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10 VEGETATION AND WETLANDS

10.1 Introduction

This section presents the baseline setting and impact assessment for terrestrial vegetation and wetland resources in the Local Study Area (LSA) and Regional Study Area (RSA) for Vegetation and Wetlands. The purpose is to provide a description of the composition and extent of these resources within the LSA and RSA; to predict potential effects of the Project on these resources; and to assess the expected impacts. Available mitigation strategies are outlined, if required, and an assessment of cumulative effects is also presented.

10.2 Study Area

10.2.1 Spatial Boundaries

The Project footprint includes all lands subject to potential direct surface disturbance (e.g., soil salvage) for the construction, operation or reclamation phases of the Project. The Project footprint covers approximately 485 ha (Figure 10.2-1).

The LSA is located in portions of Sections 22, 23, 25, 26, 27, 35 and 36 in Township 55 Range 21 W4M and Section 2 in Township 56 Range 21 W4M, and covers approximately 562 ha. It includes all lands in the area owned by North American and portions of road and rail right-of-ways (ROWs) within these lands. A portion of the LSA is in the Central Parkland subregion of the Parkland Natural Region, and the remainder is in the Dry Mixedwood subregion of the Boreal Forest Natural Region (Natural Regions Committee, 2006).

The RSA covers approximately 243,830 ha, and has been delineated to evaluate potential effects of the Project that may extend or occur outside the LSA (Figure 10.2-2). Its delineation incorporated considerations regarding:

- regional industrial developments and ecological variables that have the potential to interact cumulatively;
- regional impacts related to modelled potential acid inputs (PAI) and other air emissions;
- existing, approved and planned land uses such as industrial activity and natural areas; and
- cumulative effects relating to physical disturbance associated with future announced projects.

Given the ecological interrelationships among vegetation and soils, the RSA used in the assessment process is the same as that used for the Soils section (Volume 4, Section 9).

10.2.2 Temporal Boundaries

The temporal scope of the EIA reflects the timing and nature of the Project phases, as well as information available on other proposed projects. Project and cumulative effects are assessed for the construction, operations, decommissioning and reclamation, and closure phases of the Project. The Project schedule is outlined in Volume1, Section 1.4.

To establish a baseline timeframe, background conditions were assumed to be those that existed as of May 1, 2007, and include both unpublished data and published data that were readily available.

For this EIA, existing projects are defined as those that have been approved by the EUB and/or AENV. Planned developments include projects that have been publicly disclosed (but not approved) as of May 1, 2007. The projects and developments included within the scope of this assessment are listed in Volume 2, Section 1.

LANDSCAPE UNITS IN THE LSA (BASELINE SCENARIO)

- EPHEMERAL DRAW
- CLASS I/II WETLAND
- CLASS III WETLAND
- CLASS IV WETLAND
- UNCLASSIFIED WETLAND
- MIXED SHRUBLAND
- CONIFEROUS WOODLAND
- SALIX SHRUBLAND
- DECIDUOUS WOODLAND
- AGRICULTURAL LAND
- TAME PASTURE
- HABITATION
- ROAD ROW
- RAIL ROW

N

056-21W4

055-21W4

Central Parkland

Dry Mixedwood

1:15,000

0 100 200 400 600 800 1,000 m

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER LSA
- ALBERTA NATURAL SUBREGION
- ALBERTA TOWNSHIP / RANGE
- ATS SECTION LINE

WATERBODY
- PERMANENT
- RECURRING
- STREAM - INTERMITTENT
- EPHEMERAL DRAW

- RAILWAY
- ROAD

Title:

BASELINE LANDSCAPE UNITS IN THE LOCAL STUDY AREA FOR VEGETATION AND WETLANDS

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.2-1_LSA_VEGETATION_AND_WETLANDS.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.2-1**

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AGCC CODE DESCRIPTIONS

- BLACK SPRUCE BOG
- CLOSED ASPEN, BALSAM POPLAR AND/OR BIRCH
- CLOSED CONIFEROUS AND DECIDUOUS COVER
- CLOSED PINE
- CLOSED SE/SW
- CLOSED UNDIFFERENTIATED CONIFER
- CLOSED UPLAND SHRUB
- CLOUD / HAZE
- GRAMINOID WETLANDS
- UNDIF. WETLANDS
- LICHEN BOG
- MIXED GRASSLAND
- SHRUBBY WETLANDS
- EXPOSED SOIL
- UNDIF. AGRICULTURE
- UNDIF. URBAN AND INDUSTRIAL FEATURE
- MAJOR ROADS, HIGHWAY AND RAILWAYS
- LAKE, POND, RESERVOIR, RIVER AND STREAM

320000 330000 340000 350000 360000 370000 380000

6000000 5990000 5980000 5970000 5960000 5950000 5940000 5930000 5920000 5910000 5900000

N

Dry Mixedwood

North Saskatchewan River

058-19W4 057-19W4 056-19W4 055-19W4 054-19W4 053-19W4 052-19W4 051-19W4 050-19W4

Dry Mixedwood

Central Parkland

049-26W4 049-25W4 049-24W4 049-23W4 049-22W4 049-21W4 049-20W4 049-19W4

1:285,000

0 2 4 8 12 16 20 km

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER RSA
- NORTH AMERICAN UPGRADER LSA
- BASELINE DISTURBANCE
- ALBERTA NATURAL SUBREGION
- ELK ISLAND NATIONAL PARK
- ALBERTA TOWNSHIP/RANGE
- WATERBODY
- RIVER/STREAM
- HIGHWAY

Title:

DISTRIBUTION OF GROUND COVER CLASSES IN THE VEGETATION AND WETLANDS RSA IN THE BASELINE CASE

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.2-2_RSA_VEGETATION_AND_WETLANDS_TABLOID.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.2-2**

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10.3 Assessment Criteria

Assessment criteria were used to describe and evaluate the predicted impacts of the Project. The criteria and their descriptions are in Volume 2, Section 1. The following criteria were further refined to be relevant to the Vegetation section of this EIA:

Duration describes how long the effect will occur. Duration for assessing impacts due to removal of vegetation is classified as short-term (occurring within the development phase), medium-term (occurring after development and during operation) or long-term (occurring after closure but diminishing with time).

Permanence describes the potential for the recovery or reversibility of an effect. Permanence is classified as effects that are reversible in the short-term (reversible during Project development), reversible in the medium-term (reversible during operation and diminishing before or upon closure), reversible in the long-term (remaining after closure but diminishing with time) or irreversible (permanent).

Conclusions for the Project effects criteria are based on quantitative and qualitative assessments. Quantitative assessments include the results of measurable predictions such as area of vegetation removed. Qualitative assessments are subjective and take into account conclusions based on best professional judgment. This is important when quantitative predictions are not feasible, such as uncertainty in predicting future vegetation community structure and succession.

The integration of the various impact criteria ratings result in a final impact rating for each potential Project effect. The possible final impact ratings are: no impact, low impact, medium impact or high impact. Combining objective and quantitative assessments with subjective evaluations and best professional judgment results in a conclusion for each predicted Project effect.

Key indicators identified for vegetation and wetlands include: terrestrial vegetation communities, wetlands, rare plants and rare plant communities. Potential impacts to the stated indicators are assessed with respect to removal of vegetation and alteration or changes in hydrology.

10.4 Methods

10.4.1 Assessment Approach

The assessment approach included defining issues and resources for evaluation, and conducting impact analyses relating to terrestrial vegetation and wetlands. Mitigation strategies were reviewed to determine possible and appropriate measures that would reduce potential Project impacts. Impacts were assessed at the LSA level for ecological units and all selected indicators; however, only those that had an environmental impact rating of low or higher were assessed at the RSA level.

The Baseline Case for impact analyses included existing and approved projects and activities that were judged to have a potential influence within the Project study area. A list of projects and activities included in the Baseline Case, Application Case and Cumulative Case is found in Volume 2, Section 1. Baseline information was mapped and quantified (using GIS) for terrestrial vegetation and wetlands in the LSA and RSA. The Application Case included the Baseline Case, plus potential impacts from development and operation of the Project (Project footprint). Mapping was undertaken for resources specifically affected by the Project in the LSA and RSA.

The final step of the impact analysis was a cumulative effects assessment. Cumulative effects assessments (cumulative cases) are required under the *Alberta Environmental Protection and Enhancement Act* and the *Canadian Environmental Assessment Act*. Cumulative effects likely to result from the combination of the Project, other existing and proposed projects in the area and reasonably foreseeable environmental changes present during the operational phase of the Project were considered and evaluated. Impacts at Project closure were predicted qualitatively based on this evaluation. Project effects in the LSA with a predicted magnitude of low or higher that could act cumulatively with other environmental pressures were included in the cumulative case.

10.4.2 Scoping of Indicators

Due to time and resource considerations, a scoping exercise was undertaken to determine indicators representative of broader groups of terrestrial vegetation and wetland landscape features. The following indicators have been selected to focus this assessment for terrestrial vegetation and wetlands:

- diversity and abundance of terrestrial vegetation and wetland communities;
- rare plants; and
- rare plant communities.

These indicators, as well as ecological units in the study areas, are assessed with regard to vegetation removal and alterations to hydrology. Potential impacts from non-native and invasive species and air emissions are discussed and assessed separately.

10.4.3 Ecological Land Classification Mapping

The framework for the assessment of impacts on landscape biodiversity in the LSA uses the hierarchical landscape classification system used by the Alberta Government. This classification 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 Dry Mixedwood subregion).

Habitat identification and mapping in the RSA were further refined using Alberta Groundcover Classification (AGCC) categories (Sánchez-Azofeifa et al., 2004). Due to the relatively large area of the RSA, data used in AGCC mapping are at a coarser scale than those used for mapping the LSA. Whereas LSA data are directly derived from digitized polygons, AGCC derives land cover information from interpretation of Landsat pixel spectral data. Spectral clustering is used to separate subtle variations in land cover.

Previous EIAs for other upgrader projects in the region have defined vegetation communities in their LSA using “A Preliminary Classification of Plant Communities in the Central Parkland Natural Sub-Region of Alberta” (Wheatley and Bentz, 2002). Many of the communities described in that document are based on only one or two examples, and contain limited information on species composition and relative abundance. For this assessment, therefore, landscape units in the LSA were initially delineated using aerial photographs, and then further defined on the basis of their structural characteristics. The EIAs for other upgraders in the region were also consulted. Local terrestrial plant communities and wetlands mapped in those EIAs were not included in this assessment because there was no overlap in project LSAs.

10.4.3.1 Terrestrial Vegetation

Terrestrial vegetation communities were given a general classification according to the dominant species (e.g., Deciduous Woodland, Mixed Shrubland). On this basis, five natural or semi-natural terrestrial vegetation types were identified in the LSA at baseline (Table 10.5-1). The following text describes these vegetation communities, which are based on species lists compiled from vegetation meanders and visual checks in the field. The most similar communities described in Wheatley and Bentz (2002) are also noted. A plant species list for each community is given in Appendix 10A.

Deciduous Woodland

Vegetation in this area includes a tree canopy dominated by trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*), and a shrub layer that includes saskatoon (*Amelanchier alnifolia*), choke cherry (*Prunus virginiana*) and prickly rose (*Rosa acicularis*). Common herbaceous species include cream-colored vetchling (*Lathyrus ochroleucus*), northern bedstraw (*Galium boreale*) and marsh reed grass (*Calamagrostis Canadensis*). The most common mosses are red-stem feather moss (*Pleurozium schreberi*) and stair-step moss (*Hylocomium splendens*).

Wheatley and Bentz (2002) describe several deciduous forest/woodland communities that are similar to the *Populus* spp. deciduous woodland. These include:

- the *Populus tremuloides* / *Prunus virginiana* – (Shrub) / Low herb community in the *Populus tremuloides* forest/woodland alliance; and
- the *Populus balsamifera* / *Salix petiolaris* community in the *Populus balsamifera* woodland alliance.

The *Populus tremuloides* / *Prunus virginiana* – (Shrub) / Low herb community is described as having an average of 41% cover of *Populus tremuloides*, 43% low shrubs and 58% herb-dwarf shrubs (Wheatley and Bentz, 2002; Fehr, 1984). This plant community grows on dry, exposed upper slopes such as sandy outwash planes, dune complexes, inter-dune depressions and kame moraines (Fehr, 1982; Pearson Timberline, 1993). Species that are common in this community include *Populus tremuloides*, *Amelanchier alnifolia*, snowberry (*Symphoricarpos*) spp., *Rosa* spp., *Lathyrus ochroleucus* and *Galium boreale* (Fehr, 1984; Meijer and Karpuk, 1999; Pearson Timberline, 1993).

The *Populus balsamifera* / *Salix petiolaris* community is described in Wheatley and Bentz (2002) as being dominated by *Populus balsamifera,* with a shrub layer of basket willow *Salix petiolaris*, and an understorey with abundant *Juncus balticus* (wire rush). This community occupies areas where the water table is at a depth of around 1.5 m, especially around lakes and sloughs in Parkland regions (Wheatley and Bentz, 2002).

Coniferous Woodland

This plant community is present in the LSA as patches of spruce (*Picea* spp.) trees of various ages, surrounded by deciduous shrubs. Identification was based on aerial photography. No surveys were carried out in this community.

The most similar community described in Wheatley and Bentz (2002) is likely to be the *Picea glauca – Populus tremuloides – Populus balsamifera* / (shrubs and herbs) community in the *Picea glauca* mixed-evergreen deciduous forest/woodland alliance. However, a detailed description of that community is not available.

Salix Shrubland

This community is characterized by an extensive overstorey of *Salix* spp. shrubs. It has some similarities to the low shrubs and herbs (*Salix petiolaris*) community of the *Salix* spp. shrubland alliance in Wheatley and Bentz (2002). The low shrubs and herbs (*Salix petiolaris*) community is described by Wheatley and Bentz (2002) as occupying banks around sloughs and mesic depressions in moist areas with rolling topography. In the LSA the *Salix* shrubland is found in the study area around temporarily or semi-permanently flooded unclassified wetlands in the north.

In Wheatley and Bentz (2002), basket willow (*Salix petiolaris*) and yellow willow (*Salix lutea*) are given as common species in the low shrubs and herbs (*Salix petiolaris*) community of the *Salix* spp. shrubland alliance. *Populus* spp. may also be present. *Salix* spp. and *Populus balsamifera* were recorded in 2006 in the survey plot within the *Salix* shrubland community.

Mixed Shrubland

Survey data suggest that this community is highly similar to the *Populus tremuloides – Amelanchier alnifolia – Prunus virginiana* / *Rosa* spp. community in the *Populus tremuloides* shrubland alliance in Wheatley and Bentz (2002). That association is described as "a young shrub-level successional stage of regenerating trembling aspen in areas where the canopy has opened as a result of natural disturbance" (Wheatley and Bentz, 2002). *Amelanchier alnifolia*, *Prunus virginiana* and *Rubus idaeus* are identified as common shrubs, and all were found in the Mixed shrubland community in the LSA.

None of the forb species listed for the *Populus tremuloides – Amelanchier alnifolia – Prunus virginiana* / *Rosa* spp. community were recorded in the Mixed shrubland community in the LSA, but several species typical of open woods were found. These species include wild vetch (*Vicia Americana*) and Canada goldenrod (*Solidago Canadensis*). Mosses that are indicative of the presence of poplars (e.g., *Pylaisiella polyantha* and *Platygyrium repens*) and the forest floor mosses such as *Pleurozium schreberi*, *Hylocomium splendens* and knight's plume (*Ptilium crista-castrensis*) were also observed. These forest floor species are typical of late successional spruce (*Picea* spp.) forests and may be relics of earlier woodland plant communities.

Tame Pasture

Tame Pasture is a grazing area in which periodic cultivation is used to maintain introduced (non-native) forage species. The area of Tame Pasture in the LSA is no longer in use, and native species are becoming established. Moreover, a rare plant species was found in this community. For these reasons, Tame Pasture has been included among the natural and semi-natural plant communities in the LSA on which Project impacts are assessed.

Species surveys in the Tame Pasture community in 2006 identified a mixture of weedy species of disturbed or waste ground and forbs typical of moist or marshy areas, including common great bulrush (*Scirpus validus*), common horsetail (*Equisetum arvense*), wild mint *Mentha arvensis* and water parsnip (*Sium suave*). No shrub species were recorded, and the only bryophytes noted were *Ceratodon purpureus*, a ruderal species common to disturbed soil, and *Brachythecium* sp. Species recorded in 2007 included snowberry (*Symphoricarpos occidentalis*), *Rosa acicularis*, smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), Canada goldenrod (*Solidago canadensis*), *Aster* spp., Philadelphia fleabane (*Erigeron philadelphicus*) and *Equisetum arvense*.

10.4.3.2 Wetlands

Wetlands were classified based on the categories given in "Classification of Natural Ponds and Lakes in the Glaciated Prairie Region" (Stewart and Kantrud, 1971). Seven major classes of wetlands are distinguished by Stewart and Kantrud (1971) on the basis of the vegetational zone occurring in the central or deeper part of the wetland and occupying five percent or more of the total wetland area. Four of the wetland classes described in Stewart and Kantrud (1971) were considered to be present in the LSA: Classes I to IV. Classes I and II were combined in the classification used in this assessment because data were not sufficient to confidently allocate wetlands to one class or the other. Some wetlands could not be allocated to any class due to a lack of data, and were therefore categorised as Unclassified Wetlands.

A general description of wetlands in each category is given below. A detailed species list for each wetland category is given in Appendix 10A.

Class I/II Wetland – Ephemeral Wetlands/Wet-Meadow Zone

Ephemeral wetlands are generally shallow and only hold water for very short periods, typically in wetter seasons and years. When ephemeral wetlands become dry in cropland areas, a cropland drawdown phase and a cropland tillage phase are generally common. Typical species include Kentucky bluegrass (*Poa pratensis*) and toad rush (*Juncus bufonius*).

Wet-meadow vegetation occupies the central areas of many shallow pond basins, and as a peripheral band in deeper ponds and lakes. Water is generally present for several weeks in spring and summer after heavy rainfall. Under cultivation, wet-meadow zones in early spring generally have an open-water phase, without submerged aquatic plants. Unless plants from previous years are present, this is soon replaced by a drawdown bare-soil phase. When there is repeated cultivation, the bottom soils are generally dominated by annual field weeds. Planted small grain or row crops are often present.

Class I/II Wetlands are distributed throughout the LSA (Figure 10.2-1). Some of these ponds are part of a wetland complex that drains across the Canadian National Railway (CNR) rail line on the south boundary of the LSA and through an ephemeral draw towards the North Wetland Complex (described below).

Class III Wetland – Seasonal Ponds

Seasonal ponds are represented by shallow marsh vegetation (moderately coarse grasses and sedges with associated forbs). Surface water is generally present until early summer, but frequently is dry by late summer and early fall. Under cultivation, wetland phases occurring within the shallow marsh include an open-water phase (with or without submerged plants), a drawdown bare-soil phase, a cropland drawdown phase and a cropland tillage phase. Typical dominant species in the emergent phase are grasses or grass-like plants that are intermediate in height.

A single Class III Wetland is located in the southwest portion of the property in NW 26-55-21 W4M.

Class IV Wetland – Semi-Permanent Ponds

Semi-permanent ponds are represented by areas of pond basins that generally maintain surface water throughout the spring and summer and frequently into the fall and winter. Only the normal emergent wetland phase is presented within the LSA. Plant species within this wetland class are dominated by coarser and taller plants (i.e., cattail [*Typha latifolia*], bulrush [*Scirpus* spp]) and submerged or floating plants.

Several Class IV Wetlands form a region to the north of the property that drains into an unnamed creek outside the LSA for Vegetation and Wetlands. In this EIA, these are collectively referred to as the North Wetland Complex.

Ephemeral Draw

Ephemeral draw is an intermittent, ephemeral water course that carries stream flow during wet periods, or after heavy rainfall and snowmelt events. At other times, the land occupied by the ephemeral draw may be converted to cropland.

The extent of Ephemeral Draws in the LSA was extrapolated from aerial photographs for the Hydrology section of this EIA (Volume 3, Section 6). Surface flow within these draws was not observed in the field, and may be limited to extreme snowmelt and storm events. The drainage path, as indicated in Figure 6.5-3 in the Hydrology section, appears to connect several Class I/II Wetlands and the North Wetland Complex on the east side of the LSA, and a Class I/II Wetland, Class III Wetland and the North Wetland Complex on the west side of the LSA (Figure 10.2-1).

Unclassified Wetlands

Some wetlands could not be classified due to a lack of field data. However, aerial photographs indicate that these are Class I/II Wetlands. These are located in the far north of the LSA (Figure 10.2-1).

10.4.4 Field Program

Field surveys were conducted to verify mapping of vegetation communities and wetlands in the LSA, and to survey for rare species. Surveys (meanders) were conducted on August 22, 2006, and on June 29 and 30, 2007. The timing of surveys was chosen to coincide with early and late flowering periods for rare plants. Project development was still conceptual in 2006, and a footprint had not yet been defined. Therefore, sampling sites were chosen that were representative of the plant communities in the LSA or that had high potential for the presence of rare species. Locations of surveys in 2007 were chosen to ensure coverage of communities that were considered likely to be under the Project footprint.

Meanders involve walking randomly through a site and noting each new species until no more new species are observed (Lancaster, 2000). They are recommended by the Alberta Native Plant Council as an effective scientific means of assessing an area for rare plants (Lancaster 2000), and can also be used to compile a representative list of species in a given habitat. For this assessment, common tree, shrub and groundcover species (forbs and cryptogams) were recorded at all survey sites. A list of all species encountered in the LSA is provided in Appendix 10A. Species lists and GPS co-ordinates were recorded for each meander, and photographs were taken of representative vegetation at each location. The location of sampling sites is shown in Figure 10.4-1.

10.4.5 Rare Plants

A rare plant species is considered to be any native vascular or non-vascular plant that exists in low numbers or in very restricted areas of Alberta due to (i) its biological characteristics; (ii) it being at the fringe of its range; or (iii) for some other reason (Lancaster, 2000). Rare plant species of Alberta include those listed on the current Alberta Natural Heritage Information Centre (ANHIC) tracking list (Gould, 2006), and those listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2006, Internet site).

For this assessment, surveys were carried out to locate rare plants that would be directly affected by development of the Project. These surveys were conducted in accordance with the protocols described in "Guidelines for Rare Plant Surveys" (Lancaster, 2000). Prior to conducting the rare plant survey, a list of rare plants expected to occur in the Central Parkland subregion and the Dry Mixedwood subregion was generated by searching ANHIC databases and consulting "Rare Vascular Plants of Alberta" (Kershaw et al., 2001), other EIAs and other vegetation studies conducted in the region. ANHIC ranks species based on their global and provincial status using a system developed by The Nature Conservancy (Gould, 2006). Status is determined primarily by the number of occurrences of each species in the Province of Alberta or globally, and is assigned using a scale of 1 (very rare) to 5 (secure). For the purposes of this assessment, species with a provincial rank of 1 to 3 were considered rare. The ranks for Alberta (S) and globally (G) are as follows:

- G1/S1: fewer than 5 occurrences or only a few remaining individuals;
- G2/S2: 6 to 20 occurrences, or with many individuals in fewer occurrences;
- G3/S3: 21 to 100 occurrences may be rare and local throughout its range, or in a restricted range (may be abundant in some locations or may be vulnerable to extirpation because of some factor of its biology);
- G4/S4: apparently secure under present conditions, typically greater than 100 occurrences, but may be fewer with many large populations; may be rare in parts of its range, especially peripherally;
- G5/S5: demonstrably secure under present conditions, greater than 100 occurrences, may be rare in parts of its range, especially peripherally;
- GNR/SNR: unranked or under review;
- GH/SH: historically known, may be relocated in the future; and
- GNA/SNA: conservation status not applicable (includes exotic species).

The list of rare plant species that could potentially occur in the LSA is given in Appendix 10B. An ANHIC data search for occurrences of tracked plant and lichen elements found no historical records of occurrences within the LSA (Rintoul, 2007, personal communication).

Available ecological and phenological information was reviewed to determine appropriate timing of field work. Meanders were conducted on August 22, 2006, to identify late-flowering rare plant species, and on June 29 and 30, 2007, to identify early-flowering rare species (Figure 10.4-1). Species were initially identified using a variety of taxonomical references, including "Flora of the Pacific Northwest" (Hitchock and Cronquist, 2001), "Flora of Alberta" (Moss, 1996) and "A Checklist of Rare Vascular Plants in Alberta" (Packer and Bradley, 1984). Where a rare species was found, a GPS reading was taken and the approximate size of the population was recorded. Whenever possible, voucher specimens were collected or photographs were taken. Species identified were independently confirmed by qualified taxonomic experts.

10.4.6 Rare Plant Communities

A rare plant community is defined by ANHIC as a combination of species that is unusual, uncommon, of limited extent or infrequently encountered (Allen, 2007). Vegetation types that are considered to be in decline or threatened are considered rare communities. Rare communities

may or may not be associated with rare plants, because it is the assemblage of species that determines rarity, rather than presence or absence of rare species. Only natural communities are considered. Rare community rankings for Alberta are explained in Appendix 10C.

Rare plant communities cannot be identified from aerial photos because detailed species lists are required. For this assessment, rare plant communities were identified from data collected during vegetation meanders and visual checks.

10.4.7 Non-Native and Invasive Species

Non-native and invasive species are defined by the Alberta Native Plant Council as plants not originally native to Alberta, or plants that, once introduced into native habitats, can displace native plants (ANPC, 2000, Internet site). For the purposes of this EIA, non-native and invasive species also include weed species that are identified in the Alberta *Weed Control Act*. The Alberta *Weed Control Act* recognizes three classes of non-native and invasive species: Restricted weeds, Noxious weeds and Nuisance weeds. The *Weed Control Act* requires that landowners or occupants "destroy" Restricted weeds wherever they occur in order to prevent the wider establishment of these species. Landowners or occupants are also required to "control" Noxious weeds where these are identified as problematic. "Destroy" is defined in the *Weed Control Act*, with reference to a Restricted weed, as to (i) kill all growing parts of the weed, or (ii) render the reproductive mechanisms of the weed non-viable. "Control" is defined in the *Weed Control Act*, with reference to a Noxious weed, as to (i) carry out measures designed to inhibit propagation of the weed, (ii) destroy the weed, or (iii) carry out measures prescribed by an inspector for the control of the weed. Nuisance weeds are common species that can be found throughout the province, and can cause economic losses.

No specific surveys were done to identify non-native and invasive species. These species were noted when observed in the LSA, and are described in this report.

10.4.8 Air Emissions

The Project will be a source of sulphur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOC) and $PM_{2.5}$ emissions that result from combustion processes. Fugitive sources also produce VOC and reduced sulphur compound (RSC) emissions. Further details are given in the Air Quality section (Volume 2, Section 2).

Among plant species, cryptogams (bryophytes and lichens) can be particularly sensitive to air emissions (Häffner, 2001, Vitt et al., 2003). They respond rapidly to the uptake of chemical substances in precipitation, and are effective accumulators of potentially toxic substances in solution (Conti and Cecchetti, 2001; Onianwa, 2001). Critical thresholds of SO_2, NO_2 and nitrogen deposition for cryptogams are typically lower than those for vascular plants (WHO, 2000, Internet site).

Given the above considerations, potential Project-related impacts of SO_2, NO_2 and nitrogen deposition on vegetation and wetlands were assessed using critical thresholds for cryptogams. The area of each AGCC vegetation and wetland cover category in the RSA exposed to concentrations of SO_2, NO_2 and nitrogen deposition above critical thresholds for cryptogams was determined at baseline. These values were then compared with those predicted at application and under the cumulative case to determine whether project development is likely to lead to an increase in the area of exposure. Particular attention was paid to cover categories that are associated with high bryophyte or lichen cover (e.g., Closed Pine, Closed Se/Sw [Engelmann spruce/white spruce], Closed Undifferentiated Coniferous Forest, Lichen Bog, Black Spruce Bog and Lake, Pond, Reservoir, River and Stream). Critical thresholds for specific substances are discussed below.

Sulphur Dioxide and Nitrogen Dioxide Concentration

The World Health Organization (WHO) has proposed that a critical concentration threshold (i.e., annual average) for NO_2 that protects all plants from adverse effects should be lower than 15 ug/m^3 (WHO, 2000, Internet site). For SO_2, the WHO's Air Quality Guidelines (WHO, 2000, Internet site) cite the United Nations Economic Commission for Europe critical threshold annual mean to protect certain lichen species as 10 ug/m^3.

Based on the above, critical concentration thresholds for cryptogams have been established in this assessment as:

- 10 ug/m^3 of SO_2;
- 15 ug/m^3 of NO_2.

To evaluate the potential effects of SO_2 and NO_2 emissions on plant communities, threshold isopleths for these emissions were superimposed on a map of AGCC cover classes in the different assessment scenarios. GIS analysis was then used to determine the percentage of each vegetation and wetland cover category that is predicted to be exposed to above-threshold concentrations in each scenario.

Nitrogen Deposition

The WHO and the United Nations Environment Program/Netherlands National Institute for Public Health and the Environment (UNEP/RIVM, 1999) have established critical nitrogen deposition rates for sensitive species and ecosystems. Critical nitrogen deposition rates are those at which point growth and compositional characteristics may change. WHO guidelines have estimated that nitrogen deposition should not exceed 5 kg/ha/y to 10 kg/ha/y for ombrotrophic bogs, and 10 kg/ha/y to 15 kg/ha/y for managed acidic coniferous forests in Europe (WHO, 2000, Internet site). In Alberta, Vitt et al. (2003) estimated that nitrogen deposition should not exceed 15 kg/ha/y for *Sphagnum* species. Using such thresholds as a guide, a critical load of 10 kg/ha/y was used in this assessment.

To evaluate the potential effects of nitrogen deposition on plant communities, threshold isopleths for this chemical were superimposed on a map of AGCC cover classes in the different assessment scenarios. GIS analysis was then used to determine the percentage of each vegetation and wetland cover category that is predicted to be exposed to above-threshold concentrations in each scenario.

Potential Acid Input

Effects on vegetation from acid deposition may include changes to health and vigour. Where these effects are severe, acid deposition may result in the loss of sensitive species. Air emissions effects on vegetation can occur directly through foliar deposition and/or indirectly through changes in soil chemistry.

In this EIA, sensitivity to acid deposition is assessed at the level of AGCC groundcover classes for the RSA. Although the sensitivity of some plant species has been researched (Kennedy et al., 1988) and sensitivity ratings suggested, the response to air emissions of any particular plant species is highly variable. This is due to additive factors such as stress induced by interspecific and intraspecific competition, disease and herbivory. Abiotic conditions that affect growth rates, such as drought, lack of nutrients and light availability, can also influence sensitivity to acid deposition. For this assessment, the sensitivity of groundcover classes has been determined using modelled soil sensitivities rather than the composition of sensitive plant species. Methods

of determining soil sensitivity are described and discussed in the Soils section (Volume 4, Section 9).

To determine potential impacts from PAI, land cover classes in the RSA were correlated with sensitivity to acidification ratings for the dominant soils in those classes. Soil sensitivity, therefore, was used as a proxy for possible vegetation sensitivities. The cumulative effects case and impact results for soils in this assessment are based on modelled soil sensitivities (Volume 4, Section 9.8.2). Areas that fall under a PAI load greater than the critical load will be identified as potential monitoring locations.

LANDSCAPE UNITS IN THE LSA

- EPHEMERAL DRAW
- CLASS I/II WETLAND
- CLASS III WETLAND
- CLASS IV WETLAND
- UNCLASSIFIED WETLAND
- MIXED SHRUBLAND
- CONIFEROUS WOODLAND
- SALIX SHRUBLAND
- DECIDUOUS WOODLAND
- AGRICULTURAL LAND
- TAME PASTURE
- HABITATION
- ROAD ROW
- RAIL ROW

N

056-21W4

055-21W4

Central Parkland

Dry Mixedwood

1:15,000

0 100 200 400 600 800 1,000 m

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER LSA
- ALBERTA NATURAL SUBREGION
- ALBERTA TOWNSHIP / RANGE
- ATS SECTION LINE

WATERBODY
- PERMANENT
- RECURRING
- STREAM - INTERMITTENT
- EPHEMERAL DRAW

- RAILWAY
- ROAD
- LATE MEANDER POINT
- EARLY MEANDER POINT

Title:

SAMPLING SITES IN LANDSCAPE UNITS IN THE VEGETATION AND WETLANDS LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.4-1_VEG_SAMP_SITES_IN_LSA_TABLOID.mxd

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10.5 Existing Conditions

10.5.1 Regional Context

The RSA and LSA of the Project lie partly within the Dry Mixedwood subregion of the Boreal Forest Natural Region, and partly within the Central Parkland subregion of the Parkland Natural Region. A general description of these subregions is given below.

10.5.1.1 The Dry Mixedwood Subregion

The northern portion of the proposed Project site, i.e., the area north of Township 56 Range 21, is within the Dry Mixedwood subregion. This subregion is characterized by low relief and terrain that is level to undulating (Sweetgrass Consultants Ltd., 1997). It borders on the Central Mixedwood subregion to the north, the Lower Foothills subregion to the west and the Central Parkland subregion to the south.

Deciduous forests dominated by trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) are common in the south of this subregion. The understorey in these forests can include low-bush cranberry (*Viburnum edule*), beaked hazelnut (*Corylus cornuta*), prickly rose (*Rosa acicularis*), red-osier dogwood (*Cornus stolonifera*), cream-coloured pea vine (*Lathyrus ochroleucus*), twinflower (*Linnaea borealis*) and saskatoon (*Amelanchier alnifolia*). White spruce (*Picea glauca*) is frequent in the north. Drier soils may be occupied by jack pine (*Pinus banksiana*), and poorly drained sites can be dominated by black spruce (*Picea mariana*), willows (*Salix* spp.) and sedges (*Carex* spp.).

The most common soils in the Dry Mixedwood subregion are Grey Luvisols, on well-drained, upland till sites; Eutric Brunisols, on coarse-textured sandy uplands; and Organics or Gleysols, on wet depressional sites. The vegetation consists largely of trembling aspen and balsam poplar-dominated plant communities. In mixedwood forests, these species occur in combination with coniferous trees such as white spruce (*Picea glauca*) or balsam fir (*Abies balsamifera*).

10.5.1.2 The Central Parkland Subregion

The portion of the proposed Project south of Astotin National Park (Township 56) is located within the Central Parkland subregion.

The Central Parkland subregion covers the majority of the Parkland Natural Region. It is bordered to the west and north by the Dry Mixedwood subregion of the Boreal Forest Natural Region. To the south, it is bordered by the Foothills Parkland subregion of the Parkland Natural Region, and the Foothills Fescue and Northern Fescue subregions of the Grassland Natural Region (Sweetgrass Consultants Ltd., 1997).

Vegetation in the southern and eastern parts of the Central Parkland subregion is dominated by plains rough fescue (*Festuca hallii*) prairie. Clumps of trembling aspen are present but are restricted to moist sites. In the northern and western parts of this subregion, trembling aspen forest is dominant, and grasslands are restricted to drier areas. Most of this subregion is under cultivation. Current information suggests that only about five percent of the Central Parkland subregion contains native vegetation (Natural Regions Committee, 2006).

Soils in the Central Parkland subregion are predominantly Black and Dark Brown Chernozems, under grasslands, and Dark Grey Chernozems and Luvisols, under trembling aspen woodlands. Saline lakes and wetlands occur throughout the subregion. Trembling aspen and balsam poplar

forests are common in the north, whereas grassland vegetation dominated by rough fescue is common in the south.

Agriculture and oil and gas production facilities are prominent features of the landscape in the Central Parkland (Wheatley and Bentz, 2002). This area has a high human population, and between 85% and 95% of the landscape is believed to have been converted to agriculture, urbanization and infrastructure since the mid 1800s (IISD, 1994).

10.5.2 LSA

The RSA and LSA habitat types were defined using different levels of data. The RSA habitat types were based on coarser data (AGCC cover categories), resulting in different landscape categories from those identified in the LSA, which were defined using more detailed data.

10.5.2.1 Diversity and Abundance of Terrestrial Vegetation and Wetlands

Five natural or semi-natural terrestrial vegetation communities were identified in the LSA (Table 10.5-1). The community with the highest cover is Tame Pasture, which occupies approximately 19.3 ha, (3.4% of the LSA). Deciduous Woodland is the next most common, covering 3.7 ha (0.7%). All other terrestrial plant communities represent 1.0% or less of the LSA. The LSA at baseline consists mostly of Agricultural Land (483.5 ha or 85.8% of the LSA).

Wetlands occupy approximately 31.8 ha (5.7%) of the LSA. Class I/II Wetlands have the highest cover in the LSA (10.3 ha or 1.8% of the LSA) and Class IV Wetlands have the second-highest cover (9.6 ha; 1.7% of the LSA). The cover of all wetland types at baseline is shown in Table 10.5-1.

Table 10.5-1 Abundance and Diversity of Vegetation Types, Wetlands and Anthropogenic Disturbances in the LSA at Baseline

Landscape Unit	Baseline	
	Area (ha)	% of LSA
Terrestrial Vegetation		
Deciduous Woodland	3.7	0.7
Coniferous Woodland	0.4	0.1
Salix Shrubland	1.0	0.2
Mixed Shrubland	0.5	0.1
Tame Pasture	19.3	3.4
Terrestrial Subtotal	**25.0**	**4.4**
Wetlands		
Class I/II Wetland	10.3	1.8
Class III Wetland	5.1	0.9
Class IV Wetland	9.6	1.7
Ephemeral Draw	5.4	1.0
Unclassified Wetland	1.4	0.3
Wetland Subtotal	**31.8**	**5.7**
Anthropogenic Disturbances		
Agricultural Land	483.5	85.8
Habitation	8.4	1.5
Railway	4.9	0.9
Road	10.1	1.8
Anthropogenic Disturbances Subtotal	**506.8**	**89.9**
Total	**563.6**	**100.0**

10.5.2.2 Rare Plants and Rare Plant Communities

One population of the rare species *Asclepias ovalifolia* Dcne. (low milkweed) was identified in the LSA. This population was found in the Tame Pasture in SE 2-56-21 W4M, and was divided into several subpopulations (Figure 10.5-1). ANHIC has given *A. ovalifolia* a provincial ranking of S3 and a global ranking of G5. ANHIC rankings are explained in Section 10.4.3. SE 2-56-21 W4M is outside of the Project footprint. No development of this quarter section is proposed by North American.

No rare plant communities were found in the LSA.

10.5.2.3 Non-Native and Invasive Species

Non-native and invasive plant species that were found in the LSA are listed in Table 10.5-2 with the vegetation type in which they were found. One Restricted weed, scentless chamomile (*Matricaria maritime*), was recorded along the roadside at the site of two meanders in Class IV Wetlands. Three Noxious weeds and two Nuisance weeds were also found in the LSA.

Table 10.5-2 Non-Native and Invasive Species Recorded in LSA

Scientific Name	Common Name	Community Type	Status in Alberta
Matricaria maritima L.	Scentless chamomile	Class IV Wetland	Restricted weed
Cirsium arvense (L.) Scop.	Canada thistle	Class I/II Wetland, Class IV Wetland	Noxious weed
Ranunculus acris L.	Tall buttercup	Class IV Wetland	Noxious weed
Sonchus arvensis L.	Perennial sow thistle	Class I/II Wetland, Class IV Wetland	Noxious weed
Taraxacum officinale Weber	Common dandelion	Class IV Wetland, Deciduous Woodland	Nuisance weed
Thlaspi arvense L.	Stinkweed	Class IV Wetland	Nuisance weed
Bromus inermis Leyss.	Awnless brome	Class I/II Wetland, Class IV Wetland, Tame Pasture, Deciduous woodland	Invasive
Chenopodium album L.	Lamb's-quarters	Class I/II Wetland, Class IV Wetland	Non-native
Matricaria matricarioides (Less.) Porter	Pineapple weed	Class IV Wetland	Non-native
Melilotus officinalis (L.) Lam.	Yellow sweet clover	Class IV Wetland	Non-native
Plantago major L.	Common plantain	Class IV Wetland	Non-native
Poa pratensis L.	Kentucky bluegrass	Tame Pasture	Non-native
Polygonum arenastrum Jord ex Bor.	Common knotweed	Class IV Wetland	Non-native
Silene pratensis (Rafn) Godron & Gren.	White cockle	Class I/II Wetland	Non-native
Sonchus asper (L.) Hill	Annual sow thistle	Class IV Wetland	Non-native
Stellaria arvense L.	Common chickweed	Class IV Wetland	Non-native
Tragopogon dubius Scop.	Goat's-beard	Class I/II Wetland	Non-native

10.5.3 RSA

10.5.3.1 Diversity and Abundance of Terrestrial Vegetation and Wetlands

Based on AGCC cover categories, seven natural or semi-natural terrestrial vegetation communities are present in the RSA at baseline (Table 10.5-3). The most common is

Closed Aspen, Balsam Poplar and/or White Birch, which covers 30,098 ha (12.3% of the RSA). Mixed Grassland is the only other terrestrial vegetation community that covers greater than 1.0% of the RSA (13,179 ha or 5.4% of the RSA).

Six wetland cover categories occur in the RSA. These cover a total of 27,236 ha, or 11.2% of the RSA (Table 10.5-3) at baseline. Wetlands classified in the AGCC data as Undifferentiated Wetlands have the highest cover, at 16,710 ha (6.9% of the RSA). Lakes, Ponds, Reservoirs, Rivers and Streams occupy 7,702 ha (3.2%) of the RSA. Each of the other wetland types covers less than 1.0% of the RSA.

Table 10.5-3 Abundance and Diversity of Vegetation Types, Wetlands and Anthropogenic Disturbances in the RSA at Baseline

Landscape Unit	Baseline	
	Area (ha)	% of LSA
Terrestrial Vegetation		
Closed Aspen, Balsam Poplar and/or White Birch	30,098	12.3
Mixed Grassland	13,179	5.4
Closed Upland Shrub	784	0.3
Closed Se/Sw	457	0.2
Closed Pine	421	0.2
Closed Coniferous and Deciduous Cover (40-60%)	341	0.1
Closed Undifferentiated Coniferous Forest	755	0.3
Terrestrial Subtotal	**46,035**	**18.9**
Wetlands		
Undifferentiated Wetlands	16,710	6.9
Lake, Pond, Reservoir, River and Stream	7,702	3.2
Black Spruce Bog (*Sphagnum* understorey; 6-100 % tree cover)	1,532	0.6
Shrubby Wetlands (willow and birch)	1,122	0.5
Graminoid Wetlands (sedges/grasses/forbs; <6% tree cover, <25% shrub)	158	0.1
Lichen Bog (Lichen understorey; 6-25 % tree cover)	13	<0.1
Wetland Subtotal	**27,236**	**11.2**
Anthropogenic Disturbances		
Undifferentiated Agriculture	65,078	26.7
Undifferentiated Urban and Industrial Feature	749	0.3
Major Roads, Highways and Railways	1,420	0.6
Other Baseline Disturbances[1]	94,050	38.6
Exposed Soil	9,254	3.8
Anthropogenic Subtotal	**170,551**	**69.9**
Cloud/Haze	8	<0.1
Total	**243,830**	**100.0**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

10.5.3.2 Rare and Unique Natural Resources

The term “rare and unique natural resources” applies to features that are significant, sensitive or which require special recognition (Parks Canada, 2005). A list of rare and unique natural resources that potentially occur in the RSA was compiled using information from Allen (2007) and Parks Canada (2005). There are nine such resources that have been identified within the RSA.

These include saline marshes, soap holes, needle-leafed evergreen and deciduous wetlands, spruce islands of Astotin Lake, old growth mixed wood forest, jack pine, the sand hills, white birch communities and natural licks and groundwater springs. These resources are located within Elk Island National Park and are described below (Parks Canada, 2005).

Saline Marshes

The saline marshes are the rarest wetlands in the park. Dominated by the arrowgrass family, they are found along the park's eastern boundary and south of Walter Lake.

Soap Holes

The evaporation of groundwater at these locations contributes to the accumulation of soluble salts at the surface. Poorly drained, these soils support a unique community of alkali grasses. Soap holes in the park are on the east side of the Hayburger Trail.

Needle-Leafed Evergreen and Deciduous Wetlands

These swamps consist of a mix of white spruce, black spruce and larch. The only wetland of its type in Western Canada, it is found in the northern section of the park.

Spruce Islands of Astotin Lake

Large mature stands of native white spruce grow on several islands in Astotin Lake. These unique areas escaped the effects of fire and browsing by ungulates. They are important habitat for some species.

Old Growth Mixed Wood Forest

The most representative area of old growth mixed wood forest is found in the northern part of the park. Loss of this small, localized habitat would be devastating for certain birds.

Jack Pine

A small, isolated stand of jack pine grows west of the parkway, south of the turnoff to the park administration building. Recent surveys located only one living jack pine in this stand.

The Sand Hills

Sandy soils are naturally exposed in three areas: southeast of Moss Lake; the southwest corner of the Wood Bison Trail, known locally as the Blueberry Hills; and the west side of Walter Lake. The Blueberry Hills, where soil conditions have turned the aspen bark white, are of particular interest.

White Birch Communities

White birch communities are rare in the area. They occur in closed stands and are prominent on the west side of Tawayik Lake.

Natural Licks and Ground Water Springs

Several springs in the park provide a source of minerals for ungulates. The water chemistry of the springs also supports unique vegetation.

10.5.3.3 Air Emissions

Sulphur Dioxide Concentration

A total of 97 ha (<0.1% of the RSA) are exposed to annual average SO_2 concentrations exceeding 10 ug/m^3 at baseline (Table 10.5-4). The areas under such concentrations are predominantly anthropogenic disturbances (94 ha or 97.3% of the total area exposed; Figure 10.5-2).

Lake, Pond, Reservoir, River and Stream is the only vegetation or wetland landscape unit that includes areas exposed to SO_2 concentrations exceeding the threshold for cryptogams at baseline. Three hectares of this community are exposed, which is less than 0.1% of the total area of this community in the RSA (7,702 ha; Table 10.5-4).

Nitrogen Dioxide Concentration

A total of 154,403 ha (63.3% of the RSA) are exposed to annual average NO_2 concentrations exceeding 15 ug/m^3 at baseline (Table 10.5-4). The areas affected by such concentrations are predominantly anthropogenic disturbances at baseline (123,440 ha or 79.9% of the total area exposed in the RSA; Figure 10.5-2).

The area of terrestrial vegetation and wetlands exposed to annual average NO_2 concentrations exceeding the critical threshold for cryptogams is 30,963 ha, which represents 42.3% of the total area of vegetation and wetlands in the RSA (73,271 ha). Among the terrestrial vegetation communities, Mixed Grassland has the highest percentage of area exposed (55.9% of the total area of this community in the RSA; Table 10.5-4). Among wetlands, Lichen Bog has the highest percentage of area exposed (98.1% of the total area of this community in the RSA; Table 10.5-4).

Nitrogen Deposition

A total of 50,746 ha (20.8% of the RSA) are exposed to annual average nitrogen deposition levels exceeding 15 kg/ha/y at baseline (Table 10.5-4). Anthropogenic disturbances are the areas predominantly affected at baseline (48,852 ha or 96.3% of the total area exposed; Figure 10.5-2).

The area of terrestrial vegetation and wetlands exposed to annual average nitrogen deposition levels exceeding 15 kg/ha/y at baseline is 1,894 ha, which represents 2.6% of the total area of vegetation and wetlands in the RSA (73,271 ha; Table 10.5-4). Among vegetation communities, the Lake, Pond, Reservoir, River and Stream category has the highest percentage of area exposed (10.3% of the total area of this community in the RSA; Table 10.5-4). For all other vegetation or wetland communities, the percentage of area exposed is less than 2.0% of the total area of the community in the RSA at baseline (Table 10.5-4).

Table 10.5-4 Areas of Landscape Units in the RSA that are Exposed to Air Emissions Exceeding Critical Limits at Baseline

Landscape Unit	Total Area in RSA (ha)	SO_2		NO_2		Nitrogen Deposition	
		Area Exposed (ha)	% of Total Area in RSA	Area Exposed (ha)	% of Total Area in RSA	Area Exposed (ha)	% of Total Area in RSA
Terrestrial Vegetation							
Closed Aspen, Balsam Poplar and/or White Birch	30,098	0	0.0	11,964	39.7	545	1.8
Mixed Grassland	13,179	0	0.0	7,362	55.9	222	1.7
Closed Upland Shrub	784	0	0.0	35	4.5	0	0.0
Closed Se/Sw	457	0	0.0	44	9.5	1	0.1
Closed Pine	421	0	0.0	78	18.5	1	0.2
Closed Coniferous and Deciduous Cover (40-60%)	341	0	0.0	5	1.6	0	0.0
Closed Undifferentiated Coniferous	755	0	0.0	166	22.0	4	0.6
Terrestrial Subtotal	46,035	**0**	**0.0**	**19,653**	**42.7**	**772**	**1.7**
Wetlands							
Undifferentiated Wetlands	16,710	0	0.0	8,019	48.0	322	1.9
Lake, Pond, Reservoir, River and Stream	7,702	3	<0.1	3,207	41.6	797	10.3
Black Spruce Bog (*Sphagnum* understorey; 6-100% tree cover)	1,532	0	0.0	44	2.9	2	0.1
Shrubby Wetlands (willow and birch)	1,122	0	0.0	19	1.7	0	0.0
Graminoid Wetlands (sedges/grasses/forbs; <6% tree cover, <25% shrub)	158	0	0.0	8	5.0	0	0.0
Lichen Bog (Lichen understorey; 6-25% tree cover)	13	0	0.0	13	98.1	<1	1.9
Wetland Subtotal	27,236	**3**	**<0.1**	**11,310**	**41.5**	**1,121**	**4.1**
Terrestrial and Wetland Subtotal	**73,271**	**3**	**<0.1**	**30,963**	**42.3**	**1,894**	**2.6**
Anthropogenic Disturbances							
Undifferentiated Agriculture	65,078	0	0.0	29,248	44.9	1,336	2.1
Undifferentiated Urban and Industrial Feature	749	19	2.6	353	47.2	25	3.4
Major Roads, Highways and Railways	1,420	0	0.0	796	56.1	34	2.4
Other Baseline Disturbances[1]	94,050	75	0.1	87,175	92.7	47,244	50.2
Exposed Soil	9,254	0	0.0	5,867	63.4	214	2.3
Anthropogenic Subtotal	170,551	**94**	**0.1**	**123,440**	**72.4**	**48,852**	**28.6**
Cloud/Haze	8	0	0.0	1	8.9	0	0.0
Total	243,830	**97**	**<0.1**	**154,403**	**63.3**	**50,746**	**20.8**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

LANDSCAPE UNITS IN THE LSA

- EPHEMERAL DRAW
- CLASS I/II WETLAND
- CLASS III WETLAND
- CLASS IV WETLAND
- UNCLASSIFIED WETLAND
- MIXED SHRUBLAND
- CONIFEROUS WOODLAND
- SALIX SHRUBLAND
- DECIDUOUS WOODLAND
- AGRICULTURAL LAND
- TAME PASTURE
- HABITATION
- ROAD ROW
- RAIL ROW

N

056-21W4

055-21W4

Central Parkland

Dry Mixedwood

1:15,000

0 100 200 400 600 800 1,000 m

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER LSA
- ALBERTA NATURAL SUBREGION
- ALBERTA TOWNSHIP / RANGE
- ATS SECTION LINE

WATERBODY
- PERMANENT
- RECURRING
- STREAM - INTERMITTENT
- EPHEMERAL DRAW

- RAILWAY
- ROAD
- ASCLEPIAS OVALOFOLIA

Title:

RARE PLANTS OBSERVED IN BASELINE LANDSCAPE UNITS IN THE VEGETATION AND WETLANDS LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.5-1_RARE_PLANTS_IN_LSA_TABLOID.mxd

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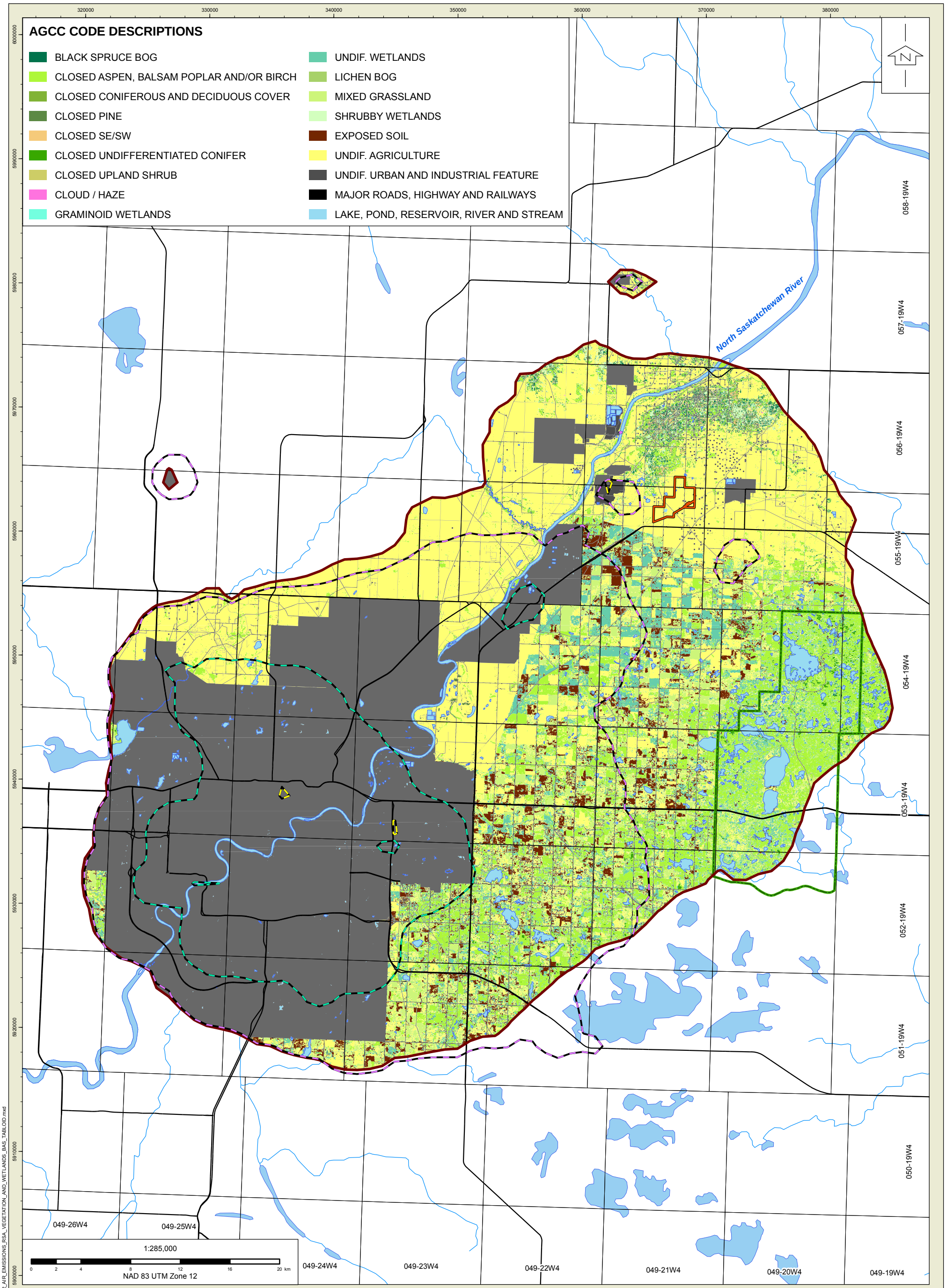
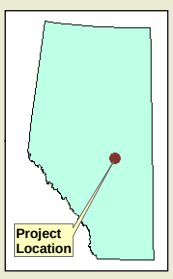
AGCC CODE DESCRIPTIONS

- BLACK SPRUCE BOG
- CLOSED ASPEN, BALSAM POPLAR AND/OR BIRCH
- CLOSED CONIFEROUS AND DECIDUOUS COVER
- CLOSED PINE
- CLOSED SE/SW
- CLOSED UNDIFFERENTIATED CONIFER
- CLOSED UPLAND SHRUB
- CLOUD / HAZE
- GRAMINOID WETLANDS
- UNDIF. WETLANDS
- LICHEN BOG
- MIXED GRASSLAND
- SHRUBBY WETLANDS
- EXPOSED SOIL
- UNDIF. AGRICULTURE
- UNDIF. URBAN AND INDUSTRIAL FEATURE
- MAJOR ROADS, HIGHWAY AND RAILWAYS
- LAKE, POND, RESERVOIR, RIVER AND STREAM





Legend

- NORTH AMERICAN UPGRADER RSA
- NORTH AMERICAN UPGRADER LSA
- BASELINE DISTURBANCE
- ELK ISLAND NATIONAL PARK
- ALBERTA TOWNSHIP/RANGE
- WATERBODY
- RIVER/STREAM
- HIGHWAY
- 10 µg/m³ SO_2 ISOPLETH
- 15 µg/m³ NO_2 ISOPLETH
- 10kg/ha/a NITROGEN DEPOSITION ISOPLETH

Title: **AIR EMISSIONS AND DISTRIBUTION OF GROUND COVER CLASSES IN THE VEGETATION AND WETLANDS RSA IN THE BASELINE CASE**

NORTH AMERICAN OIL SANDS CORPORATION

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10.6 Impact Assessment and Mitigative Measures

Development of the Project will include the clearing of vegetation for the construction of the Upgrader facilities. During construction, there will also be a laydown area.

10.6.1 LSA

10.6.1.1 Diversity and Abundance of Terrestrial Vegetation

The Project will potentially affect vegetation community abundance and diversity, as some parts of the footprint fall on natural terrestrial vegetation communities (Figure 10.6-1). The area of each vegetation community that is predicted to be affected in the application case is presented in Table 10.6-1. The expected percentage change in resource at closure (relative to the baseline case) is also given in Table 10.6-1.

Following closure and reclamation, the total area of natural or semi-natural terrestrial vegetation will be reduced in area by 1.6 ha (6.4% of baseline levels). The most affected vegetation type will be Mixed Shrubland, which will be removed, leading to a reduction in community diversity (Table 10.6-1). The only other terrestrial vegetation community that will be affected is Deciduous Woodland, of which 1.1 ha will be removed, representing a 29.9% reduction from baseline levels.

The C&R plan (Volume 1, Section 7) provides for reclamation to land capability equivalent to pre-disturbance conditions. Areas currently under cultivation will be reclaimed to a condition that will allow them to support similar agricultural land uses. For the purposes of this assessment, it is assumed that all lands under the Project footprint will be reclaimed for agricultural use (Figure 10.6-2; Table 10.6-1). The actual land use to which land is returned at closure will depend on the zoning at that time and the subsequent planned use of the land.

Mixed Shrubland and Deciduous Woodland contain species that are common in the Central Parkland (e.g., *Populus tremuloides*, *Salix* sp.), and both occupy less than 1.0% of the LSA at baseline (Table 10.6-1). Furthermore, a large proportion of the Deciduous Woodland will remain intact. Mitigation of impacts on these vegetation community types is not considered necessary.

Given the above considerations, impacts on terrestrial vegetation communities are rated as negative in direction, subregional in extent, low in magnitude, of medium-term duration, isolated in frequency and reversible in the long-term, with high confidence. The environmental impact on terrestrial vegetation is predicted to be low.

Impacts on terrestrial vegetation communities in the LSA are summarized in Table 10.9-1. Impacts on community and species diversity in the LSA are further assessed in the Biodiversity section (Volume 4, Section 12).

10.6.1.2 Diversity and Abundance of Wetlands

Project construction will require dewatering of all Class I/II Wetlands in the LSA. The total area of Class I/II Wetlands to be dewatered is 8.9 ha (1.6% of the LSA). Class I/II Wetlands are ephemeral in nature and can be important contributors to biodiversity (Zedler, 2003). However, those in the study area are frequently plowed over. The one Class III Wetland existing at baseline (in NW 26-55-21 W4M) will also be dewatered during project construction, leading to a reduction in wetland diversity (Table 10.6-1). Dewatering is expected to reduce total wetland

area in the LSA by 21.1 ha (3.7% of the LSA; Table 10.6-1). This represents a reduction in the abundance and diversity of wetlands.

A compensation program to mitigate the effects of dewatering wetlands in the LSA will be designed in consultation with AENV and in accordance with AENV's Provincial Wetland Restoration/Compensation Guide (AENV, 2007). Enhancement of the existing wetlands in SE 2-56-21 W4M is also proposed.

Given that the details of the proposed compensatory wetlands have yet to be determined, Tables 10.6-1 and 10.6-2 assume no compensation has taken place at application or closure. It is expected that the values given for wetlands in these tables underestimate total wetland area at application and closure, and overestimate changes to this resource.

Assuming wetland mitigation measures are implemented, potential impacts to wetlands in the LSA are predicted to be negative in direction, subregional in extent, medium in magnitude, medium-term in duration, isolated in frequency and reversible in the medium-term, with medium confidence. Environmental impact of vegetation removal in wetlands is predicted to be medium.

Wetland vegetation communities can be affected indirectly by changes in hydrology, such as modification of ground and surface water flows and the height of the water table. The Project development will decrease the surface drainage area to the North Wetland Complex, potentially resulting in a decrease in runoff and water levels in this wetland. This reduction in runoff will be offset by directing the upslope drainage south of the Project area to the North Wetland Complex via road ditching to this area. A water management and sediment control plan will also be developed to provide appropriate isolation and containment of all runoff from the disturbed area during construction. Further details of these mitigation measures are provided in the Hydrology section (Volume 3, Section 6).

Assuming the above mitigation methods are implemented and successful, there is predicted to be no environmental impact on vegetation and wetlands due to changes in hydrology.

Impacts on wetlands in the LSA are summarized in Table 10.9-1. Impacts on community and species diversity in wetlands in the LSA are further assessed in the Biodiversity section (Volume 4, Section 12).

10.6.1.3 Rare Plants

The development footprint is not expected to impact rare plants. The only rare species found in the LSA was located in the area of Tame Pasture in the LSA. No construction is planned for this area.

No overall environmental impact is predicted on rare plants in the LSA.

10.6.1.4 Non-Native and Invasive Species

Impacts on vegetation and wetlands in the study area resulting from construction of the Project may include the passive introduction of weed species not present at baseline, or additional populations of those already in the LSA. Seeds or plant parts could be introduced in soil used in construction or reclamation operations, or carried on footwear and vehicles. The specific nature and extent of such introductions and their impacts in the LSA cannot be reliably predicted. In general, however, the introduction of non-native and invasive plant species is undesirable because it can cause a displacement of native species.

To mitigate potential effects of non-native and invasive species, a weed management plan will be instituted. Details are provided in the Conservation and Reclamation Plan (Volume 1, Section 8).

10.6.2 RSA

10.6.2.1 Diversity and Abundance of Terrestrial Vegetation and Wetlands

The distribution of terrestrial vegetation and wetlands at application is shown in Figure 10.6-3. Construction of the Project will result in a less than 1.0% change in the area of any terrestrial vegetation or wetland cover class in the RSA (Table 10.6-2). Project impacts on terrestrial vegetation and wetlands in the RSA are therefore rated as negative in direction, subregional in extent, negligible in magnitude, medium-term in duration, isolated in frequency and reversible in the long-term, with high confidence. The overall impact rating for terrestrial vegetation and wetlands in the RSA is considered negligible. A summary of project impacts on the diversity and abundance of vegetation and wetlands is given in Table 10.9-1.

10.6.2.2 Rare and Unique Natural Resources

No impact to rare and unique natural resources is predicted to occur as a result of project construction and operation, because none of these resources falls within the LSA. There is also expected to be no impact on these resources due to air emissions (Section 10.7.2.3).

Table 10.6-1 Abundance and Diversity of Landscape Units in the LSA at Baseline, Application and Closure

Landscape Units	Baseline		Application		Closure		Change to Resource	
	Area (ha)	% of LSA	Area (ha)	% of LSA	Area (ha)	% of LSA	Area (ha)	% Change
Terrestrial Vegetation								
Deciduous Woodland	3.7	0.7	2.6	0.5	2.6	0.5	-1.1	-29.9
Coniferous Woodland	0.4	0.1	0.4	0.1	0.4	0.1	0.0	0.0
Salix Shrubland	1.0	0.2	1.0	0.2	1.0	0.2	0.0	0.0
Mixed Shrubland	0.5	0.1	0.0	0.0	0.0	0.0	-0.5	-100.0
Tame Pasture	19.3	3.4	19.3	3.4	19.3	3.4	0.0	0.0
Terrestrial Subtotal	**25.0**	**4.4**	**23.4**	**4.2**	**23.4**	**4.2**	**-1.6**	**-6.4**
Wetlands								
Class I/II Wetland	10.3	1.8	1.4	0.3	1.4	0.3	-8.9	-86.3
Class III Wetland	5.1	0.9	0.0	0.0	0.0	0.0	-5.1	-100.0
Class IV Wetland	9.6	1.7	8.2	1.5	8.2	1.5	-1.4	-14.7
Ephemeral Draw	5.4	1.0	0.0	0.0	0.0	0.0	-5.3	-99.6
Unclassified Wetland	1.4	0.3	1.1	0.2	1.1	0.2	-0.3	-19.8
Wetland Subtotal	**31.8**	**5.7**	**10.8**	**1.9**	**10.8**	**1.9**	**-21.1**	**-66.2**
Anthropogenic Disturbances								
Project Footprint	N/A	N/A	482.2	85.6	N/A	N/A	N/A	N/A
Agricultural Land	483.5	85.8	39.3	7.0	521.5	92.5	38.0	7.9
Habitations	8.4	1.5	0.8	0.1	0.8	0.1	-7.6	-90.8
Railway	4.9	0.9	4.9	0.9	4.9	0.9	0.0	0.0
Road	10.1	1.8	2.3	0.4	2.3	0.4	-7.7	-77.0
Anthropogenic Disturbances Subtotal	**506.8**	**89.9**	**529.5**	**93.9**	**529.5**	**93.9**	**22.7**	**4.5**
Total	**563.6**	**100.0**	**563.6**	**100.0**	**563.6**	**100.0**	**N/A**	**N/A**

Notes:

The percentage change to resource is calculated as follows: (Area at Closure - Area at Baseline) / Area at Baseline)*100.

The subtotals for wetlands assume no mitigation for dewatered wetlands; it is expected that these values underestimate the area of this resource at closure and overestimate the percentage change.

Summed totals may differ due to rounding.

N/A = not applicable.

Table 10.6-2 Abundance and Diversity of Landscape Units in the RSA at Baseline, Application and Closure

Landscape Units	Baseline		Application		Closure		Change to Resource	
	Area (ha)	% of RSA	Area (ha)	Area (ha)	% of RSA	% of RSA	Area (ha)	% Change
Terrestrial Vegetation								
Closed Aspen, Balsam Poplar and/or Birch	30,098	12.3	30,090	12.3	30,090	12.3	-8	-<0.1
Mixed Grassland	13,179	5.4	13,179	5.4	13,179	5.4	<1	<0.1
Closed Upland Shrub	784	0.3	782	0.3	782	0.3	-2	-0.2
Closed Se/Sw	457	0.2	457	0.2	457	0.2	-<1	-<0.1
Closed Pine	421	0.2	419	0.2	419	0.2	-2	-0.4
Closed Coniferous and Deciduous Cover (40-60%)	341	0.1	341	0.1	341	0.1	-<1	-<0.1
Closed Undifferentiated Coniferous Forest	755	0.3	755	0.3	755	0.3	<1	<0.1
Terrestrial Subtotal	**46,035**	**18.9**	**46,023**	**18.9**	**46,023**	**18.9**	**-12**	-<0.1
Wetlands								
Undifferentiated Wetlands	16,710	6.9	16,709	6.9	16,709	6.9	-1	-<0.1
Lake, Pond, Reservoir, River and Stream	7,702	3.2	7,695	3.2	7,695	3.2	-7	-<0.1
Black Spruce Bog (*Sphagnum* understorey; 6-100% tree cover)	1,532	0.6	1,532	0.6	1,532	0.6	<1	<0.1
Shrubby Wetlands (willow and birch)	1,122	0.5	1,122	0.5	1,122	0.5	-<1	-<0.1
Graminoid Wetlands (sedges/grasses/forbs; <6% tree cover, <25% shrub)	158	0.1	158	0.1	158	0.1	<1	<0.1
Lichen Bog (Lichen understorey; 6-25% tree cover)	13	<0.1	13	<0.1	13	<0.1	<1	<0.1
Wetland Subtotal	**27,236**	**11.2**	**27,228**	**11.2**	**27,228**	**11.2**	**-8**	-<0.1
Anthropogenic Disturbances								
Project Footprint	N/A	N/A	485	0.2	N/A	N/A	N/A	N/A
Undifferentiated Agriculture	65,078	26.7	64,637	26.5	65,122	26.7	44	0.1
Undifferentiated Urban and Industrial Feature	749	0.3	749	0.3	749	0.3	<1	<0.1
Major Roads, Highways and Railways	1,420	0.6	1,416	0.6	1,416	0.6	-4	-0.3
Other Baseline Disturbances[1]	94,050	38.6	94,029	38.6	94,029	38.6	-21	-<0.1
Exposed Soil	9,254	3.8	9,254	3.8	9,254	3.8	<1	<0.1
Anthropogenic Subtotal	**170,551**	**69.9**	**170,571**	**70.0**	**170,571**	**70.0**	**20**	**<0.1**
Cloud / Haze	8	<0.1	8	<0.1	8	<0.1	0	0.0
TOTAL	**243,830**	**100.0**	**243,830**	**100.0**	**243,830**	**100.0**	**N/A**	**N/A**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

The percent change to resource is calculated as follows: (Area at Closure - Area at Baseline) / Area at Baseline)*100.

The closure scenario assumes that all land under the Project footprint is reclaimed to Undifferentiated Agriculture and assumes no compensation for dewatered wetlands; it is expected that subtotals for wetlands underestimate the area of this resource at closure and overestimate the percentage change to this resource.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

10.6.2.3 Air Emissions

Sulphur Dioxide Concentration

Based on air emissions models, the area of the RSA exposed to SO_2 concentrations exceeding 10 ug/m^3 at application is predicted to be 187 ha (Table 10.6-3; Figure 10.6-4). This represents an increase in area of 91 ha (93.7%) over baseline levels. However, the percentage of the RSA that is exposed is less than 1.0% greater at application than it was at baseline (Table 10.6-3). The area of vegetation and wetlands exposed to above-threshold concentrations of SO_2 at application is predicted to be 3 ha (less than 0.1% of the total area of vegetation and wetlands in the RSA at application [73,252 ha]). The percentage of the total area of vegetation and wetlands that is predicted to be exposed at application is less than 1.0% greater than at baseline (Table 10.6-3).

Lake, Pond, Reservoir, River and Stream and Closed Aspen, Balsam Poplar and/or Birch are the only vegetation or wetland landscape units that are expected to be exposed to SO_2 concentrations exceeding 10 ug/m^3 at application. In both cases, the area of exposure is expected to be less than 0.1% of the total area each community covers in the RSA (Table 10.6-3). None of the communities that may have high cover of cryptogams (Closed Se/Sw, Closed Pine, Closed Coniferous and Deciduous Forest, Closed Undifferentiated Coniferous, Undifferentiated Wetlands, Lichen Bog and Black Spruce Bog) is predicted to be exposed to SO_2 concentrations exceeding the critical threshold used in this assessment.

Nitrogen Dioxide Concentration

According to air emissions models (Figure 10.6-4), the area of the RSA exposed to NO_2 concentrations exceeding 15 ug/m^3 is predicted to be 156,931 ha at application (64.4% of the RSA). This represents an increase in area of 2,527 ha (1.6%) over baseline levels. However, the percentage of the RSA that is exposed has increased by only 1.0% over levels at baseline (from 63.3% to 64.4%; Table 10.6-4). The area of vegetation and wetlands exposed to above-threshold concentrations is predicted to be 31,642 ha at application. That represents 43.2% of the total area of vegetation and wetlands at application (73,252 ha). The percentage of the total area of vegetation and wetlands that is exposed to NO_2 concentrations above the critical limit for cryptogams is therefore predicted to increase by 0.9% over baseline levels (from 42.3% to 43.2%; Table 10.6-4).

At application, all terrestrial vegetation and wetland communities are predicted to have a higher percentage of their total area exposed to above-threshold NO_2 concentrations than at baseline. However, increases are not predicted to exceed 2.1% (Table 10.6-4).

Nitrogen Deposition

Air emissions models (Figure 10.6-4) indicate that the area of the RSA exposed to nitrogen deposition levels exceeding 10 kg/ha/y will be approximately 50,791 ha at application (20.8% of the RSA). This represents an increase in area of 45 ha (0.1%) over baseline levels. However, the percentage of the RSA that is exposed is less than 1.0% greater at application than it was at baseline (Table 10.6-5). The area of vegetation and wetlands exposed to above-threshold concentrations is predicted to be 1,899 ha at application. That represents 2.6% of the total area of vegetation and wetlands at application (73,252 ha). The percentage of the total area of vegetation and wetlands in the RSA that will be exposed to above-threshold nitrogen deposition levels at application is expected to be less than 0.1% higher than at baseline (Table 10.6-5).

PAI

The total area of soils that are predicted to receive PAI greater than their critical load is less than 1.0% of the RSA (287 ha). No highly sensitive soils were found in the RSA.

Air emissions resulting from the Upgrader Project will cease following closure of the Project. The impact assessment for air emissions is therefore focused on impacts during project operation. At application there is predicted to be only minor changes in the area of any vegetation or wetland community exposed to air emissions exceeding critical limits for cryptogams. Project emissions on vegetation and wetlands are therefore expected to have a negligible impact on vegetation and wetlands.

Prediction confidence for air emissions relates to the uncertainty associated with the emission estimates and assumptions, and to the uncertainty associated with the air emissions model's ability to predict ambient concentrations. Further details of the limitations of this model are provided in the Air section (Volume 2, Section 2). Confidence in predicting impacts of air emissions is also limited by uncertainty over the sensitivity of many plant species to airborne chemicals, as well as the impact of local conditions on sensitivity within species. Critical concentration thresholds for cryptogams were used in this assessment because they apply to highly sensitive plant groups (bryophytes and lichens). These thresholds are therefore assumed to represent worst-case scenarios.

Table 10.6-3 Areas of Landscape Units in the RSA Exposed to Annual Average SO_2 Emissions Exceeding 10 ug/m^3 at Baseline and Application

Landscape Units	Baseline			Application			Change from Baseline in % of Total Area in RSA (%)
	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	
Terrestrial Vegetation							
Closed Aspen, Balsam Poplar and/or White Birch	30,098	0	0.0	30,090	0	<0.1	<0.1
Mixed Grassland	13,179	0	0.0	13,179	0	0.0	N/A
Closed Upland Shrub	784	0	0.0	782	0	0.0	N/A
Closed Se/Sw	457	0	0.0	457	0	0.0	N/A
Closed Pine	421	0	0.0	419	0	0.0	N/A
Closed Coniferous and Deciduous Cover (40-60%)	341	0	0.0	341	0	0.0	N/A
Closed Undifferentiated Coniferous	755	0	0.0	755	0	0.0	N/A
Terrestrial Subtotal	**46,035**	**0**	**0.0**	**46,023**	**0**	**<0.1**	**<0.1**
Wetlands							
Undifferentiated Wetlands	16,710	0	0.0	16,709	0	0.0	N/A
Lake, Pond, Reservoir, River and Stream	7,702	3	<0.1	7,695	3	<0.1	0.0
Black Spruce Bog *(Sphagnum* understorey)	1,532	0	0.0	1,532	0	0.0	N/A
Shrubby Wetlands (willow and birch)	1,122	0	0.0	1,122	0	0.0	N/A
Graminoid Wetlands (sedges/grasses/forbs)	158	0	0.0	158	0	0.0	N/A
Lichen Bog (Lichen understorey)	13	0	0.0	13	0	0.0	N/A
Wetland Subtotal	**27,236**	**3**	**<0.1**	**27,228**	**3**	**<0.1**	**<0.1**
Terrestrial and Wetland Subtotal	**73,271**	**3**	**<0.1**	**73,252**	**3**	**<0.1**	**<0.1**
Anthropogenic Disturbances							
Project Footprint	N/A	N/A	N/A	485	0	0.0	0.0
Undifferentiated Agriculture	65,078	0	0.0	64,637	0	0.0	N/A
Undifferentiated Urban and Industrial Feature	749	19	2.6	749	72	9.6	7.0
Major Roads, Highways and Railways	1,420	0	0.0	1,416	0	0.0	N/A
Other Baseline Disturbances[1]	94,050	75	0.1	94,029	112	0.1	0.0
Exposed Soil	9,254	0	0.0	9,254	0	0.0	N/A
Anthropogenic Subtotal	**170,551**	**94**	**0.1**	**170,571**	**184**	**0.1**	**0.1**
Cloud/Haze	8	0	0.0	8	0	0.0	N/A
Total	**243,830**	**97**	**<0.1**	**243,830**	**187**	**0.1**	**<0.1**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

N/A = not applicable.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

Table 10.6-4 Areas of Landscape Units in the RSA Exposed to Annual Average NO_2 Emissions Exceeding 15 ug/m^3 at Baseline and Application

Landscape Units	Baseline			Application			Change from Baseline in % of Total Area in RSA
	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	
Terrestrial Vegetation							
Closed Aspen, Balsam Poplar and/or White Birch	30,098	11,964	39.7	30,090	12,195	40.5	0.8
Mixed Grassland	13,179	7,362	55.9	13,179	7,596	57.6	1.8
Closed Upland Shrub	784	35	4.5	782	51	6.6	2.1
Closed Se/Sw	457	44	9.5	457	44	9.7	0.1
Closed Pine	421	78	18.5	419	79	18.8	0.3
Closed Coniferous and Deciduous Cover (40-60%)	341	5	1.6	341	6	1.9	0.3
Closed Undifferentiated Coniferous	755	166	22.0	755	167	22.1	0.1
Terrestrial Subtotal	**46,035**	**19,653**	**42.7**	**46,023**	**20,138**	**43.8**	**1.1**
Wetlands							
Undifferentiated Wetlands	16,710	8,019	48.0	16,709	8,161	48.8	0.8
Lake, Pond, Reservoir, River and Stream	7,702	3,207	41.6	7,695	3,243	42.1	0.5
Black Spruce Bog *(Sphagnum* understorey)	1,532	44	2.9	1,532	55	3.6	0.7
Shrubby Wetlands (willow and birch)	1,122	19	1.7	1,122	23	2.1	0.4
Graminoid Wetlands (sedges/grasses/forbs)	158	8	5.0	158	10	6.3	1.3
Lichen Bog (Lichen understorey)	13	13	98.1	13	13	99.0	1.0
Wetland Subtotal	**27,236**	**11,310**	**41.5**	**27,228**	**11,505**	**42.3**	**0.7**
Terrestrial and Wetland Subtotal	**73,271**	**30,963**	**42.3**	**73,252**	**31,642**	**43.2**	**0.9**
Anthropogenic Disturbances							
Project Footprint	N/A	N/A	N/A	485	74	15.3	15.3
Undifferentiated Agriculture	65,078	29,248	44.9	64,637	30,702	47.5	2.6
Undifferentiated Urban and Industrial Feature	749	353	47.2	749	392	52.3	5.1
Major Roads, Highways and Railways	1,420	796	56.1	1,416	813	57.4	1.3
Other Baseline Disturbances[1]	94,050	87,175	92.7	94,029	87,335	92.9	0.2
Exposed Soil	9,254	5,867	63.4	9,254	5,973	64.5	1.1
Anthropogenic Subtotal	**170,551**	**123,440**	**72.4**	**170,571**	**125,288**	**73.5**	**1.1**
Cloud/Haze	8	1	8.9	8	1	8.9	0.0
Total	**243,830**	**154,403**	**63.3**	**243,830**	**156,931**	**64.4**	**1.0**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

Table 10.6-5 Areas of Landscape Units in the RSA Exposed to Annual Average Nitrogen Deposition Exceeding 10 kg/ha/y at Baseline and Application

Landscape Units	Baseline			Application			Change from Baseline in % of Total Area in RSA
	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	
Terrestrial Vegetation							
Closed Aspen, Balsam Poplar and/or White Birch	30,098	545	1.8	30,090	547	1.8	<0.1
Mixed Grassland	13,179	222	1.7	13,179	222	1.7	<0.1
Closed Upland Shrub	784	0	0.0	782	0	0.0	N/A
Closed Se/Sw	457	1	0.1	457	1	0.1	<0.1
Closed Pine	421	1	0.2	419	1	0.2	<0.1
Closed Coniferous and Deciduous Cover (40-60%)	341	0	0.0	341	0	0.0	N/A
Closed Undifferentiated Coniferous	755	4	0.6	755	4	0.6	<0.1
Terrestrial Subtotal	**46,035**	**772**	**1.7**	**46,023**	**776**	**1.7**	**<0.1**
Wetlands							
Undifferentiated Wetlands	16,710	322	1.9	16,709	324	1.9	<0.1
Lake, Pond, Reservoir, River and Stream	7,702	797	10.3	7,695	798	10.4	<0.1
Black Spruce Bog *(Sphagnum* understorey)	1,532	2	0.1	1,532	2	0.1	-<0.1
Shrubby Wetlands (willow and birch)	1,122	0	0.0	1,122	0	0.0	N/A
Graminoid Wetlands (sedges/grasses/forbs)	158	0	0.0	158	0	0.0	N/A
Lichen Bog (Lichen understorey)	13	<1	1.9	13	0	1.9	0.0
Wetland Subtotal	**27,236**	**1,121**	**4.1**	**27,228**	**1,124**	**4.1**	**<0.1**
Terrestrial and Wetland Subtotal	**73,271**	**1,894**	**2.6**	**73,252**	**1,899**	**2.6**	**<0.1**
Anthropogenic Disturbances							
Project Footprint	N/A	N/A	N/A	485	0	0.0	0.0
Undifferentiated Agriculture	65,078	1,336	2.1	64,637	1,339	2.1	<0.1
Undifferentiated Urban and Industrial Feature	749	25	3.4	749	25	3.4	<0.1
Major Roads, Highways and Railways	1,420	34	2.4	1,416	34	2.4	<0.1
Other Baseline Disturbances[1]	94,050	47,244	50.2	94,029	47,280	50.3	<0.1
Exposed Soil	9,254	214	2.3	9,254	215	2.3	<0.1
Anthropogenic Subtotal	**170,551**	**48,852**	**28.6**	**170,571**	**48,892**	**28.7**	**<0.1**
Cloud/Haze	8	0	0.0	8	0	0.0	N/A
Total	**243,830**	**50,746**	**20.8**	**243,830**	**50,791**	**20.8**	**<0.1**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

N/A = not applicable.

LANDSCAPE UNITS IN THE LSA (BASELINE SCENARIO)

- EPHEMERAL DRAW
- CLASS I/II WETLAND
- CLASS III WETLAND
- CLASS IV WETLAND
- UNCLASSIFIED WETLAND
- MIXED SHRUBLAND
- CONIFEROUS WOODLAND
- SALIX SHRUBLAND
- DECIDUOUS WOODLAND
- AGRICULTURAL LAND
- TAME PASTURE
- HABITATION
- ROAD ROW
- RAIL ROW

N

056-21W4

055-21W4

Central Parkland

Dry Mixedwood

1:15,000

0 100 200 400 600 800 1,000 m

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER LSA
- ALBERTA NATURAL SUBREGION
- ALBERTA TOWNSHIP / RANGE
- ATS SECTION LINE

WATERBODY
- PERMANENT
- RECURRING
- STREAM - INTERMITTENT
- EPHEMERAL DRAW

- RAILWAY
- ROAD
- PROJECT FOOTPRINT

Title:

PROJECT FOOTPRINT OVERLAYED ON BASELINE LANDSCAPE UNITS IN THE VEGETATION AND WETLANDS LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.6-1_FOOTPRINT_IN_LSA_TABLOID.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.6-1**

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LANDSCAPE UNITS IN THE LSA (CLOSURE SCENARIO)

- EPHEMERAL DRAW
- CLASS I/II WETLAND
- CLASS IV WETLAND
- UNCLASSIFIED WETLAND
- CONIFEROUS WOODLAND
- SALIX SHRUBLAND
- DECIDUOUS WOODLAND
- AGRICULTURAL LAND
- TAME PASTURE
- HABITATION
- ROAD ROW
- RAIL ROW

N

056-21W4

055-21W4

Central Parkland

Dry Mixedwood

1:15,000

0 100 200 400 600 800 1,000 m

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER LSA
- ALBERTA NATURAL SUBREGION
- ALBERTA TOWNSHIP / RANGE
- ATS SECTION LINE

WATERBODY
- PERMANENT
- RECURRING
- STREAM - INTERMITTENT
- EPHEMERAL DRAW

- RAILWAY
- ROAD

Title:

LANDSCAPE UNITS IN THE CLOSURE SCENARIO IN THE VEGETATION AND WETLANDS LSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.6-2_CLOSURE_SCENARIO_IN_LSA_TABLOID.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.6-2**

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AGCC CODE DESCRIPTIONS

- BLACK SPRUCE BOG
- CLOSED ASPEN, BALSAM POPLAR AND/OR BIRCH
- CLOSED CONIFEROUS AND DECIDUOUS COVER
- CLOSED PINE
- CLOSED SE/SW
- CLOSED UNDIFFERENTIATED CONIFER
- CLOSED UPLAND SHRUB
- CLOUD / HAZE
- GRAMINOID WETLANDS
- UNDIF. WETLANDS
- LICHEN BOG
- MIXED GRASSLAND
- SHRUBBY WETLANDS
- EXPOSED SOIL
- UNDIF. AGRICULTURE
- UNDIF. URBAN AND INDUSTRIAL FEATURE
- MAJOR ROADS, HIGHWAY AND RAILWAYS
- LAKE, POND, RESERVOIR, RIVER AND STREAM

320000 330000 340000 350000 360000 370000 380000

6000000 5990000 5980000 5970000 5960000 5950000 5940000 5930000 5920000 5910000 5900000

N

Dry Mixedwood

North Saskatchewan River

Dry Mixedwood

Central Parkland

058-19W4 057-19W4 056-19W4 055-19W4 054-19W4 053-19W4 052-19W4 051-19W4 050-19W4

049-26W4 049-25W4 049-24W4 049-23W4 049-22W4 049-21W4 049-20W4 049-19W4

1:285,000

0 2 4 8 12 16 20 km

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER RSA
- NORTH AMERICAN UPGRADER LSA
- APPLICATION DISTURBANCE
- BASELINE DISTURBANCE
- ELK ISLAND NATIONAL PARK
- ALBERTA TOWNSHIP/RANGE
- WATERBODY
- RIVER/STREAM
- HIGHWAY

Title:

PROJECT FOOTPRINT OVERLAYED ON BASELINE GROUND COVER CLASSES IN THE VEGETATION AND WETLANDS RSA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.6-3_FOOTPRINT_IN_RSA_TABLOID.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.6-3**

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AGCC CODE DESCRIPTIONS

- BLACK SPRUCE BOG
- CLOSED ASPEN, BALSAM POPLAR AND/OR BIRCH
- CLOSED CONIFEROUS AND DECIDUOUS COVER
- CLOSED PINE
- CLOSED SE/SW
- CLOSED UNDIFFERENTIATED CONIFER
- CLOSED UPLAND SHRUB
- CLOUD / HAZE
- GRAMINOID WETLANDS
- UNDIF. WETLANDS
- LICHEN BOG
- MIXED GRASSLAND
- SHRUBBY WETLANDS
- EXPOSED SOIL
- UNDIF. AGRICULTURE
- UNDIF. URBAN AND INDUSTRIAL FEATURE
- MAJOR ROADS, HIGHWAY AND RAILWAYS
- LAKE, POND, RESERVOIR, RIVER AND STREAM

320000 330000 340000 350000 360000 370000 380000

6000000 5990000 5980000 5970000 5960000 5950000 5940000 5930000 5920000 5910000 5900000

N

North Saskatchewan River

058-19W4 057-19W4 056-19W4 055-19W4 054-19W4 053-19W4 052-19W4 051-19W4 050-19W4

049-26W4 049-25W4 049-24W4 049-23W4 049-22W4 049-21W4 049-20W4 049-19W4

1:285,000

0 2 4 8 12 16 20 km

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER RSA
- NORTH AMERICAN UPGRADER LSA
- APPLICATION DISTURBANCE
- BASELINE DISTURBANCE
- ELK ISLAND NATIONAL PARK
- ALBERTA TOWNSHIP/RANGE
- WATERBODY
- RIVER/STREAM
- HIGHWAY
- 10 µg/m³ SO_2 ISOPLETH
- 15 µg/m³ NO_2 ISOPLETH
- 10kg/ha/a NITROGEN DEPOSITION ISOPLETH

Title: **AIR EMISSIONS AND DISTRIBUTION OF GROUND COVER CLASSES IN THE VEGETATION AND WETLANDS RSA IN THE APPLICATION CASE**

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.6-4_AIR_EMISSIONS_RSA_VEGETATION _AND_WETLANDS_APP_TABLOID.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.6-4**

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10.7 Cumulative Effects Assessment

10.7.1 Vegetation Removal

The vegetation cumulative effects assessment considers the impacts of the Project with other existing, approved, planned and potential projects in the vegetation RSA that overlap temporally and spatially. A list of approved, planned and potential projects in the region of the Upgrader Project is given in Table 1.5-1 (Volume 2, Section 1).

The Project, in conjunction with other existing, approved and planned projects, will potentially affect the abundance and diversity of vegetation communities in the RSA (Figure 10.7-1). A summary of the area affected by vegetation removal in the cumulative case, and the changes relative to the baseline case is presented in Table 10.7-2 for each landscape unit. The total area of the Project footprint (485 ha) represents 5.7% of the total area of disturbance predicted in the cumulative case (8,440 ha). In terms of impacts on the area occupied by individual terrestrial vegetation communities and wetlands, the contribution of the Project to total disturbance is predicted to be highest in the Lake, Pond, Reservoir, River and Stream (100.0% of total disturbance) and Closed Pine (14.9%) categories. Closed Pine occupies less than 1.0% of the RSA, and the Lake, Pond, Reservoir, River and Stream category occupies only 3.2% of the RSA. Assuming mitigation measures are implemented for impacts on wetlands in the LSA, the area of the Lake, Pond, Reservoir, River and Stream category in the cumulative case is likely to be greater than shown in Table 10.7-2. Concomitantly, the contribution of the Project to the cumulative effects on this wetland type, and wetlands in general, will be less than that indicated in Table 10.7-2. For all other terrestrial vegetation communities and wetlands in the RSA that are impacted in the cumulative case, the contribution of the Project amounts to less than 2.0% of the total disturbance. The total contribution of the Project to cumulative effects on all vegetation communities and wetlands is 1.9% of total disturbance (Table 10.7-2).

Table 10.7-1 Comparison of Baseline and Cumulative Effects Cases for Landscape Units in the RSA

Landscape Unit	Baseline		Cumulative Case				
	Area (ha)	% of RSA	Area (ha)	Total disturbance (ha)	Disturbance due to Project (ha)	Disturbance due to other projects (ha)	Contribution of Project to cumulative case (%)
Terrestrial Vegetation							
Closed Aspen, Balsam Poplar and/or Birch	30,098	12.3	29,610	-489	-8	-480	1.7
Mixed Grassland	13,179	5.4	13,138	-41	0	-41	0.0
Closed Upland Shrub	784	0.3	682	-102	-2	-100	1.7
Closed Se/Sw	457	0.2	445	-12	0	-12	0.5
Closed Pine	421	0.2	409	-12	-2	-10	14.9
Closed Coniferous and Deciduous Cover (40-60%)	341	0.1	319	-22	0	-22	0.1
Closed Undifferentiated Conifer	755	0.3	755	0	N/A	N/A	N/A
Terrestrial Subtotal	**46,035**	**18.9**	**45,358**	**-677**	**-12**	**-665**	**1.7**
Wetlands							
Undifferentiated Wetlands	16,710	6.9	16,587	-123	-1	-123	0.7
Lake, Pond, Reservoir, River and Stream	7,702	3.2	7,695	-7	-7	0	100.0
Black Spruce Bog *(Sphagnum* understorey)	1,532	0.6	1,398	-133	0	-133	0.0
Shrubby Wetlands (willow and birch)	1,122	0.5	1,033	-89	0	-89	0.0
Graminoid Wetlands (sedges/grasses/forbs)	158	0.1	137	-21	0	-21	0.0
Lichen Bog (Lichen understorey)	13	<0.1	13	0	N/A	N/A	N/A
Wetland Subtotal	**27,236**	**11.2**	**26,862**	**-374**	**-8**	**-366**	**2.1**
Terrestrial and Wetland Subtotal	**73,271**	**30.1**	**72,220**	**-1,051**	**-20**	**-1,031**	**1.9**
Anthropogenic Disturbances							
Project Footprint and Other Projects in the Cumulative Case	N/A	N/A	8,440	8,440	485	7,955	5.7
Undifferentiated Agriculture	65,078	26.7	62,321	-2,757	-441	-2,316	16.0
Undifferentiated Urban and Industrial Feature	749	0.3	126	-623	0	-623	0.0
Major Roads, Highway and Railways	1,420	0.6	1,377	-43	-4	-39	8.8
Other Baseline Disturbances[1]	94,050	38.6	90,275	-3,775	-21	-3,754	0.6
Exposed Soil	9,254	3.8	9,063	-191	0	-191	0.0
Anthropogenic Subtotal	**170,551**	**69.9**	**171,603**	**1,052**	**20**	**1,032**	**1.9**
Cloud / Haze	8	<0.1	7	-1	0	-1	0.0
TOTAL	**243,830**	**100.0**	**243,830**	**N/A**	**N/A**	N/A	**N/A**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

10.7.2 Air Emissions

Sulphur Dioxide Concentration

In the cumulative case (Figure 10.7-2), the total area under SO_2 concentrations exceeding 10 ug/m^3 is predicted to be 11,182 ha (4.6% of the RSA; Table 10.7-2). This represents an increase of 11,085 ha over baseline levels. The contribution of the Upgrader Project to this total is predicted to be 51 ha, or 0.5% of the total area exposed in the cumulative case. The majority of the area exposed to the above-threshold concentrations is classified as anthropogenic disturbances (8,616 ha; Table 10.7-2). This is equivalent to 77.1% of the total area exposed.

The total area of terrestrial vegetation and wetlands under SO_2 concentrations exceeding 10 ug/m^3 is predicted to be 2,566 ha (3.6% of the total area of vegetation and wetlands in the Cumulative Case). This represents an increase in area of 2,563 ha over baseline levels. The contribution of the Upgrader Project to this area is predicted to be less than one hectare, or less than 0.1% of the increase in area (Table 10.7-3).

Nitrogen Dioxide Concentration

The total area under NO_2 concentrations exceeding 15 ug/m^3 is predicted to be 191,250 ha (78.4% of the RSA) in the cumulative case (Table 10.7-3; Figure 10.7-2). The contribution of the Upgrader Project to this total is predicted to be 2,527 ha, or 1.3% of the total area exposed in the cumulative case. The majority of the area exposed to supracritical SO_2 concentrations is classified under anthropogenic disturbances (149,070 ha; Table 10.7-4). This is equivalent to 77.9% of the total area exposed in the RSA.

The total area of terrestrial vegetation and wetlands under NO_2 concentrations exceeding critical limits for cryptogams is predicted to be 42,177 ha (58.4% of the total area of vegetation and wetlands in the RSA). This represents an increase in area of 11,214 ha over baseline levels. The contribution of the Upgrader Project is predicted to be 679 ha, or 6.1% of the increase in area (Table 10.7-3). The Upgrader Project is predicted to contribute 54% to the increase in the area of Lichen Bog exposed to above-threshold NO_2 concentrations. However, the total change in area is less than 1 ha.

Nitrogen Deposition

In the cumulative case (Figure 10.7-2), the total area under nitrogen deposition levels above 10 kg/ha/y is predicted to be 51,395 ha (21.1% of the RSA; Table 10.7-4). This represents an increase of 648 ha (1.3%) over baseline levels. The contribution of the Upgrader Project is predicted to be 45 ha, or 0.1% of the total area exposed in the RSA. Most of the area under supracritical nitrogen deposition concentrations is classified under anthropogenic disturbances (49,421 ha, or 28.8% of the total area exposed) in the cumulative case (Table 10.7-4).

The total area of terrestrial vegetation and wetlands under nitrogen deposition levels exceeding critical limits is predicted to be 1,974 ha (2.7% of the total area of vegetation and wetlands in the RSA). This represents an increase in area of 80 ha over baseline levels. The contribution of the Upgrader Project is predicted to be 5 ha, or 6.8% of the increase in area (Table 10.7-5). The Upgrader Project is predicted to contribute 17.5% to the increase in the area of the Closed Undifferentiated Conifer category exposed to nitrogen deposition levels above 10 kg/ha/y. However, the total change in area amounts to less than 1 ha.

Given that a large proportion of the RSA is already disturbed (70.6%), and the total contribution of the Project to cumulative effects on all terrestrial vegetation communities and wetlands is

generally small, the cumulative impact rating to vegetation at closure is predicted to be low. This prediction is based on the following assumptions:

- vegetation mitigation and reclamation methods for the planned and proposed projects will be similar to those identified by North American; and
- end land use targets for the planned and proposed projects will be similar to North American's.

The confidence of the cumulative case predictions is lowered by the uncertainty of future project timing and details. Moreover, prediction confidence for air emissions relates to the uncertainty associated with the emission estimates and assumptions, and to the uncertainty associated with the air emissions model's ability to predict ambient concentrations. Further details of the limitations of this model are provided in the Air Quality section (Volume 2, Section 2). Confidence in predicting impacts of air emissions is also limited by uncertainty over the sensitivity of many plant species to airborne chemicals, and the impact of local conditions on sensitivity within species. Critical concentration thresholds for cryptogams were used in this assessment because they apply to highly sensitive plant groups (bryophytes and lichens). These thresholds are therefore assumed to represent worst-case scenarios.

Table 10.7-2 Areas of Landscape Units in the RSA Exposed to SO_2 Emissions Exceeding 10 ug/m^3 in the Cumulative Case

Landscape Units	Baseline			Cumulative Case						
	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Change in Area Exposed (ha)	Area Exposed due to Project (ha)	Area Exposed due to Other Projects (ha)	Contribution of Project to Cumulative Case (%)
Terrestrial Vegetation										
Closed Aspen, Balsam Poplar and/or Birch	30,098	0	0.0	29,610	961	3.2	961	<1	961	<0.1
Mixed Grassland	13,179	0	0.0	13,138	18	0.1	18	0	18	0.0
Closed Upland Shrub	784	0	0.0	682	197	28.8	197	0	197	0.0
Closed Se/Sw	457	0	0.0	445	144	32.4	144	0	144	0.0
Closed Pine	421	0	0.0	409	76	18.5	76	0	76	0.0
Closed Coniferous and Deciduous Cover (40-60%)	341	0	0.0	319	134	42.0	134	0	134	0.0
Closed Undifferentiated Conifer	755	0	0.0	755	0	0.0	0	0	0	N/A
Terrestrial Subtotal	**46,035**	**0**	**0.0**	**45,358**	**1,529**	**3.4**	**1,529**	**<1**	**1,529**	**<0.1**
Wetlands										
Undifferentiated Wetlands	16,710	0	0.0	16,587	41	0.2	41	0	41	0.0
Lake, Pond, Reservoir, River and Stream	7,702	3	<0.1	7,695	243	3.2	240	<1	240	0.1
Black Spruce Bog *(Sphagnum* understorey)	1,532	0	0.0	1,398	423	30.2	423	0	423	0.0
Shrubby Wetlands (willow and birch)	1,122	0	0.0	1,033	293	28.4	293	0	293	0.0
Graminoid Wetlands (sedges/grasses/forbs)	158	0	0.0	137	37	27.1	37	0	37	0.0
Lichen Bog (Lichen understorey)	13	0	0.0	13	0	0.0	0	0	0	N/A
Wetland Subtotal	**27,236**	**3**	**<0.1**	**26,862**	**1,037**	**3.9**	**1,034**	**<1**	**1,034**	**<0.1**
Terrestrial and Wetland Subtotal	**73,271**	**3**	**<0.1**	**72,220**	**2,566**	**3.6**	**2,563**	**<1**	**2,563**	**<0.1**
Anthropogenic Disturbances										
Project Footprint and Other Projects in the Cumulative Case	N/A	N/A	N/A	8,440	2,709	32.1	2,709	0	2,709	0.0
Undifferentiated Agriculture	65,078	0	0.0	62,321	4,716	7.6	4,716	0	4,716	0.0
Undifferentiated Urban and Industrial Feature	749	19	2.6	126	33	26.1	14	14	0	100.0
Major Roads, Highway and Railways	1,420	0	0.0	1,377	69	5.0	69	0	69	0.0
Other Baseline Disturbances[1]	94,050	75	0.1	90,275	1,074	1.2	1,000	37	962	3.7
Exposed Soil	9,254	0	0.0	9,063	15	0.2	15	0	15	0.0
Anthropogenic Subtotal	**170,551**	**94**	**0.1**	**171,603**	**8,616**	**5.0**	**8,522**	**51**	**8,471**	**0.6**
Cloud / Haze	8	0	0.0	7	0	0.0	0	0	0	N/A
TOTAL	**243,830**	**97**	**<0.1**	**243,830**	**11,182**	**4.6**	**11,085**	**51**	**11,034**	**<0.1**

Notes:

1 .Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce)

Summed totals may differ due to rounding.

Table 10.7-3 Areas of Landscape Units in the RSA Exposed to NO_2 Emissions Exceeding 15 ug/m^3 in the Cumulative Case

Landscape Units	Baseline			Cumulative Case						
	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Change in Area Exposed (ha)	Area Exposed due to Project (ha)	Area Exposed due to Other Projects (ha)	Contribution of Project to Cumulative Case (%)
Terrestrial Vegetation										
Closed Aspen, Balsam Poplar and/or Birch	30,098	11,964	39.7	29,610	15,988	54.0	4,024	231	3,794	5.7
Mixed Grassland	13,179	7,362	55.9	13,138	9,488	72.2	2,126	234	1,892	11.0
Closed Upland Shrub	784	35	4.5	682	283	41.6	248	16	232	6.6
Closed Se/Sw	457	44	9.5	445	188	42.2	144	1	143	0.4
Closed Pine	421	78	18.5	409	132	32.3	54	1	53	1.7
Closed Coniferous and Deciduous Cover (40%-60%)	341	5	1.6	319	132	41.3	127	1	126	0.8
Closed Undifferentiated Conifer	755	166	22.0	755	191	25.3	25	1	25	2.8
Terrestrial Subtotal	**46,035**	**19,653**	**42.7**	**45,358**	**26,402**	**58.2**	**6,749**	**485**	**6,265**	**7.2**
Wetlands										
Undifferentiated Wetlands	16,710	8,019	48.0	16,587	11,159	67.3	3,140	141	2,998	4.5
Lake, Pond, Reservoir, River and Stream	7,702	3,207	41.6	7,695	3,914	50.9	707	36	671	5.1
Black Spruce Bog *(Sphagnum* understorey)	1,532	44	2.9	1,398	407	29.1	363	11	352	2.9
Shrubby Wetlands (willow and birch)	1,122	19	1.7	1,033	234	22.7	215	4	211	1.9
Graminoid Wetlands (sedges/grasses/forbs)	158	8	5.0	137	48	34.9	40	2	38	5.2
Lichen Bog (Lichen understorey)	13	13	98.1	13	13	99.9	<1	<1	<1	54.0
Wetland Subtotal	**27,236**	**11,310**	**41.5**	**26,862**	**15,775**	**58.7**	**4,465**	**195**	**4,270**	**4.4**
Terrestrial and Wetland Subtotal	**73,271**	**30,963**	**42.3**	**72,220**	**42,177**	**58.4**	**11,214**	**679**	**10,535**	**6.1**
Anthropogenic Disturbances										
Project Footprint and Other Projects in the Cumulative Case	N/A	N/A	N/A	8,440	6,271	74.3	6,271	74	6,197	1.2
Undifferentiated Agriculture	65,078	29,248	44.9	62,321	46,040	73.9	16,792	1,454	15,338	8.7
Undifferentiated Urban and Industrial Feature	749	353	47.2	126	123	97.4	-230	38	-269	-16.7
Major Roads, Highway and Railways	1,420	796	56.1	1,377	1,068	77.5	271	16	255	6.0
Other Baseline Disturbances[1]	94,050	87,175	92.7	90,275	88,100	97.6	925	159	766	17.2
Exposed Soil	9,254	5,867	63.4	9,063	7,469	82.4	1,602	106	1,496	6.6
Anthropogenic Subtotal	**170,551**	**123,440**	**72.4**	**171,603**	**149,070**	**86.9**	**25,631**	**1,848**	**23,783**	**7.2**
Cloud / Haze	8	1	8.9	7	2	28.3	1	0	1	0.0
TOTAL	**243,830**	**154,403**	**63.3**	**243,830**	**191,250**	**78.4**	**36,846**	**2,527**	**34,319**	**6.9**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

Table 10.7-4 Areas of Landscape Units Exposed to Nitrogen Deposition Exceeding 10 kg/ha/a in the Cumulative Case

Landscape Units	Baseline			Cumulative Case						
	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Total Area in RSA (ha)	Area Exposed (ha)	% of Total Area in RSA	Change in Area Exposed (ha)	Area Exposed due to Project (ha)	Area Exposed due to Other Projects (ha)	Contribution of Project to Cumulative Case (%)
Terrestrial Vegetation										
Closed Aspen, Balsam Poplar and/or Birch	30,098	545	1.8	29,610	580	2.0	35	2	33	6.6
Mixed Grassland	13,179	222	1.7	13,138	234	1.8	12	1	11	6.9
Closed Upland Shrub	784	0	0.0	682	0	0.0	0	0	0	N/A
Closed Se/Sw	457	1	0.1	445	1	0.1	0	0	0	N/A
Closed Pine	421	1	0.2	409	1	0.2	0	0	0	N/A
Closed Coniferous and Deciduous Cover (40-60%)	341	0	0.0	319	0	0.0	0	0	0	N/A
Closed Undifferentiated Conifer	755	4	0.6	755	5	0.6	<1	<1	<1	17.5
Terrestrial Subtotal	**46,035**	**772**	**1.7**	**45,358**	**820**	**1.8**	**48**	**3**	**44**	**6.7**
Wetlands										
Undifferentiated Wetlands	16,710	322	1.9	16,587	343	2.1	21	1	19	6.8
Lake, Pond, Reservoir, River and Stream	7,702	797	10.3	7,695	808	10.5	12	1	11	7.2
Black Spruce Bog *(Sphagnum* understorey)	1,532	2	0.1	1,398	2	0.1	0	0	0	N/A
Shrubby Wetlands (willow and birch)	1,122	0	0.0	1,033	0	0.0	0	0	0	N/A
Graminoid Wetlands (sedges/grasses/forbs)	158	0	0.0	137	0	0.0	0	0	0	N/A
Lichen Bog (Lichen understorey)	13	0	1.9	13	0	1.9	0	0	0	N/A
Wetland Subtotal	**27,236**	**1,121**	**4.1**	**26,862**	**1,154**	**4.3**	**33**	**2**	**30**	**6.9**
Terrestrial and Wetland Subtotal	**73,271**	**1,894**	**2.6**	**72,220**	**1,974**	**2.7**	**80**	**5**	**75**	**6.8**
Anthropogenic Disturbances										
Project Footprint and Other Projects in the Cumulative Case	N/A	N/A	N/A	8,440	326	3.9	326	0	326	0.0
Undifferentiated Agriculture	65,078	1,336	2.1	62,321	1,380	2.2	44	3	41	7.4
Undifferentiated Urban and Industrial Feature	749	25	3.4	126	25	19.9	<1	<1	<1	11.8
Major Roads, Highway and Railways	1,420	34	2.4	1,377	35	2.5	1	<1	1	6.3
Other Baseline Disturbances[1]	94,050	47,244	50.2	90,275	47,433	52.5	189	36	153	19.0
Exposed Soil	9,254	214	2.3	9,063	222	2.4	7	<1	7	5.6
Anthropogenic Subtotal	**170,551**	**48,852**	**28.6**	**171,603**	**49,421**	**28.8**	**568**	**40**	**528**	**7.0**
Cloud / Haze	8	0	0.0	7	0	0.0	0	0	0	N/A
TOTAL	**243,830**	**50,746**	**20.8**	**243,830**	**51,395**	**21.1**	**648**	**45**	**603**	**7.0**

Notes:

1 Other Baseline Disturbances include towns and cities, other upgraders and additional ROWs in the RSA.

Se/Sw = (Engelmann spruce/white spruce).

Summed totals may differ due to rounding.

AGCC CODE DESCRIPTIONS

- BLACK SPRUCE BOG
- CLOSED ASPEN, BALSAM POPLAR AND/OR BIRCH
- CLOSED CONIFEROUS AND DECIDUOUS COVER
- CLOSED PINE
- CLOSED SE/SW
- CLOSED UNDIFFERENTIATED CONIFER
- CLOSED UPLAND SHRUB
- CLOUD / HAZE
- GRAMINOID WETLANDS
- UNDIF. WETLANDS
- LICHEN BOG
- MIXED GRASSLAND
- SHRUBBY WETLANDS
- EXPOSED SOIL
- UNDIF. AGRICULTURE
- UNDIF. URBAN AND INDUSTRIAL FEATURE
- MAJOR ROADS, HIGHWAY AND RAILWAYS
- LAKE, POND, RESERVOIR, RIVER AND STREAM

320000 330000 340000 350000 360000 370000 380000

6000000 5990000 5980000 5970000 5960000 5950000 5940000 5930000 5920000 5910000 5900000

N

Dry Mixedwood

North Saskatchewan River

058-19W4 057-19W4 056-19W4 055-19W4 054-19W4 053-19W4 052-19W4 051-19W4 050-19W4

Dry Mixedwood

Central Parkland

049-26W4 049-25W4 049-24W4 049-23W4 049-22W4 049-21W4 049-20W4 049-19W4

1:285,000

0 2 4 8 12 16 20 km

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER RSA
- NORTH AMERICAN UPGRADER LSA
- BASELINE DISTURBANCE
- APPLICATION DISTURBANCE
- CEA DISTURBANCE
- ALBERTA NATURAL SUBREGION
- ELK ISLAND NATIONAL PARK
- ALBERTA TOWNSHIP/RANGE
- HIGHWAY
- WATERBODY
- RIVER/STREAM

Title: **DISTRIBUTION OF GROUND COVER CLASSES IN THE VEGETATION AND WETLANDS RSA IN THE CUMULATIVE CASE**

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.7-1_DIST_AGCC_CEA_SCENARIO_IN_RSA_TABLOID.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.7-1**

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AGCC CODE DESCRIPTIONS

- BLACK SPRUCE BOG
- CLOSED ASPEN, BALSAM POPLAR AND/OR BIRCH
- CLOSED CONIFEROUS AND DECIDUOUS COVER
- CLOSED PINE
- CLOSED SE/SW
- CLOSED UNDIFFERENTIATED CONIFER
- CLOSED UPLAND SHRUB
- CLOUD / HAZE
- GRAMINOID WETLANDS
- UNDIF. WETLANDS
- LICHEN BOG
- MIXED GRASSLAND
- SHRUBBY WETLANDS
- EXPOSED SOIL
- UNDIF. AGRICULTURE
- UNDIF. URBAN AND INDUSTRIAL FEATURE
- MAJOR ROADS, HIGHWAY AND RAILWAYS
- LAKE, POND, RESERVOIR, RIVER AND STREAM

320000 330000 340000 350000 360000 370000 380000

6000000 5990000 5980000 5970000 5960000 5950000 5940000 5930000 5920000 5910000 5900000

N

North Saskatchewan River

058-19W4 057-19W4 056-19W4 055-19W4 054-19W4 053-19W4 052-19W4 051-19W4 050-19W4

049-26W4 049-25W4 049-24W4 049-23W4 049-22W4 049-21W4 049-20W4 049-19W4

1:285,000

0 2 4 8 12 16 20 km

NAD 83 UTM Zone 12

Project Location

Legend

- NORTH AMERICAN UPGRADER RSA
- NORTH AMERICAN UPGRADER LSA
- BASELINE DISTURBANCE
- APPLICATION DISTURBANCE
- CEA DISTURBANCE
- ELK ISLAND NATIONAL PARK
- ALBERTA TOWNSHIP/RANGE
- HIGHWAY
- WATERBODY
- RIVER/STREAM
- 10 µg/m³ SO_2 ISOPLETH
- 15 µg/m³ NO_2 ISOPLETH
- 10kg/ha/a NITROGEN DEP. ISOPLETH

Title: **AIR EMISSIONS AND DISTRIBUTION OF GROUND COVER CLASSES IN THE VEGETATION AND WETLANDS RSA IN THE CUMULATIVE CASE**

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
BE	Nov.15, 2007

File: FIGURE_10.7-2_AIR_EMISSIONS_RSA_VEGETATION _AND_WETLANDS_CEA_TABLOID.mxd

Drawn by:	Checked:	Fig. No.:
LZ	MS	**10.7-2**

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10.8 Follow-up and Monitoring

Wetland restoration and compensation initiatives to mitigate wetland losses in the LSA will be monitored for success as part of an adaptive management program. North American will also introduce a weed management and control program to limit the potential for weeds and invasive plant species to become established in the LSA.

10.9 Summary

The LSA and RSA associated with the Project were assessed for impacts on vegetation, wetlands, rare plant species and rare plant communities.

The majority of land in the LSA is classified as Agricultural Land (85.8%) at baseline. Natural or semi-natural terrestrial vegetation communities constitute 4.4% of the LSA, with wetlands comprising 5.7%. One rare vascular plant species, low milkweed *Asclepias ovalifolia* Dcne., was recorded in the LSA. The low milkweed is located in SE 2-56-21 W4M, in an area that will not be disturbed by the Project. No rare plant communities were found in the LSA.

The proposed development will have a low impact on natural or semi-natural terrestrial vegetation communities, and a medium impact on wetlands in the LSA. Project construction will primarily impact areas classified at baseline as Agricultural Land or other anthropogenic disturbances. Several terrestrial communities and wetlands, including the community in which the rare species was recorded, are not expected to be affected by construction because the proposed footprint does not encroach on these areas. A community classified as Mixed Shrubland will be removed. However, this community occupies only 0.5 ha (0.1% of the LSA), and contains species that occur frequently in the region. The area of the Deciduous Woodland community will be reduced by 1.1 ha (29.9% of baseline levels). Other terrestrial natural and semi-natural habitats will be reduced by less than 1.0% of baseline levels, or will be unaffected.

The area of Class I/II Wetlands (Ephemeral Wetlands/Wet-Meadow Zone) is expected to be reduced by 86.3% through dewatering. In addition, the one Class III Wetland existing at baseline will be dewatered. A compensation program to mitigate the effects of dewatering wetlands will be designed in conjunction with AENV; the details of this program had not been decided at the time of this assessment. With mitigation measures, the potential overall environmental impact to wetlands is predicted to be medium. It is anticipated that construction and operation of the Project will not significantly impact drainage patterns.

Effects of Project construction and operation on terrestrial and wetland communities in the RSA are predicted to be negligible. Vegetation removal is predicted to affect less than 1.0% of any natural or semi-natural vegetation or wetland cover class in the RSA. Furthermore, there are predicted to be only minor changes in the area of any vegetation or wetland community exposed to air emissions that exceed critical limits for cryptogams.

Given that a large proportion of the RSA is already disturbed (70.6%), and the total contribution of the Project to cumulative effects on all terrestrial vegetation communities and wetlands is predicted to be of low magnitude, the cumulative impact rating for vegetation and wetlands is predicted to be low.

Table 10.9-1 Summary of Potential Impacts on Vegetation and Wetlands in the LSA

	Parameter	Direction	Extent	Magnitude	Duration	Frequency of Occurrence	Permanence	Level of Confidence	Final Impact Rating
LSA									
Terrestrial Vegetation	Removal of Vegetation	Negative	Subregional	Low	Medium-term	Isolated	Reversible in long-term	High	Low
Wetlands	Removal of Vegetation	Negative	Subregional	Medium	Medium-term	Isolated	Reversible in medium-term	Medium	Medium
	Alterations in Hydrology	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No impact
Rare Plants	Removal of Vegetation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No impact
Rare Plant Communities	Removal of Vegetation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RSA									
Terrestrial Vegetation	Removal of Vegetation	Negative	Subregional	Negligible	Medium-term	Isolated	Reversible in long-term	High	Negligible
Wetlands	Removal of Vegetation	Negative	Subregional	Negligible	Medium-term	Isolated	Reversible in long-term	High	Negligible

N/A - not applicable.

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10.10.2 Personal Communication

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