessment resulted in several source water and water disposal wells being located outside of the North American leases. In addition, the ROWs interconnecting the hubs were defined, some of which extended between North American leases. The refined Project footprint was used to assess impacts related to the Project.

The evolution of the Project footprint, following completion of the field programs, has resulted in small portions of the Project footprint occurring outside of the vegetation LSA boundary. The initial developments of Leismer Commercial, Leismer Expansion and Corner hubs are entirely within the vegetation LSA. The small portions of infrastructure that are outside of the LSA are more conceptual in nature and are associated with future development. The implications of the small portions of the footprint being outside of the vegetation LSA was not considered to affect the overall evaluation of vegetation impacts. In addition, it is anticipated that the overall Project footprint will be further refined, based on additional geological, biophysical and construction/reclamation information. Prior to construction, pre-development assessments (PDAs) will be conducted on the CPFs and SAGD pads to evaluate potential impacts and to develop C&R Plans for each site.

12.3.2 Regional Study Area

The RSA has been delineated to evaluate potential effects of the Project that may extend or occur beyond the LSA (Figure 12.3-2). Its delineation incorporated considerations regarding:

- Regional industrial developments and ecological variables that have the potential to interact cumulatively;
- An 11 km buffer surrounding the LSA, representing one radius of the lateral extent of a typical moose home range; and
- Existing, approved and planned land uses such as forestry, industrial and natural areas.

In the northwest corner, the RSA follows the natural boundary of Highway 63 where the 11 km buffer is exceeded. Portions of Al-Pac's proposed resource road in the south, linking Highway 881 to Highway 63 are also included.

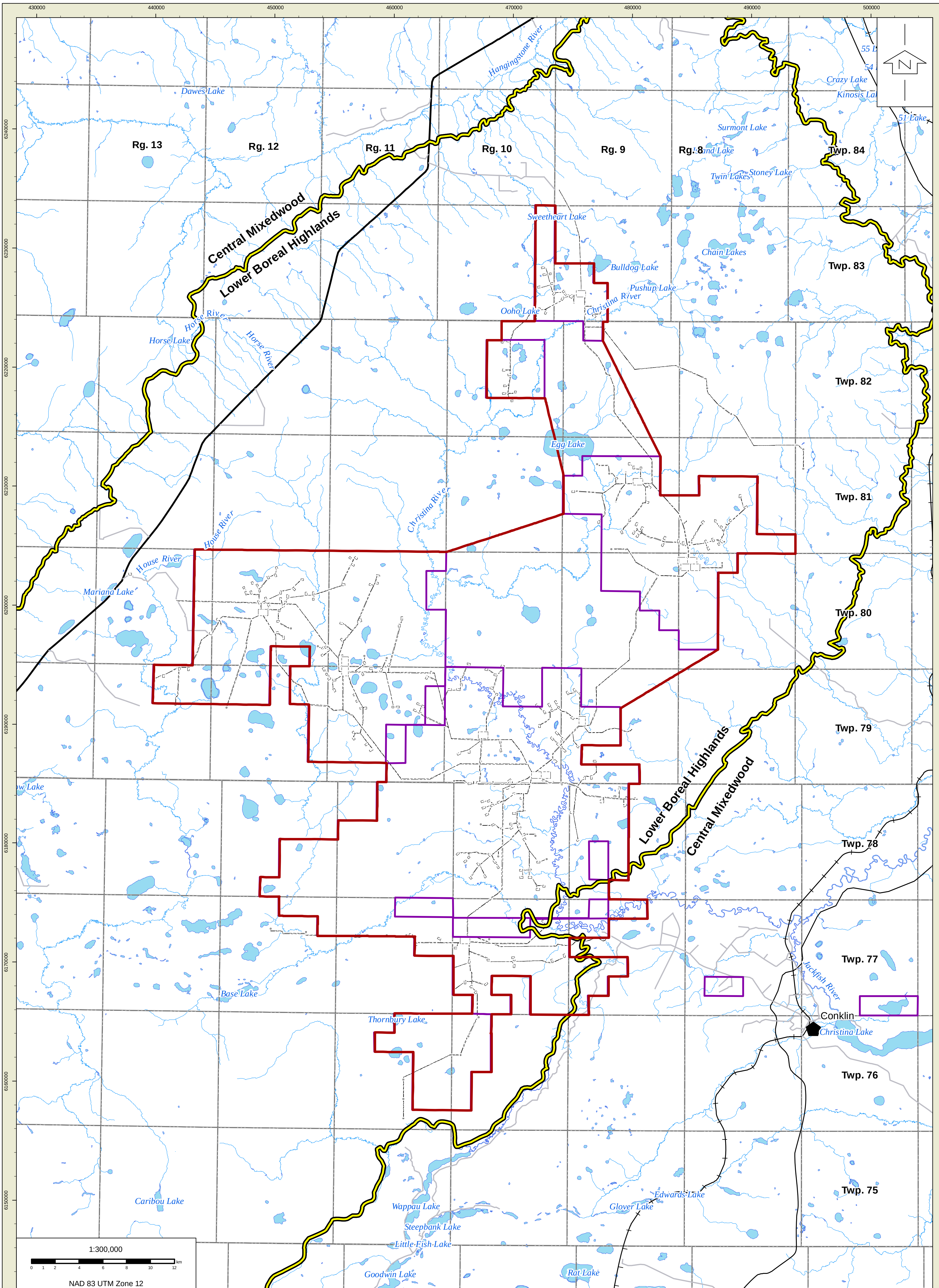
Surrounding projects incorporated within the 11 km boundary extension include Whitesands In-situ Project, Petro-Canada Meadow Creek, JACOS Hangingstone and Connacher Great Divide. These projects have been previously assessed, with the conclusion that they will not have significant cumulative effects on wildlife. Therefore, the perimeters of these projects have not been expanded by an additional 11 km buffer to create the North American RSA boundary.

Further, the RSA boundaries have not been delineated to encompass a cumulative effects assessment related to PAI for each of the surrounding projects. To incorporate lands that are expected to receive a load of 0.25 keq of PAI would increase the size of the RSA to an extent that may cause a dilution effect of the Project's impact.

Given the ecological interrelationships among vegetation, wildlife and biodiversity, this RSA will be used in the assessment process for all of these disciplines.

12.3.3 Temporal Boundaries

The temporal scope of this assessment reflects the timing and nature of Project phases as well as information available on other proposed projects. A description of the temporal boundaries of this assessment is provided in Volume 2, Section 1.



Legend

- North American Biodiversity LSA
- North American Lease
- Natural Subregions
- Project Footprint
- Major Road (Hwy. 63)
- Road (881)
- Rivers
- Lake
- Twp. Rg. Lines

Title:

LOCAL STUDY AREA FOR BIODIVERSITY

NORTH AMERICAN OIL SANDS CORPORATION

Approved: MS	Revision Date: June 05, 2007
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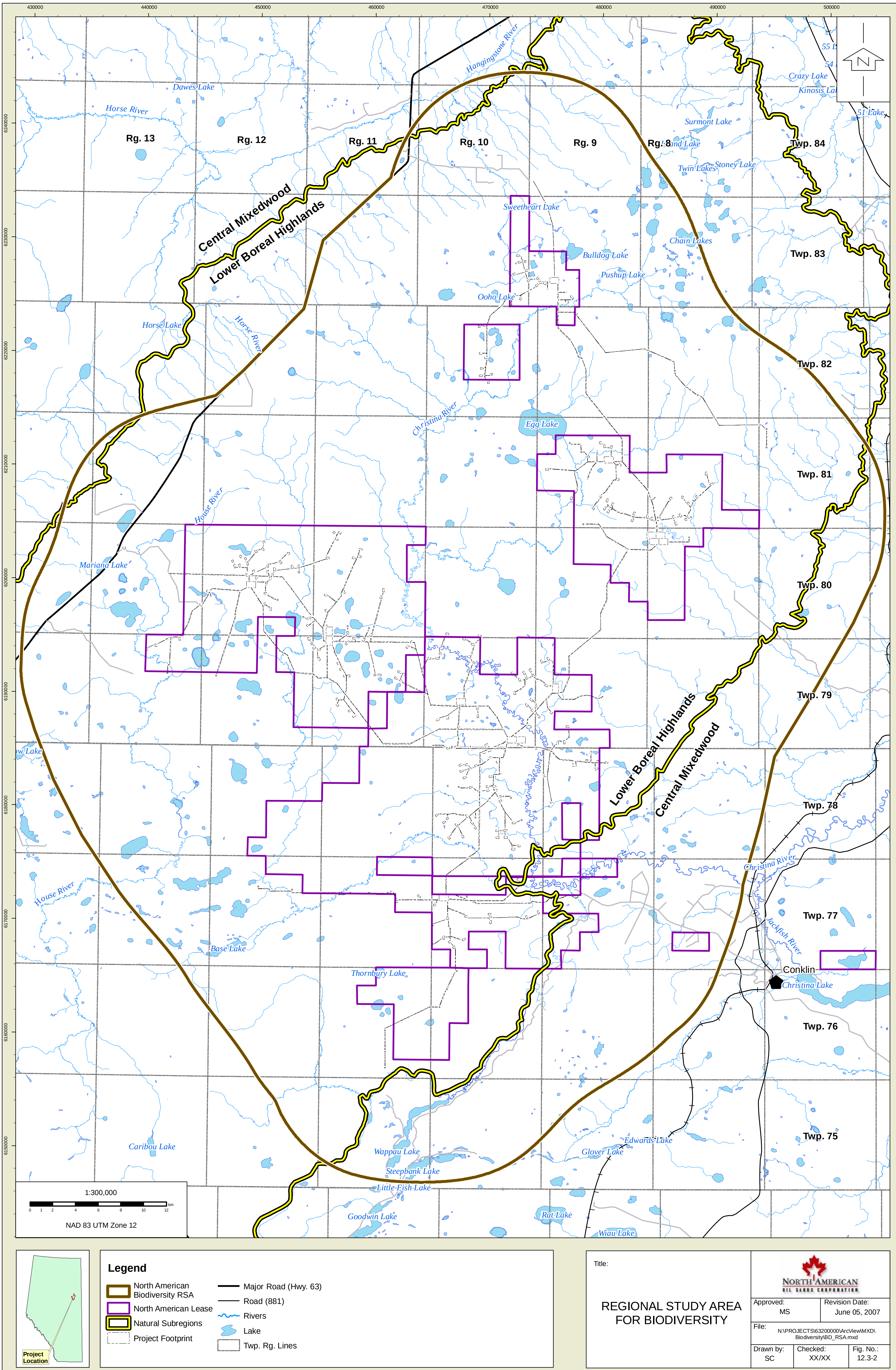

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Twp. 84
Twp. 83
Twp. 82
Twp. 81
Twp. 80
Twp. 79
Twp. 78
Twp. 77
Twp. 76
Twp. 75
Central Mixedwood
Lower Boreal Highlands
Lower Boreal Highlands
Central Mixedwood
Dawes Lake
Horse River
Hangingstone River
Crazy Lake
Kinosis Lake
51 Lake
Surmont Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Bulldog Lake
Chain Lakes
Pushup Lake
Ooho Lake
Horse Lake
Horse River
Christina River
Egg Lake
House River
Mariana Lake
House River
Base Lake
Thornbury Lake
Christina River
Jackfish River
Conklin
Christina Lake
Caribou Lake
Wappau Lake
Steepbank Lake
Little Fish Lake
Goodwin Lake
Rat Lake
Wiau Lake
Glover Lake
Edwards Lake
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NAD 83 UTM Zone 12
Project Location
Legend
North American Biodiversity RSA
North American Lease
Natural Subregions
Project Footprint
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Title:
REGIONAL STUDY AREA FOR BIODIVERSITY
NORTH AMERICAN OIL SANDS CORPORATION
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Revision Date: June 05, 2007
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12.4 Methods

12.4.1 Definition of Landscape Terms

The assessment of impacts on biodiversity in this EIA uses, as a framework, a hierarchical landscape classification system approved by the Alberta Government. This system defines the landscape according to spatial variations in the plant species present (Beckingham and Archibald, 1996). At the highest level of classification, the landscape is divided into Natural Regions (e.g., the Boreal Forest Natural Region). Natural Regions are divided into subregions, which are defined by differences in the general character of the dominant vegetation (e.g., the Lower Boreal Highlands and Central Mixedwood subregions). Within subregions, vegetation types are divided into ecosites and ecosite phases. Ecosites are groups of one or more ecosite phases that have similar nutrient and moisture conditions. An ecosite phase is defined by the dominant species in the canopy (Beckingham and Archibald, 1996). Natural subregions that have similar ecosite types are grouped into ecological areas.

Habitat identification and mapping in the RSA were based on Alberta Groundcover Classification (AGCC) categories because of the large area involved. To maximize the accuracy of the impact assessment, however, habitat identification and mapping within the LSA were based on AVI data and the ELC system for Alberta, which provide data at a finer scale than AGCC cover classes. These systems identify landscape units with similar abiotic (i.e., climate, soils and terrain) and biotic (i.e., tree canopy and shrub layer) features (Beckingham and Archibald, 1996). Non-vegetated landscapes features, such as waterbodies and anthropogenic disturbances, were also mapped using AGCC and AVI land labels (Nesby, 1997). Waterbodies include lakes, open water features, rivers, streams and draws. Non-vegetated anthropogenic features include farms, gravel pits, roads, railways, industrial plants, mines, cities and towns. Further details on ELC mapping and descriptions of individual ecosite phases can be found in Beckingham and Archibald (1996) and in the Vegetation section (Volume 4, Section 10). The use of different mapping methods for the RSA and the LSA may have resulted in slight differences in area calculations.

12.4.2 Assessment Approach

In this assessment, changes to landscape structure and species composition were measured to help predict impacts on landscape and species biodiversity. Assessment methods were chosen that address the issues identified in Section 12.3 and the following criteria adopted from Noss (1990):

- Sensitivity to disturbances or environmental stresses that may occur as a result of construction and operation of the Project;
- Potential indicators of the effects of disturbance on a wide number of species with similar habitat requirements;
- Trophic importance (i.e., pivotal species upon which other species may depend);
- Importance to ecosystem function (i.e., potentially important for maintaining ecological services);
- Special conservation status (e.g., species that are rare, genetically impoverished, of low fecundity, dependent on patchy or unpredictable resources, extremely variable in population density, or otherwise vulnerable to extinction);
- Economic and social importance (e.g., popular, charismatic species or species important for hunting, fishing, traditional land use or recreation);

- Ability to be assessed from existing data sources; and
- Ability to be efficiently and effectively monitored.

Impacts of the Project on species diversity were assessed indirectly by ranking ecosite phases in the LSA at baseline for their biodiversity potential. This ranking was determined by calculating species richness indices, rare species indices and unique species indices for plants and wildlife in each ecosite phase. Calculation of indices is explained in Appendix 12A. Species evenness could not be determined because relative abundance data were not available. Species diversity was calculated only for terrestrial and wetland ecosite phases because these were the only habitats for which detailed species richness data were available. Potential impacts of the Project on aquatic habitats are discussed in Volume 3, Section 8.

Changes in habitat richness and fragmentation were evaluated by comparing habitat richness, patch number, total habitat area and mean patch size at baseline with conditions during Project construction and operation, and after closure and reclamation. All data representing patch characteristics were obtained using GIS. Patches were defined by first associating polygons in a GIS map with AVI land labels and then dissolving boundaries between adjacent polygons in the same AGCC or AVI category. In each AVI category, therefore, patch area could be equivalent to the area of an individual isolated polygon or the sum of the area of two or more adjacent polygons. Metrics were calculated only for natural habitats (i.e., AVI categories that did not represent anthropogenic features). Impacts of the Project on soils and topography are covered in the Soils and Terrain section (Volume 4, Section 9).

The results of the fragmentation analyses (patch number, total habitat area and mean patch size) were assessed with respect to the biodiversity ranking of individual ecosite phases and other landscape units.

The metrics described below were assessed with reference to the assessment criteria given in Volume 2, Section 1.

12.4.2.1 Habitat Richness

Habitat richness is a measure of the number of different habitat types in the study area. A greater number of habitat types can indicate greater diversity at lower levels of organization because different habitats may contain at least some different species (McGarigal et al., 2002).

If development of the Project results in the elimination of any habitat types, this would be a negative impact because it would reduce landscape diversity and might cause the local extinction of species. An increase in habitat richness may be a positive impact on biodiversity because it may represent an increase in the number of habitats in the study area. However, an increase in habitat richness that is associated with substantially increased fragmentation of a high diversity habitat would not be a positive impact.

12.4.2.2 Ranking of Ecosite Phases for Species Diversity

Ecosite phases were ranked (high, intermediate, low and zero) for their species biodiversity potential by summing indices for vegetation and wildlife species that indicate species richness, rare species potential and the relative frequency of unique species. An example calculation of the overall ranking is given in Appendix 12A.

Potential species richness is a measure of the number of species that are expected to occupy a habitat. For this assessment, potential plant species richness was determined by combining lists of species recorded during field surveys for the Vegetation assessment (Volume 4, Section 10) and prominent species named for each ecosite phase by Beckingham and Archibald (1996). Wildlife species data were obtained from field surveys for the Wildlife assessment (Volume 4, Section 11). The rarity of plant species was determined by consulting the ANHIC element lists for lichens, vascular plants and bryophytes (ANHIC, 2002; ANHIC, 2006a; ANHIC, 2006b). Rare wildlife species included those listed as species-at-risk. Unique species were those that were observed or expected in three or fewer ecosite phases. Species data were not collected throughout the RSA so data are presented only for the LSA. Furthermore, results are presented only for ecosite phases in the Lower Boreal Highlands because only a very small proportion of the LSA falls within the Boreal Mixedwood.

12.4.2.3 Habitat Fragmentation

Habitat fragmentation refers to the abundance, frequency and dispersion of patches of a given habitat on the landscape. It can be analyzed using a variety of indices. Disturbances that result in a decrease in the area of existing patches, increases in the number of patches or isolation of patches are considered to increase habitat fragmentation. Changes in the amount of contrast between patches (in terms of their physical characteristics) and the related metrics of patch isolation and patch connectivity can imply changes in the ability of the landscape to maintain its biological diversity following disturbance (McGarigal et al., 2002). However, the relative importance of such changes varies among habitat types and plant and animal taxa (Williams et al., 2006).

For this EIA, habitat fragmentation was assessed by considering Project effects on the following habitat patch characteristics:

- Proportion of the landscape occupied by each habitat type;
- Number of habitat patches; and
- Mean patch size.

Given the low area occupied by landscape units in the Central Mixedwood subregion, patch number and mean patch size measures have been calculated for this assessment by combining data from the Central Mixedwood and Lower Boreal Highlands subregions.

In many studies of fragmentation, decreased patch size (Golden and Crist, 2000; Hovel and Lipicus, 2001), increased patch isolation and habitat loss (Fuller, 2001; Carlson and Hartman, 2001; Summervilee and Crist, 2001) have been documented to have negative effects on biodiversity. In general, smaller patches support fewer species and plant and animal populations in isolated patches are more vulnerable to extinction.

A decrease in the area occupied by ecosite phases with high diversity potential would imply a reduced capability for the LSA to sustain high levels of biodiversity because smaller patches tend to support fewer species. A decrease in mean patch size without a significant decrease in total area would imply a shift in the distribution of patch sizes towards a greater number of smaller patches, which would be a negative impact. An increase in the number of patches without an increase in total area would suggest greater fragmentation. This would also be a negative impact.

Edge effects were not included in this assessment because their severity varies among species and depends on the structure of adjacent patches.

12.5 Existing Conditions

Most of the LSA (97.7%; 142,069 ha) for the Project occurs within the Lower Boreal Highlands subregion of the Boreal Forest Natural Region. The rest of the LSA (2.3%; 3,280 ha) occurs within the Central Mixedwood subregion.

The Lower Boreal Highlands subregion includes the lower slopes of a number of Northern Alberta hill and mountain systems. These include the Caribou and Birch Mountains and the Stony Mountain and Peerless Uplands. Terrain is gentle to strongly sloping with some undulating upland areas. Forest composition is diverse, including upland forests of aspen (*Populus tremuloides*) and white spruce (*Picea glauca*), with balsam poplar (*Populus balsamifera*) and white birch (*Betula papyrifera*) in wetter areas, and jack pine-lodgepole pine (*Pinus banksiana-Pinus contorta*) hybrids, either in pure stands or mixed with black spruce (*Picea mariana*; Natural Regions Committee, 2006).

The Central Mixedwood subregion extends from the Caribou Mountains south to Edmonton and spans Alberta from British Columbia to Saskatchewan. In general, the terrain has low relief, with level to undulating surfaces. Aspen and white spruce are common in upland areas and occur in both pure and mixed stands. Dry, open and sandy upland sites are dominated by jack pine. Peatlands are common and extensive throughout the Central Mixedwood Subregion and include both nutrient-poor, acidic bogs dominated by *Picea mariana* (black spruce), *Ledum groenlandicum* (Labrador tea), and *Sphagnum* spp. (peatmosses) and nutrient-rich fens containing *Larix laricina* (tamarack), *Betula* spp. (dwarf birches), *Carex* spp. (sedges), and brown mosses such as *Aulacomnium palustre, Tomenthypnum nitens* and *Drepanocladus* spp. (Natural Regions Committee, 2006).

Vegetation communities comprise approximately 96.7% (458,991 ha) of the RSA. Anthropogenic disturbances (major roads, highways and railways) comprise 0.08% (386 ha). Around 2.6% (12,443 ha) is covered by waterbodies (lakes, ponds, reservoirs, rivers and streams). Features that comprise the remaining area (0.6%; 2,884 ha) were identified as rock formations, exposed soil or areas that could not be differentiated from satellite imagery due to shadow or haze.

About 94.0% (136,655 ha) of the LSA is composed of terrestrial and wetland ecosite phases. Approximately 2.5% (3,694 ha) consists of waterbodies and 3.4% (5,000 ha) is anthropogenic features.

12.5.1 Habitat Richness

The RSA and LSA habitat types were defined using different levels of data. The RSA habitat types were based on coarser data (AGCC), resulting in fewer defined habitat types relative to the LSA, which were defined using more detailed data.

Sixteen different habitat types are present in the RSA at baseline (Table 12.5-2). Of these, 15 are vegetation cover classes and 1 consists of waterbodies.

In the LSA, 51 different habitats have been differentiated for the purposes of this assessment. Of these, 18 are ecosite phases in the Lower Boreal Highlands subregion (Table 12.5-3) and 23 are ecosite phases in the Central Mixedwood subregion (Table 12.5-4; ecosite phases that have the same code - i.e., d1 - in the two subregions are counted separately because they may not have identical species compositions, habitat structure or environmental conditions). Ten other habitats (seven vegetation types and three types of aquatic features) have been identified in the Lower Boreal Highlands and six other habitats (three vegetation types and three aquatic feature classes) have been differentiated in the Central Mixedwood subregion (Table 12.5-5).

12.5.2 Potential Species Richness

Overall species richness was highest in ecosite phase h1 (treed bog; 169 species; Figure 12.5-1). Other ecosite phases with relatively high species richness were j1 (treed rich fen; 155 spp.), c1 (Labrador tea-mesic Pj-Sb; 131 spp.), j2 and i1 (shrubby rich fen and treed poor fen; 113 spp.), and g1 (Labrador tea-hygric Sb-Pj; 106 spp.) A complete list of all plant species is given in Volume 4, Section 10, and a complete list of all wildlife species is given in Volume 4, Section 11.

12.5.3 Ranking of Ecosite Phases for Species Biodiversity Potential

Ecosite phases d1, h1 and j2 have high species biodiversity potential (Table 12.5-1). These cover approximately 34.2% (49,728 ha) of the LSA (Figure 12.5-2). Approximately 43.3% (62,865 ha) of the LSA is covered by ecosite phases with intermediate Species Biodiversity Potential, and 7.3% (10,645 ha) is covered by ecosite phases with relatively low Species Biodiversity Potential. The species biodiversity potential of two ecosite phases in the Lower Boreal Highlands subregion (b2 and f1), all ecosite phases in the Central Mixedwood subregion, as well as clear cuts, burned areas, meadows, shrublands, clearings, cutbanks and all waterbodies in both subregions, could not be calculated because data were absent or incomplete.

Table 12.5-1 Rankings of Ecosite Phases in the LSA for Species Diversity

Ranking	Ecosite phases	Area of LSA (ha)	Percent of LSA (%)
High	d1, h1, j2	49,728	34.2
Intermediate	b1, c1, d2, d3, g1, i1, i2, j1, j3	62,865	43.3
Low	a1, b3, e1, h2	10,645	7.3
Nil[1]	N/A	5,000	3.4
Unknown[2]	b2, f1, Central Mixedwood ecosite phases, waterbodies, shrublands, clear cuts, burns, etc.	17,112	11.8
TOTALS		**145,349**	**100.0**

[1] Anthropogenic disturbances (roads, power lines, etc.)

[2] Ecosite phases and other habitats for which data were absent or incomplete

Table 12.5-2 Area and Percentage of the RSA Occupied by AGCC Landscape Cover Categories at Baseline, Construction and Operation, and After Closure and Reclamation

Cover Category	Baseline		Construction and Operation			Closure and Reclamation		
	Area (ha)	Percent of LSA	Area (ha)	Percent of LSA	Difference from Baseline (%)	Area (ha)	Percent of LSA	Difference from Baseline (%)
Graminoid (grasses/sedges/forbs) dominated clear-cut	2,041	0.4	2,035	0.4	-0.3	2,041	0.4	0.0
Undifferentiated burn	121	<0.1	120	<0.1	-0.1	121	<0.1	0.0
Graminoid (grasses/sedges/forbs) dominated burn	64	<0.1	64	<0.1	<-0.1	64	<0.1	0.0
Tree/shrub dominated burn	590	0.1	586	0.1	-0.6	590	0.1	0.0
Closed Pine	31,679	6.7	31,421	6.6	-0.8	31,679	6.7	0.0
Closed Se/Sw	146,573	30.9	145,373	30.6	-0.8	146,573	30.9	<-0.1
Closed Aspen, Balsam Poplar and/or Birch	31,722	6.7	31,464	6.6	-0.8	31,722	6.7	0.0
Closed Coniferous and Deciduous Cover (40% to 60%)	8,417	1.8	8,339	1.8	-0.9	8,417	1.8	0.0
Closed Upland Shrub	651	0.1	650	0.1	-0.1	651	0.1	0.0
Mixed Grassland	721	0.2	721	0.2	<0.1	721	0.2	0.0
Graminoid Wetlands (sedges/grasses/forbs) (less than 6% tree cover and 25% shrub)	56,706	11.9	56,395	11.9	-0.5	56,395	11.9	-0.5
Shrubby Wetlands (willow and birch)	16,674	3.5	16,549	3.5	-0.7	16,549	3.5	-0.7
Black Spruce Bog (Sphagnum understorey)	100,406	21.2	99,761	21.0	-0.6	99,761	21.0	-0.6
Open Pine	48,219	10.2	48,081	10.1	-0.3	48,219	10.2	0.0
New Burn	14,409	3.0	14,409	3.0	<0.1	14,409	3.0	0.0
Waterbodies	12,443	2.6	12,441	2.6	<-0.1	12,443	2.6	0.0
Other features	2,883	0.6	2,874	0.6	-0.3	2,883	0.6	0.0
Anthropogenic features	386	0.1	3,417	0.7	785.8	386	0.1	0.0
Transitional reclamation	N/A	N/A	N/A	N/A	N/A	1,079	0.2	N/A
Total	**474,702**	**100.0**	**474,702**	**100.0**	**N/A**	**474,702**	**100.0**	**N/A**

Table 12.5-3 Changes in Area and Percentage of the LSA Occupied by Ecosite Phases in the Lower Boreal Highlands at Construction and Operation, and After Closure and Reclamation

Ecosite phase	Baseline		Construction and Operation				Closure and Reclamation			
	Area (ha)	Percent of LSA	Area (ha)	Percent of LSA	Difference from Baseline (%)	Change as a % of the LSA	Area (ha)	Percent of LSA	Difference from Baseline (%)	Change as a % of the LSA
a1	2,477	1.7	2,412	1.7	-2.6	<-0.1	2,484	1.7	0.3	<0.1
b1	3,994	2.7	3,837	2.6	-3.9	-0.1	4,004	2.8	0.2	<0.1
b2	962	0.7	900	0.6	-6.4	<-0.1	966	0.7	0.4	<0.1
b3	626	0.4	612	0.4	-2.3	<-0.1	628	0.4	0.2	<0.1
c1	1,540	7.9	11,178	7.7	-3.1	-0.2	11,566	8.0	0.2	<0.1
d1	7,852	5.4	7,620	5.2	-3.0	-0.2	7,884	5.4	0.4	<0.1
d2	3,185	2.2	3,143	2.2	-1.3	<-0.1	3,187	2.2	0.1	<0.1
d3	1,142	0.8	1,133	0.8	-0.8	<-0.1	1,143	0.8	0.1	<0.1
e1	1,343	0.9	1,317	0.9	-1.9	<-0.1	1,344	0.9	0.1	<0.1
f1	86	0.1	84	0.1	-1.2	0.0	86	0.1	0.1	0.0
g1	14,151	9.7	13,842	9.5	-2.2	-0.2	14,998	10.3	6.0	0.6
h1	37,516	25.8	36,795	25.3	-1.9	-0.5	37,125	25.5	-1.0	-0.3
h2	6,198	4.3	6,066	4.2	-2.1	-0.1	6,117	4.2	-1.3	-0.1
i1	7,308	5.0	7,157	4.9	-2.1	-0.1	7,222	5.0	-1.2	-0.1
i2	7,210	5.0	7,120	4.9	-1.3	-0.1	7,164	4.9	-0.6	<-0.1
j1	10,688	7.4	10,576	7.3	-1.0	-0.1	10,633	7.3	-0.5	<-0.1
j2	4,360	3.0	4,320	3.0	-0.9	<-0.1	4,339	3.0	-0.5	<-0.1
j3	3,647	2.5	3,604	2.5	-1.2	<-0.1	3,622	2.5	-0.7	<-0.1
Total	**124,285**	**85.5**	**121,719**	**83.7**	**N/A**	**N/A**	**124,511**	**85.7**	**N/A**	**N/A**

Note: Totals shown here are calculated from original GIS data but all values have been rounded for display purposes.

Table 12.5-4 Area and Percentage of the LSA Occupied by Ecosite Phases in the Central Mixedwood Subregion at Construction and Operation, and After Closure and Reclamation

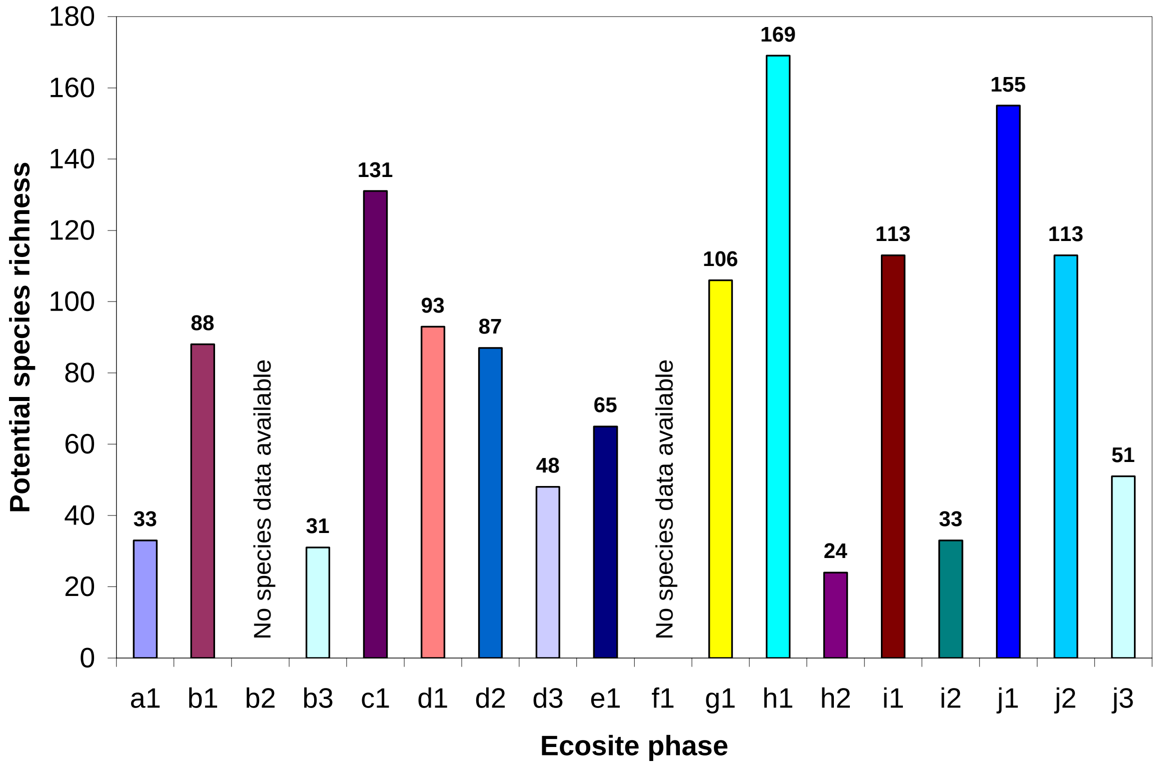
Ecosite Phase	Baseline		Construction and Operation				Closure and Reclamation			
	Area (ha)	Percent of LSA	Area (ha)	Percent of LSA	Difference from Baseline (%)	Change as a % of the LSA	Area (ha)	Percent of LSA	Difference from Baseline (%)	Change as a % of the LSA
a1	9	<0.1	9	<0.1	<-0.1	<-0.1	9	<0.1	<-0.1	<-0.1
b1	109	0.1	109	0.1	-0.4	<-0.1	109	0.1	<0.1	<0.1
b3	27	<0.1	26	<0.1	-2.8	<-0.1	27	<0.1	<-0.1	<-0.1
b4	24	<0.1	24	<0.1	<-0.1	<-0.1	24	<0.1	<0.1	<0.1
c1	58	<0.1	58	<0.1	-0.4	<-0.1	58	<0.1	<0.1	<0.1
d1	477	0.3	477	0.3	<0.1	<0.1	477	0.3	<0.1	<0.1
d2	287	0.2	287	0.2	<-0.1	<-0.1	287	0.2	<0.1	<0.1
d3	111	0.1	111	0.1	<0.1	<0.1	111	0.1	<0.1	<0.1
e1	311	0.2	310	0.2	-0.3	<-0.1	311	0.2	<0.1	<0.1
e2	77	0.1	77	0.1	<-0.1	<-0.1	77	0.1	<0.1	<0.1
e3	19	<0.1	19	<0.1	<-0.1	<-0.1	19	<0.1	<-0.1	<-0.1
f1	4	<0.1	4	<0.1	<0.1	<0.1	4	<0.1	<-0.1	<-0.1
f2	8	<0.1	8	<0.1	<-0.1	<-0.1	8	<0.1	<-0.1	<-0.1
f3	2	<0.1	2	<0.1	<-0.1	<-0.1	2	<0.1	<-0.1	<-0.1
g1	83	0.1	83	0.1	<0.1	<0.1	83	0.1	0.2	<0.1
h1	96	0.1	96	0.1	<0.1	<0.1	96	0.1	<-0.1	<-0.1
i1	548	0.4	548	0.4	<-0.1	<-0.1	548	0.4	<-0.1	<-0.1
i2	36	<0.1	36	<0.1	<0.1	<0.1	36	<0.1	<0.1	<0.1
j1	41	<0.1	41	<0.1	<0.1	<0.1	41	<0.1	<-0.1	<-0.1
j2	109	0.1	109	0.1	-0.2	<-0.1	109	0.1	<-0.1	<-0.1
k1	15	<0.1	15	<0.1	<0.1	<0.1	15	<0.1	<0.1	<0.1
k2	204	0.1	204	0.1	<0.1	<0.1	204	0.1	<-0.1	<-0.1
k3	62	<0.1	62	<0.1	<-0.1	<-0.1	62	<0.1	<-0.1	<-0.1
Total	**2,717**	**1.9**	**2,714**	**1.9**	**N/A**	**N/A**	**2,717**	**1.9**	**N/A**	**N/A**

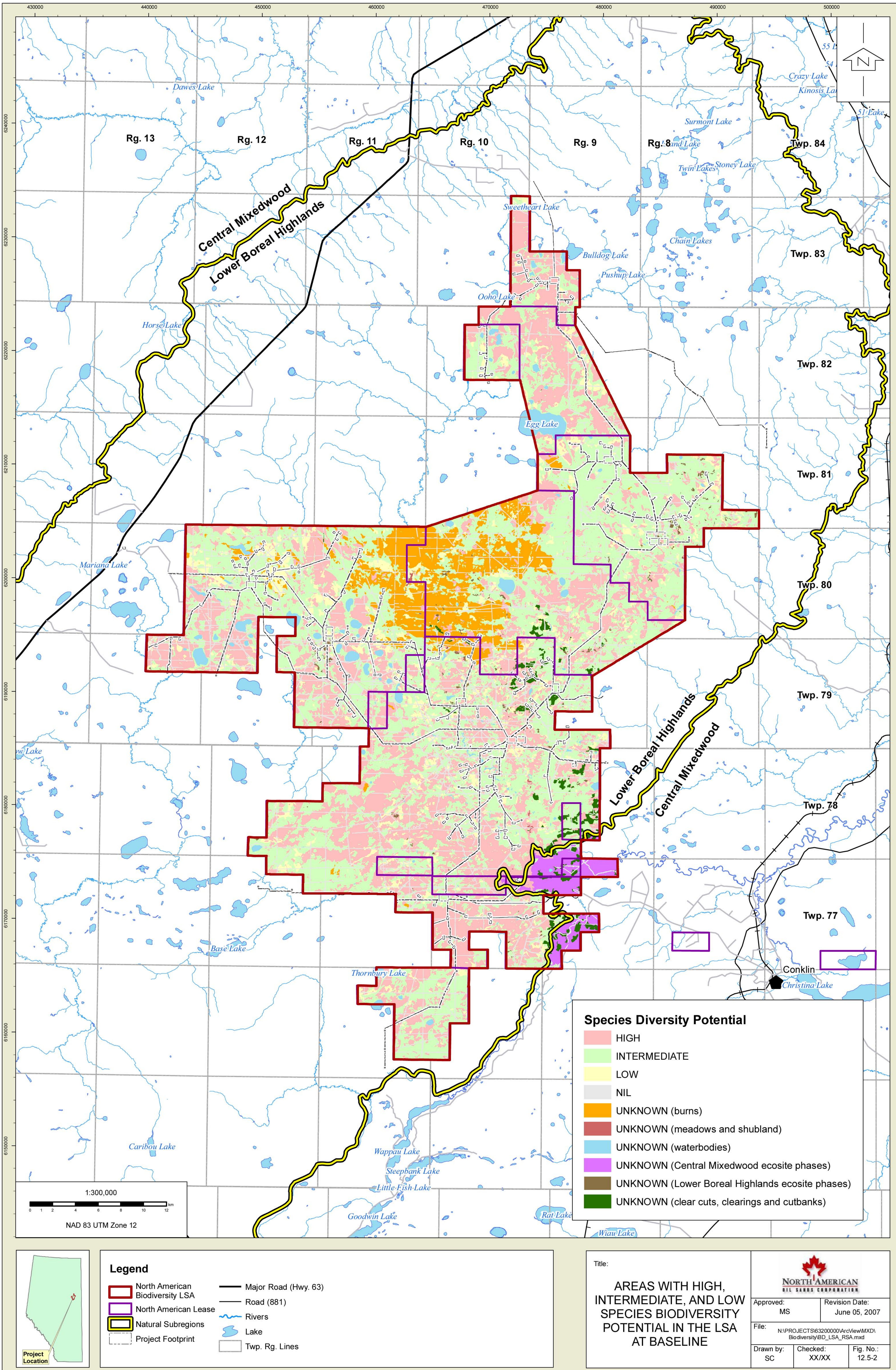
Note: Totals shown here are calculated from original GIS data but all values have been rounded for display purposes

Table 12.5-5 Area and Percentage of the LSA Occupied by Other Landscape Units at Construction and Operation, and After Closure and Reclamation

Landscape unit	Baseline		Construction and Operation				Closure and Reclamation			
	Area (ha)	Percent of LSA	Area (ha)	Percent of LSA	Difference from Baseline (%)	Change as a % of the LSA	Area (ha)	Percent of LSA	Difference from Baseline (%)	Change as a % of the LSA
Lower Boreal Highlands										
Clearing	49	<0.1	48	<0.1	-2.9	<-0.1	49	<0.1	0.1	<0.1
Burn	8,385	5.8	8,356	5.7	-0.3	<-0.1	8,356	5.7	-0.3	<-0.1
Burned clear-cut	38	<0.1	38	<0.1	<-0.1	<-0.1	38	<0.1	<0.1	<0.1
Regenerating burn	1,100	0.8	1,081	0.7	-1.8	<-0.1	1,134	0.8	3.1	<0.1
Meadow	35	<0.1	35	<0.1	<-0.1	<-0.1	35	<0.1	<-0.1	<-0.1
Recent burn (no regen)	2	<0.1	2	<0.1	<-0.1	<-0.1	2	<0.1	<-0.1	<-0.1
Shrubland	41	<0.1	41	<0.1	-0.2	<-0.1	41	<0.1	<-0.1	<-0.1
Flooded areas	276	0.2	275	0.2	-0.6	<-0.1	277	0.2	<0.1	<0.1
Lakes and ponds	2,991	2.1	2,991	2.1	<-0.1	<-0.1	2,991	2.1	<-0.1	<-0.1
Watercourses	320	0.2	315	0.2	-1.5	<-0.1	320	0.2	<0.1	<0.1
Anthropogenic features	4,545	3.1	7,168	4.9	57.7	<-0.1	4,314	3.0	-5.1	<-0.1
Central Mixedwood										
Meadow	1	<0.1	1	<0.1	<-0.1	<-0.1	1	<0.1	<0.1	<0.1
Cutbank	1	<0.1	1	<0.1	<0.1	<0.1	1	<0.1	<0.1	<0.1
Shrubland	1	<0.1	1	<0.1	<-0.1	<-0.1	1	<0.1	<-0.1	<-0.1
Flooded areas	10	<0.1	10	<0.1	<-0.1	<-0.1	10	<0.1	<0.1	<0.1
Lakes and ponds	25	<0.1	25	<0.1	<0.1	<0.1	25	<0.1	<0.1	<0.1
Watercourses	72	<0.1	72	<0.1	<0.1	<0.1	72	<0.1	<0.1	<0.1
Anthropogenic features	454	0.3	457	0.3	0.5	<0.1	454	0.3	<-0.1	<-0.1

Figure 12.5-1 Potential Species Richness of Lower Boreal Highlands Ecosite Phases in the LSA





Species Diversity Potential
HIGH
INTERMEDIATE
LOW
NIL
UNKNOWN (burns)
UNKNOWN (meadows and shubland)
UNKNOWN (waterbodies)
UNKNOWN (Central Mixedwood ecosite phases)
UNKNOWN (Lower Boreal Highlands ecosite phases)
UNKNOWN (clear cuts, clearings and cutbanks)
Central Mixedwood
Lower Boreal Highlands
Rg. 13
Rg. 12
Rg. 11
Rg. 10
Rg. 9
Rg. 8
Twp. 84
Twp. 83
Twp. 82
Twp. 81
Twp. 80
Twp. 79
Twp. 78
Twp. 77
Dawes Lake
Surmont Lake
Crazy Lake
Kinosis Lake
51 Lake
Twin Lakes
Stoney Lake
Sweetheart Lake
Chain Lakes
Bulldog Lake
Pushup Lake
Ooho Lake
Horse Lake
Egg Lake
Mariana Lake
Base Lake
Thornbury Lake
Conklin
Christina Lake
Caribou Lake
Wappau Lake
Steepbank Lake
Little Fish Lake
Goodwin Lake
Rat Lake
Wiau Lake
1:300,000
NAD 83 UTM Zone 12
Project Location
Legend
North American Biodiversity LSA
North American Lease
Natural Subregions
Project Footprint
Major Road (Hwy. 63)
Road (881)
Rivers
Lake
Twp. Rg. Lines
Title:
AREAS WITH HIGH, INTERMEDIATE, AND LOW SPECIES BIODIVERSITY POTENTIAL IN THE LSA AT BASELINE
NORTH AMERICAN OIL SANDS CORPORATION
Approved: MS
Revision Date: June 05, 2007
File: N:\PROJECTS\63200000\ArcView\MXD\Biodiversity\BD_LSA_RSA.mxd
Drawn by: SC
Checked: XX/XX
Fig. No.: 12.5-2

12.5.4 Habitat Fragmentation

Closed Se/Sw (closed spruce) is the AGCC cover class in the RSA with the greatest overall area, comprising 30.9% of the landscape (146,573 ha; Figure 12.5-3). Black spruce bog (*Sphagnum* understorey) was the next most common cover class, occupying 21.2% (100,406 ha). A map of the distribution of AGCC cover classes in the RSA is provided in Volume 4, Section 10, Figure 10.5-6.

Treed bog (ecosite phase h1 in the Lower Boreal Highlands subregion) is the ecosite phase in the LSA with the largest total area, comprising 25.8% (37,516 ha) of the LSA (Figure 12.5-4). Labrador tea-hygric Sb-Pj (ecosite phase g1 in the Lower Boreal Highlands), was the next most common, occupying 9.7% (14,151 ha) of the LSA. All ecosite phases in the area of the LSA in the Central Mixedwood subregion occupy less than one percent of the LSA. Summary statistics for all landscape units in the LSA at baseline are given in Tables 12.5-3 to 12.5-5. A map of the distribution of ecosite phases in the LSA is provided in Volume 4, Section 10; Figure 10.5-1).

Ecosite phases with a high species biodiversity potential have a slightly higher mean patch size than most of those with intermediate species biodiversity potential and all that have low Species Biodiversity Potential. The mean patch size of all ecosite phases is generally small (mean 3.7 ha ± 1.7 ha). Of the terrestrial habitats, the burn vegetation unit has the highest mean patch size at 16.8 ha (Table 12.5-6). The greatest mean patch size is found in rivers (78.3 ha), and lakes and ponds (25.8 ha). For most landscape categories, the distribution of patch sizes is strongly skewed towards small patches (less than 10 ha) (Table 12.5-6).

Table 12.5-6 Patch Size Distribution and Mean Patch Sizes for Landscape Units According to Their Ranking for Species Biodiversity Potential

Landscape Unit	% of Patches in Each Size Category					Mean Patch Size (ha)	Ranking for Biodiversity Potential
	< 1 ha	1 - 10 ha	11 - 50 ha	51 - 100 ha	< 100 ha		
d1	44.4	47.1	7.1	0.9	0.5	5.1	HIGH
h1	45.1	42.6	9.8	1.5	1.0	7.1	HIGH
j2	40.6	49.2	8.7	0.8	0.7	5.1	HIGH
b1	40.4	52.9	6.6	0.2	0.0	3.1	INT
c1	37.7	51.3	10.1	0.7	0.1	4.6	INT
d2	39.1	54.4	5.9	0.6	0.0	3.4	INT
d3	38.5	58.3	3.2	0.0	0.0	2.5	INT
g1	39.4	49.4	9.9	1.0	0.4	4.9	INT
i1	39.9	50.4	9.1	0.5	0.2	4.0	INT
i2	46.8	44.3	7.8	0.9	0.2	4.9	INT
j1	39.4	43.2	14.0	2.2	1.3	8.3	INT
j3[1]	44.7	47.3	6.2	1.1	0.6	4.5	INT
a1	37.9	54.1	7.5	0.5	0.2	3.8	LOW
b3	41.8	52.7	5.4	0.0	0.0	2.7	LOW
e1	42.7	53.2	4.1	0.0	0.0	2.3	LOW
h2[1]	43.9	48.1	7.6	0.3	0.0	3.5	LOW
b2[1]	39.2	58.3	2.5	0.0	0.0	2.2	UNK
b4[2]	38.5	61.5	0.0	0.0	0.0	1.8	UNK
e2[2]	6.7	80.0	13.3	0.0	0.0	5.1	UNK

Landscape Unit	**% of Patches in Each Size Category**					**Mean Patch Size (ha)**	**Ranking for Biodiversity Potential**
	< 1 ha	**1 - 10 ha**	**11 - 50 ha**	**51 - 100 ha**	**< 100 ha**		
e3[2]	25.0	50.0	25.0	0.0	0.0	4.7	UNK
f1	42.9	57.1	0.0	0.0	0.0	1.6	UNK
f2[2]	0.0	100.0	0.0	0.0	0.0	2.1	UNK
f3[2]	0.0	100.0	0.0	0.0	0.0	1.6	UNK
k1[2]	25.0	75.0	0.0	0.0	0.0	3.8	UNK
k2[2]	44.1	45.6	10.3	0.0	0.0	3.0	UNK
k3[2]	38.7	58.1	3.2	0.0	0.0	2.0	UNK
Burn[1]	41.6	39.4	12.3	3.0	3.8	16.8	UNK
Burned clear cut[1]	37.5	50.0	12.5	0.0	0.0	4.8	UNK
Regenerating burn[1]	44.2	46.3	8.3	1.3	0.0	4.6	UNK
Meadow	28.6	64.3	7.1	0.0	0.0	2.6	UNK
Clearing	84.3	15.7	0.0	0.0	0.0	0.7	UNK
Recent burn (no regen) [1]	0.0	100.0	0.0	0.0	0.0	2.4	UNK
Cutbank [2]	100.0	0.0	0.0	0.0	0.0	0.5	UNK
Shrubland	51.4	48.6	0.0	0.0	0.0	1.2	UNK
Flooded areas	37.9	59.8	2.3	0.0	0.0	2.2	UNK
Lakes and ponds	7.7	40.2	41.9	6.0	4.3	25.8	UNK
Watercourses	20.0	0.00	40.0	0.0	40.0	78.3	UNK
Means ± 1 standard deviation	**37.2 ± 19.4**	**52.7 ± 21.1**	**8.2 ± 9.6**	**0.6 ± 1.1**	**1.4 ± 6.6**	**6.4 ± 13.0**	

[1] Ecosite phase occurs only in the Lower Boreal Highlands

[2] Ecosite phase occurs only in the Central Mixedwood

Figure 12.5-3 Percentage Cover of AGCC cover Classes in the RSA at Baseline (values are given only for land units with cover greater than 1.0%)

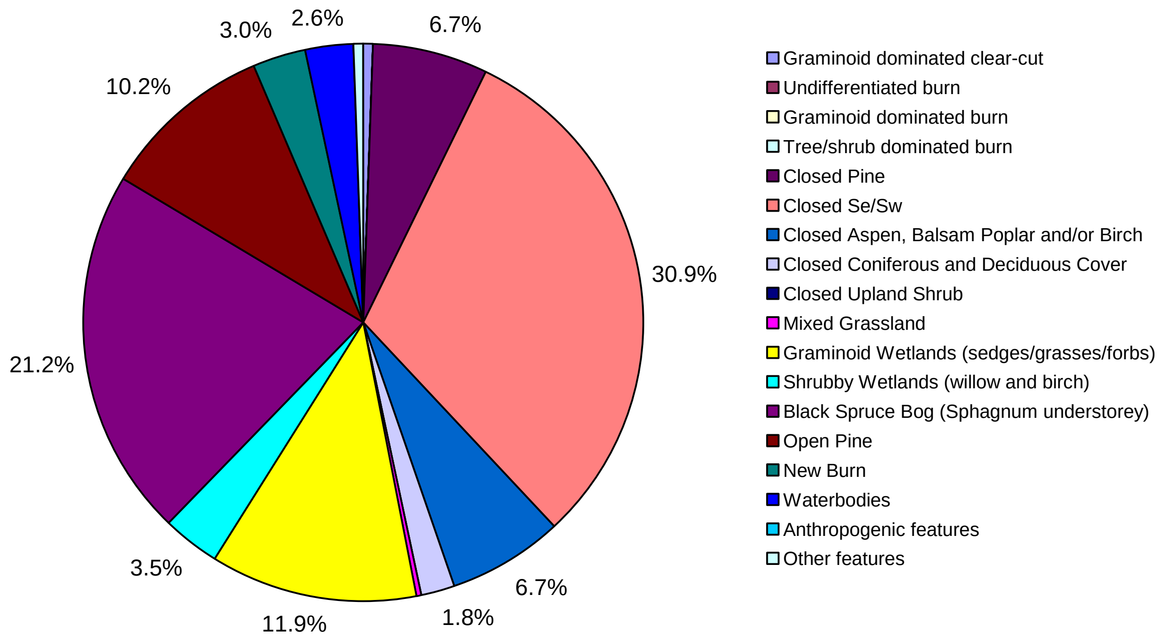
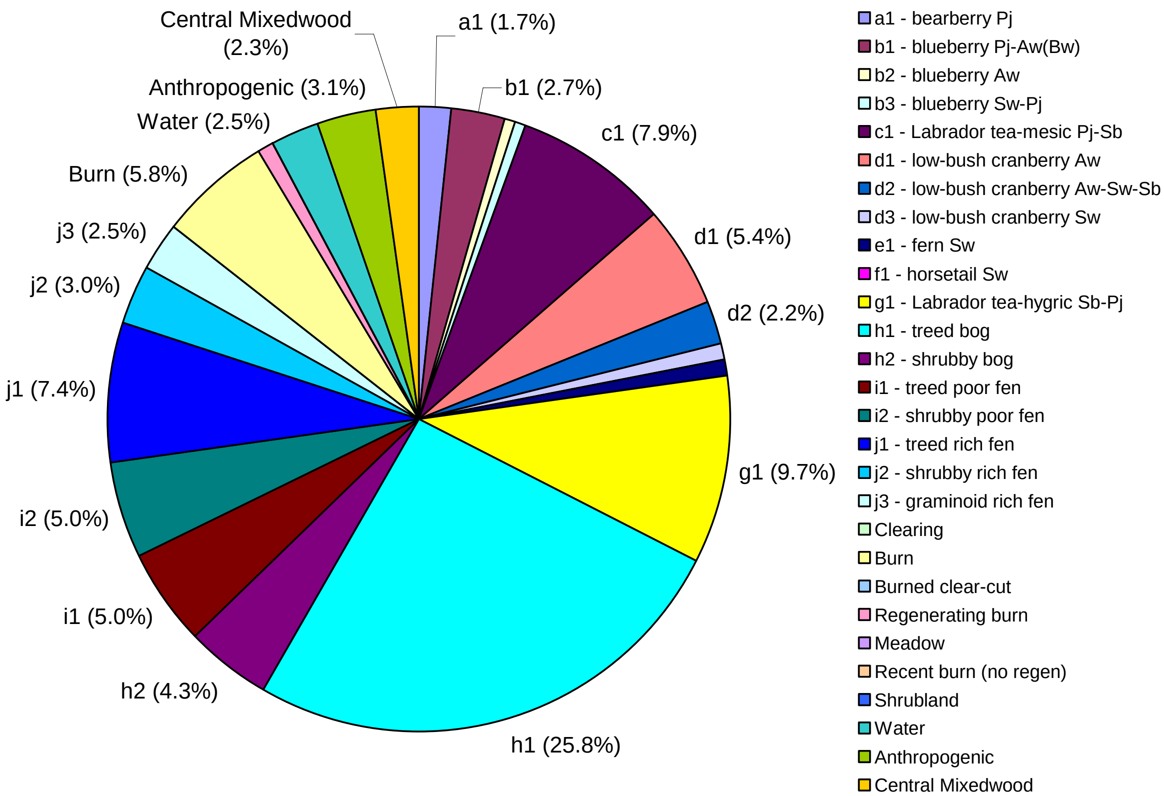


Figure 12.5-4 Percentage Cover of Lower Boreal Highlands Landscape Units in the LSA at Baseline (values are only given for land units with cover greater than 1.0%)



12.6 Impact Assessment and Mitigative Measures

12.6.1 Habitat Richness

The habitat richness in the RSA and the LSA is predicted to not change over the lifetime of the Project (Tables 12.5-2 to 12.5-5).

12.6.2 Species Diversity

Project construction will result in decreases in the area of the LSA occupied by all ecosite phases with a high species diversity ranking (d1, h1 and j2; Table 12.5-3). However, all decreases will be small relative to baseline levels (3.0%, 1.9% and 0.9%, respectively). The mean patch sizes of ecosite phases with high potential for biodiversity are also predicted to decrease during the construction phase by 11.2%, 12.4% and 7.8%, respectively (Table 12.6-1). For each ecosite phase, it is expected that this will be accompanied by an increase in the number of patches by 9.5%, 11.9% and 7.5%, respectively (Table 12.6-2).

The area of ecosite phases with high species biodiversity potential is expected to have returned to levels similar to those at baseline following closure and reclamation (Table 12.5-3). The mean patch sizes of ecosite phases with high potential for biodiversity are predicted to be 3.1% greater at closure than at baseline for ecosite phase d1, 6.7% lower for ecosite phase h1 and 5.6% lower for ecosite phase j2 (Table 12.6-3). It is predicted that following reclamation, the number of patches in two of the three ecosite phases that have high species biodiversity potential, h1 and j2, will have increased by 6.0% and 5.4%, respectively, relative to baseline. The number of patches in ecosite phase d1 is expected to have decreased by 2.6% relative to baseline levels (Table 12.6-2).

Impacts on ecosite phases with intermediate and low potential for biodiversity and on other habitats are described below.

12.6.3 Habitat Fragmentation

All vegetation cover classes in the RSA are predicted to be reduced in area by less than one percent relative to baseline (Table 12.5-2) at any stage during the lifetime of the Project (Figures 12.6-1 to 12.6-4). The most common ecosite phase in the LSA, Treed bog (ecosite phase h1 in the Lower Boreal Highlands subregion), is expected to be reduced by 1.9% relative to baseline (Table 12.5-3). The largest reduction in area is predicted to occur in the b2 (blueberry Aw) ecosite phase in the Lower Boreal Highlands, which is expected to decline from 962 ha to 900 ha, a reduction of 6.4% relative to baseline. However, this habitat type occupies less than one percent of the LSA.

Given the negligible impact of Project construction on the area occupied by all AGCC cover classes in the RSA, it is predicted that following closure and reclamation areas will be similar to those at baseline (Table 12.5-2). Reclamation is also expected to result in only minor changes in the area occupied by habitat types in the LSA relative to levels at baseline (Table 12.5-3). Ecosite phase g1 (Labrador tea-hygric Sb-Pj) is expected to increase in area by 6.0% compared with baseline and for most other habitat types, the area existing after closure and reclamation is expected to have changed by less than one percent.

For almost all ecosite phases with intermediate and low Species Biodiversity Potential, and other potential habitats, mean patch size is predicted to be lower than baseline levels during Project construction and operation (Tables 12.6-1 and 12.6-3). This is due to a predicted decrease in total area and an expected increase in the total number of patches (Table 12.6-2). The ecosite phase with the greatest predicted decrease in mean patch size is c1 (Labrador tea-mesic Pj-Sb), which has intermediate potential for biodiversity. Mean patch size for this ecosite phase is predicted to decline by 15.2% and the total number of patches is predicted to increase by 14.3%. In general, the largest percentage change in both variables is predicted to occur in the smallest patch size categories (<1 ha and 1 ha to 10 ha).

Edge effects were not included in this assessment because their severity varies among species and depends on the structure of adjacent patches. However, any increase in edge effects is not expected to be severe.

Following closure and reclamation, the majority of ecosite phases are predicted to show an increase in mean patch size relative to baseline or reductions in mean patch size that are lower than those expected at the construction and operational phase (Tables 12.6-4 and 12.6-5). The ecosite phase with the greatest predicted increase in mean patch size is g1 (Labrador tea-mesic Sb-Pj), which has intermediate potential for biodiversity. Mean patch size for this ecosite phase is predicted to increase by 29.5%.

The largest predicted increase in the number of patches will be in ecosite phase g1, which is expected to have 11.8% more patches relative to baseline (Table 12.6-2).

Table 12.6-1 Patch Size Distribution and Mean Patch Sizes for Ecosite Phases at the Construction and Operational Phase

Ecosite Phase	% of all Patches					Change from Baseline (%)					Mean Patch Size (ha)	Change from Baseline (%)	Ranking for Biodiversity Potential
	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha			
d1	48.5	43.8	6.5	0.8	0.3	19.6	1.9	0.0	0.0	-25.0	5.1	-11.2	HIGH
h1	47.8	40.8	9.1	1.3	0.9	18.4	7.2	4.7	2.6	3.8	7.1	-12.4	HIGH
j2	43.0	47.7	8.0	0.7	0.5	14.0	4.1	-1.3	0.0	-16.7	5.1	-7.8	HIGH
b1	45.2	49.2	5.4	0.1	0.0	22.4	1.7	-11.4	0.0	0.0	3.1	-11.9	INT
c1	43.0	47.7	8.8	0.5	0.1	30.1	6.2	-0.4	-22.2	-33.3	4.6	-15.2	INT
d2	42.4	51.3	5.7	0.6	0.0	14.7	-0.4	1.7	0.0	0.0	3.4	-6.5	INT
d3	40.7	56.2	3.1	0.0	0.0	8.2	-1.4	0.0	0.0	0.0	2.5	-3.1	INT
g1	44.0	46.0	8.8	0.9	0.2	24.5	3.8	-0.7	0.0	-30.0	4.9	-12.2	INT
i1	44.9	46.8	7.9	0.3	0.1	25.6	3.8	-3.3	-30.0	0.0	4.0	-12.2	INT
i2	49.6	42.4	7.2	0.8	0.0	15.7	4.5	1.4	-5.9	-66.7	3.9	-9.7	INT
j1	43.6	40.5	12.9	2.0	1.0	25.0	6.1	3.8	3.6	-11.8	8.3	-12.4	INT
j3	46.3	45.9	6.5	0.7	0.6	10.8	3.9	12.0	-33.3	0.0	4.5	-7.7	INT
a1	43.0	50.2	6.4	0.3	0.1	25.4	2.5	-6.1	-33.3	0.0	3.8	-11.8	LOW
b3	45.5	49.8	4.7	0.0	0.0	17.0	1.6	-7.7	0.0	0.0	2.7	-9.1	LOW
e1	47.9	48.4	3.7	0.0	0.0	21.3	-1.6	-3.4	0.0	0.0	2.3	-9.0	LOW
h2	47.8	45.3	6.7	0.2	0.0	19.9	3.6	-2.9	-50.0	0.0	3.5	-11.1	LOW
b2	45.8	52.7	1.5	0.0	0.0	28.1	-0.8	-36.4	0.0	0.0	2.2	-14.6	UNK
b4	38.5	61.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	UNK
e2	6.7	80.0	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	UNK
e3	25.0	50.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	UNK
f1	43.6	56.4	0.0	0.0	0.0	0.0	-3.1	0.0	0.0	0.0	1.6	0.6	UNK
f2	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	UNK
f3	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	UNK
k1	25.0	75.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	UNK
k2	44.1	45.6	10.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	UNK
k3	38.7	58.1	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	UNK
Mean	**38.1**	**55.1**	**6.3**	**0.4**	**0.2**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**3.7**	**-6.8**	**N/A**

Table 12.6-2 Patch Frequency for Ecosite Phases and Other Habitat Types in the LSA at Baseline, Construction and Operation and After Closure and Reclamation

Habitat type	Baseline	Construction and Operation		Closure and Reclamation		Ranking for Biodiversity Potential
	No. of Patches	No. of Patches	Change from Baseline (%)	No. of Patches	Change from Baseline (%)	
d1	1,639	1,795	9.5	1,596	-2.6	HIGH
h1	5,266	5,893	11.9	5,584	6.0	HIGH
j2	882	948	7.5	930	5.4	HIGH
b1	1,326	1,448	9.2	1,273	-4.0	INT
c1	2,544	2,908	14.3	2,453	-3.6	INT
d2	1,011	1,068	5.6	993	-1.8	INT
d3	506	518	2.4	505	-0.2	INT
g1	2,896	3,226	11.4	3,579	23.6	INT
i1	1,980	2,211	11.7	2,109	6.5	INT
i2	1,849	2,021	9.3	1,959	5.9	INT
j1	1,300	1,468	12.9	1,391	7.0	INT
j3	807	864	7.1	847	5.0	INT
a1	655	723	10.4	630	-3.8	LOW
b3	239	257	7.5	231	-3.3	LOW
e1	705	762	8.1	690	-2.1	LOW
h2	1,795	1,976	10.1	1,930	7.5	LOW
b2	436	478	9.6	414	-5.0	UNK
b4	13	13	0.0	13	0.0	UNK
e2	15	15	0.0	15	0.0	UNK
e3	4	4	0.0	4	0.0	UNK
f1	56	55	-1.8	56	0.0	UNK
f2	4	4	0.0	4	0.0	UNK
f3	1	1	0.0	1	0.0	UNK
k1	4	4	0.0	4	0.0	UNK
k2	68	68	0.0	68	0.0	UNK
k3	31	31	0.0	31	0.0	UNK
Burn	498	527	5.8	527	5.8	UNK
Burned clear cut	8	8	0.0	8	0.0	UNK
Regenerating burn	240	269	12.1	268	11.7	UNK
Meadow	14	14	0.0	14	0.0	UNK
Clearing	70	73	4.3	70	0.0	UNK
Recent burn (no regen)	1	1	0.0	1	0.0	UNK
Cutbank	1	1	0.0	1	0.0	UNK
Shrubland	35	36	2.9	35	0.0	UNK
Flooded areas	132	141	6.8	132	0.0	UNK
Lakes and ponds	117	117	0.0	117	0.0	UNK
Watercourses	5	17	240.0[1]	5	0.0	UNK

[1] This result is an artifact of GIS mapping and does not represent actual fragmentation of watercourses

Table 12.6-3 Patch Size Distribution and Mean Patch Sizes for Other Habitats at the Construction and Operational Phase

Habitats	% of all Patches					Change from Baseline (%)					Mean Patch Size (ha)	Change from Baseline (%)	Ranking for Biodiversity Potential
	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha			
Burn[1]	41.7	39.5	12.0	3.0	3.8	6.3	6.1	3.3	6.7	5.3	16.8	-5.8	UNK
Burned clear cut[1]	37.5	50.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	UNK
Regenerating burn[1]	48.7	43.5	6.7	1.1	0.0	23.6	5.4	-10.0	0.0	0.0	4.6	-12.4	UNK
Meadow	28.6	64.3	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	UNK
Clearing	84.9	15.1	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.7	-6.9	UNK
Recent burn (no regen)	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	UNK
Cutbank	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	UNK
Shrubland	52.8	47.2	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	1.2	-3.0	UNK
Flooded areas	39.7	58.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	-6.9	UNK
Lakes and ponds	7.7	40.2	41.9	6.0	4.3	12.0	3.8	0.0	0.0	0.0	25.8	0.0	UNK
Watercourses	29.4	11.8	41.2	11.8	5.9	0.0	0.0	0.0	0.0	0.0	78.3	-70.9	UNK
Mean	**42.8**	**42.7**	**11.2**	**2.0**	**1.3**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**12.7**	**-9.6**	**N/A**

Table 12.6-4 Patch Size Distribution and Mean Patch Sizes for Ecosite Phases at Closure and Reclamation

Ecosite Phase	% of all Patches					Change from Baseline (%)					Mean Patch Size (ha)	Change from Baseline (%)	Ranking for Biodiversity Potential
	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha			
d1	44.0	47.4	7.2	0.8	0.5	-3.4	-1.9	-1.7	-7.1	0.0	5.2	3.1	HIGH
h1	47.7	41.3	8.7	1.4	1.0	11.9	2.8	-5.2	-1.3	1.9	6.7	-6.7	HIGH
j2	42.8	47.6	8.2	0.9	0.5	11.2	2.1	-1.3	14.3	-16.7	4.8	-5.6	HIGH
b1	39.5	53.4	6.8	0.2	0.0	-6.0	-3.0	-1.1	50.0	0.0	3.2	4.4	INT
c1	37.3	51.7	10.1	0.8	0.1	-4.8	-2.8	-4.3	11.1	0.0	4.7	3.9	INT
d2	38.5	54.8	6.0	0.7	0.0	-3.3	-1.1	0.0	16.7	0.0	3.5	1.9	INT
d3	38.6	58.2	3.2	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	2.5	0.3	INT
g1	48.0	43.2	7.7	0.8	0.3	50.6	8.1	-3.5	-3.6	10.0	6.4	29.5	INT
i1	42.9	48.2	8.3	0.4	0.1	14.6	2.0	-2.2	-20.0	0.0	3.7	-7.1	INT
i2	48.6	43.0	7.3	0.9	0.1	10.0	2.9	-0.7	5.9	-33.3	3.7	-6.2	INT
j1	42.6	40.8	13.3	2.0	1.2	15.8	1.2	1.6	0.0	0.0	7.7	-7.0	INT
j3	46.2	46.0	6.3	0.9	0.6	8.3	2.1	6.0	-11.1	0.0	4.3	-5.4	INT
a1	37.0	54.6	7.8	0.3	0.3	-6.0	-2.8	0.0	-33.3	100.0	4.0	4.2	LOW
b3	39.4	55.0	5.6	0.0	0.0	-9.0	0.8	0.0	0.0	0.0	2.8	3.7	LOW
e1	41.4	54.5	4.1	0.0	0.0	-5.0	0.3	-3.4	0.0	0.0	2.4	2.3	LOW
h2	46.7	46.2	6.9	0.2	0.0	14.5	3.1	-2.2	-50.0	0.0	3.2	-8.2	LOW
b2	38.9	58.5	2.7	0.0	0.0	-5.8	-4.7	0.0	0.0	0.0	2.3	5.7	UNK
b4	38.5	61.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	UNK
e2	6.7	80.0	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	UNK
e3	25.0	50.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	UNK
f1	42.9	57.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.1	UNK
f2	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	UNK
f3	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	UNK
k1	25.0	75.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	UNK
k2	44.1	45.6	10.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	UNK
k3	38.7	58.1	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	UNK
Mean	**36.2**	**56.6**	**6.6**	**0.4**	**0.2**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**3.7**	**0.5**	**N/A**

Table 12.6-5 Patch Size Distribution and Mean Patch Sizes for Other Habitats at Closure and Reclamation

Habitat	% of all Patches					Change from Baseline (%)					Mean Patch Size (ha)	Change from Baseline (%)	Ranking for Biodiversity Potential
	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha	< 1 ha	1 - 10 ha	10 - 50 ha	50 - 100 ha	> 100 ha			
Burn[1]	41.7	39.5	12.0	3.0	3.8	6.3	6.1	3.3	6.7	5.3	15.9	-5.8	UNK
Burned clear cut[1]	37.5	50.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	UNK
Regenerating burn[1]	47.4	44.0	7.1	1.5	0.0	19.8	6.3	-5.0	33.3	0.0	4.2	-7.7	UNK
Meadow	28.6	64.3	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	UNK
Clearing	84.3	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.1	UNK
Recent burn (no regen)	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	UNK
Cutbank[2]	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	UNK
Shrubland	51.4	48.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	UNK
Flooded areas	37.9	59.8	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	UNK
Lakes and ponds	7.7	40.2	41.9	6.0	4.3	0.0	0.0	0.0	0.0	0.0	25.8	0.0	UNK
Watercourses	20.0	0.0	40.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	78.3	0.0	UNK
Mean	**41.5**	**42.0**	**11.2**	**1.0**	**4.4**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**12.59**	**-1.2**	**N/A**

12.6.3.1 Mitigation

Landscape Diversity

The following mitigation measures have been incorporated into the Project design to help to minimize impacts on terrestrial landscape diversity during construction and ongoing operations:

- Previously disturbed areas should be used where possible to reduce the amount of new clearing.
- The proposed surface areas for Project facilities should be minimized where practicable.
- Multiple-use areas such as roads, pipelines and power lines within the same ROW should be used where practical.
- Land should be reclaimed to equivalent land capability.
- Non-native and invasive plant species should be controlled using a combination of mechanical and chemical methods.

Potential mitigation measures to minimize impacts on aquatic features include:

- Avoiding development on aquatic features where practicable.
- Removing crossings as part of Project reclamation.
- Making use of existing creek crossings, where practicable, to reduce the number of new crossings.
- Using industry best practices when constructing crossings (bridges and culverts) to minimize impacts on stream habitat (e.g., sedimentation, habitat loss, spills).
- Monitoring culvert crossings and replacing hanging or damaged culverts to ensure habitat connectivity is maintained.

Reclamation activities will involve re-contouring land surfaces and replacement of soil and re-vegetation. Most of the seed for reclamation is expected to be present in the form of a preserved seed bank in the soil stockpile. Planting trees, such as aspen and jack pine, and shrubs will also help to expedite the reclamation process. A description of reclamation and re-vegetation activities is provided in the Conservation and Reclamation Plan (Volume 1, Section 8).

Mitigation measures for minimizing impacts to vegetation are discussed in more detail in Volume 4, Section 10. Mitigation measures for wildlife are discussed in more detail in Volume 4, Section 11.

Species Diversity

Mitigation of impacts on species diversity is primarily dependant on successful reclamation following Project closure. This involves establishing suitable natural habitat conditions that are able to support a community of native species representative of the target habitat types or desired reclamation goals (e.g., habitat enhancement for wildlife). Means of achieving reclamation success and maintaining species diversity include:

- Re-vegetating sites using native plant species as determined after consultation with regulators; and

- The direct placement of soils to enhance recruitment of native plant species present in the seed bank during reclamation.

Reclamation activities alone will not result in the re-establishment of all native species present prior to development. It is assumed that by re-establishing the appropriate habitat conditions, the native species will return (both plants and wildlife), and species diversity will increase over time as conditions change and the habitat matures. Maintaining representative natural habitat in proximity to disturbed sites will provide a natural source for species recruitment and help restore native species diversity.

Where habitat fragmentation has occurred, the contribution that reclaiming land to equivalent land capability makes to mitigating the fragmentation will depend upon the structural similarity of reclaimed habitats to surrounding or nearby habitats. Mitigation will be most effective if land is reclaimed to a habitat that is highly similar to any habitat types in the area that were fragmented during Project construction and operation.

12.6.3.2 Conclusion

There is predicted to be no environmental impact on habitat richness in the RSA or LSA as a result of the Project. This prediction is made with high confidence.

Impacts on species diversity involve land clearing for Project facilities that will be present for the lifetime of the Project (approximately 40 years). Generally, a smaller area is likely to contain fewer species and a lower core area of suitable habitat. However, the amount of any habitat type lost during construction and operation will not exceed 6.4% relative to baseline levels. Ecosite phases with high species biodiversity potential will not be disproportionately or substantially reduced in area during Project construction. After closure and reclamation, the area occupied by these ecosite phases is expected to be similar to that at baseline. Actual impacts on all habitats should be less than predicted because not all parts of the Project will be constructed and operational at the same time.

Overall, the direction of the impact of the Project on species diversity is predicted to be negative due to the loss of area in some high diversity ecosite phases during Project construction. The magnitude of the impact is predicted to be low because the loss of area will be small and temporary. The impact is expected to be sub-regional in extent, long-term in duration, isolated in frequency and reversible in the long-term. The overall environmental impact is predicted to be low. Confidence in this prediction is medium.

It is expected that some habitats will become more fragmented as a result of the construction of the Project. At the construction and operational phase, there will be decreases in the mean patch area of ecosite phases and some other habitat types, and these are expected to occur in patches that are already small. The proportional effect of loss of area on small patches can be greater than that on relatively large patches because as patch size decreases, the ratio of area to length of boundary decreases, increasing the potential for edge effects. Edge effects were not included in this assessment because their severity varies among species and depends on the structure of adjacent patches. However, any increase in edge effects is not expected to be severe. Ecosite phases with high potential for species diversity are not expected be disproportionately affected and predicted decreases in mean habitat area do not exceed 16% for any ecosite phase or other habitat type.

Project closure will be followed by the reclamation of much of the land disturbed during construction and operation so that the area occupied by each landscape unit is not likely to be substantially different from that recorded at baseline. Some habitat types (g1, regenerating burns) will show an increase in area over baseline levels greater than one percent. This should enhance their capacity to sustain baseline levels of biodiversity, assuming that the biotic community is able to recover to those levels. The reclamation procedures recommended in this EIA are also expected to reduce fragmentation relative to levels at the application and operational phase.

Overall, the direction of Project impacts on habitat fragmentation in the RSA and LSA is considered to be negative because the area occupied by most ecosite phases or other potential habitats is reduced at the construction and operational phase at least, while the number of patches is increased. Although Project facilities will be built within two ecological subregions, the area affected within all habitat types in the Central Mixedwood will be less than one percent. The extent of the impact is therefore predicted to be subregional. The magnitude of the impact is predicted to be low because during the construction and operational phase the change in area affected in most ecosite phases and other habitats is expected to be less than three percent and less than one percent after closure and reclamation. Habitats with high potential for biodiversity are not predicted to be disproportionately affected. The overall environmental impact is predicted to be low. These predictions are made with medium confidence.

Figure 12.6-1 Percentage Cover of AGCC Cover Categories in the RSA at the Construction and Operational Phase

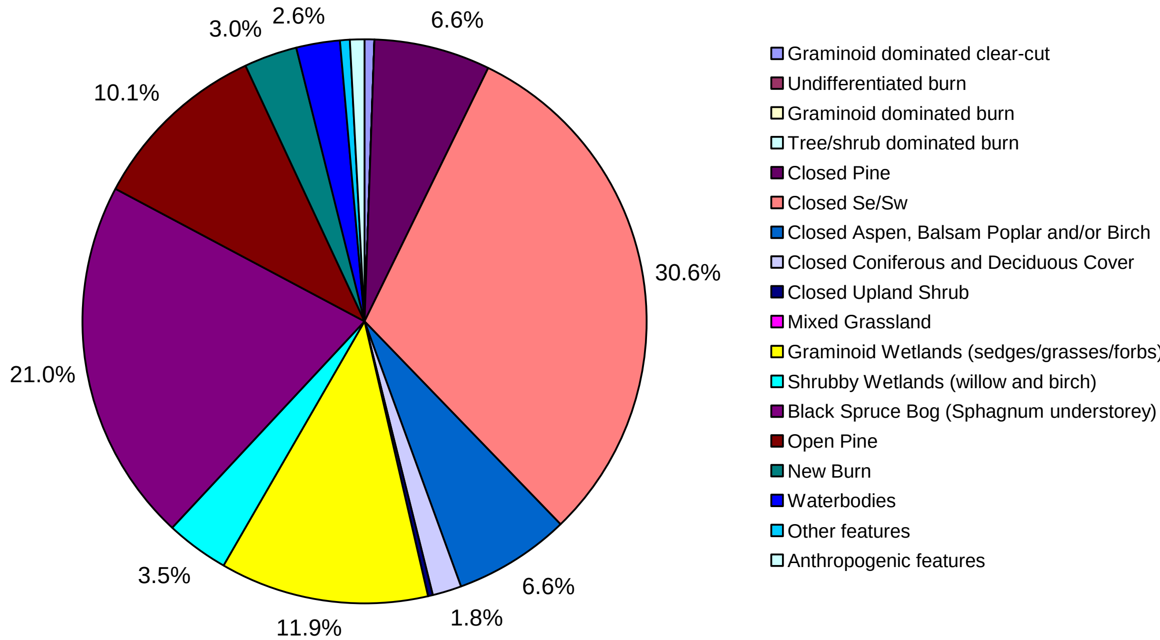


Figure 12.6-2 Percentage Cover of Lower Boreal Highlands Landscape Units in the LSA at the Construction and Operational Phase

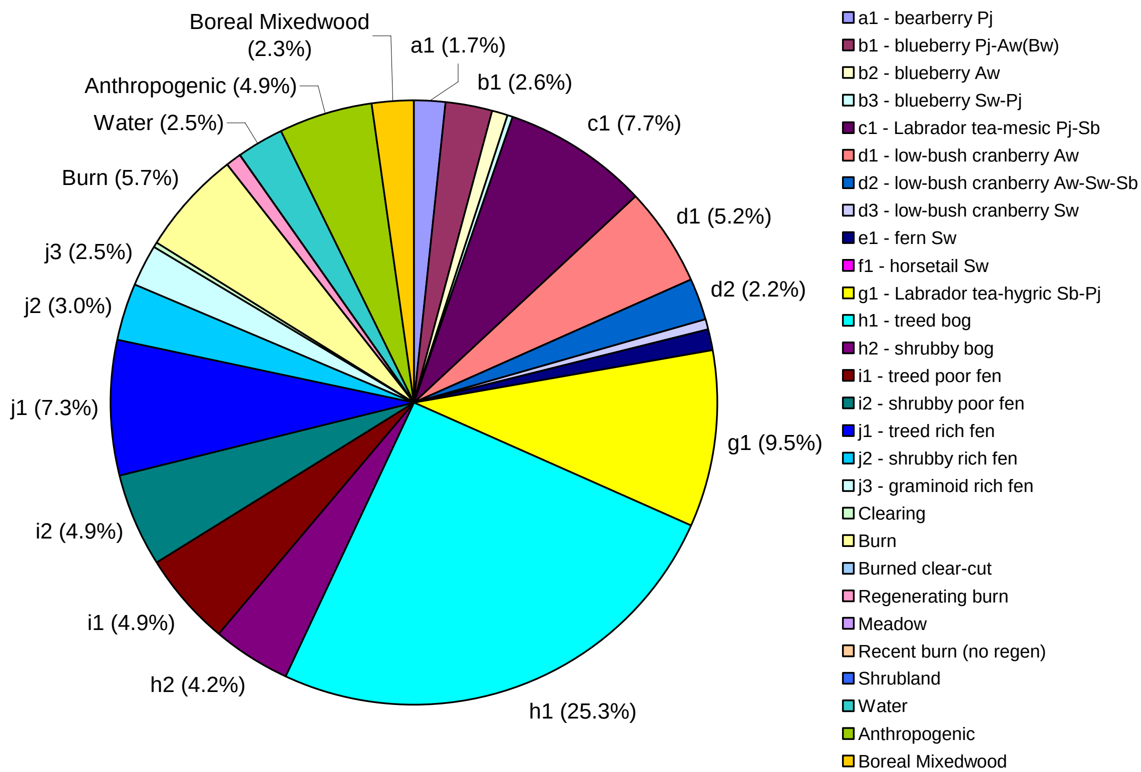


Figure 12.6-3 Percentage Cover of AGCC Cover Categories in the RSA After Closure and Reclamation

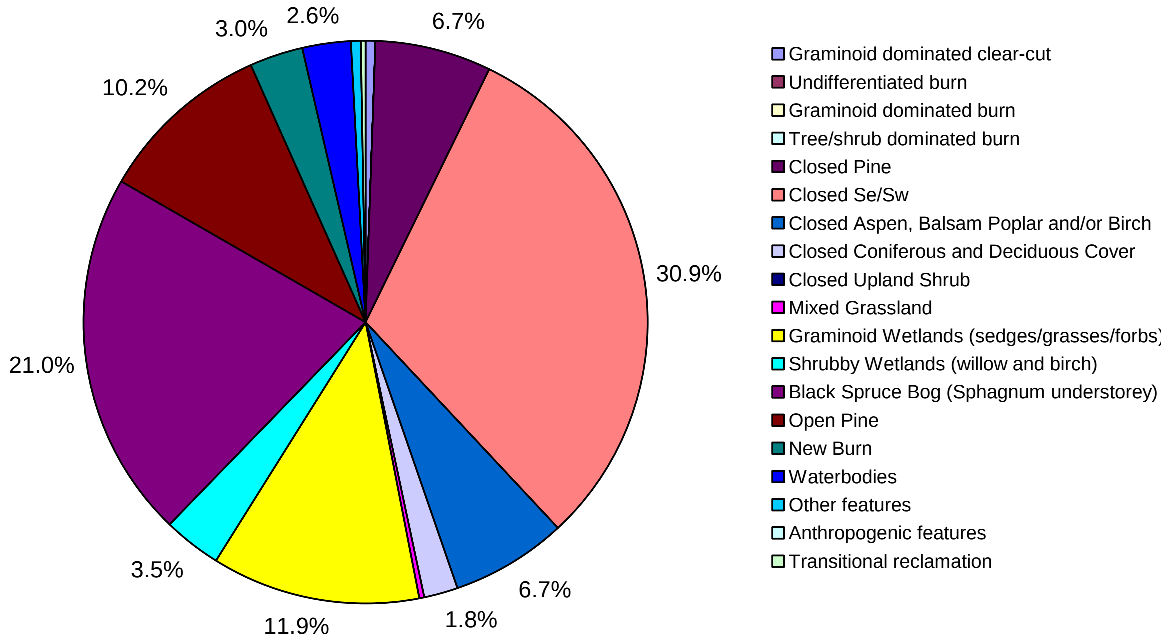
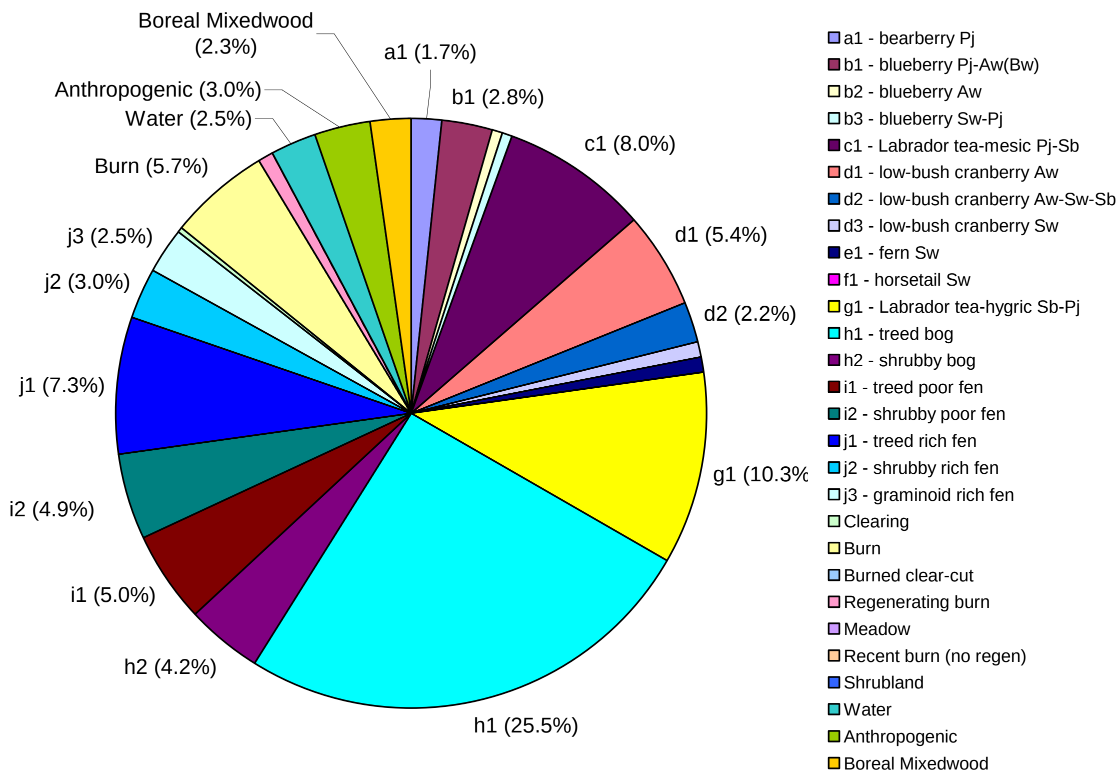


Figure 12.6-4 Percentage Cover of Lower Boreal Highlands Landscape Units in the LSA After Closure and Reclamation



12.7 Cumulative Effects Assessment

A cumulative effects assessment (CEA) considers the impacts of the Project with other existing, approved, planned and potential projects in the region that overlap temporally and spatially. These projects are listed in Volume 2, Section 1, Table 1.1 1 and include other planned or existing oil and gas facilities, forest harvesting, recreational activity and road construction (possible connector highway and bypass between Highway 63 and Highway 881).

At the time of this assessment, there were no publicly announced future oil sands developments identified in the RSA. Future industrial activities within the RSA are predicted to include exploration for oil and gas, seismic activity and forest harvesting however quantitative details (or footprints) of these future activities and associated developments are not available to North American. As such a qualitative CEA was conducted for biodiversity.

While it is not possible to quantify the future disturbances in the RSA it is expected that these projects will result in additional vegetation and habitat disturbance. For the purposes of the cumulative effects assessment, the following assumptions have been made:

- vegetation and wildlife mitigation, and reclamation methods will be similar to those identified by North American;
- vegetation and wildlife monitoring will be used to assess the effectiveness of mitigation measures;
- regional biodiversity monitoring initiative will be continued;
- properly located and constructed wildlife crossing structures are a successful form of mitigation for wildlife movement.
- end land use targets for the planned and proposed projects will be similar to North American's; and
- coordination of site developments, through integrated land management, is a successful form of mitigation.

Based on these assumptions, potential impacts and mitigation measures in the cumulative case are anticipated to be similar to those discussed in the application case. Therefore, the residual cumulative impact rating to biodiversity, at closure, is predicted to be low as in the application case. The confidence of the CEA predictions is lowered by the uncertainty of future project timing and details.

12.8 Follow-up and Monitoring

The impacts of the Project on species diversity and fragmentation were assessed to be low. Therefore, monitoring is not considered to be technically warranted. However, North American supports the Alberta Biodiversity Monitoring Program and will conduct wildlife and vegetation monitoring. This will provide data that is expected to reflect changes in, or impacts on, biodiversity.

12.9 Summary

This assessment assumed that all components of the Project will be fully developed and operational at the same time. This conservative, worst-case approach over-predicts Project impacts to biodiversity and adds a safety margin to the assessment.

At closure, the Project is predicted to have low impacts on biodiversity indicators in the LSA and RSA. Habitat richness will be unchanged from baseline levels throughout the construction and operation of the Project and after closure and reclamation. The area of most ecosite phases and other habitat types is expected to be reduced by less than three percent during construction and operation of the Project and less than one percent after closure and reclamation relative to baseline levels. The largest reduction in area will occur in ecosite phase b2 (6.4%) during the construction and operational phase. The species biodiversity potential of this ecosite phase could not be calculated because data were incomplete, but this habitat covers less than one percent of the LSA at baseline. The area occupied by ecosite phase g1 is predicted to increase as a result of reclamation. This ecosite phase has intermediate Species Biodiversity Potential. An increase in area should enhance the capacity of this habitat to sustain baseline levels of biodiversity, assuming that the biotic community is able to recover to those levels.

Habitat fragmentation will occur during the operational life of the Project as mean patch size of most/all habitats will decrease. However, decreases are not expected to exceed 16%, and will be substantially reversed in most cases during closure and reclamation.

Impacts on species richness cannot be quantified directly because only baseline species data are available. However, possible impacts on species diversity can be inferred from changes in landscape data because of the relationships between landscape diversity, patch size, the degree of fragmentation and species diversity. Ecosite phases with high potential for species diversity are not expected to be disproportionately affected by Project development and, overall, the predicted impacts on landscape diversity are not considered likely to significantly impact species diversity.

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