Appendix D

Technical Review Reports - Shell Jackpine Mine Expansion Project

Appendix D-1

Shell Jackpine Mine Expansion and Pierre River Mine Project – Environmental Impact Assessment Methodology Review for Athabasca Chipewyan First Nation – April 5, 2010, by C. Dana Bush of Bush Ecology

Shell Jackpine Mine Expansion and Pierre River Mine Project

Environmental Impact Assessment Methodology Review for Athabasca Chipewyan First Nation

By:

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April 5, 2010

Introduction

The methods used in Environmental Impact Assessments (EIAs) have a direct bearing on the results of the impact assessment. Problems with environmental impact analysis, and in particular cumulative effects analyses, have been addressed in several key papers (Kennett 1999 and 2000; Duinker and Greig 2006). Several of their criticisms of cumulative effects assessments are pertinent to this EIA. In particular:

- Cumulative effects arise from individually insignificant but cumulatively important activities, and are not adequately addressed;
- The analysis of cumulative effects requires better baseline information and analysis on a regional level, at a scale appropriate to the Key Indicator Resource (KIR) being analyzed; and
- Determination of significance (or environmental consequence) requires clear definitions, and in lieu of biological thresholds, should use very conservative cut-offs.

The EIA for the Jackpine Mine Expansion (JME) and the Pierre River Mine Project (PRM) consists of several volumes and addenda:

- Volume 5: Environmental Impact Assessment, December 2007;
- Environmental Setting Report, December 2007;
- Environmental Assessment Update, May 2008 (excluding the Fort McKay lease and separating the JME and PRM);
- PRM Supplemental Information with an EIA update, May 2007;
- Shell Jackpine Mine Expansion and Pierre River Mine Project EIA Update, December 2009;
- Pierre River Mine Project Supplemental Information, May 2009.

In addition, the original EIA combined the data and discussion from the two projects, even though they were distinctly different projects, on different sides of the Athabasca River, with different soil and vegetation conditions, and with different issues. An update was issued in 2008 that separated the two projects. As a consequence of these numerous volumes, following the logic from methods to conclusion was difficult.

Environmental Setting and Scope

The Jackpine Mine Expansion (JME) Local Study Area (LSA) is in the Central Mixedwood Natural Subregion. The LSA is along the Muskeg River, east of the Athabasca River, and covers 18,348 ha, based on the project development area plus a 500 m buffer zone. The JME "is primarily composed of a large, intricate wetlands complex that follows the Muskeg River, which is bound by the Fort Hills to the north and uplands near Kearl Lake to the south. The wetlands complex is primarily fens, but also includes bogs and non-peatland wetlands", including a patterned fen in the NE. Only 13% of the LSA is upland, with 59% of the area wetlands (mostly peatlands), 17% burn, and 11% disturbances such as cutblocks, borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines".

The JME project is an expansion of the existing Jackpine open pit mine, and includes:

- Expanding the Jackpine Mine and adding more mining equipment;
- Constructing bitumen extraction and treatment facilities;
- Building an asphaltene fired co-generation plant;
- Increasing the annual water withdrawal from the Athabasca River;
- Constructing a new External Tailings Disposal Area.

The Pierre River Mine (PRM) LSA is in both the Central Mixedwood Natural Subregion and the Athabasca Plain Natural Subregion. The PRM LSA is on the west side of the Athabasca River, and covers 21,136 ha. The Athabasca Plain Natural Subregion is warmer and has sandier soils than the Central Mixedwood Natural Subregion, and therefore has more upland forest than is typical in the Boreal Forest. It includes a higher proportion of merchantable timber, and the Calamut Old Growth Forest, and the Eymundson Sinkhole Environmentally Significant Areas. Two thirds (66%) of the PRM LSA is upland.

The PRM is a new open pit mine which includes:

i. Mining equipment, infrastructure, processing and support facilites

ii. Site access infrastructure including a bridge across the Athabasca River;

iii. Constructing bitumen extraction and treatment facilities;

iv. Building an asphaltene fired co-generation plant;

v. Building a water intake from the Athabasca River;

vi. Building a worker camp;

vii. Constructing a raw water and wastewater system, power distribution system, cooling water system, instrument and utility air system, a flare system, and new buildings;

- Constructing a new External Tailings Disposal Area.

Discussion

This section includes a discussion of some problems with the EIA methods used by Shell in their assessment of the Pierre River Mine and Jackpine Mine Expansion projects. Further details on the issues discussed here, and issues on data and data analyses are discussed in each specialist section.

1. Cumulative effects from individually insignificant but cumulatively important activities, and cumulative effects from previous activities are not adequately addressed;
2. Regional study area is too large to determine significance;
3. Significance (or environmental consequence) definitions are arbitrary or not biologically relevant;
4. Time lags from clearing to reclamation are not adequately assessed for wildlife, vegetation, or aboriginal use
5. The assessment is based on reclamation and reversibility which rely on broad definitions of success not in line with aboriginal values, weak assumptions, and short term data;
6. Lack of confidence in the data, assumptions, or predictions.

Baseline Data

Cumulative assessment is done after the project assessment

Section 1.3.3 states that " The Base Case includes consideration of the existing environmental conditions as well as existing and approved projects or activities within the study area" and the Planned Development Case (PDC) "assessment is completed only when the predicted residual impacts predicted for the Application Case are rated greater than negligible".

In practice, this custom of conducting cumulative impact assessments only on residual project effects ignores the premise behind cumulative effects - that they are the result of many small impacts, most of which are negligible when considered in isolation. In addition, the assessment of residual impacts relies on several unsubstantiated assumptions for mitigation (this point is discussed further down).

Cumulative impact assessments would more effectively evaluate impacts if they were conducted first, to assess the cumulative impacts of prior developments, i.e. how has the vegetation been affected by development and is it already significant. If the impacts are already significant, then additional developments, even if less than 1 %, will contribute a *small incremental increase to an already significant impact*.

Please justify why cumulative impacts should be assessed after project impacts.

Impact Description Criteria (Table 1.3-4, EIA) does not consider confidence in the final impact rating.

Low or even moderate confidence in the predictions should influence the final classification and should be displayed in the table

Please explain how confidence was included in the final impact rating and include confidence in the summary table

The use of a current Baseline Scenario does not support a cumulative effects assessment.

The Base Case includes consideration of the existing environmental conditions as well as existing and approved projects or activities within the study area" (Section 1.3.3 EIA).

By using a current baseline case, the EIA is incapable of assessing the current impacts as there is no undeveloped scenario with which it can be compared. The predicted changes are meaningless from a wildlife or vegetation standpoint if it is not also understood how much change has already occurred to wildlife populations and habitat in the region. Satellite data and air photo data is available for pre-oil sands development period, and other EIAs have used a 'hypothetical baseline" where the developments are lifted off and the polygons joined together. This allows the assessment to evaluate the current impacts (and to determine if they are already significant), the project, the project and the current impacts, and planned developments.

Use either a pre-development baseline or a hypothetical baseline to assess the current cumulative effects, and then assess the addition of the project.

Regional Study Area too large

The large size of the Regional Study Area (RSA) obscures the cumulative effects. The JME comprises less than 1% of the RSA (10,036 ha / 2,277,376 ha = 0.48%) which increases the probability that the contribution of project-related effects will be assessed as 'negligible' under the effects assessment methods used in this EIA. In addition, the 'one size fits all' approach used in this assessment does not meaningfully address effects on all species. The RSA may be appropriate for large roaming animals such as moose, but it is inappropriate to smaller animals such as beaver and Canadian toad (see Wildlife and Vegetation for further discussion).

Please justify the use of a large RSA and explain how any area based KIRs could be significant if the LSA is less than 1% of the RSA (for JME or PRM) or 1.7% (for both projects combined).

Lack of Regional Data

Regional data is not available at a scale appropriate to analyze the cumulative impacts on KIRS of interest to the ACFN. A result, Shell uses coarse scale maps (LANDSAT satellite image classification) at the RSA level to develop Land Cover Classes. Land Cover Classes are generalized vegetation types (6 upland and 3 wetland native vegetation types plus a burn category). These broad classes cannot differentiate the impacts on, for example, patterned fens (Section 7.5.2), or between a marsh and an open bog. Analyses of traditionally used plants or rare plant potential using these coarse scale maps is virtually meaningless, as they include vast areas of unsuitable habitat.

Work with CEMA to develop ELC level maps for the regional study area. This will require data sharing and similar databases.

Reclamation and Reversibility

Reclamation is a core part of any EIA (Environmental Impact Assessment), as the assumption of successful reclamation is used to mitigate the project impacts, resulting in low residual impacts. The definition of reclamation and reversibility, and the assumptions used in assessing reclamation success are therefore critical. The EIA states that

> *"Shell's reclamation goal is to achieve maintenance-free, self-sustaining ecosystems with a capability equivalent to predevelopment conditions (EIA Section 1.2 EIA)"*
>
> *"The target vegetation communities identified in the C&R Plan are conceptual, and it is not currently possible to predict ecosystem succession over time."*
>
> *"Project areas will be reclaimed with native vegetation as soon as practical" (EIA Section 8.1.3.3.).*
>
> *"Because ecosystems are dynamic, a site is considered to be restored if natural succession processes are restored. Reversibility does not necessarily require the establishment of a mature stage of the successional pattern, but can be achievement of a development stage that can be assumed to be moving towards an acceptability stage of maturity" (EIA Section 1.3.6.1).*

There is little discussion of diversity in the reclaimed landscape, and the time-line is considered long-term but is not specified. The final landscapes in the Jackpine Mine Expansion and Pierre River Mine Project will be noticeably different than the original, with more large hills, 4 times the area of open water with fewer peatlands and less riverine habitat, no old growth forest (within human generations), more non-native species, and far fewer native species than in an intact boreal forest. By using a low diversity reclaimed landscape in an unspecified time-line as a goal, the EIA can confidently claim that reclamation will be successful and most impacts will be reversible, and that the prediction confidence is high for uplands and moderate for riparian communities.

Several examples follows with further details in the Vegetation and Soils sections:

- peatlands cannot be reclaimed, however the EIA lumps marshes and treeless bogs as 'non-treed wetlands' and then assumes that a reclaimed non-treed wetland (i.e. a marsh) will offset the loss of the bogs. Marshes and treeless bogs are not biologically equivalent.
- direct placement of suitable material to reclamation areas will enhance site revegetation, however only 1/3 of the topsoil will be used for direct placement: the rest will be stored until final reclamation, by which time most seeds and propagules will have died.
- reclamation plans include trees and shrubs but very few forbs, and the size of the mine in addition to the proximity and size of neighboring mines will preclude the natural invasion of most native plant species.

In addition, the degree of success in reclaiming all of the tailings ponds (in-pit and external ponds) is uncertain, as new technology is required. The water, the shallow groundwater, and the soils in these areas are likely to be contaminated with process – affected water. This will result in salt-affected soils (saline and sodic soils) over an unknown percentage of the areas. The soils may also be contaminated with hydrocarbons and trace elements. These contaminated landscapes will be permanent and should be identified as long term, adverse effects

It is perfectly acceptable to use ecosite phase as a target, but to assume that reclamation will succeed to ecosite phase (which includes forbs), and to base an assessment on this assumption, exceeds the current scientific knowledge and presents the illusion of full restoration.

Please provide scientific evidence that community and species biodiversity will be restored within the 80 year timeline.

Time-Lags

The EIA for the Jackpine Mine Expansion and Pierre River Mine Project states that clearing is planned to begin in 2010 but revegetation at JME is planned for 2034, 24 years later. Clearing is planned in 2010 at the PRM, soil salvage in 2017, with soil placement and revegetation beginning in 2039 (C&R Section 20.2), 29 years later. As a result, there will be a significant time-lag before the post-reclamation forest is useable by animals and people, especially by those species who require old growth forest. Mature lichen jackpine forests may take 60 years or more to develop (ESR Table 3.3-7), and it is not known how long it will take lichen to develop (for caribou), or for a blueberry and cranberry understory (for animals and people).

For fisheries, there will be a substantial time-lag between the clearing and the construction of compensation lakes and channels. The Muskeg River will be diverted through pipes and fish will be transported by truck to Kearl Lake for 30-40 years before the final channel system is constructed. A compensation lake will be constructed for the PRM but there are no dates provided and no discussion of when they would be capable of supporting fish and other aquatic organisms.

The obvious conclusion is that for at least 34 years (24 years from clearing to reclamation and 10 years of growth) there will be a loss of moose habitat, 40 years for fish habitat, more than 85 years for caribou habitat, and more than 125 years for old growth forest. Shell uses 80 years.

The Wildlife and Vegetation Sections in the JME and PRM EIA assume that after this time-lag, plants, animals, and fish will move into the area without assistance. The EIA doesn't explain 1) what will happen to those animals in the meantime, and 2) where the plants and animals will migrate from to repopulate the areas specially if there are also adjacent mines with no animal habitat (i.e. the Jackpine mine to the south). The Wildlife Section of the EIA assumes that moose, for example, will move away from the lease into surrounding areas. This assumes that there is 'empty' habitat available, which is not substantiated in the report.

In addition, oil sands operators may not release their leases after reclamation because they need continuing access for operations, and because they prohibit access and/or firearms for safety reasons. The JME and PRM areas may be inaccessible for aboriginal users for many years after reclamation.

The result is a large area of forest that has 1) no access, 2) no or low numbers of traditionally used plants and animals for several human generations. The time-lags for clearing, construction and reclamation will result in a loss of cultural knowledge for two to four generations of people, as the ACFN can't hunt, trap, fish, or gather plants during operations and reclamation. Aboriginal users consider the physical loss of food and the cultural loss of knowledge to be a significant impact (Dersch and Bush 2008) .

The second concern with the long timelines is the ability to detect slow developing problems. Monitoring may not detect problems with reclamation, with animal or plant immigration, or with seepage of contaminated water into the groundwater for 20 years. Detection may be too late for adaptive management, especially in the case of groundwater contamination.

Environmental Consequence and Thresholds

Environmental Consequence ranks are used to determine whether or not a measurable impact will have significant impacts to the Key Indicator Resources (KIRs) (such as moose or traditionally collected plants). Proponents are required to assess magnitude, geographic extent, duration, reversibility, and frequency; however there is little guidance on what constitutes high, medium, or low impacts. The proponent generally develops these definitions and thresholds during the EIA process, and different EIAs have different thresholds.

While some thresholds are based on widely accept guidelines (i.e. Air Quality Guidelines), others are relatively arbitrary. For example, high magnitude impacts have been set at 10%, 14% or 20% change in other EIAs: in this EIA, Shell has chosen 20% as the cutoff for high magnitude impacts. In some EIAs, the magnitude is based on the percentage of the KIR (e.g. peatlands) however the JME and PRM EIA uses the percentage of the Regional Study Area (RSA). Clearing in the JME and PRM "will result in the removal of 1,223 ha of the old growth forest, representing a loss of 2% of the LSA" (EIA Table 7.5-18). However, the table indicates that 40% of the old growth forest in the LSAs will be removed. The Residual Impact Classification assigned a low magnitude for old growth forests, based on the LSA not the resource (Table 7.5-34). This evaluation understates the impacts to old growth forests in the JME and PRM areas.

In addition, the rating systems used by Shell are ill defined or ignored in some sections. The rating system for Water Quality Guidelines (slightly, marginal and substantial) is unclear and subjective, and the impact ratings were inappropriately used for temperature changes to Eymundson Creek. In the Fisheries Section of the EIA, heavy metals were assessed against benchmarks, and then the benchmarks were disregarded. There is little value in assessing impacts and then disregarding the results because the methods were flawed.

Many of the thresholds used by Shell in the JME and PRM EIA have little biological relevance. For example, the Alberta Air Quality Guidelines are based on human health, not ecosystem health. Although other EIAs also use the more sensitive World Health Organization guidelines to assess the effects on vegetation, Shell relies on the provincial criteria which is not relevant to vegetation. From an aboriginal perspective the WHO guidelines make more sense, for if the ecosystem is not healthy then neither are the people.

Numerous traditional land use surveys report that aboriginal users are very concerned with tainted fish. Although there is evidence of tainting (CEMA, 2007), it is not known what causes the tainting nor is there an estimate of the proportion of tainted fish therefore tainting is not considered to be environmentally significant.

In the Hydrology Section of the EIA, the effects of water drawdown is considered high if it is greater than 1 m, and low if it is less than 10 cm. The significance of drawdown, however, will depend on the shape of the wetland: a wetland with a wide shallow margin may be significantly impacted by a 9 cm drawdown, whereas a wetland with a narrow shallow margin may not be. This arbitrary threshold has no biological relevance.

Synergistic effects are effects that work together so that the total effect is greater than the sum of the two (or more). Several of the concerns from ACFN may be due to synergistic effects, such as cancer rates or fish tainting, however none of the sections in the EIA discuss synergistic effects. In particular, there are no assessments of mixtures of chemicals in air or water, and their effects on aquatic organisms, fish, or terrestrial receptors. Research into fish tainting shows that it does occur, it is not due to naphthenic acids, but may be due to a mixture of compounds (CEMA, 2007). Synergistic effects may also be due to a combination of chemicals, changes in edaphic conditions and biotic conditions. Reclaimed areas will have high levels of PAI (Potential Acid Input), poor soil conditions, and impoverished vegetation diversity, but the EIA does not consider the synergistic effects, nor does it consider these factors in the confidence predictions.

Finally, the method of combining the results of the impact criteria into one rating, (magnitude, geographic extent, duration, reversibility and frequency), based on an arbitrary score serves to obscure a number of impacts. The vegetation section of this review considers this in detail.

Confidence and Assumptions

An assessment is only as good as the data and the assumptions that are used in the maps, models or conclusions. An EIA is to clearly state where the data and/or assumptions are weak so that the reviewers can understand and have confidence in the conclusions. This EIA contains a number of cases where the data is missing or weak, or the assumptions are not supported by science. A number of examples are listed below, with greater details included in each specialist's section.

- The Vegetation Section of the EIA uses existing Alberta Vegetation Inventories (AVI) as a basis for developing ecosite phase maps for the LSA, and LANDSAT satellite image classification at the RSA level, but there is no discussion of the accuracy of the maps or whether field data was used to test the accuracy. The resulting maps are used as the basis of the vegetation and wildlife assessment leaving the reader to guess at the accuracy of the assessment.
- Old growth forest is assessed, in the EIA, using an 80 year fire cycle which estimates 20-28% old growth using modeling and air photo interpretation (AVI); however other peer reviewed research, some of which is based on actual data, estimates fire intervals at 34 years or 5% old growth in the RSA. This contradictory data is not discussed in the report leading to a lack of confidence in the assessment of old growth forest.
- In the Soils Section of the EIA, the Land Cover Class is used as a goal; however the text states that it is not to be used for assessment and only applies to white spruce-mesic soils. The reclamation assessment assumes that reclamation will achieve the specified landforms based on CEMA design guidelines, and that reconstructed soils will mimic natural soils, but there is little or no evidence to support these assumptions.
- The Reclamation Section of the EIA does not state how Shell intends to process mature fine tailings, nor does it describe how Shell will meet Guideline 74. The assessment assumes that small experimental ponds will predict the changes in large ponds that are becoming increasingly toxic as water is recycled.
- The Reclamation Section of the EIA is based on a broad definition of 'successfully reclaimed' which will result in a different terrain, a loss of peatlands and low biodiversity. In addition, reclamation has only been done on overburden sites not on tailing sands, and there is limited years of data.
- The Wildlife and Vegetation Sections of the EIA assume that the landscape will be reclaimed to ecosite phase and use ecosite phase for the predictive models. Shell presents no data to support this assumption.
- The assessment assumes that animals pushed out of the mine area will move into unfilled territory, but there is no research to support this.
- The Hydrology section of the EIA claims that changes in surface water upon disturbance of land between the Muskeg River and the McClelland Fen will not

impact McClelland Fen; however fens are fed by groundwater, which may be altered by construction. The water levels in the Athabasca River were at an all-time low in 2009. The EIA does not indicate if their models predicted the low years in 2007-2008. The report does not address sediment quality nor does it assess the impacts to water quality and fish health. The existing Jackpine mine has problems with their monitoring programme and the 2007 results and yet they are confident that future impacts can be accurately predicted.

- The Surface Water Quality Section of the PRM EIA relied upon the uncertainty analysis conducted for the JME. No independent uncertainty analysis was conducted for the PRM data or predictions. Considering different datasets were used and that some of the PRM predictions relied upon information provided and modelled by another project (CNRL Horizon), it would seem prudent to conduct an uncertainty analysis specific to this project.
- The Fish and Habitat Section of the PRM EIA did not provide a timeline for construction of the compensation lake or discuss how long fish habitat would be lost.
- The EIA contains no discussion or assessment of mercury in the no net loss ponds (end pit lakes), or how to remove the mercury.

In summary, the EIA contains several instances where model results were not verified or did not correlate with field data, where models relied heavily on unproven assumptions.

Monitoring

Hydrology - monitoring plans barely mention. Shell indicates that they will modify the existing network of flow and water level monitoring stations during operations. No details are given about hydrologic monitoring as required by the Terms of Reference Section 5.6.6 (iii) and 6.0. Shell provided the location of the monitoring plans (Vol. 4B, App 4-9, Section 3). They suggested that the request to review monitoring and research plans might be discussed as part of future negotiations towards an agreement.

Recommendation: ACFN should follow up on the requested commitment to be involved in future hydrologic monitoring and research plans.

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Appendix D-2

Cumulative Effects Review of Shell Pierre River Mine and Shell Jackpine Mine Expansion Projects for Athabasca Chipewyan First Nation, August 2010, by Daniel Smith of DS Environmental Consulting Inc.

Cumulative Effects Review of Shell Pierre River Mine and Shell Jackpine Mine Expansion Projects

For Athabasca Chipewyan First Nation

Daniel Smith (DS Environmental Consulting Inc.)

August 2010

Cumulative Effects

Overview

The assessment of both the Shell Pierre River Mine and Jackpine Mine Expansion Projects did not adequately assess or consider the cumulative effects and impact of the project in conjunction with other past, present, and future projects on the traditional lands, traditional use, and rights of the ACFN.

Assessment Review

There are serious flaws with the approach and cumulative effects assessment methodologies used by Shell in this assessment. These include:

- Lack of a pre-industrial basecase – In both the Pierre River Mine and Jackpine Mine Expansion Projects assessments all impacts were compared against an artificially high basecase that is based on all current operating projects plus all previous approved (but not yet operating) project – all operating simultaneously at their maximum. This serves to mask any possible impact that the proposed project would have – especially when applied to an excessively large regional study area. A true cumulative effects assessment would have used a pre-industrial baseline. A 1970 pre-industrial baseline would be reasonable for the region since the first large industrial projects (i.e. Syncrude and Suncor) did not begin large scale operations until after this time.
- Unrealistic 'basecase' used in the assessment – Shell used three assessment cases in the assessment of the Pierre River Mine and Jackpine Mine Expansion Projects. The 'basecase' (as required by the terms of reference) is an artificial construct that includes all currently operating and approved projects operating at their maximum levels. This does not consider the effects of historic impacts of all activities and impacts to-date. While the 'Project Case' does form a partial cumulative assessment (but only as far as adding in the proposed project on top of

those which have already been approved), it is not at all adequate to address the impacts that have taken place due to previous industrial activities nor does it adequately address the future projects. The 'Planned Development Case' is supposed to include all reasonably expected and know projects, but this was only used by Shell on a limited number of impacts.

- Limited cumulative assessment of impacts - the current practice of only doing an assessment against the "Planned Development Case" (i.e. looking at the cumulative impacts of future projects) when project level impacts at the local or regional scale are shown to be significant is not a reasonable or pre-cautious approach to cumulative effects assessment and provides a biased assessment. It presumes that because the effects of any one project are determined to of low environmental consequence at a project level, that these effects will not be significant (or remain of low consequence) when the impacts of future projects are considered.
- The EIA, including the cumulative assessment, is narrowly scoped and, as such, it fails to address the issues of the ACFN related to Rights and traditional use. The cumulative assessment required by the Terms of Reference is limited and inadequate. Shell even fails to achieve this test. The current approach to cumulative assessments, as encouraged by Alberta, requires a narrow, project-specific approach that looks at the cumulative effects mostly when the the proposed project is predicted to have a significant effect at a local scale. However, it is well understood that cumulative effects can be relatively insignificant at the project-scale, but can be significant at larger scales of space and time.
- The cumulative assessment needs to consider the current baseline first. This should be inventoried and compared with the pre-industrial baseline to determine if the increment of change and impacts detected are acceptable. Next the assessment should verify that that anticipated impacts of the approved projects still meets the test of acceptability – given the new baseline. Finally, the new predicted impacts of the proposed project should be assessed and tested against the current and 'approved' cases.
- There are no regional management targets, policy guidelines, or thresholds for most of the traditional resources important to the ACFN. These are necessary to ensure that these resources are sustained at levels appropriate for and acceptable to the ACFN's practice of their Rights. In absence of these targets, guidelines, and thresholds, the predictions in the EIA, and the promises of the Proponent to monitor and restore (and the conditions of the government's approval) are of negligible value.

There are also a number of significant deficiencies with regards to cumulative effects that were identified in the review of both the Pierre River Mine and Jackpine Mine Expansion Projects. Many of these deficiencies affect the ability of the ACFN to use its traditional lands and to exercise their rights with respect to traditional use. These include:

- Land disturbance:
    - Direct loss of traditional lands - leads to a loss of harvesting areas, spiritual sites, oral traditions (stories linked to specific landscape features that transmit important traditional knowledge), hereditary harvesting and hunting rights (linked to a complex social network) - as well as traditional knowledge related to all the above;
    - Impacted access, connectivity, use, and occupancy of traditionally important areas.
- Aquatic ecosystem impacts:
    - Long-lasting and adverse impacts on groundwater and surface water quality, and their potential use by ACFN members, due to seepage from the proposed external tailings disposal area (ETDA);
    - Impacts on water quality, aquatic health, fish, and fish habitat - plus a persistent uncertainty about the quality and integrity of these resources from project-related and cumulative effects to water;
    - Diversions, withdrawals, and watershed disturbances which will contribute to flow reductions in the Athabasca River and to impacts on the Peace-Athabasca Delta.
- Air ecosystem impacts:
    - Increases in foul odour occurrences at some cabin locations and, potentially, at the ACFN's Poplar Point Reserve;
    - Impacts of degraded air quality on human health, wildlife health, and plant health - plus a persistent uncertainty about the quality and integrity of these resources from project-related and cumulative effects to air;
    - Increased acidic deposition affecting water and traditional plants.
- Terrestrial ecosystem impacts:
    - Restricted wildlife movement along the Athabasca River (a major regional wildlife movement corridor) and related effects on the exercising of the ACFN's Rights within their traditional territories, including the success and quality of those hunts.
    - Loss of wildlife, wetlands, and traditionally important plants;
    - Long-lasting (or permanent) changes in biodiversity and habitat;
    - Unproven reclamation, resulting in simplified landscapes and more open water (in the form of pit lakes).

Key Concerns

Several key concerns were identified with regards to cumulative effects during the review. These include:

Water Quality

1. <u>Cumulative Impacts on Athabasca River from process-affected seepage.</u> Tailings ponds (both in-pit and out-of-pit varieties) are a major physical feature of conventional oil sands operations. Current estimates are that the present ponds contain 840 000 Mm^3 of contaminated water (ERCB, 2010). Both the Pierre River Mine and Jackpine Mine Expansion Projects would add to this inventory. These ponds leak and their seepage is known to contaminate underlying groundwater and contribute toxins from baseflow to the Athabasca River. The current and future cumulative effects of all the current and planned tailings ponds in the region on the Athabasca River are unknown. The residual impacts on groundwater and surface waters could last decades if not centuries after these ponds are closed and reclaimed.

   Because the Athabasca River will receive process-affected seepage from tailings ponds located on both sides of the river, a cumulative effects assessment on tailings ponds seepage was required for the Pierre River Mine Project. Shell concluded that the net cumulative impact of the seepage on the Athabasca River would be insignificant. However, there is new information indicating that concentrations of toxins in the Athabasca River are significantly elevated downstream of the current oil sands projects relative to the concentrations upstream (Kelly et al., 2009, Kelly et al., 2010; Timoney & Lee, 2009).

   ➔ **Recommendations:**

   i. *Discuss the apparent contradiction between modeled forecast for the concentrations of toxins in the Athabasca River and current data presented in Timoney & Lee (2009) that suggests that the impacts are already significant.*

   ii. *Identify the impact of the cumulative effects of regional tailings seepage on groundwater and surface water quality and on downstream ecosystems (including the sediments of the Athabasca River and the Peace-Athabasca Delta), against a pre-industrial baseline.*

   iii. *Discuss how the cumulative impacts of regional tailings seepage will affect the ACFN's Rights and use of traditional resources.*

2. Cumulative effects of the discharges from multiple end pit lakes into the Athabasca River not adequately assessed.

   Shell did not adequately assess the cumulative effect of simultaneous water discharge from multiple end pit lakes into watercourses connected to the Athabasca River. Many of the region's oil sands projects are operating on similar timelines and consequently will have pit lakes working at the same time. If several end pit lakes are discharged within similar timeframes into the Athabasca River, there may be incremental increases in contaminant and nutrient loadings to the Athabasca River, the Athabasca Delta and the western portion of Lake Athabasca, possibly impacting their water quality. The lack of guidelines for the release of pit lake waters adds to the uncertainties related to contaminant concentrations of regional water quality. Diluting water quality constituents to below guidelines levels does not diminish the issue of the incremental and cumulative effects of multiple releases on receiving waters.

   ➔ **Recommendations:**

   i. *Assess the cumulative impact of the discharges of multiple pit lakes in the region on water quality in the Athabasca River and, on downstream ecosystems.*

   ii. *Identify how the cumulative impact of multiple pit lakes discharges in the region would affect the ACFN's Rights and traditional use of the River.*

Aquatics

3. Regional and cumulative effects on fish populations and habitat productivity not assessed. Oil sands operators plan to replace disturbed fish habitat with constructed habitat on a case-by-case basis as required by the federal Fisheries Act. However, the process for replacing fish habitat is experimental and unproven. In addition, there has never been an assessment of the cumulative impact of all of the regional No Net Loss (NNL) projects. Ideally, each NNL pond would replace the habit lost to oil sands projects in advance of the destruction and on a 2:1 basis. However, since there are no functioning NNL projects in the region, it is uncertain how well compensation habitats will work or how long before they reach their full productivity (i.e. minimally replacing lost habitat, and possibly contributing to gains in fish habitat). Fisheries and Oceans Canada will require long-term monitoring to verify the habitat replacement and productivity gains. There should be a contingency plan in case the NNL plan(s) does not meet expectations.

   With the mining-related loss of fish habitat and the construction of NNL habitat, there will be a shift of riverine (stream and river) habitat to lacustrine (lakes) habitats. On a regional scale this could be significant and should be assessed.

In addition, there is a concern about the release of mercury, from the construction of the NNL reservoirs into aquatic environments and subsequently into fish and other aquatic organisms, and ultimately humans. This is likely also a cumulative effect due to the number of NNL reservoirs being planned or built in the region, which may affect the Athabasca River and downstream ecosystems. No assessment of the cumulative effects of the release of mercury from all regional NNL reservoirs has been completed.

➔ **Recommendations:**

i. *Assess the regional and cumulative effects on fish populations (including species richness) and habitat productivity of multiple NNL fish habitat compensation projects. Include impacts on:*

   a. *regional fish population and species richness;*

   b. *total effective habitat units (by fish species);*

   c. *productivity of habitat;*

   d. *form of habitat – change from riverine to lacustrine;*

   e. *mercury levels in fish and aquatic systems from NNL projects.*

ii. *Identify the impact of the cumulative effects noted above on the ACFN's traditional resource use and their Rights. Specifically, identify how the shifts in species and habitat types, along with the time lags and mercury contamination of fish, would affect the ACFN's traditional use and ability to exercise their Rights. Provide documentation to the regulators that these predicted effects have been submitted to the ACFN for verification. Provide documentation that the ACFN have provided this verification.*

4. <u>Inadequate assessment of impacts from losses of multiple streams in the region.</u> Many small streams are being impacted or lost by increasing regional disturbances. There are many unknowns about the role these streams play, collectively, on regional aquatic health and hydrology.

➔ **Recommendations:**

i. *Assess the cumulative effects of the loss of the region's many smaller tributary streams on aquatics and hydrology:*

ii. *Document changes in species richness and quality of habitat, range and populations of affected species, and predicted* *timeframe(s) to replace these losses in quality and quantity of habitat.*

Hydrology

5. Cumulative impacts to the Athabasca Delta not assessed. Shell assesses changes in water depths and flows in the Athabasca River, but does not assess the effect of cumulative changes in water depths on the Athabasca Delta. Changes in depth and flow affect the Delta and reduce flushing of side channels and perched water bodies. Changes to the delta directly affect area residents.

   ➔ **Recommendations:**

   i. *Extend the Regional Study Area (RSA) for surface water hydrology from Embarras Portage to the inflow of Lake Athabasca (i.e. encompass the Athabasca Delta).*

   ii. *Re-calculate the impacts, including those on the Athabasca Delta.*

   iii. *Given the significance of the Delta to the ACFN, commit to provide the predictive results to the ACFN and to seek the ACFN's verification of these predictions based on the TEK of the ACFN.*

Air Quality / Emissions

6. Cumulative effect of multiple projects on regional air quality inadequately assessed. Incremental increases in air emissions from each new project in the region adversely affect the overall regional air quality and, ultimately, the health of the ecosystem and animals (including humans). Shell's method of assessing effects, using an artificially high baseline, masks the true magnitude of this effect. Prior to major industrial projects in the late 1960's emissions of air pollutants were near zero. These days there can be no denying the massive amounts of air contaminants being emitted in the Oil Sands Region.

   ➔ **Recommendations:**

   i. *Assess and provide an analysis on the cumulative effects of the growth of air emissions in the region using a pre-industrial baseline and projecting this out by 100 years – (i.e. from 1965 to 2065).*

   ii. *Provide a summary table of the projects included in the various assessment cases with their projected emissions listed over the same time frame as above.*

Wildlife

7. Cumulative effects of tailings ponds on migratory bird populations not assessed. Because of the proximity of the Pierre River Mine and Jackpine Mine Expansion Projects to regionally or provincially significant migratory staging areas (Athabasca River, McClelland Lake, Kearl Lake, etc.), risks of exposure of migrating water birds to tailings might be increased. Cumulative effects of tailings ponds in the oil sands region on wildlife (including migratory birds) have not been assessed.

   The ACFN are concerned with mortality of migratory birds exposed to tailings ponds. An assessment of the cumulative effects of all existing, approved, and planned oil sands tailings ponds should be included in the EIA – using a pre-industrial baseline.

   ➔ **Recommendations:**

   i. *Provide the results of a comprehensive assessment of the cumulative effects of oil sands tailings ponds on migratory bird populations and health – based on a pre-industrial baseline.*

   ii. *Discuss the effects of these changes on traditional use and on the ACFN's Rights.*

8. Cumulative effect of multiple projects on wildlife inadequately assessed. Incremental increases in disturbed land area from each new project in the region adversely affect both local and regional wildlife. Shell's method of assessing effects, using an artificially high baseline, masks the true magnitude of this effect. Prior to major industrial projects in the late 1960's impacts on wildlife were restricted to local hunting pressures. Currently wildlife are impacted by many more factors, the majority of which are related to the oil sands industry

   ➔ **Recommendations:**

   i. *Provide estimates of wildlife populations, habitat availability, and vegetation communities (including wetlands) under pre-industrial conditions, and compare these to the present day and 'Base Case' scenarios.*

   ii. *Identify the expected area of land from which wildlife and vegetation would migrate back into the reclaimed land, taking into consideration any nearby operations which would be also be cleared.*

   iii. *Discuss and assess the impacts of the changes in wildlife in the region on traditional use and on the Rights of the ACFN.*

   iv. *Given the significance of the wildlife to the ACFN's traditional use and Treaty and Aboriginal rights, commit to provide the predictive* *results to the ACFN and to seek the ACFN's verification of these predictions based on the TEK of the ACFN.*

Vegetation & Wetlands / Biodiversity

9. Project-related and regional loss of wetlands inadequately assessed. The Pierre River Mine and Jackpine Mine Expansion Projects are just one of many projects that would lead to the destruction and loss of natural wetlands in the region. As stated in the *CEMA Guideline for Wetland Establishment on Reclaimed Oil Sands Leases* (Harris, 2007), "Natural boreal wetlands are a critical habitat for many important wildlife species, including woodland caribou, moose, muskrat, waterfowl (particularly diving ducks) and amphibians", and "Wetlands in the oil sands region are indelibly linked to the traditional way of life… People of the Fort McKay, Anzac, and Fort Chipewyan communities continue to use wetlands for subsistence hunting and trapping, for food and medicinal plant collection, and for spiritual well-being". A realistic assessment of the cumulative loss of wetlands in the region and the effects of this loss on the traditional use and Rights of the ACFN, using a pre-industrial baseline, has not yet been conducted.

   ➔ **Recommendations:**

   i. *Discuss and assess the cumulative impacts arising from the Pierre River Mine and Jackpine Mine Expansion Projects predicted permanent wetland loss, as well as the total loss of wetlands in the entire Oil Sands Region on biodiversity, habitat loss, wildlife, traditional users, groundwater, surface water, and vegetation. Use a pre-industrial baseline for all assessments.*

   ii. *Discuss the impact of the loss of wetlands on traditional use and on the Rights of the ACFN.*

10. Impacts of combined air emissions on vegetation key indicator resources unclear. The increase in nitrogen causing eutrophication is a concern - nitrogen accumulates in the environment causing long-term to permanent changes.

    While nitrogen is a naturally occurring nutrient, most northern vegetation communities are adapted to low nitrogen levels. The addition of nitrogen to treed bogs and poor fens may result in a shift in species, and, potentially, an increase in sedges and shrubs and a decrease in mosses and lichens (depending on the species). Plant species particularly adapted to low nutrient conditions, such as pitcher plant (which is both rare and collected for use by Aboriginal users) may be out-competed in a more nutrient-rich environment. Although the area potentially affected is small, the long-term impacts may be noticeable to Aboriginal users and wildlife.

The combined effects of acid deposition, sulphur dioxide, nitrogen dioxide, and eutrophication on treed / poor bogs may cause more permanent changes than anticipated. The interrelationships between these elements and northern Canadian ecosystems are not well understood, and therefore the confidence level in these assessments is not high.

➔ **Recommendation:**

Provide a qualitative description of how air emissions (Potential Acid Input, SO_2, NO_2, and eutrophication) might cumulatively affect plants around the mine during operations and reclamation, taking synergistic effects into consideration.

Reclamation

11. Reclamation of wetlands as upland forest inadequately assessed and planned. Loss of large landscape-sized wetlands is happening at every oil sands mine in the region, including the Pierre River Mine Project. Much of the large areas of wetlands removed as a result of oil sands mining is expected to be reclaimed as upland forests, constituting a major shift in the ecosystem of the region.

➔ **Recommendation:**

Present the area of wetlands in the region that would be converted into uplands.

Traditional Land Use

12. Cumulative impacts to traditional users not fully addressed. The ACFN are concerned that the impacts from both the Pierre River Mine and Jackpine Mine Expansion Projects, and the regional industrialization as a whole, would have near permanent impacts on the ACFN's use of this area for traditional purposes.

➔ **Recommendation:**

Re-assess the cumulative impacts from both the Pierre River Mine and Jackpine Mine Expansion Projects and nearby operations, using actual data from reclamation efforts from these neighbouring operations. After identifying the gaps between what was promised and what was delivered, identify what mitigations Shell would consider. Use a pre-industrial baseline for the assessment.

13. Industrial activities directly and indirectly impact on Traditional Land Uses and practice of Aboriginal and Treaty rights. The incremental and increasingly prevalent impacts of industrial activity, both in the region and locally, will have a significant and long-lasting impact on First Nation

members. With each new industrial project in the region there are incremental and cumulative impacts that cause increased traffic and congestion; light pollution; noise; odours; off-road use; hunting pressures; displacement of wildlife; habitat loss and fragmentation, loss of traditional plants and berries; contamination of traditional foods, air, water, etc. In turn there is increased competition for traditional resources; impediments to access to preferred harvesting areas; deteriorated quality and quantity of traditional resources; deteriorated aesthetic and spiritual qualities of harvesting and occupancy areas; psychosocial barriers to harvesting; and, a decreased ability to pass traditional knowledge and cultural practices to younger generations. The additional stress and anxiety among ACFN members that results from both a lack of confidence in the quality and safety of traditional foods and from impacts to cultural and community well-being as traditional practices begin to decline, is an important effect that goes unexamined and unaccounted for. While the impacts of each individual project may seem insignificant and go unnoticed, over time the additive effects may result in considerable and permanent environmental, socioeconomic, and cultural losses.

Combined, these impacts result in a decreased ability to practice Treaty and Aboriginal rights, and ultimately in a loss of culture and connection to the land. People use the land less; they take fewer trips and collect fewer foods and medicines; their ability and desire to use the land for traditional purposes is significantly and irreversibly impacted, resulting in more store bought foods, less exercise, fewer social gatherings, loss of language, and poorer health and well-being. In short, industry's presence impacts the ACFN and its practice of Treaty and Aboriginal rights

➔ **Recommendations:**

viii. Assess the direct and indirect effects of both the Pierre River Mine and Jackpine Mine Expansion Projects, in combination with all other regional projects, on the well-being and culture of the ACFN. Take into consideration the incremental and cumulative effects of industry and other activities in the region.

ix. Assess the direct and indirect effects of the Pierre River Mine and Jackpine Mine Expansion Projects in combination with all other regional projects (in the past, present, and future) on the ability of the ACFN to practice their Aboriginal and Treaty rights.

Literature Cited

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Timoney, Kevin P. and Lee, Peter. 2009. "Does the Alberta Tar Sands Industry Pollute? The Scientific Evidence" *The Open Conservation Biology Journal*, 3 (2009): 65-81.

Appendix D-3

Shell Jackpine Mine Expansion Project – Environmental Impact Assessment Report – Review for Athabasca Chipewyan First Nation – Groundwater Component – September 2008, by Lew Fahner of Agua Consulting

Shell Jackpine Mine Expansion Project
Environmental Impact Assessment Report
Review for Athabasca Chipewyan First Nation
By:
Agua Consulting
September, 2008

Groundwater Component

Groundwater Component

Overview

Several of the activities associated with the Shell Jackpine Mine Expansion Project (JEMA) will impact the groundwater resources in the project area. These impacts may result in changes to groundwater levels, changes in groundwater flows and flow directions and changes in the groundwater quality. These changes can impact the aquatic resources including surface water flows, surface water quality and wetlands in the Local Study Area (LSA) and the Regional Study Area (RSA). Terrestrial vegetation can also be impacted.

Activities* which are specific to the JEMA and which can result in changes to the groundwater resources are:

- Dewatering and removal of the overburden and the Pleistocene Channel Aquifer
- Basal Aquifer depressurization
- External tailings disposal
- Pit backfill
- Reclamation and the mine closure landscape

* There is no new plant-site construction proposed for JEMA.

Dewatering and Removal of the Overburden

Discontinuous minor thicknesses of muskeg occur throughout the project area. Where necessary, the muskeg will be drained using finger ditches and sumps prior to the dewatering and removal of the overburden and the Pleistocene Channel Aquifer. The muskeg will be removed and stored for use during reclamation as will any other suitable materials. Water from dewatering of the muskeg will be directed to polishing ponds and will be released to the environment, if the water quality is satisfactory.

The overburden and the Pleistocene Channel Aquifer will be dewatered to allow its removal prior to mining of the underlying bitumen. The groundwater will be removed using ditches and sumps and possibly de-watering wells. The dewatering will have an effect on groundwater levels, flows and flow patterns in the LSA.

The dewatering will result in the lowering of the groundwater levels within the dewatering area to, or below, the level of the mining surface. The dewatering and the development of the pit will result in the incidental or passive dewatering of the geological materials surrounding the mining pit. The lower water level associated with the pit, the bottom of which will be many metres below the water table in the surrounding undisturbed materials, will cause the groundwater in the surrounding materials to flow towards the pit walls where some will discharge into the pit as groundwater seeps and some will be lost as evaporation. Some of the groundwater entering the mining pit through the pit walls will be collected for use around the mine as it may be affected by mining activities. The amount of lowering of the water level in the area surrounding the pit will gradually decrease from a maximum equal to the depth of the mining pit at the pit walls, to zero at a distance predicted to be a maximum of 3,500 metres from the pit walls.

The overburden and Pleistocene Channel Aquifer dewatering will impact the Muskeg River and its tributaries as the amount of groundwater normally discharged to these features decreases. These magnitudes of the impacts are uncertain, but are predicted to be “small” when compared to the mean annual flow of the river. The drawdown in the overburden and the Pleistocene Channel Aquifer is expected to reach the southern edge of the patterned fen northeast of JEMA and south-east of McClelland Lake, but is predicted to have little impact on the fen itself as the reduction in the amount of groundwater being discharged to the fen is predicted to be negligible.

The dewatering will also result in a reduction in the amount of groundwater recharge to the overburden and the Pleistocene Channel Aquifer that occurs in the area of the mine excavation as precipitation will be intercepted in the working pit drainage system to keep the working area dry. This recharge would normally be destined for the groundwater flow system that existed in the mining area prior to any mining activity. The reduction in the amount of recharge is predicted be small, due to the low permeability of the underlying bedrock which would naturally limit the downward movement of groundwater.

The dewatering will result in an increase in the amount of groundwater recharge that occurs in the area of passive water level decline surrounding the mining pit in response to the increased hydraulic gradient. The amount of the increase is predicted to be small.

The water derived from dewatering the overburden and the Pleistocene Channel Aquifer will be discharged to sedimentation ponds and then to the surface environment if the water quality is satisfactory. This will mitigate some of the losses of groundwater normally discharged to the surface water features.

Basal Aquifer Depressurization

The Basal Aquifer is a geological unit occurring below the zone to be mined and is more continuous to the south and west and is discontinuous in other areas. The elevation of the water level associated with the Basal Aquifer is above the elevation of the mining pit floor so it will be necessary to lower the water level by depressurization prior to the mining of the bitumen, for safety reasons. Depressurization of the Basal Aquifer will have an effect on groundwater levels, flows and flow patterns in the LSA and the RSA.

The Basal Aquifer water level will be lowered in the mine area by pumping groundwater from the Basal Aquifer using depressurizing water wells. As pumping proceeds, the water level associated with the Basal Aquifer will decline to the maximum needed for mining to proceed. Depressurization will result in the flow of groundwater in the Basal Aquifer from the area surrounding the mine towards the depressurization wells. The water level decline, which will be greatest in the immediate vicinity of the pumping wells, particularly to

the south and west where the Basal Aquifer is more continuous, will gradually decrease with increasing distance from the depressurization wells. The decline is predicted to extend a maximum of three kilometres beyond mining pit walls. The drawdown may result in changes to amount of groundwater recharge/discharge from the Basal Aquifer to the shallow groundwater and surface water.

Basal Aquifer depressurization will have an impact on shallow groundwater in the area surrounding the mining pits, by increasing the rate at which the groundwater moves downward through the overlying material in response to the increased hydraulic gradient. However, the hydrogeological conditions between the surface and the Basal Aquifer are of low permeability and the increase in the amount of groundwater moving downward is predicted to be minimal.

Groundwater from the depressurization of the Basal Aquifer will be incorporated into the mining operation via an expanded closed-circuit system collecting process-affected water and the External Tailings Disposal Area, and will not be released to the environment. This will mitigate some of the loss of Basal Aquifer groundwater discharge to the surface environment.

Jackpine Expansion Mine Project Tailings Disposal

Tailings are produced during the bitumen separation process and will need to be stored. An External Tailings Disposal Area (ETDA) will be used for disposal of the tailings until there is sufficient space in the mine pits to accommodate in-pit disposal. The ETDA will be a topographic high, about 60 metres higher than the original ground surface elevation, and will become a groundwater recharge feature. Construction and operation of the JEMA ETDA will result in changes to the local topography and groundwater levels and quality.

Process-affected seepage from the ETDA can be expected to enter the shallow surficial deposits (Quaternary) and possibly the Basal Aquifer beneath the ETDA. Once the process-affected groundwater reaches the surficial deposits and the Basal Aquifer it will enter the local or regional groundwater flow system. The Pleistocene Channel Aquifer beneath the ETDA will become a preferential flow path for process-affected groundwater which may flow towards Kearl Lake or the Kearl Compensation Lake.

During operations, seepage of process-affected groundwater from the ETDA is to be intercepted by the use of toe ditches, seepage collection wells and collection sumps. A pumping system will recycle the collected water back to the external tailings area pond for use in processing. This can help prevent process-affected groundwater from entering the groundwater flow system and impacting the quality of the groundwater in the aquifer.

Pit Backfill

Tailings will be stored in the mining pits as soon as there is sufficient space available to accommodate in-pit disposal. Once the backfilling commences, seepage from these deposits will begin and continue through operation and closure of the mine. The backfill material has the potential to change groundwater levels, flows, flow patterns and quality in the areas around the backfill locations. Backfill material will be placed directly on undisturbed surficial material (Quaternary) and the McMurray Formation.

The tailings will be placed behind low-permeability barriers to reduce the amount of seepage from the backfill. Tailings that will be placed in areas where there are sands and gravels will be separated from the sands and gravels by low-permeable materials to minimize seepage. During operations any seepage from backfilled areas within the mining pits will be contained within a closed water system to prevent it from entering the environment.

Reclamation and the Mine Closure Landscape

Mining results in the removal of materials with a low hydraulic conductivity from the pit areas, and replaces them with materials, such as tailings, which have a higher hydraulic conductivity. The groundwater flow system which develops after mining ceases will be controlled by the precipitation infiltration rates that develop for the reclaimed landscape.

After closure and reclamation at the end of the mining process, the water levels in the area surrounding the mine will recover with the final recovery level being controlled by the water table elevation in the reclaimed ground surface in the mine area. Where the water table levels recover to pre-mining elevations, the re-established groundwater flow systems will restore flow to drainage channels, terrestrial plant areas and wetlands. Where water table elevations do not recover to pre-mining elevations, either higher or lower, groundwater flow will remain permanently altered.

Precipitation which would normally recharge the area where the ETDA is located will recharge to the groundwater flow system through a topographic high (the reclaimed ETDA) which contains process-affected porewater. The recharging groundwater will flush out some process-affected porewater as it moves downward through the tailings in the ETDA. Some of the process-affected groundwater will discharge as springs along the edge of the ETDA and some will flow towards the reclaimed mine areas to the west and the northwest, and to wetlands and the pit lake. Some of the process-affected groundwater could be discharged to surface water features in the area surrounding the ETDA and have an impact on the water quality. A plume of process-affected groundwater can be expected to follow the Pleistocene Channel Aquifer beneath the ETDA, moving towards Kearl Lake. There is some seepage rate uncertainty due to uncertainty of some hydrogeological parameters in the ETDA materials. The ETDA is predicted to be filled by 2024 although reclamation is not planned until 2065 when the ETDA will be capped and reclaimed.

Seepages from backfilled areas within the mine are more certain as pathways can be avoided by man-made control of the landscape and the resulting hydrostratigraphy. A plume of process-affected groundwater is expected to follow the Pleistocene Channel Aquifer east towards Kearl Lake and the Basal Aquifer to the west of the reclaimed mine area.

The groundwater flow system will re-establish after the reclamation and mine closure landscape has been completed. The flow system will largely be controlled by the infiltration rates that develop for the reclamation topography. The main components of the mining project that can have a lasting impact on the groundwater resources of the area are seepages of process-affected groundwater from the tailings within the ETDA and backfilled mine pits.

Shallow seepages from the ETDA will be prevented from entering the groundwater flow system in the area around the ETDA by being intercepted and directed towards the pit lake through wetland areas. The magnitude of the seepage is difficult to predict due to hydrostratigraphic uncertainty. The computer model predictions were based on conservative hydrogeological parameters to reduce some of the uncertainty. The magnitude of the seepage from the process-affected tailings in the backfilled mine pits are more controllable as pathways can be controlled by selective placement of materials with low hydraulic conductivity. Seepages will be directed towards the pit lake through wetland areas.

Discussion

Dewatering and Removal of the Overburden

Mitigative measures to counter the effects of dewatering and removal of the overburden and the resulting reduction in discharge of groundwater to surface water features are planned and are likely to be effective. Water from the dewatering process will be directed towards sedimentation ponds prior to release to the surface environment. No appreciable reduced flows in surface water bodies, as the results of the dewatering and removal of the overburden, should be evident from the start. According to the proponent, the proposed mitigation has been successfully used at similar mining projects.

Basal Aquifer Depressurization

Use of groundwater from the depressurization of the Basal Aquifer in the mining operation via an expanded closed-circuit system collecting process-affected water should be effective in mitigating/offsetting the losses of Basal Aquifer discharge to surface water bodies by reducing the amount of make-up water that has to be diverted from the Athabasca River. The losses to surface water bodies are predicted to be relatively minor and are unlikely to be related to a measurable outcome. The mitigation has been used by the proponent at other similar mining operations.

Jackpine Expansion Mine Project ETDA

During operations, seepage of process-affected groundwater from the ETDA is to be mitigated by the use of toe ditches, seepage collection wells and collection sumps to intercept process-affected groundwater. A pumping system will recycle the collected water back to the external tailings area pond for use in processing. This can help prevent process-affected groundwater from entering the groundwater flow system and impacting the quality of the groundwater in the aquifer and can reduce the amount of surface water that needs to be diverted for make-up from the Athabasca River. An outcome should be process-affected free groundwater in the surficial deposits around the ETDA. Mitigation should be effective, and has reportedly been used successfully by the proponent at similar mining projects in the area.

Pit Backfill

Mitigating the flow of process-affected water from the pit backfilled areas through cell construction techniques should be effective with the outcome being minimal seepage from the cells being observable from the time backfilling of the mine pits commences.

This mitigative procedure had been used by the proponent at similar mining projects in the area.

Reclamation and the Mine Closure Landscape

Mitigative measures to prevent/minimize seepages of process-affected groundwater into the environment surrounding the ETDA and backfilled mine pits can be effective and are linked to outcomes such as the absence of, or minimal presence of, process-affected contaminants in groundwater or in surface water bodies that receive groundwater as baseflow. Confirmation that end-pit lakes are capable of improving water quality would be an important step in verifying that this mitigative measure actually works. The existing projects are insufficiently advanced to have long-term experience with some planned mitigative measures and the proposed outcomes.

Assessment Review

Overall the groundwater resource impact assessment has been reasonably well done and the impacts the existing and approved developments (the base case), the proposed JEMA, as well as the potential development case will have on groundwater resources have been considered. There is a degree of uncertainty in the validity of some of the impacts predicted for changes in groundwater discharge from the Quaternary (part of the overburden) deposits. The proponent indicates "The predictions and conclusions present in this EIA are therefore not considered sensitive to the degree of hydrogeological prediction uncertainty associated with changes in groundwater discharge from Quaternary deposits to surface water".

Several computer model simulations have been used to predict changes and impacts of the proposed development on the groundwater resources of the area. The various parameters used in the models are within acceptable limits. Although the understanding of the hydrogeological characteristics of the general area east of the Athabasca River have greatly improved as a result of this and previous EIA investigations, computer modelling predictions are always subject to possible errors as a result of the hydrogeological uncertainties in a complex environment, and hence the potential impacts could be under or over estimated. Ongoing groundwater level and groundwater chemistry monitoring is necessary to ensure computer-predicted results are valid.

Key Concerns

1. <u>The JEMA may affect the ability of the AFCN to harvest traditionally-used plants, dependent on groundwater flow for survival.</u>

   ACFN people could be impacted by the loss of groundwater-supported wetland areas which may contain traditionally used plants that are dependent on groundwater for survival. Traditionally used plants which are found in non-wetland areas may also be lost if they are dependent on groundwater. Such losses would be permanent, unless reclamation provides suitable areas where the plants could re-establish. Wetlands that develop after reclamation may have the potential to be impacted by process-affected groundwater from areas where tailings have been stored and may be less desirable areas for the collection of plants.

Recommendation

It is recommended that the ACFN discuss the locations of traditionally-used plants that may be in the area impacted by the JEMA with the proponent and to confirm that the proponent is aware of where they exist and that where necessary, mitigative measures to protect the growing environments are planned.

2. The JEMA may affect the ability of the AFCN to access traditionally used groundwater sources.

   ACFN people could be impacted if any groundwater sources (waterwells, dugouts, muskegs or springs) which are used by ACFN residents when visiting traditional lands (for hunting, gathering or trapping) in the proposed mine or the immediate surrounding area. Any groundwater sources located in the mining area will be permanently impacted and/or be unsuitable for further use. Any groundwater sources located in the surrounding area may be permanently or temporarily impacted and may or may not be unsuitable for further use after closure and reclamation.

   Recommendation

   It is recommended that the ACFN discuss the locations of traditionally used groundwater sources that may be in the area impacted by the JEMA and to confirm that the proponent is aware of where they exist and that where necessary, mitigative measures to protect the sources are planned.

3. Groundwater incidents (unexpected groundwater quantity and/or quality changes) are reported to the authorities.

   The ACFN may want to be advised of any groundwater incidents reported to the authorities and to be provided with the outcome of any investigations.

   Recommendation

   It is recommended that the ACFN require the proponent to advise the community of any groundwater incidents reported to the authorities and to meet with the community to discuss the incident, the subsequent investigation, any follow-up action to be taken and the results of the follow-up actions.

4. Computer-predicted impacts, or lack of impacts, are subject to some uncertainty.

   Groundwater monitoring must demonstrate that project activities are proceeding without unreasonable impacts on the groundwater resources in the area. ACFN may want to have copies of the proposed groundwater monitoring programs made available to, and discussed with, the community. Any discussions should focus on how the proposed groundwater monitoring will confirm that computer-predicted impacts are accurate.

Recommendation

It is recommended that the proponent be asked to prepare a table summarizing computer-predicted and professional judgment impacts and to outline the groundwater level and/or quality monitoring to be undertake to verify the predictions. As monitoring data becomes available it should be added to the table and the updated table should be shared with the ACFN. Deviations from the predicted impacts which indicate that impacts have been underestimated should result in a reassessment of those impacts, updating of the table and reassessment of mitigative measures. The AFCN should be provided with the results of any reassessment of mitigative measures.

Other Items Indirectly Related to Groundwater

1. ETDA predicted to be filled by 2024; reclamation planned for 2065 when the ETDA will be capped and reclaimed.

   What conditions prevent reclamation from being done earlier?

2. Pit cell 8 (tailings) will be capped with sand due to no “conveniently available overburden”.

   Since pit cell 8 parallels the Muskeg River for about five kilometres in relatively close proximity, should “convenience” be accepted if it does not result in the most desirable capping to minimize seepage of process-affected groundwater from entering the Muskeg River?

Appendix D-4

Shell Jackpine Mine Expansion and Pierre River Mine Projects Responses to ACFN SIRs – Environmental Impact Assessment Report Review for Athabasca Chipewyan First Nation – Groundwater Component, August 2009, by Lew Fahner of Agua Consulting

Shell Jackpine Mine Expansion and Pierre River Mine Projects
Responses to ACFN SIRs
Environmental Impact Assessment Report
Review for Athabasca Chipewyan First Nation
By:
Agua Consulting
August, 2009

Groundwater Component

The groundwater SIRs were essentially the same for the two projects and Shell's responses are therefore essentially the same. The following comments apply to both sets of SIRs for the groundwater resources component.

SIR #1 – Shell acknowledges that there will be an impact on traditional plants and that the most feasible mitigation is to re-establish areas capable of supporting traditional plants after reclamation. However, CEMA (2007) indicates that, based current reclamation knowledge and experience in the region, organic bogs and fens cannot be reclaimed. ACFN community member's access to plants in the local study area will be impacted for a significant period of time. If ACFN community members gather plants from the area to be effected, further discussion may an appropriate during agreement negotiations.

SIR # 2 – Groundwater from fens is often used during traditional pursuits as a water source as the inflow-outflow of groundwater makes it suitable for consumption. Shell indicates that it is not aware of any groundwater use, other than possibly at trapper's cabins. If ACFN community members use groundwater in the local study area, further discussion may an appropriate during agreement negotiations.

SIR #3 – Shell agrees to discuss groundwater incident reporting with the ACFN as part of future negotiations towards an agreement.

SIR #4 – Shell included a proposed groundwater monitoring program in Volume 4B, Appendix 4-9 Section 2.1. The proposed monitoring program has not been designed to confirm computer-predicted and professional judgements impacts on groundwater resources, which is desirable from the ACFN's perspective to confirm that impacts are not under-estimated on any traditionally-used land. Shell indicated that it may agree to reassess mitigative measures as part of future negotiations but did not express any willingness to develop a groundwater monitoring table to simplify the presentation of monitoring data and make it easier to review by ACFN community residents.

Reference: CEMA, 2007. Guideline for wetland establishment on reclaimed oil sands leases (revised second edition) Prepared by M.L. Harris for CEMA Wetlands and Aquatic Subgroup of the Reclamation Working Group, Fort McMurray, Alberta December 07.

Appendix D-5

Shell Jackpine Mine Expansion Project Environmental Impact Assessment Report - Review for Athabasca Chipewyan First Nation, September 25, 2008, by Fay Westcott of Clearwater Environmental Consultants

Shell Jackpine Mine Expansion Project

Environmental Impact Assessment Report

Review for Athabasca Chipewyan First Nation

By:

Clearwater Environmental Consultants Inc.

Sept. 25, 2008

Introduction

As a part of their application of approval of expansions to their current oil sands operations, Shell Canada Limited (Shell) has submitted an Application and Environmental Impact Assessment (EIA) for the Jackpine Mine Expansion and Pierre River Mine Project. This application and EIA are also used to support their request for operating approvals under the Alberta Oil Sands Conservation Act, Alberta Environmental Protection and Enhancement Act (EPEA) and Alberta Water Act. Shell is seeking approval for future expansion plans through an amendment to the Jackpine Mine – Phase 1 approval for development of a new mine located on the east side of the Athabasca River (Jackpine Mine Expansion Area – JMEA). The project would specifically affect portions of the Muskeg River watershed as well as reaches of the Athabasca River. This application and EIA have been reviewed on behalf of the Athabasca Chipewyan First Nation (ACFN).

The objectives of this review of these Applications and the EIA are to:

- Assess whether the EIA is based on adequate data
- Determine if the analysis and conclusions presented are adequate
- Identify potential issues of concern for the ACFN and provide recommendations

Note to Dan: This review did not assess whether the EIA adequately addresses the Terms of Reference, as this information was in another binder and not on the CD.

This review includes the following components:

- Surface Water Quality
- Aquatic Health
- Fish and Fish Habitat

The following documents were consulted in order to conduct this review of Shell's Jackpine Mine Expansion Project:

- Volume 4A: Aquatic Resources
- Volume 4B: Aquatic Resources Appendices

Overview

Overall, the Aquatic Resources components of the Shell JEMA Project EIA were well done, well detailed and logical. However, the combination of two completely separate projects into one Application and EIA was very difficult to review. I would recommend that this approach not be permitted in the future. The rationale for the inclusion of both projects was unclear and not described in the EIA. The projects are on the opposite sides of the Athabasca River, and not physically connected. If Shell were concerned about providing a better cumulative effects impact assessment for these two projects, then that was not achieved, as cumulative effects on the Athabasca River (the only common LSA and RSA areas for the two projects) was done in a cursory manner and not a true cumulative effects analysis.

In reality, it appears that the only reason that these two projects (JEMA and PRMA) were combined into one Application and EIA is that the compensation plans for both projects have been consolidated into one area, located in the Pierre River Mine area. It is alarming that the Muskeg River watershed will be so disturbed by existing, approved and planned projects, that there is no room for locating on-site compensation efforts for one of the many projects within the watershed.

When impacts were identified, their significance was often downplayed. For example, several metals were found to exceed the benchmarks for aquatic health, but the impacts were considered negligible because the benchmarks didn't really represent an impacted state or were not appropriate for the area. In addition, other metals for which impacts were predicted were considered to be overestimated due to the conservative assumptions used to complete the assessment. If the benchmarks can be so easily disregarded, then perhaps a more stringent method of determining benchmarks should be employed, so that meaningful results can be determined. There is little value in assessing impacts, and then disregarding the results because the methods were flawed.

Since the release of this EIA, Alberta Environment has developed the Muskeg River Interim Management Framework (IMF), which provides a strategy to manage the aquatic resources (water quantity and quality) of the watershed. The goal is to provide an integrated regional plan that will help minimize the impacts of development. Since the Jackpine Expansion project is located within the Muskeg River, this IMF is relevant to the project's development plans, monitoring activities and water quality impacts. Any updates to this EIA or Supplemental Information should discuss the Muskeg River IMF in context, including its ramifications for the project. The Supplemental Information should discuss whether the project will meet the IMF's water quality targets and limits for the Muskeg River. Note to Dan: The IMF also has water quantity objectives for the Muskeg River and Kearl Lake.

Some information on End Pit Lakes and the research going on into them was provided, which was good, as little information has been provided in previous oil sands mine EIAs.

The Conceptual Compensation Plan puts forward a combined plan for both the PRMA and JEMA projects. The habitat units and actual productive capacity of fish habitat to be lost in either the PRMA or JEMA projects were not determined at this stage, nor was the productive capacity of the proposed compensation habitats. The proposed compensation would be a lake and two channels, which are intended to compensate for the habitat losses for both projects. Similar to other regional mine plans, the majority of the compensation appears to be for lacustrine habitat, while the majority of losses would be for riverine habitat. Without additional information, and in particular, habitat unit information, it is not possible to assess the adequacy of this compensation plan.

Overall, the major concerns for the PRMA project regarding surface water quality, aquatic health and fish and fish habitat components are:

- A discussion of the Muskeg River Interim Management Framework is required as it relates to this project
- The water quality limits for pit lake discharges are unknown
- A cumulative effects analysis on water quality, aquatic health and fish and fish habitat on the Athabasca River was not conducted (Note to Dan: I am not entirely sure on this, because the full PDC is in another binder that I didn't have)
- Aquatic health benchmark exceedances were dismissed
- The Conceptual Compensation Plan does not determine the productive capacity of lost habitat or compensation habitat, therefore it is not possible to determine whether the proposed plans are sufficient.

Surface Water Quality

Overview

The Jackpine Mine Expansion (JEMA) would be located adjacent to the previously approved Jackpine Mine-Phase 1, located about 70 km north of Fort McMurray, Alberta on the east side of the Athabasca River. This expansion would bring the Jackpine Mine's total nominal bitumen production to 300,000 bbl/cd. It would include additional mining areas and associated processing facilities, utilities and infrastructure.

The key environmental issues arising from the projects with respect to surface water quality are:

- Changes in constituent concentrations in water and sediment of watercourses and waterbodies
- Changes in the thermal regime and dissolved oxygen levels of receiving waters

- Effectiveness of mitigation and environmental management plans to reduce effects
- Attainment of relevant water and sediment quality guidelines
- Water quality of pit lakes and their releases
- Confidence in water quality predictions
- Climate change effects on water quality and water temperatures
- Acidification of surface waters resulting from air emissions

An Aquatics LSA has been defined to encompass the aquatic resources which may be potentially affected by the development area. The LSA and RSA boundaries for Water Quality are the same as those for Fish and Fish Habitat, Surface Water Hydrology and Aquatic Health.

The Jackpine Expansion Mining Area (JEMA) is located within the Muskeg River watershed. This mining area includes the lower drainage areas of Shelley, Khahgo, Wapasu, Stanley and Unnamed creeks and an upper reach of the Muskeg River. Project features or facilities that would affect aquatic resources within JEMA include diversion channels, polishing ponds, reclaimed mine pits, overburden disposal areas, External Tailings Disposal Areas (ETDAs) and pit lakes. The LSA for the JEMA consists of the following areas:

- The Muskeg River watershed (Wapasu Creek and Muskeg River and Unnamed Waterbodies 1, 2, 3, 14 and 16)
- Athabasca River reach from the Muskeg River to the water intake for Muskeg River Mine Expansion

The RSA includes the LSA and the Lower Athabasca River from Fort McMurray to Embarras.

Potential effects of the Project are evaluated under conditions of pre-development, Base Case, Application Case and Planned Development Case (PDC). The Base Case assesses surface water and sediment quality due to existing environmental conditions as well as present and future activities of currently operating projects or approved developments that haven’t been built yet. The Application Case considers the effects of the existing and approved developments and the Project. The PDC considers existing and approved developments, the Project, plus other potential developments that have been publicly disclosed.

Surface water and sediment quality predictions and assessments are based on the environmental setting water and sediment quality, chemistry and toxicity for release waters and flow, seepage and water releases from within the LSA and RSA. Historical or literature records were used to characterize existing conditions of the water and sediment quality of major streams, rivers, lakes and ponds, including data collected by AENV, RAMP, AOSERP, Northern River Basins Study, industry field studies and Shell’s specific water and sediment quality field programs. The environmental setting information for was also derived from additional data collected for the Aquatics Environmental Setting Report (Golder 2007) for the Project from 2005 to 2007.

Water Quality Baseline Conditions – Muskeg River Watershed

Watercourses and waterbodies in the Muskeg River watershed have water quality characteristics typical of bog systems in the Oil Sands Region. Low winter DO concentrations are frequent and sometimes lower than the acute aquatic life guideline. Low DO concentrations are associated with naturally occurring high levels of sulphide that often exceed the aquatic life guideline. The watercourses and waterbodies in the LSA are dark brown due to high concentrations of TOC and DOC, especially in the headwater tributaries of the Muskeg River. The Muskeg River is typically alkaline with pH values generally within guidelines.

Levels of hardness, TDS, conductance, alkalinity and major ions are moderate, with higher concentrations of these parameters occurring in winter. The high winter values can be attributed to a higher proportion of groundwater discharge than in other seasons, as well as from salts expelled into the water column during the formation of ice-cover in early winter. Hardness, TDS, conductance, alkalinity and major ions generally have higher concentrations in the upper Muskeg River than in the Athabasca River.

Concentrations of TSS are typically lower in waterbodies than in watercourses. Nutrients are often high, reflecting input from peatlands, and often exceed water quality guidelines. Total nitrogen (TN) and total phosphorus (TP) concentrations within the watersheds are much lower in lakes than in streams, with the exception of nitrogen concentrations in Kearl Lake.

Metals concentrations are generally low, but frequently or occasionally exceed guideline values, depending on the parameter (exceedances are found for aluminum, arsenic, cadmium, hexavalent chromium, copper, iron, lead, mercury, methy mercury, nickel , selenium, silver and zinc). These elevated levels are characteristic of natural surface water conditions in the Oil Sands Region.

In contrast, concentrations of organics are generally low and are natural in origin. Naphthenic acids and total recoverable hydrocarbons are often below detection limits, but occasionally high concentrations occur. Total phenolics generally exceed the aquatic life guideline. Toxicity testing indicates slight to no toxicity to aquatic organisms from natural surface waters.

In general, existing developments from within the Muskeg River watershed have not had an appreciable impact on water quality, except sulphate. Sulphate concentrations have increased in the lower reach of the Muskeg River (from 1998 to 2001) due to releases from the Alsands Drain. The upper Muskeg River, including Wapsu and Muskeg creeks and Kearl Lake, has received no process-affected water releases from mine developments, and observed water quality data is considered to represent pre-development conditions.

The Base Case (existing and approved developments) is predicted to affect water quality in the Muskeg River. Impacts include increases in TDS, boron, chloride, molybdenum, nickel, refractory naphthenic acids, sulphate and vanadium, especially during closure. Similarly, Jackpine Creek is predicted to have increased TDS, ammonia, chloride, molybdenum, sulphate and total phosphorus levels as a result of the Base Case. Kearl

Lake will also show increased TDS, aluminum, sulphate and molybdenum concentrations under the Base Case.

Water Quality Baseline Conditions – Athabasca River

DO concentrations in the Athabasca River are often high, but can occasionally be lower than the chronic aquatic guideline. The river is slightly alkaline and moderately soft. Its hardness, alkalinity, TDS and major ions concentrations generally increase in the winter, under low flow conditions. Concentrations of TSS and particulate-bound nutrients and total metals increase in spring and summer, under higher flows. Guideline exceedances are found for total phosphorus and total nitrogen in all seasons, while guideline values are exceeded periodically for several metals (aluminum, arsenic, cadmium, chromium, hexavalent chromium, copper, iron, lead, mercury, nickel, selenium, silver and zinc). Levels of organics and PAHs are generally low. Naphthenic acids are often lower than 1 mg/L but occasionally have localized levels as high as 20 mg/L. Sulphide occasionally exceeds the guideline in the Athabasca River upstream of the Firebag River. There is little to no toxicity of the river. The data indicates that developments in the Lower Athabasca basin are not affecting local water and sediment quality.

Sediment Quality Baseline Conditions – Muskeg River Watershed

Bottom sediments of most streams in these watersheds are mainly sand with relatively small proportions of silt and clay. Kearl Lake sediment is dominated by clay and silt, and sand is the major component of sediments in unnamed waterbodies. Concentrations of metals and Polycyclic Aromatic Hydrocarbons (PAHs) in sediments of waterbodies and watercourses are generally lower than the Interim Sediment Quality Guideline (ISQG) values. Occasional exceedances are found for chromium, zinc, arsenic and several PAHs. These exceedances are natural and typical of the Oil Sands Region. The combined toxicity effect of all parameters is predicted to have a negligible to low impact on aquatic organisms' survival or growth.

The Base Case is expected to result in sediment increases in one PAH, molybdenum and nickel. These increases are predicted for existing and approved projects affecting the Muskeg River and Jackpine Creek, where direct process-affected seepages can result.

Sediment Quality Baseline Conditions – Athabasca River

Particle size distribution and carbon content in the lower Athabasca River sediments are generally similar to those in the Muskeg River downstream of Jackpine Creek, with high sand and inorganic carbon contents. Several metals exceed the ISQG values (chromium, arsenic, cadmium, lead and mercury). Concentrations of metals are also higher in the Athabasca River than in the Muskeg River. Several PAH concentrations exceed sediment quality guidelines.

Impacts

The following JEMA activities would have potential impacts on surface water quality:

- Expansion of surface mining to the north
- Increased water withdrawal from the existing Athabasca River intake

- Construction of access roads, overburden disposal areas, other infrastructure and bitumen extraction facilities
- Construction of a cogeneration plant
- Construction of diversion channels, reclaimed mine pits, polishing ponds, an External Tailings Disposal area (EDTA) and pit lakes

The key factors that could potentially impact surface water and sediment quality include:

- Release of muskeg drainage and overburden dewatering flows
- Closed-circuit of development areas
- Discharge of pit lake outflows
- Seepage of process-affected water

Impacts on surface water quality were determined by assessing several water quality constituents, similar to those used in previous oil sands EIAs. Key indicators included naphthenic acids, tainting potential, acute and chronic toxicity and total dissolved solids (TDS). Different water quality models and approaches were used for specific issues or key questions, and the corresponding watercourse or waterbody. The Athabasca River Model (ARM), small streams model (HSPF) and pit lake model (CE-QUAL-W2) were all used in the assessment. Monte Carlo simulations were used to determine the incremental contribution that climate change could have on the water quality predictions in the EIA. Potential changes to water and sediment quality due to the project were assessed by determining if non-compliance with guidelines or appreciable increases in constituent concentrations would occur compared to the Base Case condition.

The JEMA would result in the diversion of the Muskeg River and some of its tributaries. The project would remove 232 km^2 of the Muskeg River watershed and divert a 21 km long section of the Muskeg River. Flows would be maintained by diversion channels and pipelines. The headwaters of Pemmican, Green Stockings, Blackfly, Wesukemin and Iyinimin creeks would be diverted to Kearl Lake. Two outlets would be constructed for Kearl Lake. The muskeg drainage and overburden dewatering would be released in the Muskeg River and Muskeg Creek.

Water sources would primarily be the Athabasca River, but connate water from within the oil sands, tailings reclaim water, groundwater from basal aquifer dewatering and surface runoff would also be used. To reduce the use of river water and in order to meet the IFN requirements for the Lower Athabasca River, up to 30 days worth of water would be stored.

Following mine decommissioning, the reclamation landscape would consist of two ETDAs, engineering drainage channels, wetlands and one new pit lake (updated from two pit lakes in the original EIA). The already planned South Pit Lake would discharge to the already planned South Central Pit Lake, which would discharge to the Muskeg River. The new North Pit Lake would contain Mature Fine Tailings (MFT) and would discharge to the Muskeg River. Small amounts of process-affected seepage from mine pits, ETDAs, NST consolidation flux waters and tailings porewater would discharge to local watercourses and Kearl Lake. The North and South Central pit lakes would release water into the Muskeg River in 2065, when water quality is predicted to be acceptable for release.

Water Quality Impacts – Muskeg River Watershed

Within the Muskeg River, the majority of the measured constituents (including PAHs, naphthenic acids and metals) would show increased median concentrations compared to the base case during both operations and in the far future. Increased guideline exceedances would occur for aluminum, chromium, copper, iron, molybdenum, PAHs and total nitrogen. Acute and chronic toxicity and tainting potential would also increase but would remain below guidelines. At closure, and when the pit lakes start to discharge, the Muskeg River would be slightly cooler during the summer and slightly warmer during the fall. No impacts on DO concentrations were predicted.

Within Jackpine Creek, the median concentrations of most constituents would also increase during operations, and all but one (silver) would increase in the far future. Increased guideline exceedances would occur for chromium, molybdenum, PAHs and silver. Acute and chronic toxicity would also increase, but would not exceed guidelines. These results are due to the changed integrated closure drainage system, which would direct runoff from the Aurora South Mine ETDA through wetlands to Jackpine Creek, rather than through the Jackpine Mine Phase 1 pit lakes.

The revised integrated closure drainage system would also affect water quality of Kearl Lake. The median concentrations of all constituents would increase during operations and in the far future. Increased guideline exceedances would occur for aluminum, boron, copper, molybdenum and total nitrogen. Acute and chronic toxicity would also increase, but would not exceed guidelines. These results are due to the diversions planned for discharge into the lake. These increased flows would reduce the retention time of the lake, which would reduce the buffering capacity of the lake and cause the elevated peak values. This decrease in retention time does not affect the median concentrations, as the EIA states, which would experience real increases. The increased levels during closure would occur because of the discharge of reclamation waters into Kearl Lake. The EIA states that because these increases decline over time, it demonstrates that the process-affected tailings material would be continuously flushed from the reclamation landscape after closure.

Overall, the project was considered to have low to negligible effects on key water quality constituents (acute and chronic toxicity, labile naphthenic acids, TDS and tainting potential).

Water Quality Impacts – Pit Lakes

There would be one new pit lake in the project area (updated from two in the original EIA), and the designs for the two already planned pit lakes (part of the Jackpine Mine – Phase 1 Project) would be updated. While all pit lakes would contain MFT, the downstream cell of the North Pit Lake would contain no MFT. The pit lakes would have water volumes ranging from 26 to 317 Mm^3, which would be underlain by MFT volumes ranging from 26 to 513 Mm^3. The pit lakes would have residence times ranging from 2 to 14 years.

Because they would receive reclamation runoff, process-affected water and mine tailings, high concentrations would be expected at least during the initial period after filling. Water and sediment quality of the pit lakes would be expected to change over time, as treatment would occur as a result of dilution, biodegradation and further settling prior to discharge to surface waters. At the beginning of pit lake discharge in 2065, key constituents (acute and chronic toxicity, tainting potential) would be below guidelines or threshold values. However, many constituents (including metals and PAHs) would be higher than natural levels in the region. TDS values, in particular, would be significantly higher. Molybdenum, PAHs and total nitrogen levels would exceed water quality guidelines in the pit lakes that would then discharge to the Muskeg River.

Sediment Quality Impacts – Muskeg River Watershed

The potential mobilization of soluble PAHs and metals and the transport of particulate-bound constituents from oil sands to surrounding surface waters could impact sediment quality. The transport of sediments into the Muskeg River and Kearl Lake is predicted to be low to negligible. The potential effects of direct seepage and surface waters on sediment quality were considered negligible, therefore any changes to sediment quality was considered negligible. None of the predicted sediment concentrations exceeded ISQG levels.

Note to Dan: The actual sediment quality appendices and tables were not included in the CD and binder. Usually, I use the actual tables and look at the data, because the EIA text is sometimes misleading or incomplete in its description of the results. In this case, then, I had to rely on the EIA text to summarize the water quality of pit lakes. I normally would report which parameters increased from the Base Case. Although no ISQG levels were exceeded, I would normally look at the level of increase to see if it were slight, if it doubled, or if it increased by an order of magnitude, for example.

Sediment Quality Impacts –Pit Lakes

The EIA did not predict the sediment concentrations of the key constituents within pit lakes. Rather, the concentrations in MFT solids (which will be the initial sediments of most of the pit lakes) are provided, with a comparison with sediment quality guidelines. The EIA states that the metals concentrations are generally lower than the ISQG and within the range of regional lakes. PAHs are higher in the MFT than in regional lakes, but will biodegrade over time within the pit lake.

Water Quality and Sediment Quality Impacts – Athabasca River

The water quality of the Athabasca River could be affected by direct or indirect discharges from the project site, including muskeg drainage and overburden dewatering, pit lake discharge, seepage of process-affected water or groundwater. At Node A1 (downstream of the confluence with the Muskeg River), the Application Case found that acute and chronic toxicity were lower than guidelines and tainting potential was below the threshold. Slight increases were found for boron, naphthenic acids (labile and refractory), tainting potential, TDS and acute and chronic toxicity. No other water quality data, including general chemistry, metals, nutrients and other PAHs were presented for impacts on the Athabasca River.

These small changes in water chemistry are unlikely to cause a significant change in the sediment quality of the Athabasca River. Overall, negligible effects on the water and sediment quality of the Athabasca River were predicted as a result of the project. For the Planned Development Case (existing, approved and planned projects), water quality results for Node A1 are the same as those reported for the Application Case. Negligible increases are predicted for boron, acute and chronic toxicity, labile and refractory naphthenic acids, TDS and tainting potential.

Note to Dan: The full details of the Planned Development Case are in Appendix 4-8, which I don't have in either the binder or the CD, therefore, I can't really go into any more detail or fully assess this section of the report.

Note to Dan: The impacts from atmospheric deposition and potential acidification is included in the air section, and not in the binder or CD that I have, therefore, I couldn't assess this component.

Note to Dan: The impacts of climate change on water quality are included in Volume 3, which I don't have in the binder or CD, so I haven't assessed this component.

Mitigations

The above impacts are based upon the assumption that existing and approved developments will implement the specified mitigations, including those for the JEMA project. A summary of mitigations include:

- Intercept, capture and recycle seepage from backfilled cells through the closed-circuit drainage system
- Place tailings below the top of the McMurray Formation or behind low-permeability barriers such as dykes to minimize seepage
- Install an impermeable barrier between the Jackpine Mine –Phase 1 ETDA and Jackpine Creek
- Isolate non-segregated tailings pit backfill from Quaternary sand and gravel deposits through a layer of low-permeability material
- Manage ETDS seepage to ensure groundwater discharge quality to the Athabasca River is acceptable
- At closure, wetlands and/or pit lakes will be built at the downstream end to provide treatment for the tailings porewater releases before they are discharged to the Muskeg or Athabasca Rivers
- A minimum 100 m offset will be left intact along the Muskeg River valley
- Implement a closed-circuit water management and recycling system for process-affects waters during operation
- Direct muskeg and overburden drainage waters to polishing ponds prior to release to receiving surface waters
- Construct perimeter ditches around ETDAs to capture and pump tailings pond seepage back into the pond during operation

- Design sustainable closure drainage systems that direct mine water releases to wetlands and pit lakes before being released to existing waterbodies and watercourses
- Direct tailings pond seepages that are not captured by perimeter ditches to wetlands with sufficient residence time for natural treatment of organic constituents and to reduce associated tailings potential and whole effluent toxicity
- Increase the volume of the wetlands that provide treatment to runoff prior to discharge
- Maintain water levels in Kearl Lake and the Imperial Kearl Compensation Lake by ensuring the appropriate design, construction and operation of outlet structures, diversion channels and pipelines
- Modify the existing network of flow and water level monitoring stations to include the expansion areas
- Comprehensive monitoring program may include the assessment of streamflows, water levels and discharge rates, channel stability and morphology, water and sediment quality, littoral zone development, growth of aquatic vegetation as well as benthic invertebrate communities, fish populations and riparian zone vegetation
- Active participation and support to CEMA, its working task ground and the End Pit Lake task group
- Continue to participate in RAMP, CEMA, CONRAD and other regional initiatives to monitor water quality and to confirm performance of mitigations

Discussion

The data used to characterize water chemistry was rated as moderately high quality. Temperature data was considered high quality. Confidence in the predicted concentrations for the small streams assessment (HSPF model) is based on the use of conservative estimates and assumptions and was considered high to fairly high. Sensitivity and uncertainty analyses indicated that the EIA predictions were robust. Essentially, the worst case scenarios were presented. This approach appears reasonable.

The data regarding PAHs and metals in sediments was considered to provide a reasonable level of prediction confidence. Because many of the parameters are below detection limits, the actual concentrations are likely to be much less than the values used in the assessment, indicating that they are conservative estimates.

The water and sediment quality data for pit lakes was based on the CE-QUAL-W2 model, and used the same water quality data as above. The estimates of constituent levels and flow rate predictions are considered to have a high level of certainty. Conservative decay rates were used, and no settling of suspended solids was assumed, another conservative assumption that ensures the worst case scenario was assessed.

The Athabasca River model was used to predict changes in the Athabasca River from Fort McMurray to Embarras. The water quality data source for the model was from Alberta Environment, RAMP, industry and field programs. The data for most constituents, including key water quality constituents is rates of moderately higher quality. Concerns are the fact that analytical detection limits haven't improved over time, and different sources of data are used. Conservative estimates were also achieved by excluding decay in the river. Sensitivity analysis showed that the EIA predictions are robust. However, the model assumes that mitigation success will be achieved, and that the treatment efficiency of wetlands and pit lakes is able to minimize changes to the water quality of the Athabasca River.

Key Concerns

Several key concerns were identified with regards to surface water components during the review. These include:

1. Unclear changes of the integrated drainage plan and subsequent impacts on Kearl Lake.

Section 6.5.5.3 discusses that the integrated drainage plan for this and other projects has been changed. I am unsure as to whether Kearl Lake was always intended to receive direct discharge from the Aurora South End Pit Lake. Please compare the original plan with the new plan in greater detail, so that it is possible to better understand the changes.

➔ **Recommendation:**

Provide additional details regarding the changes to the integrated drainage plan. Provide additional information on the differences between the predicted impacts of the old and new plans on the water and sediment quality of Kearl Lake.

2. For parameters with guidelines, only guideline exceedances are considered as part of the rating criteria, and not increases in the values themselves.

The EIA concluded that for the Muskeg River, Jackpine Creek and Kearl Lake, the impacts on water quality would be low to negligible. Table 1.3-4 outlines the impact description criteria when a constituent has a guideline available, and when there is no guideline. The implications of these ratings differ substantially, such that when a parameter has a guideline associated with it, only guideline exceedances are considered to be significant, any absolute increases in the actual values are completely discounted.

Within the EIA, several of the parameters were predicted to increase by over a degree of magnitude, but because the guideline wasn't exceeded, there was no impact. While I can understand that guideline exceedances would certainly be the key criterion, absolute value increases should also be considered, because they represent a change from existing conditions. I understand that the guidelines have been developed as representative end points of change in survival, growth, reproduction, behaviour etc. However, substantial changes in water quality may still impact aquatic organisms, even if guidelines are not exceeded, particularly within natural systems and not a controlled laboratory.

➔ **Recommendation:**

Please provide additional discussion on the impacts of absolute increases in parameters with guidelines, irrespective of whether guideline exceedances occurred.

3. Insufficient information provided in the water quality impact tables.

Although the ratings criteria used the percent increase to determine the magnitude of change for water quality constituents, no percent increase values were provided in the text or tables. As a result, it was very difficult and inconvenient to check the results tables against the ratings criteria to determine how the ratings had been applied and whether they had been applied correctly.

➔ **Recommendation:**

Please provide the percentage change, rather than just the absolute change, in the results tables for the water quality assessment to allow comparison with the ratings criteria.

4. Unclear ratings system for constituents with guidelines.

Where guideline exceedances were found to result from the project, it was unclear whether the ratings criteria used the higher acute guideline or the lower chronic guideline, or both, to determine the ratings impact. For example, Table 6.5-6 shows that median aluminum concentrations in the Muskeg River from 2012 to 2065 would increase from 0.23 mg/L (Base Case) to 0.3 mg/L (Application Case). The acute guideline for aluminum is 0.75 mg/L, while the chronic guideline is 0.1 mg/L. Clearly, these exceedances would occur over a chronic time period, therefore, the 0.1 mg/L guideline should be applied. The question becomes whether this increase (a difference of 0.07 mg/L) is considered to be negligible, low, moderate or high. The ratings criteria are vague and give subjective criteria (low is when the release contributes slightly to existing background values over guidelines, medium is a marginal contribution and high is a substantial contribution). It is unclear what the definitions of "slightly", "marginal" and "substantial" are.

➔ **Recommendation:**

Please provide additional rationale and clear ratings classifications for the ratings system when guidelines are present. State whether the rating is provided against changes to the acute guideline, chronic guideline or both. Define "slightly", "marginal" and "substantial" exceedances.

5. Pit lakes would have relatively small littoral zones.

Shell states that the littoral zones of the pit lakes would be adequate to provide biological activity and support a viable ecosystem. The littoral zones would be up to 15% of the total value area. This is on the small size of other reclamation waterbodies, in which generally 20 to 30% of the area of the lake is comprised of littoral zone. Since the littoral zone is the most productive part of a lentic system, its relative area should be maximized, not minimized.

➔ **Recommendation:**

Please discuss the adequacy of a maximum 15% littoral zone area for these end pit lakes in light of the more standard 20 to 30% area, and redesign if necessary.

6. Unclear if pit lake discharge to surface waters would exceed water quality guidelines.

Shell states that the pit lakes will discharge to surface waters only when water quality is of sufficient quality and when discharge water quality limits are met. It is unclear what is considered sufficient quality and what these discharge limits would be. It would be reasonable to hope that the limits would be the same as the water quality guidelines, however, this is not likely the intent, since at closure, when discharge will begin, guidelines (molybdenum, PAHs and total nitrogen) will be exceeded in several pit lakes.

➔ **Recommendation:**

Please define what is considered to be sufficient quality for the water of the pit lakes and what the discharge limits would be. Discuss the rationale behind discharging water from pit lakes that exceeds water quality guidelines.

7. Sediment quality of pit lakes (both with and without MFT) has not been modelled.

Shell provides the sediment quality of the MFT to be added to the bottom of the pit lakes, but does not characterize the sediment quality of the lakes at the time of closure. Similarly, in the pit lake where MFT will not be stored, the sediments have not been characterized. It is unclear why these have not been modelled.

➔ **Recommendation:**

Please explain why the sediment quality of the pit lakes at closure cannot be characterized.

Fish and Fish Habitat / Aquatic Health

Overview

The Fish and Fish Habitat and Aquatic Health assessment sections were combined in this one review section. The key environmental issues arising from the projects with respect to fish and fish habitat and aquatic health are:

- Changes in water quality and/or sediment quality and direct or indirect effects on aquatic health
- Increased uptake of substances into fish tissues from sediment and water and direct effects on fish health
- Changes in water quality due to acidifying emissions and direct effects on aquatic health
- Changes in habitat area, streamflows, channel regime/geomorphic condition, water levels and effects on fish habitat
- Changes in water quality, sediment yield and deposition and aquatic health and effects on fish habitat and fish abundance
- Changes in benthic invertebrate communities or invertebrate drift
- Changes in habitat accessibility to fish
- Changes in fishing pressure and effects on fish abundance

The LSA and RSA boundaries for Fish and Fish Habitat/Aquatic Health are the same as those for Water Quality and Surface Water Hydrology.

Development activities to be assessed include those activities during mine construction, operations, closure and reclamation that could alter the condition or area of fish habitat as these relate to stream flow and water level, sediment loading, channel regime and water quality.

Potential effects of the Project on Aquatic Health were assessed in relation to fish populations and other aquatic organisms (invertebrates, algae and aquatic plants). The Key Indicator Resources (KIRs) are the key fish species and benthic invertebrate communities that act as sentinels for the aquatic ecosystem. The toxicity data from fish and other aquatic life are used to derive chronic effects benchmarks. Results from the water quality modelling was the basis for this assessment. Uptake to fish tissue was modelled using site-specific Bioaccumulation Factors. Substances of Potential Concern (SOPCs) were identified, as those higher than the Base Case that also exceed water quality guidelines. Chronic effects benchmarks were used to assess how the SOPCs may affect aquatic health. The benchmarks are concentrations beyond which changes to aquatic health could occur on the scale of individual organisms. The benchmarks are less conservative than water quality guidelines, but are considered to be conservative thresholds.

Potential effects to fish and fish habitat from the Project and drainage integration were assessed in relation to Key Indicator Resources (KIRs) for each of the watercourses and waterbodies in the LSA and RSA. The biological receptors of fish and fish habitat include benthic invertebrate populations, fish abundance and aquatic diversity. All KIRs are used to provide information, within a relatively short time frame, about potential responses to environmental changes that may occur. The effects of the Project on KIR fish species were assessed in relation to the various life stages and their habitat needs.

Data sources included historical aquatic studies and field studies conducted within the LSA. Additional data was provided by government agencies (Alberta Sustainable Resource Development), industries, consultants, government research programs (AOSERP, Northern River Basins Study), multi-stakeholder group research and monitoring (CONRAD, RAMP and CEMA), Traditional Knowledge and Land Use information and information from other related disciplines within this EIA.

Fish and Fish Habitat Baseline Conditions – Muskeg River Watershed

In the Muskeg River mainstem, habitat use potential during the open-water season is generally high for a variety of fish species due to high DO concentrations. The lower 16.5 km of the river mainstem has high habitat potential, but the upstream 105.5 km are of limited potential due to depth and low DO constraints.

Overwintering conditions in the mainstem Muskeg River are variable. Low DO events, and episodic anoxia are common in the Muskeg River upstream of the mouth during the winter months (AXYS 2005). Reduced streamflow is considered to exacerbate DO depletion in the Muskeg River. Lack of reliable overwintering habitat was considered an important limiting factor in the upper river.

Tributary watercourses and waterbodies in the upper Muskeg River watershed primarily provide habitats with low to moderate suitability. Habitat limitations include small size, shallow depths, low discharge volume, poor habitat diversity, substrate dominated by fine sediments, poor fish passage and limited overwintering habitat. Jackpine Creek has the highest quality of fish habitat of all Muskeg River tributaries due to increased habitat diversity in the middle reaches.

A total of 26 fish species have been reported from the Muskeg River, including 10 sport species, two sucker species, and 14 forage fish species. These species have been divided into three classes based on their general abundance and distribution, including seven resident species that are typically abundant with wide distributions, five regular migrant species that use the river during the open-water period for part of their life-cycle and 14 restricted species that occur in low abundance with restricted distributions.

Four of the five dominant, migrant species in the mainstem Muskeg River have declined in number recently: white sucker; longnose sucker; lake chub and Arctic grayling. The decline has not been as severe for northern pike. This decline may be attributed to an increase in beaver activity in the basin. Fish species diversity declines along the length of the Muskeg River due to habitat changes and increasing distance from the Athabasca River. The fish community in the upper Muskeg River tributaries is primarily dominated by forage fish.

Mean benthic invertebrate density from four depositional sites in the upper watershed ranged from 12,000 to 44,000 organisms/m^2. Total taxonomic richness ranged from 28 to 29 taxa/site, indicating rich benthic communities of low to moderate density. The dominant taxa observed are midges, bristle worms and seed shrimp.

Several existing or approved oil sands developments lie within and affect the fish and fish habitat within the Muskeg River watershed. Existing developments include Syncrude Aurora North Mine and Albian Sands Muskeg River Mine. Approved developments include the Shell Jackpine Mine - Phase 1, Syncrude Aurora South Mine, Albian Sands MRME and Imperial Oil Kearl Oil Sands Project.

The existing developments account for less than 5% of the total drainage area of the Muskeg River watershed, and Shell states that these existing developments combined would be expected to only cause small changes in the flows of the Muskeg River. The activities of these existing developments are not expected to interact with existing fish and fish habitat resources within the LSA of this project, except in terms of potential effects of cumulative flow reductions of the Muskeg River. The mitigation, habitat compensation and monitoring activities in association with the existing projects are assumed to be successful, and that No Net Loss of the productive capacity of fish habitat will be achieved. The existing Jackpine Mine – Phase 1 will compensate for its fish habitat impacts through the construction of a new compensation lake near the existing mouth of Muskeg Creek. Compensation requirements for the Aurora South Mine were not known at the time the Shell EIA was written. Since then, it has been revealed that their compensation efforts would include the creation of stream and lake habitat.

Overall, the existing and approved projects will contribute to cumulative hydrologic impacts on the Muskeg River, Jackpine Creek and Kearl Lake. However, reclamation will ensure no residual adverse effects on fish habitat.

Fish and Fish Habitat Baseline Conditions – Athabasca River RSA

The Athabasca River within the Aquatics LSA and RSA for the Project is a large-volume, low-gradient mainstem river that provides turbid, cool-water habitat for a variety of fish. The river is wide but generally shallow, with dynamic, shifting sand channels. Instream cover is limited, and provided by depth and turbidity. Structural cover is limited here. Only 17% of the bank habitats are composed of rocky materials and hardened soils.

Thirty-one fish species occur in the lower Athabasca River, including 12 sport species, two non-sport species, and 17 forage fish species. Of these, 11 species are common, abundant, or seasonally abundant. The Athabasca River in the RSA provides juvenile rearing habitat and adult feeding habitat for regionally significant commercial, subsistence and sport species, and also provides some fry nursery habitat and overwintering habitat. The Athabasca River in the RSA provides an important migratory route for fish from Lake Athabasca to the Peace-Athabasca Delta, and tributary confluences provide important habitat for a variety of life history functions.

Benthic invertebrate diversity is not high in the Athabasca River and historical surveys have found population density to be variable. Midges are typically the dominant group in depositional areas. Bristleworms, roundworms, stoneflies and caddisflies are common in erosional habitats.

There is the potential for the Athabasca River to be affected by several existing or approved developments. Flow and water level reductions may occur in the river due to cumulative water withdrawals from oil sands and other developments and users, and could affect fish habitat. The total water withdrawals are small on an annual basis, relative to the large flows of the Athabasca river. The net annual water allocation to all existing and approved oil sands projects results in a reduction of the mean annual flow of about 2.1%. However, operators are required to meet the Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River, recently developed by Alberta Environment and Fisheries and Oceans Canada. This includes water withdrawal restrictions that are designed to minimize habitat effects during sensitive time periods, such as low winter flows.

Fish and Fish Habitat Baseline Conditions – Traditional Ecological Knowledge

Several fish species have been identified as traditional resources through the collection of TEK. The TEK confirmed that the range of species selected as KIRs included most of the species of value and importance to local Aboriginal communities. Lake trout was the only species with a high use ranking that was not included as a KIR because they are not typically present in the LSA, but are found in Lake Athabasca.

Impacts – Aquatic Health – Muskeg River Watershed

The levels of chronic and acute toxicity in local streams, Jackpine Creek, Muskeg River and Kearl Lake were predicted to be below guidelines, therefore, no effects for sensitive aquatic organisms were predicted. Elevated TDS concentrations were expected to have negligible effects on aquatic health, because of reports of fish species surviving in lakes with even higher TDS concentrations.

In Jackpine Creek, other SOPCs (total nitrogen, ammonia, several metals, PAH Group 1) were below guideline levels, therefore, no toxic effects on aquatic health were expected for those constituents. Chromium and strontium levels were predicted to exceed the chronic effects benchmarks, but no real assessment on aquatic health was provided, beyond statements that the impacts were low in magnitude, low in frequency, localized and long term.

In the Muskeg River at Node M0 (below confluence with Stanley Creek), other SOPCs (metals, PAH Groups 5 and 6) were below guideline levels, therefore, no toxic effects on aquatic health were expected for those constituents. Chromium, strontium and iron levels were predicted to exceed the chronic effects benchmarks, but no real assessment on aquatic health was provided, beyond statements that the impacts were low in magnitude, high in frequency, localized and long term.

In Kearl Lake, other SOPCs (metals, PAH Group 6) were below guideline levels, therefore, no toxic effects on aquatic health were expected for those constituents. Aluminum, cadmium and strontium levels were predicted to exceed the chronic effects benchmarks, but no real assessment on aquatic health was provided, beyond statements that the impacts were low in magnitude, high in frequency, localized and long term.

Predicted changes in fish tissue metal concentrations were predicted to be below toxicological benchmarks for all parameters considered, except for nickel in the Muskeg River, which is predicted to exceed the benchmark. However, negligible effects to fish health were expected, since the nickel benchmark is based on a NOEC (no observed effects concentration) value. Concentrations higher than the NOEC will not necessarily result in detrimental effects.

No impacts to fish tainting were expected within the LSA. Overall, potential changes to aquatic health resulting from the project and its integrated drainage were considered negligible for the Muskeg River, Jackpine Creek and Kearl Lake.

Impacts – Aquatic Health – Pit Lake

The capability of the pit lake to support aquatic life was evaluated in terms of the predicted water, sediment and fish tissue quality within the pit lake, both when it initially begins discharging to the environment and in the far future.

Acute and chronic toxicity in the pit lake were predicted to be below the thresholds when it would begin to discharge to the receiving environment. These results indicated that there is a high level of confidence that the pit lake would be able to support aquatic life. Other SOPCs (total nitrogen, ammonia, TDS, several metals, PAH Groups 2 and 6) were below guideline levels, therefore, no toxic effects on aquatic health were expected. Strontium levels were predicted to exceed the chronic effects benchmark, but were then dismissed, because the benchmark may not be appropriate for the area.

Fish tissue concentrations in the pit lake were predicted to be below benchmarks for most metals, with the exception of nickel and vanadium. These impacts were considered negligible because the nickel benchmark was based on a NOEC value, and the vanadium benchmark was established using non-detectable values, overestimating the benchmark.

Overall, no residual impacts are predicted for aquatic health of the pit lake, and it is expected to be able to support a viable aquatic ecosystem.

Impacts – Aquatic Health – Athabasca River

The levels of chronic and acute toxicity in the Athabasca River downstream of the Muskeg River and upstream of Embarras were predicted to be below guidelines, therefore, no effects for sensitive aquatic organisms were predicted.

Only two SOPCs were identified for the Athabasca River immediately downstream of the Muskeg River (boron and naphthenic acids). The levels of boron were below the benchmark, therefore negligible effects to aquatic health are expected as a result. Naphthenic acids were removed from the SPOC list because of the difficulty in establishing a benchmark. Instead, the whole effluent acute and chronic toxicity were used to indirectly assess naphthenic acids, since they contribute the majority of the toxicity. Since predicted levels of acute and chronic toxicity were below guidelines in the Athabasca River, the effects of naphthenic acids were considered negligible.

Negligible impacts on fish tissue concentrations in the Athabasca River were predicted, because the median concentrations of all parameters were essentially unchanged between the Base Case and Application Case.

Overall, the project was expected to result in negligible effects to aquatic health of the Athabasca River.

Impacts – Fish Habitat and Fish Abundance – Muskeg River Watershed

Fish habitat and riparian areas lost due to the project would occur in the upper Muskeg River mainstem, the lower reaches of Wapasu Creek, unnamed tributaries to the upper Muskeg River and Wapasu Creek and unnamed waterbodies in the upper Muskeg River watershed. These habitat losses amount to 795,347 m^2 of habitat, most of which would occur in the unnamed waterbodies (506,413 m^2) and the upper Muskeg River (111,707 m^2).

The Conceptual Compensation Plan would offset these losses and eliminate potential adverse effects due to changes in habitat area. The CCP is described in Section 1.4.1.10 below. Overall, a net gain in the productive capacity of available fish habitat would be predicted. As a result, there are no predicted adverse impacts on fish habitat due to changes in habitat area.

Flow increases and reductions in the Muskeg River due to the project would also alter available fish habitat. Initially (2012 and 2033 snapshots), the project would result in higher discharges. Reductions would occur in 2052, with cumulative reductions predicted for the mean annual discharge (30%), mean open-water discharge (35%) and the 2 year and 10 year flood peak discharges (55 and 77%, respectively). About 1/3 to 1/2 of these reductions would be due to the JEMA project. In 2052, the 7Q10 low flow discharge of the Muskeg River would show a cumulative increase of 2000%, although the JEMA project itself would actually decrease the 7Q10 low flow by 79%. Note to Dan: the Project Update provided new numbers for these changes to the flows of the Muskeg River, but they didn't update the percentages that I used to describe above. I didn't feel like doing the math, so I haven't updated them.

In the far-future, substantial changes in streamflows of the Muskeg River would still occur. While there would be very little cumulative change in the mean annual discharge (1%), there would be cumulative reductions in the mean open water discharge (25%), and the 2 year and 10 year flood peak discharges (66 and 72%, respectively). About 1/4 to 1/2 of these reductions would be due to the JEMA project. The 7Q10 low flow discharge would show a cumulative increase of almost 3500%, with the JEMA project itself increasing the 7Q10 low flow by 1700%.

These changes to the flow regime of the Muskeg River have the potential to impact the quality and quantity of fish habitat, including that of spring spawners and resident fish species. Most losses would be associated with losses of floodplain inundation, used by some species for spawning (e.g. northern pike). These impacts were considered low in magnitude and for a moderate duration. In the Far Future, the improved winter and 7Q10 flows would result in a negligible impact.

The reduction in channel-forming flows in the lower Muskeg River may result in a loss of fish habitat due to a reduction in channel size and bankfull width. However, after compensation, these impacts and changes in TSS, temperature, DO, benthic communities and benthic invertebrate drift were predicted to have negligible impacts on fish habitat.

The Muskeg River would remain accessible to fish from the Athabasca River. Increased flood flows would not impact accessibility, and increased drought flows would improve accessibility. Spawning timing and use is unlikely to be impacted by the small changes in temperature conditions. However, the loss of seasonal peak flows (particularly in 2052) could affect migration for spring spawning species (e.g. northern pike and suckers), and fewer migrants may enter the Muskeg River. Arctic grayling may not be negatively affected. Decreased flood flows could also reduce the frequency of beaver dam removal, and therefore, impede fish passage within the watershed. These changes are difficult to predict, but could negatively impact migrant fish use of the Muskeg River.

Overall, the EIA concludes that with mitigation and compensation, there is no environmental consequence of the residual impacts on fish habitat or fish diversity in the Muskeg River.

Impacts – Fish Habitat and Fish Abundance – Kearl Lake

While the JEMA would not directly affect Kearl Lake, the integrated drainage diversion of the headwaters of Pemmican, Green Stockings, Wesukemina and Iyinimin creeks into the lake in 2012 would affect lake water levels. An emergency spillway and two outlet structures would be built as part of JEMA, in order to minimize water level changes in the lake and in the adjacent compensation lake planned as part of the Imperial Oil Kearl Oil Sands project. Few changes by 2012 would occur, but even with these mitigations, the water levels of Kearl Lake would be expected to increase cumulatively in the 2033 and 2052 snapshots. The mean open water and mean ice cover water levels would increase cumulatively by over 11% and 6%, respectively, during these periods. The JEMA project itself would actually result in a decrease of the mean open water and mean ice cover water levels by about 10% and 16%, respectively, during these periods. At closure, this infrastructure would be removed and a geomorphically designed closure drainage channel constructed from Kearl Lake to the Jackpine Mine Compensation Lake. Cumulative changes to water levels in the far-future are relatively small (between 1 and 2%).

These increases to the water level of Kearl Lake could potentially increase the littoral area and lake volume, but are unlikely to have a substantial effect on fish habitat or benthic invertebrate communities. In general, the increase in depth would be less than 0.3 m, on average. The aquatic vegetation in the lake would already be adapted to this level of fluctuation. The mitigation measures would result in no predicted adverse impacts on fish habitat in Kearl Lake or the Kearl Compensation Lake as a result of the project.

In 2012, a 9.3 km long, 6 m wide diversion channel would be built to convey Kearl Lake outflows from the lake to the Muskeg River. This may improve fish access to Kearl Lake from the river and the channel will be designed for fish passage. However, the channel will not be geomorphically designed for fish habitat, as it would be lost to mining in 2033. At that point, the outlet channel would be replaced with gravity pipelines to convey Kearl Lake outflows to the Muskeg River and the Jackpine Mine Compensation Lake. This pipeline would be in place until the permanent lake outlet channel is built at closure. These changes to the outlet of Kearl Lake could affect fish accessibility to the lake. Shell, however, has committed to maintaining natural levels of fish passage between Kearl Lake and the Muskeg River during operations.

Overall, the EIA concludes that with mitigation and compensation, there is no environmental consequence of the residual impacts on fish habitat in Kearl Lake.

Impacts – Fish Habitat and Fish Abundance – Athabasca River

The project, in addition to existing and approved projects, would contribute to predicted changes in mean seasonal flows of the Athabasca River. The reduction in mean seasonal flows due to oil sands water withdrawals is 2.1% in the summer and 14.1% in the winter. Shell will meet the Water Management Framework requirements for the lower Athabasca River. As a result, no measureable impacts to fish habitat are expected in the Athabasca River, beyond those outlined in the Framework. The IFN does mention that cumulative water withdrawals, even the restricted withdrawls permitted under the Framework, may result in negative effects on fish habitat. Any incremental changes to fish habitat will be addressed through the Phase 2 process of the Water Management Framework. Habitat compensation requirements, if necessary, will be developed for the project through consultation with DFO.

The losses of the waterbodies and watercourses in the LSA could potentially alter benthic invertebrate drift into the Athabasca River. However, invertebrate drift from tributaries represents less than 1% of total drift in the Athabasca River. As a result, the overall effect is expected to be negligible.

Overall, the EIA concludes that with mitigation and compensation, there is no environmental consequence of the residual impacts on fish habitat on the Athabasca River.

Note to Dan: The full details of the Planned Development Case are in Appendix 4-8, which I don't have in either the binder or the CD, therefore, I can't really go into any more detail or fully assess this section of the report.

Mitigations

A summary of mitigations for the JEMA are provided in Table 1.7-1 and include:

- Water quantity and quality mitigations identified previously
- Minimize effects on flows and water levels by distributing muskeg drainage operations through the life of the mine
- Minimize sediment loading by routing muskeg drainage, overburden dewatering to polishing ponds before release to receiving streams
- Minimize effects of closed circuit operations by diverting natural streams around the mining area
- Design operational diversions and closure channels to provide for fish passage where required
- Schedule construction activities and use best practices
- Develop a self-sustaining closure drainage system by:
    - Direct mine water releases to wetlands and pit lakes before release to existing waterbodies and watercourses
    - Minimize sediment yields from reclaimed surfaces by developing final topography and soil moisture conditions
    - Minimize gully and channel erosion

  - Design watercourses, waterbodies and wetlands during reclamation for bioremediation of tailings porewater releases, groundwater seepage and runoff from reclaimed areas

- Compensate for loss of habitat and changes in peak flows in the Muskeg River
- Implement a fish salvage program for fish habitats permanently lost
- Implement a transport and/or stocking program for effects of habitat accessibility
- Compensate habitat losses and alterations by developing appropriate compensation habitat to ensure the No Net Loss objective is achieved
- Develop fish habitat of equivalent or higher productive capacity
- Maintain water levels in Kearl Lake and the Imperial Kearl Compensation Lake by ensuring the appropriate design, construction and operation of outlet structures, diversion channels and pipelines
- Maintain natural levels of fish passage between Kearl lake and Muskeg River during operation of the gravity pipeline system through a transport or stocking program
- Continue to participate in RAMP, CEMA, CONRAD and other regional initiatives to monitor water quality and to confirm performance of mitigations
- Design all stream diversions to provide fish passage and maintain connectivity with upstream watercourses during construction, operations and on closure
- Comprehensive monitoring program may include the assessment of streamflows, water levels and discharge rates, channel stability and morphology, water and sediment quality, littoral zone development, growth of aquatic vegetation as well as benthic invertebrate communities, fish populations and riparian zone vegetation

Fish Habitat Compensation Plan

A habitat compensation plan was developed to address the impacts to fish and fish habitat associated with development activities in the JEMA and PRMA watersheds.

In JEMA, fish habitat losses would occur throughout portions of the upper Muskeg River watershed, including Wapasu Creek. The proposed developments would also alter some aspects of the JEMA –Phase 1 development, including Khahago Lake and the repositioned Muskeg Creek. In PRMA, fish habitat losses would occur throughout portions of the Pierre River, Eymundson Creek, Big Creek and Redclay Creek. The impacts of the Athabasca River and the direct habitat losses due to the construction of the bridge and water intake (for the PRMA project) have not been identified or included in this CCP.

The fish habitat compensation plan is developed with consideration of the “No Net Loss Guiding Principle” for fish habitat, to satisfy the requirements of Fisheries and Oceans Canada, under the Fisheries Act. Watercourse segments that would result in the HADD of fish habitat due to the JEMA and PRMA are identified.

Several habitat compensation options were evaluated with respect to developing the Conceptual Compensation Plan (CCP) for the Project. The selected option would consist of constructing riverine and lacustrine compensation habitats, including a compensation lake in the lower Big Creek and lower Redclay watersheds (Redclay Compensation Lake) to provide year-round habitat for a species assemblage similar to those species affected by the Project. This option was selected because it is on the Shell lease area, has the potential to provide large habitat gains, and has design flexibility in terms of overall size and configuration. Included with the design of this lake is the construction of natural geomorphic channels that incorporate fish habitat features and facilitate fish passage from the Athabasca River to the Redclay Compensation Lake and upper reaches of Big Creek watershed.

Redclay Compensation Lake would be constructed immediately adjacent to the PRMA's Raw Water Storage Facility. The lake size would be approximately 4 km^2. The compensation lake would be constructed to provide habitat diversity in the lake (varying gradients, substrate types, and depths). Design features would include spawning, nursery, rearing, feeding and overwintering habitats to support self-sustaining fish populations. It would provide suitable habitat for a proposed fish community consisting of walleye, lake whitefish, cisco, northern pike, yellow perch, burbot, white sucker, longnose sucker and several forage fish species. The compensation lake would be connected to upstream and downstream riverine habitat.

In addition to the above lake design, two channels would be constructed as a part of the lake development to provide riverine compensation habitat. The lake outlet channel would be constructed to connect the lake to the Athabasca River and would be 15 km in length. A diversion channel would be constructed to connect the lake to the upper reaches of the Big Creek watershed and would be 13 km in length. Where appropriate, both channels would be designed to provide riverine spawning habitat for select species that prefer flowing water with rocky substrate for spawning (e.g. suckers). Permanent closure channels associated with the project would be geomorphically designed to provide fish habitat and fish accessibility and would be included as compensation in the detailed No Net Loss Plan.

The development of the compensation lake habitat would occur at the start of the project. Development of the diversion channel compensation habitat would be variable, but would generally occur later in the project life as most are closure channels. The first losses of fish habitat would occur in 2016, with the initial diversions of the PRMA. Other impacts would occur later, including losses in the Muskeg River, would start in 2046.

Discussion

The impact predictions for aquatic health within the LSA and RSA were based on conservative modelling and multiple lines of evidence, including predicted levels of while effluent chronic and acute toxicity and concentrations in water and fish tissue. Uncertainty analyses indicated that the water quality predictions were robust, particularly for whole effluent toxicity. Confidence in the overall predictions was considered high. Those metals for which low impacts were predicted were considered to be overestimated due to the conservative assumptions used to complete the assessment.

The predictions of pit lake water quality were also considered robust, with a number of adaptive management practices available to ensure suitable water quality within the lake.

The level of confidence in the fish habitat and fish abundance predictions is moderate. There is a high level of confidence in the Base Case information, assessment techniques and proposed mitigation measures. Decreased confidence is found in the analytical techniques that include estimates of changes in habitat areas and the effects of changes in flow on fish habitat. This analysis was doing based on estimates, which are preliminary and based on historical and field measurements. A more detailed assessment of habitat changes would be made during the development of the detailed No Net Loss Plan in the future.

There is also a level of uncertainty regarding the predictions of the geomorphic change in the Muskeg River. The certainty in predicting the potential change to fish habitat and productivity due to changes in channel morphological processes is low. In addition, the certainty in predicting the potential change in accessibility in the Muskeg River for spring spawning fish due to changes in the spring flow regime is also low. Additional monitoring is required to determine specific habitat changes that may occur and the effects on fish use and habitat productivity.

The level of confidence in the predictions made for fish diversity is moderate, as there is moderate confidence in interpreting the specific effects of habitat changes on habitat diversity. The assessment is based primarily on professional judgement regarding how habitat changes translate into specific effects on diversity.

Shell is committed to monitoring and providing compensation for the Project impacts, and as such, the confidence of the proposed mitigation and planned compensation is high. There is high confidence in the sediment and erosion controls. Confidence is also high that fish connectivity can be maintained between the Muskeg River and Kearl Lake, as monitoring will occur to determine the natural levels of fish movement, which Shell is committed to maintain. Overall, the CPP is predicted to have a high probability of success. The Redclay Compensation Lake and closure channels will be designed to provide habitat that is predicted to provide a net gain in productive capacity.

The level of confidence in predictions for fish and fish habitat on the Athabasca River is moderate to high. There is moderate confidence in the Base Case information and assessment techniques, and high confidence in the proposed mitigation and compensation measures. Shell has also committed to operate under Phase 1 of the Water Management Framework for the Lower Athabasca River while it is in place, and Phase 2 when it is developed.

Key Concerns

Several key concerns were identified with regards to the Fish and Fish Habitat / Aquatic Health components during the review. These include:

1. Unclear changes of the integrated drainage plan and subsequent impacts on Kearl Lake

Section 6.5.5.3 discusses that the integrated drainage plan with this and other projects, has been changed. I am unsure as to whether Kearl Lake was always intended to receive direct discharge from the Aurora South End Pit Lake. Please compare the original plan with the new plan in greater detail, so that it is possible to better understand the changes.

➔ **Recommendation:**

> *Provide additional details regarding the changes to the integrated drainage plan. Provide additional information on the differences between the predicted impacts of the old and new plans on the water and sediment quality of Kearl Lake.*

2. Little detail provided to explain why elevated nickel and vanadium levels in fish tissue would be a negligible impact.

The fish tissue analysis found that nickel would exceed the toxicological benchmark within the Muskeg River. Nickel and vanadium would exceed the benchmark in several pit lakes. However, these findings were rated as having a negligible impact on aquatic health, which was justified in several ways. One of the ways was that the nickel and vanadium benchmarks were based largely on non-detectable fish tissue concentrations, which artificially elevated the benchmark value. However, the percentage of non-detectable values is not provided, nor are the detectable values, so it is difficult to determine whether this conclusion is valid.

Another means for justification was that the nickel benchmark was based on a NOEC level, where concentrations in excess may not necessarily result in detrimental effects. However, the potential toxicological effects of nickel likely to occur at the concentrations seen were not discussed in this section. It would be helpful if the text provided more information and a better appreciation of what impacts this elevated fish tissue concentration would have. In this way, it would be easier to determine whether a negligible rating is appropriate, despite exceeding the benchmark.

➔ **Recommendation:**

> *Provide additional details regarding the toxicological effects of these levels of nickel within fish tissues. Provide the percentage of non-detectable values and the median and peak nickel/vanadium concentrations of the detectable values.*

3. Benchmark exceedances dismissed.

The results of the aquatic health and fish tissue analysis found that several constituents (TDS, nickel, aluminum, cadmium, chromium, strontium and iron) would exceed the toxicological benchmarks. However, as detailed above, these findings were rated as having a negligible impact on aquatic health, which was justified in several ways. These justifications included the following: the benchmarks didn't really represent an impacted state, were not appropriate for the area, or were overestimated due to the conservative assumptions used to complete the assessment.

If the benchmarks can be so easily disregarded, then perhaps a more stringent method of determining benchmarks should be employed, so that meaningful results can be determined. There is little value in assessing impacts, and then disregarding the results because the methods were flawed.

➔ **Recommendation:**

Provide appropriate and meaningful benchmarks, such that compliance and non-compliance can be better assessed. If this is not possible, discuss the utility of these benchmarks and how they may be improved in the future.

4. Lack of assessment on aquatic health for benchmark exceedances.

Several metals were found to exceed their benchmarks within the Muskeg River watershed and the pit lake, including TDS, aluminum, cadmium, chromium, strontium and iron. While the impacts were rated in terms of duration, frequency, location etc., no information on the actual impacts of these exceedances was included. It would be helpful to know the potential impacts of the metals, individually and synergistically, on the survival, growth, reproduction and behaviour of aquatic life.

➔ **Recommendation:**

Please provide a discussion of the potential effects of these benchmark exceedances on aquatic health.

5. Inconsistent extents of littoral zone in the pit lake.

The Water Quality assessment noted that the littoral zone of the pit lake would be up to 15% of the total area. The Aquatic Health assessment noted that the littoral zone would be between 10 to 30% of the area.

➔ **Recommendation:**

Please provide the correct littoral zone area for the pit lake.

6. All flow statistics for the Updated Mine Plans were not provided.

The EIA Update provided new flow statistics in terms of predicted changes to the streamflows of the Muskeg River at several nodes. While the flows were updated, the incremental percentage changes due to the project were not included. Similarly, the cumulative percentage changes to flows were not included. It would be helpful if all relevant information were updated .

➔ **Recommendation:**

Please provide the incremental and cumulative percent changes to streamflows in the Muskeg River.

7. Effects on fish habitat are not extrapolated to fish abundance.

While the assessment discusses the impacts on fish habitat as a result of several impact pathways and linkages, these potential changes are not extrapolated to the implications for fish abundance or populations. For example, the declines in peak spring floods in the Muskeg River are mentioned in terms of potential decreases in migration for northern pike and Arctic grayling, as well as spawning site losses for northern pike. However, these potential changes are not discussed in terms of impacts on populations. Similar concerns exist for impacts of decreased fish passage and accessibility on fish abundance.

➔ **Recommendation:**

> *Please discuss the potential impacts of changes to fish habitat on fish abundance and local and regional fish populations, where appropriate.*

8. No determination of productive capacity of fish habitat.

The compensation of losses to existing fish habitat is based on the productive capacity of fish habitat. However, the productive capacity of fish habitat has not been determined for any of the habitat losses proposed as a result of the project. Shell states that this will be completed as part of the detailed No Net Loss Plan. However, until the productive capacity of all the existing and compensation habitats have been calculated, it is impossible to determine whether the compensation efforts proposed are comparable, appropriate and adequate for the project.

Shell states that a lake with an area of 4 km^2 is sufficient to provide adequate compensation. The lengths of the compensation channels would be 13 and 15 km. Generally, this project would require at least a 2:1 habitat compensation ratio, but no information is provided to document that the proposed habitat would meet this ratio. Despite this, Shell states that a net gain in the productive capacity of available fish habitat would occur, with no predicted adverse impacts on fish habitat. However, without the detailed habitat unit information, it is impossible to determine whether the goal of no net loss of productive capacity will be achieved.

In addition, without species-specific habitat losses, it is not possible to determine if the project would exacerbate the stresses and population declines already experienced by several fish species in the region.

➔ **Recommendation:**

> *Please provide the detailed No Net Loss Plan when available, including the productive capacity of the habitat losses and compensation habitat. Provide all information necessary to prove that the compensation habitat will provide at least a 2:1 compensation ratio. Provide species-specific habitat losses, and discuss these impacts on fish species currently experiencing stress and population declines in the region.*

9. Lack of compensation riverine habitat.

As mentioned, the CCP does not determine the proportion of riverine or lacustrine habitat units lost or created as a result of the project. Presumably, the majority of fish habitat losses are from riverine habitat, however, the CCP can be assumed to consist primarily of lacustrine habitat (the Redclay Compensation Lake). More effort to creating riverine habitat may be warranted. While opportunities for compensation in the form of newly created riverine habitat or enhancement of existing habitat may be limited in the region, this was not discussed in the CCP. No explanation is given for why more riverine habitat cannot be recreated locally or enhanced regionally in order to replace lost habitat with like habitat. At the least, there should be a discussion of the issue within the report.

➔ **Recommendation:**

> *Please discuss the lack of riverine habitat and the regional implications of this and other compensation plans that focus almost entirely on lacustrine habitat compensation.*

10. Little information on the timing of compensation.

Shell states that the compensation lake would be constructed early in the project and that the compensation channels would generally be constructed later in the project, but no dates are provided. As a result, it is unclear how the compensation habitats would be developed in a timely manner to provide available fish habitat. While construction of the compensation lake may occur at the same timeline as the beginning of the existing habitat losses, the former is not the same as providing habitat actually capable of supporting fish. There would be a timelag between construction and actual use by fish. This timescale differences and the potential impacts on local fish populations are not clearly outlined in the CCP. Regional impacts were not discussed, although this same timelag issue exists for all mine developments.

➔ **Recommendation:**

> *Please provide details regarding the timing of the construction of compensation habitat, and when they would be capable of supporting fish and other aquatic organisms as part of a sustainable and diverse ecosystem. Discuss the local and regional implications of this and other compensation plans that will not provide compensation habitat at the same time as habitat losses.*

Appendix D-6

Shell Jackpine Mine Expansion Project – Application Amendment and Response to the ACFN Review, October 2, 2009, by Fay Westcott of Clearwater Environmental Consultants

Clearwater Environmental Consultants

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October 2, 2009

Dan Smith
DS Environmental Consulting Inc.
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Three Hills, AB T2K 5B8

Re: Shell Jackpine Mine Expansion Project – Application Amendment and Response to the ACFN Review

Dear Dan:

As requested, Clearwater Environmental Consultants Inc. has reviewed the responses from Shell Canada regarding the ACFN Technical Review Clarification Questions. This technical review was for the proposed Jackpine Mine Expansion Project. Below is a list of the issues raised during the initial ACFN review and the adequacy of Shell's responses. The numbered questions noted below are the same numbers used in the Shell response.

1.0 Responses to ACFN Questions

1.1 Surface Water Quality

<u>Section 2 Question 5: Impacts from the integrated drainage plan on the water and sediment quality of Kearl Lake are unclear.</u>

Shell states that the details regarding the changes to the integrated drainage plan during Closure are presented in the Closure Drainage Plan for the EIA (Volume 4, Appendix 4-3). I didn't (and don't) have access to this section of the EIA. If you would be able to forward it to me, I can review if for you. Shell also states that the Aurora South Pit Lake discharge was not changed as result of the proposed drainage integration, and that the Aurora South Pit Lake was always intended to directly discharge into Kearl Lake. **I think that this issue needs more attention. Could you please forward me the Closure Drainage Plan from the EIA so that I can review this and see if the impacts have been appropriately assessed?**

<u>Section 2 Question 6: Only guideline exceedances were considered, not increases in the values.</u>

Shell states that the most stringent guidelines (of AENV, CCME and US EPA) were applied. Shell then discusses that guidelines are meant to protect the most sensitive life sage of the most sensitive species over the long term. I would agree with Shell's statements, however, they don't answer the question. Absolute changes in the numerical values of the water quality parameters were not discussed. Sole reliance on guideline compliance does not necessarily ensure that the ecosystem remains unimpacted or unchanged. **The question remains unanswered.**

Section 2 Question 7: Percentage change of water quality impacts is lacking.

Shell states that there is sufficient information for ACFN to calculate the percentage change of the data. This is true, but it isn't ACFN's responsibility to complete tables for the EIA. Information presented should be clear and informative. Is Shell really requesting that reviewers conduct their own manipulations of the data? The calculation of percentage change and its application to the ratings criteria is a minor point, but in the bigger picture, this is not an approach that Shell should promote. **The request to provide percentage change information remains outstanding.**

Section 2 Question 8: Ratings system for constituents with guidelines is unclear.

Shell clarified that the chronic guideline is applied when both chronic and acute guidelines are present. Shell did not clarify the ratings system provided in the EIA. The ratings criteria in this section of the EIA are provided as low (when the release contributes slightly to existing background values over guidelines) medium (a marginal contribution) and high (a substantial contribution). Definitions of "slightly", "marginal" and "substantial" were not provided in the EIA and were requested. Shell stated that these terms were not used to rate guidelines exceedances. This explanation appears to combine two separate approaches to assess data: first the actual water quality assessment, and then the use of the water quality data in the subsequent Aquatic Health and Human Health components. This request applies only to the ratings of the water quality component. **The request to provide the definitions remains.**

Section 2 Question 9: Discuss the adequacy of a maximum 15% littoral zone for the end pit lakes, rather than the standard 20 to 30%.

Shell states that the littoral zones of the pit lakes will be between 10 to 30% and that the exact areas will be determined during the detailed design stage. **The request to ensure that littoral zones are 20 to 30% and not on the lower end of the expected range, remains.**

Section 2 Question 10: Unclear water quality of pit lake discharges.

Shell states that the management of pit lakes and Treatment Lake will meet discharge criteria as are currently being developed by CEMA and will be enforced by AENV in the future. This response is adequate in that this is how the process has been established, however, I have reservations about the approval and construction of mines without clear details and specific commitments as to the quality of water discharged by these pits to the environment.

Section 2 Question 11: Sediment quality of the pit lakes at closure hasn't been characterized.

Shell states that the MFT that will be added to the pit lakes is expected to be comparable to the MFT for existing oil sands operations. However, every oil sands operation is slightly different, with unique geology, and variations in the extraction and processing technology used. Therefore, the wastes, including the MFT, will be unique with different constituents. Regardless, the question asked was what the sediment quality of the pit lakes would be at closure, not the quality of the MFT initially added. **The request for pit lake sediment information at closure remains.**

Section 3 Question 12: Inadequate assessment of impacts of elevated nickel and vanadium levels in fish tissue.

Shell states that in their re-examination of the water quality modeling for nickel, errors were found. New results for nickel will be included in the Errata section of the Jackpine Project Mine Expansion Update. Shell states that the revised water quality modeling found levels to be below water quality guidelines and the chronic effects benchmarks. The tissue concentration benchmark was slightly exceeded for nickel, but concluded that the effects would be negligible. Shell also clarified that all concentrations of vanadium were below the tissue concentration benchmarks. As a result, the effects of vanadium were considered negligible. **These responses are adequate, however, see Section 3 Question 13.**

Section 3 Question 13 Exceedances of the toxicological benchmarks were disregarded.

Shell states that the question is a statement of disagreement with their methods, and should be discussed following completion of the technical review. It is unclear why justification of their methodology can't be provided in these responses to the ACFN questions. **The request remains.**

Section 3 Question 14: Chronic effects benchmark exceedances were not assessed for impacts on aquatic health.

Shell states that the findings of the assessment were that none of the parameters would pose long-term impacts to aquatic health. Any exceedances of benchmarks were flagged for further assessment. It is unclear whether Shell is planning on conducting additional assessment of these exceedances. The potential impacts on aquatic life were not discussed, apart from the conclusion that impacts would be negligible. **The request remains.**

Section 3 Question 15: Inconsistent littoral zone areas within EIA sections.

Shell clarified that the littoral zones of the pit lakes will be between 10 to 30% and that the exact areas will be determined during the detailed design stage. **The response is adequate, however, see Question 9.**

Section 3 Question 16: Impacts on fish habitat are not extrapolated to fish abundance.

Shell states that additional information will be provided in their No Net Loss Plan, once completed. Shell notes that the ACFN withdrew from the No Net Loss consultation process and asks that they reconsider this decision. This response is adequate in that this is how the process has been established, however, I have reservations about the approval and construction of mines without a clear understanding of the impacts on fish and fish habitat.

Section 3 Question 17: Productive capacity of fish habitat was not determined.

Shell states that the adequacy of the estimated compensation requirements will be confirmed in the future when the No Net Loss Plan is prepared. Shell notes that the ACFN withdrew from the No Net Loss consultation process and asks that they reconsider this decision. This response is adequate in that this is how the process has been established, however, I have reservations about the approval and construction of mines without a clear understanding of the fish habitat compensation plans.

Section 3 Questions 18: No riverine habitat included in the Conceptual Compensation Plan.

Shell states that this should be discussed as part of the No Net Loss consultation process. See concerns noted in Question 17.

Section 3 Question 19: No information on the timing of fish habitat compensation construction and function.

Shell states that these specifics are being determined in the No Net Loss Plan. See concerns noted in Question 17.

In summary, many of the responses were inadequate and did not answer the question posed. Other answers recommended that discussions be held with the ACFN following the review process. These questions are part of that review process, and should be discussed at this time. Some of the responses indicated that information was available in the Closure Drainage Plan. If I could get a copy of this binder (Volume 4 Appendix 4-3), I could confirm the impacts on Kearl Lake in more detail. Finally, Shell states that many of the questions regarding fish and fish habitat will be answered when the detailed No Net Loss Plan is prepared. Shell states that ACFN withdrew from this process in May, 2009 and requests that they reconsider this decision so they can remain part of the process.

Please give me a call if you have any questions at all about this response.

Sincerely,
Fay Westcott, M.Sc., P.Biol.
Clearwater Environmental Consultants Inc.

Appendix D-7

Shell Pierre Mine Project – Conceptual Fish Habitat Compensation Plan Review for Athabasca Chipewyan First Nation, September 25, 2008, by Fay Westcott of Clearwater Environmental Consultants

Shell Pierre River Project

Conceptual Fish Habitat Compensation Plan

Review for Athabasca Chipewyan First Nation

By:

Clearwater Environmental Consultants Inc.

Sept. 25, 2008

Introduction

As a part of their application of approval of expansions to their current oil sands operations, Shell Canada Limited (Shell) has submitted an Application and Environmental Impact Assessment (EIA) for the Jackpine Mine Expansion and Pierre River Mine Project. This application and EIA are also used to support their request for operating approvals under the Alberta Oil Sands Conservation Act, Alberta Environmental Protection and Enhancement Act (EPEA) and Alberta Water Act. Shell is seeking approval for development of a new mine located on the west side of the Athabasca River (Pierre River Mining Area – PRMA). The project would specifically affect portions of the Pierre River, Asphalt Creek, Eymundson Creek, Big Creek and Redclay Creek watersheds, as well as reaches of the Athabasca River. This application and EIA have been reviewed on behalf of the Athabasca Chipewyan First Nation (ACFN).

The following documents were consulted in order to conduct this review of Shell's Pierre River Mine Project:

- Volume 4A: Aquatic Resources
- Volume 4B: Aquatic Resources Appendices

Overview

Overall, the Aquatic Resources components of the Shell JEMA and PRMA Project EIA were well done, well detailed and logical. However, the combination of two completely separate projects into one Application and EIA was very difficult to review. I would recommend that this approach not be permitted in the future. The rationale for the inclusion of both projects was unclear and not described in the EIA. The projects are on the opposite sides of the Athabasca River, and not physically connected. If Shell were concerned about providing a better cumulative effects impact assessment for these two projects, then that was not achieved, as cumulative effects on the Athabasca River (the only common LSA and RSA areas for the two projects) was done in a cursory manner and not a true cumulative effects analysis.

In reality, it appears that the only reason that these two projects (JEMA and PRMA) were combined into one Application and EIA is that the compensation plans for both projects have been consolidated into one area, located in the Pierre River Mine area. It is alarming that the Muskeg River watershed will be so disturbed by existing, approved, and planned projects, that there is no room for locating on-site compensation efforts for one of the many projects within the watershed.

The Conceptual Compensation Plan puts forward a combined plan for both the PRMA and JEMA projects. The habitat units and actual productive capacity of fish habitat to be lost in either the PRMA or JEMA projects were not determined at this stage, nor was the productive capacity of the proposed compensation habitats. The proposed compensation would be a lake and two channels, which are intended to compensate for the habitat losses for both projects. Similar to other regional mine plans, the majority of the compensation appears to be for lacustrine habitat, while the majority of losses would be for riverine habitat. Without additional information, and in particular, habitat unit information, it is not possible to assess the adequacy of this compensation plan.

Overall, the major concerns for the PRMA project regarding surface water quality, aquatic health and fish and fish habitat components are:

- The Conceptual Compensation Plan does not determine the productive capacity of lost habitat or compensation habitat, therefore it is not possible to determine whether the proposed plans are sufficient.

Fish and Fish Habitat

Overview

The Fish and Fish Habitat and Aquatic Health assessment sections were combined in this one review section. The key environmental issues arising from the projects with respect to fish and fish habitat are:

- Changes in habitat area, streamflows, channel regime/geomorphic condition, water levels and effects on fish habitat
- Changes in water quality, sediment yield and deposition and aquatic health and effects on fish habitat and fish abundance
- Changes in benthic invertebrate communities or invertebrate drift
- Changes in habitat accessibility to fish
- Changes in fishing pressure and effects on fish abundance

The LSA and RSA boundaries for Fish and Fish Habitat/Aquatic Health are the same as those for Water Quality and Surface Water Hydrology.

Development activities to be assessed include those activities during mine construction, operations, closure and reclamation that could alter the condition or area of fish habitat as these relate to stream flow and water level, sediment loading, channel regime and water quality.

Potential effects to fish and fish habitat from the Project and drainage integration were assessed in relation to Key Indicator Resources (KIRs) for each of the watercourses and waterbodies in the LSA and RSA. The biological receptors of fish and fish habitat include benthic invertebrate populations, fish abundance and aquatic diversity. All KIRs are used to provide information, within a relatively short time frame, about potential responses to environmental changes that may occur. The effects of the Project on KIR fish species were assessed in relation to the various life stages and their habitat needs.

Data sources included historical aquatic studies and field studies conducted within the LSA. Additional data was provided by government agencies (Alberta Sustainable Resource Development), industries, consultants, government research programs (AOSERP, Northern River Basins Study), multi-stakeholder group research and monitoring (CONRAD, RAMP and CEMA), Traditional Knowledge and Land Use information and information from other related disciplines within this EIA.

Fish and Fish Habitat Baseline Conditions – LSA

The Pierre River mainstem provides suitable open water habitat for several fish species and life stages. At the mouth, the Pierre River is low gradient, depositional and consists of run habitat with silt and sand substrate. The lower reaches provide spring spawning and summer rearing habitat for species such as northern pike and Arctic grayling from the Athabasca River. Seasonal rearing and feeding habitat may also be present for occasional migrants, such as burbot, mountain whitefish and walleye.

Habitat use potential for resident fish species in the Pierre River and its tributaries is limited by poor-quality overwintering habitat (i.e. shallow depths and low winter DO). Beaver ponds may improve the potential of this area for overwintering because they increase pool depths.

The fish community within the Pierre River is relatively diverse, with a total of 17 species recorded. This includes five sport, two non-sport and 10 forage fish species. The distribution of sport fish species in the Pierre River is essentially confined to the lower reach, near the confluence with the Athabasca River.

Mean benthic invertebrate density at two depositional watercourse sites in the Pierre River was highly variable, ranging from 1,200 to 63,000 organisms/m^2. Total taxonomic richness ranged from 23 to 40 taxa/site, indicating a rich benthic invertebrate community. The dominant taxa were midges and bristle worms.

Eymundson Creek provides suitable habitat for forage fish and some seasonal habitat for large-bodied fish species from the Athabasca River. Habitat is composed of run, flat, riffle and impoundments associated with beaver dams. Shallow depths and low DO levels restrict the range of large fish in this area overwinter. A total of 11 fish species, primarily forage fish, have been documented in the watershed, primarily in the lower reaches. This watershed supports a diverse benthic invertebrate community dominated by seed shrimp, midges and bristle worms.

The Big Creek mainstem provides habitat for several fish species and life stages due to the availability of cover, presence of spawning substrate and suitable water quality. It has riffle, run and flat habitat, but limited overwintering potential. Small channel size, shallow depth, low discharge volume, poor habitat diversity and the presence of fine sediment limit fish populations. Eleven fish species, primarily forage fish, have been observed in the watershed. The area supports a moderately rich and diverse benthic invertebrate community dominated by seed shrimp, midges and bristle worms.

Suitable open-water habitat is present in much of the Redclay Creek mainstem. The habitat is primarily riffle-run and there are a number of pools and some rocky substrate. The lower reaches of the creek provide summer habitat for a number of sport fish species from the Athabasca but winter habitat is limited. Fifteen fish species have been documented in the watershed, including sport, non-sport and forage fish species. Sport fish species are concentrated in the lower reaches of the creek. Benthic invertebrate communities were moderately diverse and were dominated by midges.

There are no existing or approved developments within the LSA, therefore, the Base Case and Pre-development Case are the same.

Fish and Fish Habitat Baseline Conditions – Athabasca River RSA

The Athabasca River within the Aquatics LSAs and RSA for the Project is a large-volume, low-gradient mainstem river that provides turbid, cool-water habitat for a variety of fish. The river is wide but generally shallow, with dynamic, shifting sand channels. Instream cover is limited, and provided by depth and turbidity. Structural cover is limited here. Only 17% of the bank habitats are composed of rocky materials and hardened soils.

Thirty-one fish species occur in the lower Athabasca River, including 12 sport species, two non-sport species, and 17 forage fish species. Of these, 11 species are common, abundant, or seasonally abundant. The Athabasca River in the RSA provides juvenile rearing habitat and adult feeding habitat for regionally significant commercial, subsistence and sport species, and also provides some fry nursery habitat and overwintering habitat. The Athabasca River in the RSA provides an important migratory route for fish from Lake Athabasca to the Peace-Athabasca Delta, and tributary confluences provide important habitat for a variety of life history functions.

Benthic invertebrate diversity is not high in the Athabasca River and historical surveys have found population density to be variable. Midges are typically the dominant group in depositional areas. Bristleworms, roundworms, stoneflies and caddisflies are common in erosional habitats.

There is the potential for the Athabasca River to be affected by several existing or approved developments. Flow and water level reductions may occur in the river due to cumulative water withdrawals from oil sands and other developments and users, and could affect fish habitat. The total water withdrawals are small on an annual basis, relative to the large flows of the Athabasca river. The net annual water allocation to all existing and approved oil sands projects results in a reduction of the mean annual flow of about 2.1%. However, operators are required to meet the Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River, recently developed by Alberta Environment and Fisheries and Oceans Canada. This includes water withdrawal restrictions that are designed to minimize habitat effects during sensitive time periods, such as low winter flows.

Fish and Fish Habitat Baseline Conditions – Traditional Ecological Knowledge

Several fish species have been identified as traditional resources through the collection of TEK. The TEK confirmed that the range of species selected as KIRs included most of the species of value and importance to local Aboriginal communities. Lake trout was the only species with a high use ranking that was not included as a KIR because they are not typically present in the LSA, but are found in Lake Athabasca.

Impacts – Fish Habitat and Fish Abundance – LSA

Fish habitat and riparian areas lost due to the project would occur in the lower Pierre River, lower Eymundson Creek, lower Asphalt Creek, lower Big Creek, lower First Creek, unnamed tributaries to Pierre River, Eymundson Creek, Big Creek, Redclay Creek and the Athabasca River, and unnamed waterbodies within the Pierre River, Eymundson Creek, Big Creek and Redclay Creek watersheds. These habitat losses amount to 1,880,074 m^2 of habitat, the largest single losses would occur in the unnamed waterbodies of Big Creek (559,410 m^2) and the unnamed tributaries of the Athabasca River (205,697 and 225,553 m^2). Additional losses of 452,467 m^2 would occur at closure, due to the repositioning of diversion channels, with the largest loss in an unnamed tributary of Big Creek (100,578 m^2). The closure diversion channels would be designed to provide fish habitat that meets compensation requirements.

The Conceptual Compensation Plan would offset these losses and eliminate potential adverse effects due to changes in habitat area. The CCP is described in Section 1.4.1.10 below. Overall, a net gain in the productive capacity of available fish habitat would be predicted. As a result, there are no predicted adverse impacts on fish habitat due to changes in habitat area.

Changes in the thermal regime of Eymundson Creek could impact fish habitat, with delayed warming in the summer and delayed cooling in the fall and winter. Shell states that any effects of the changes in temperature would be localized and receiving waterbodies and watercourses would quickly attain thermal equilibrium. The overall adverse impacts were considered negligible.

The elimination of habitat would result in a temporary loss of the benthic invertebrate community. However, after compensation, these impacts were predicted to have negligible impacts on fish habitat.

All stream diversions would be designed to provide fish passage and maintain connectivity with upstream watercourses during construction, operations and on closure. Therefore, impacts on habitat accessibility were considered negligible. In particular, the Pierre River would be diverted south in 2016 around the mine to the Athabasca river. This diversion has the potential to affect fish passage from the Athabasca River to the Pierre River, particularly since the escarpment is very steep. Fish passage provisions would be installed as required to maintain connectivity. At closure, a permanent diversion channel would be constructed and designed to allow for fish movement. The downstream reach of this channel would likely be integrated with the CNRL Horizon closure drainage channel, and will accommodate flows from both the diversion of the Pierre River and the Horizon Project. Overall, no measurable impacts on habitat accessibility were expected for the Pierre River.

During operations, Eymundson and Asphalt creeks would be diverted north around the mine to the Athabasca river. Fish accessibility would be maintained. This diversion channel would be maintained during closure until the water quality in the pit lakes is suitable for release. At this time, the diversion channel would be decommissioned and the Eymundson and Asphalt creeks would flow into the Pierre North Pit Lake. Impacts on habitat accessibility were predicted to be negligible for Eymundson and Asphalt creeks.

Similarly, diversions for Unnamed Creek 1, First Creek, Big Creek were also expected to have negligible impacts on fish habitat accessibility.

Overall, the EIA concludes that with mitigation and compensation, there would be no environmental consequence of the residual impacts on fish habitat or fish diversity in the LSA.

Impacts – Fish Habitat and Fish Abundance – Athabasca River

The placement of a freshwater intake on the west bank of the Athabasca river, and the new bridge across the Athabasca river would result in a permanent small-scale loss of habitat. However, the portion of the intake on the Athabasca River consists entirely of common erosional habitat, and provides low to moderate suitability for use by key species during the open water period. For the bridge, instream piers would be installed in the river, resulting in habitat losses, and riparian habitat losses would occur on either side of the bridge. Negative impacts would occur, and compensation would likely be required. The detailed design for this intake and bridge are not available yet, and these losses have not been incorporated into the CCP yet. They will be included in the detailed No Net Loss Plan.

The project, in addition to existing and approved projects, would contribute to predicted changes in mean seasonal flows of the Athabasca River. The reduction in mean seasonal flows due to oil sands water withdrawals is 2.1% in the summer and 14.1% in the winter. Shell would meet the Water Management Framework requirements for the lower Athabasca River. As a result, no measureable impacts to fish habitat are expected in the Athabasca River, beyond those outlined in the Framework. The Framework does mention that cumulative water withdrawals, even the restricted withdrawals permitted under the Framework, may result in negative effects on fish habitat. Any incremental changes to fish habitat will be addressed through the Phase 2 process of the Water Management Framework. Habitat compensation requirements, if necessary, will be developed for the project through consultation with DFO.

The losses of the waterbodies and watercourses in the LSA could potentially alter benthic invertebrate drift into the Athabasca River. However, invertebrate drift from tributaries represents less than 1% of total drift in the Athabasca River. As a result, the overall effect is expected to be negligible.

Overall, the EIA concludes that with mitigation and compensation, there is no environmental consequence of the residual impacts on fish habitat on the Athabasca River.

Mitigations

A summary of mitigations for the PRMA are provided in Table 1.7-1 and include:

- Minimize effects of closed circuit operations by diverting natural streams around the mining area
- Design operational diversions and closure channels to provide for fish passage where required
- Implement a fish salvage program for fish habitats permanently lost
- Implement a transport and/or stocking program for effects of habitat accessibility
- Compensate habitat losses and alterations by developing appropriate compensation habitat to ensure the No Net Loss objective is achieved
- Develop fish habitat of equivalent or higher productive capacity
- Continue to participate in RAMP, CEMA, CONRAD and other regional initiatives to monitor water quality and to confirm performance of mitigations
- Design all stream diversions to provide fish passage and maintain connectivity with upstream watercourses during construction, operations and on closure
- Comprehensive monitoring program may include the assessment of streamflows, water levels and discharge rates, channel stability and morphology, water and sediment quality, littoral zone development, growth of aquatic vegetation as well as benthic invertebrate communities, fish populations and riparian zone vegetation

Fish Habitat Conceptual Compensation Plan

A habitat compensation plan was developed to address the impacts to fish and fish habitat associated with development activities in the JEMA and PRMA watersheds.

In JEMA, fish habitat losses would occur throughout portions of the upper Muskeg River watershed, including Wapasu Creek. The proposed developments would also alter some aspects of the JEMA –Phase 1 development, including Khahago Lake and the repositioned Muskeg Creek. In PRMA, fish habitat losses would occur throughout portions of the Pierre River, Eymundson Creek, Big Creek and Redclay Creek. The impacts of the Athabasca River and the direct habitat losses due to the construction of the bridge and water intake (for the PRMA project) have not been identified or included in this CCP.

The fish habitat compensation plan is developed with consideration of the “No Net Loss Guiding Principle” for fish habitat, to satisfy the requirements of Fisheries and Oceans Canada, under the Fisheries Act. Watercourse segments that would result in the HADD of fish habitat due to the JEMA and PRMA are identified.

Several habitat compensation options were evaluated with respect to developing the Conceptual Compensation Plan (CCP) for the Project. The selected option would consist of constructing riverine and lacustrine compensation habitats, including a compensation lake in the lower Big Creek and lower Redclay watersheds (Redclay Compensation Lake) to provide year-round habitat for a species assemblage similar to those species affected by the Project. This option was selected because it is on the Shell lease area, has the potential to provide large habitat gains, and has design flexibility in terms of overall size and configuration. Included with the design of this lake is the construction of natural geomorphic channels that incorporate fish habitat features and facilitate fish passage from the Athabasca River to the Redclay Compensation Lake and upper reaches of Big Creek watershed.

Redclay Compensation Lake would be constructed immediately adjacent to the PRMA's Raw Water Storage Facility. The lake size would be approximately 4 km^2. The compensation lake would be constructed to provide habitat diversity in the lake (varying gradients, substrate types, and depths). Design features would include spawning, nursery, rearing, feeding and overwintering habitats to support self-sustaining fish populations. It would provide suitable habitat for a proposed fish community consisting of walleye, lake whitefish, cisco, northern pike, yellow perch, burbot, white sucker, longnose sucker and several forage fish species. The compensation lake would be connected to upstream and downstream riverine habitat.

In addition to the above lake design, two channels would be constructed as a part of the lake development to provide riverine compensation habitat. The lake outlet channel would be constructed to connect the lake to the Athabasca River and would be 15 km in length. A diversion channel would be constructed to connect the lake to the upper reaches of the Big Creek watershed and would be 13 km in length. Where appropriate, both channels would be designed to provide riverine spawning habitat for select species that prefer flowing water with rocky substrate for spawning (e.g. suckers). Permanent closure channels associated with the project would be geomorphically designed to provide fish habitat and fish accessibility and would be included as compensation in the detailed No Net Loss Plan.

The development of the compensation lake habitat would occur at the start of the project. Development of the diversion channel compensation habitat would be variable, but would generally occur later in the project life as most are closure channels. The first losses of fish habitat would occur in 2016, with the initial diversions of the PRMA. Other impacts would occur later, including losses in the Muskeg River, would start in 2046.

Discussion

The impact predictions for aquatic health within the LSA and RSA were based on conservative modelling and multiple lines of evidence, including predicted levels of while effluent chronic and acute toxicity and concentrations in water and fish tissue. Uncertainty analyses indicated that the water quality predictions were robust, particularly for whole effluent toxicity. Confidence in the overall predictions was considered high. Those metals for which low impacts were predicted were considered to be overestimated due to the conservative assumptions used to complete the assessment.

The predictions of the pit lake and Raw Water Storage Facility water quality were also considered robust, with a number of adaptive management practices available to ensure suitable water quality within the lake.

The level of confidence in the fish habitat and fish abundance predictions is moderate to high. There is a moderate to high level of confidence in the Base Case information, assessment techniques and proposed mitigation measures. Decreased confidence is found in the analytical techniques that include estimates of changes in habitat areas and the effects of changes in flow on fish habitat. This analysis was doing based on estimates, which are preliminary and based on historical and field measurements. A more detailed assessment of habitat changes would be made during the development of the detailed No Net Loss Plan in the future.

The level of confidence in the predictions made for fish diversity is moderate, as there is moderate confidence in interpreting the specific effects of habitat changes on habitat diversity. The assessment is based primarily on professional judgement regarding how habitat changes translate into specific effects on diversity.

Shell is committed to monitoring and providing compensation for the Project impacts, and as such, the confidence of the proposed mitigation and planned compensation is high. There is high confidence in the sediment and erosion controls. Overall, the CPP is predicted to have a high probability of success. The Redclay Compensation Lake and closure channels will be designed to provide habitat that is predicted to provide a net gain in productive capacity.

The level of confidence in predictions for fish and fish habitat on the Athabasca River is moderate to high. There is moderate confidence in the Base Case information and assessment techniques, and high confidence in the proposed mitigation and compensation measures. Shell has also committed to operate under Phase 1 of the Water Management Framework for the Lower Athabasca River while it is in place, and Phase 2 when it is developed.

Key Concerns

Several key concerns were identified with regards to the Fish and Fish Habitat / Aquatic Health components during the review. These include:

8. <u>Unclear fish habitat impacts due to thermal changes in Eymundson Creek.</u>

As mentioned in the surface water quality section, the release of waters from a pit lake in 2049 would result in relatively large changes in temperature in Eymundson Creek during the spring, summer and fall. For example, the mean monthly temperature for May would decrease almost 3 ˚C, from 5.8 ˚C in the pre-development scenario to 3.1 ˚C. The mean monthly temperature for September would increase almost 6 ˚C from 3.6 ˚C to 9.4 ˚C. Despite these large differences, the impact rating on fish habitat is considered negligible. While the EIA states that thermal equilibrium would quickly be achieved, no mention on the actual extent of the impact was provided. Only mitigations for impacts of the polishing pond releases, which would result in relatively small changes (a maximum change of 0.3 ˚C) were discussed. No mitigation for pit lake discharges were mentioned, despite this being the major impact on temperature.

➔ **Recommendation:**

Please provide more information on the extent of the thermal changes to Eymundson Creek and the potential impacts on fish habitat, including stress and/or avoidance behaviours.

9. <u>Effects on fish habitat are not extrapolated to fish abundance.</u>

While the assessment discusses the impacts on fish habitat as a result of several impact pathways and linkages, these potential changes are not extrapolated to the implications for fish abundance or populations. For example, there is no discussion of the implications on fish abundance as a result of the elimination of many of the LSA watercourses and waterbodies, and replacement by diversion channels. Because some of these channels will be temporary, they will not be built to the same specifications as closure diversion channels would. Presumably there would be some impact on fish abundance within the LSA until permanent, self-sustaining channels were constructed and capable of supporting fish populations. Similar concerns exist for impacts of decreased fish passage and accessibility on fish abundance.

➔ **Recommendation:**

Please discuss the potential impacts of changes to fish habitat on fish abundance and local and regional fish populations, where appropriate.

10. <u>No determination of productive capacity of fish habitat.</u>

The compensation of losses to existing fish habitat is based on the productive capacity of fish habitat. However, the productive capacity of fish habitat has not been determined for any of the habitat losses proposed as a result of the project. Shell states that this will be completed as part of the detailed No Net Loss Plan. However, until the productive capacity of all the existing and compensation habitats have been calculated, it is impossible to determine whether the compensation efforts proposed are comparable, appropriate and adequate for the project.

Shell states that a lake with an area of 4 km^2 is sufficient to provide adequate compensation. The lengths of the compensation channels would be 13 and 15 km. Generally, this project would require at least a 2:1 habitat compensation ratio, but no information is provided to document that the proposed habitat would meet this ratio. Despite this, Shell states that a net gain in the productive capacity of available fish habitat would occur with no predicted adverse impacts on fish habitat. However, without the detailed habitat unit information, it is impossible to determine whether the goal of no net loss of productive capacity will be achieved.

In addition, without species-specific habitat losses, it is not possible to determine if the project would exacerbate the stresses and population declines already experienced by several fish species in the region.

➔ **Recommendation:**

Please provide the detailed No Net Loss Plan when available, including the productive capacity of the habitat losses and compensation habitat. Provide all information necessary to prove that the compensation habitat will provide at least a 2:1 compensation ratio. Provide species-specific habitat losses, and discuss these impacts on fish species currently experiencing stress and population declines in the region.

11. Lack of compensation riverine habitat.

As mentioned, the CCP does not determine the proportion of riverine or lacustrine habitat units lost or created as a result of the project. Presumably, the majority of fish habitat losses are from riverine habitat, however, the CCP can be assumed to consist primarily of lacustrine habitat (the Redclay Compensation Lake). More effort to creating riverine habitat may be warranted. While opportunities for compensation in the form of newly created riverine habitat or enhancement of existing habitat may be limited in the region, this was not discussed in the CCP. No explanation is given for why more riverine habitat cannot be recreated locally or enhanced regionally in order to replace lost habitat with like habitat. At the least, there should be a discussion of the issue within the report.

➔ **Recommendation:**

Please discuss the lack of riverine habitat and the regional implications of this and other compensation plans that focus almost entirely on lacustrine habitat compensation.

12. Little information on the timing of compensation.

Shell states that the compensation lake would be constructed early in the project and that the compensation channels would generally be constructed later in the project, but no dates are provided. As a result, it is unclear how the compensation habitats would be developed in a timely manner to provide available fish habitat. While construction of the compensation lake may occur at the same timeline as the beginning of the existing habitat losses, the former is not the same as providing habitat actually capable of supporting fish. There would be a timelag between construction and actual use by fish. This timescale differences and the potential impacts on local fish populations are not clearly outlined in the CCP. Regional impacts were not discussed, although this same timelag issue exists for all mine developments.

➔ **Recommendation:**

Please provide details regarding the timing of the construction of compensation habitat, and when they would be capable of supporting fish and other aquatic organisms as part of a sustainable and diverse ecosystem. Discuss the local and regional implications of this and other compensation plans that will not provide compensation habitat at the same time as habitat losses.

Appendix D-8

Shell Canada – Jackpine Mine Expansion – Environmental Impact Assessment Report. Review for Athabasca Chipewyan First Nation, February 17, 2009, by Brenda Miskimmin, Summit Environmental Consultants Ltd.

Shell Canada - <u>Jackpine Mine Expansion</u>
Environmental Impact Assessment Report
Review for Athabasca Chipewyan First Nation
By:
Summit Environmental Consultants Ltd.
17 February 2009

1.1 Introduction - Hydrology

The Environmental Impact assessment (EIA) evaluated, modeled and predicted potential impacts to water quantities in the local and regional study area of the Shell Jackpine Expansion Project. The expansion is one of a number of oil sands mines being developed in the vicinity of the Muskeg River and Kearl Lake. The EIA considers the pre-development hydrologic conditions compared to base case (all existing and approved projects), as well as the application case (base case plus the current project) during the life of the project through construction, operation, closure and far future scenarios.

The goal of this review was to evaluate the basic hydrological aspects of the EIA. While some data were used for directed calculations, it was beyond the scope of this review to examine mathematical models and resulting predictions in detail.

1.2 Overview - Hydrology

This review was undertaken due to concerns about surface water quantities withdrawn, consumed, closed circuited and diverted for the Shell Jackpine Expansion Project (also called Jackpine Expansion Mining Area, JEMA).

The first of two EIA documents (December 2007) provided the majority of information about this project. An update document (May 2008) provided minor additional information following a request to separate the JEMA from the Pierre River Mine Application (PRMA). With respect to hydrology, minimal changes were presented in the update, and included changing the snapshot years slightly, and removing the Fort McKay reserve lands from the mineable area.

Most of the predictions are based on a hydrologic model (HSPF) used in many other EIAs. While all of the data relating to increases or reductions in flows are available in the various appendices, the hydrologic information presented in the main text of the EIA is carefully selected to highlight relatively small changes that would be caused by the project. The use of generalities and *annual* mean flows (as opposed to flows at shorter timescales, e.g. seasonally, monthly or daily) describe impacts as being controllable and minor.

1.3 Hydrology

1.3.1 Overview

The three main surface water resources that are impacted by this project are:

- Muskeg River mainstem and several tributaries;
- Kearl Lake; and
- Athabasca River.

Additional water from the Athabasca River will be required for JEMA. The project requires 18 million m^3/yr (0.6 m^3/s) of water from the Athabasca River in addition to the requirements of the original Jackpine Mine (63.5 M m^3/yr in Stage 1). Shell plans to make an application under the *Water Act* to increase its allocation to 81.5 M m^3/yr (mean of 2.6 m^3/s) for the life of the mine (Vol 1, p.10-9 and Figure 10-1).

The landscape of the JEMA area will be changed by this project. In the far future, the JEMA area will have 124 km^2 of open water areas (mostly pit lakes) compared to the pre-development open water areas of 15 km^2.

The federal and provincial Water Management Framework (WMF) for the lower Athabasca provides some expectation for the protection of instream flows should any natural or unnatural event result in flows below an assigned threshold. The EIA describes an overview of instream flow needs restrictions that could occur under predicted future scenarios. Mitigation for minimizing the use of Athabasca River water includes using recycled project water, storage of 30 days of raw water (Vol. 1, Introduction), and following any water withdrawal limits prescribed by the water management framework.

Shell proposes to mitigate seepage from external tailings disposal areas and other in-pit disposal areas by a system of perimeter ditches and pumps, use of low-permeability formations (such as dykes), and the use of wetlands and pit lakes at closure. The planned closed-circuiting of process water that will cause flow reductions in natural streams, will also serve to reduce the discharge of contaminants downstream. Seepage volumes are predicted to be minimal.

1.3.2 Discussion and Assessment Review

The cumulative impacts to hydrology that will be caused by JEMA and other projects in the area are significant. Watercourses and water bodies will ultimately bear little resemblance to their pre-development condition.

JEMA gradually removes large portions of the Muskeg River mainstem and its watershed, diverting many tributaries around the mine in pipelines and ditches. In the early years, flows and suspended sediment concentrations in the Muskeg River will increase as surface areas are cleared and dewatered. As the project expands, open water flows in the Muskeg River will be steadily reduced. When watershed areas are lost through closed-circuiting or diversion, downstream flows are reduced, causing fish and other biota to lose their habitat and local people to lose a valuable resource.

Around 2044, JEMA will replace the upper reaches of the Muskeg River mainstem with a pipeline (or possibly a ditch). In the final stages, approximately 22 km of these reaches will be replaced by a massive end pit lake. The levee around Kearl Lake will be among the changes making the lake inaccessible, unnatural-looking and of little use for traditional land activities. Average flows in the Athabasca River will be reduced in all seasons related to cumulative losses from all projects in the regional study area.

Kearl Lake will be altered by the replacement of its natural outflow (Muskeg Creek) with an outflow channel, construction of an adjoined compensation lake (associated with Imperial Oil's mine), and increased flows from other diversions. The lake, which has been of high spiritual value for generations of local people, will be completely surrounded by oil sands mines by the 2049 snapshot indicated in Figure 2.6-7 of the EIA. The vegetation-rich natural shoreline will be replaced by a manmade levee to prevent flooding of project areas caused by the re-direction to the lake of many tributaries that naturally flowed elsewhere.

Flows in the Athabasca River and delta will be impacted cumulatively by both non-oil sands and oil sands users. Shell indicates that of the total predicted future cumulative annual *average* water requirement of Athabasca River water of 22.2 m^3/s, 16.3 m^3/s is expected to be for oil sands projects alone, with 16% (2.6 m^3/s) of the oil sands demand coming from JEMA.

With the scale of change described, the mitigation steps presented are insufficient to offset the impacts. Furthermore, the reliance on RAMP for monitoring falls short of the level of monitoring that should be required for the project. There is no guarantee that RAMP will not change its sampling stations or protocol related to financial or other reasons beyond the control of Shell. Furthermore, RAMP's program is not designed to monitor project-specific changes to surface water.

Shell was thorough in tabulating and mapping changes to surface water quantity although the discussion tended to use examples where small changes are predicted. Shell's overall description is that the project would cause a few small changes in flows, water levels will not be an issue, and mitigation would adequately reduce residual effects. Closer scrutiny revealed future hydrologic scenarios that may be very different than pre-development ones.

1.3.3 Key Concerns

Several key concerns were identified with regard to hydrology during the review. These include:

1. <u>Mainstem Muskeg River watershed reductions and flow losses</u>

Shell makes it clear that the watershed and upper mainstem of the Muskeg River will be incrementally removed for the application case. For example, the watershed area contributing to runoff at Node M3 (mouth) will be reduced from 1,475 km^2 to 890 km^2 by 2049 (Table 2.6-9), a reduction of 40%. At the same time, open water flows at Node M0 (Stanley Creek confluence) will be reduced by 31%, with the watershed area being reduced by 52% at that location (Table 2.6-8). These would appear to be significant impacts, but are not described as such in the EIA or the update even though they are among the parameters listed under Effects Analysis (p. 6-291, Vol. 4B; December 2007).

➔ **Recommendation:**

ACFN requests that Shell re-examine all predictions made in the updated tables (2.6-7 to 2.6-11, Update), and provide an interpretation and assessment of the significance of future cumulative changes predicted to be greater than 10% over pre-development.

2. Kearl Lake water level changes

Table 6.4-13 (p.6-300) describes 15-22% increases in long term water levels in Kearl Lake. For a lake with a fairly large surface area to volume ratio (shallow, with gradually sloped littoral areas), an increase in *mean* water level of 50 cm (1.5 ft) is substantial. Without the planned levee, the surface area would be at times much greater than normal and would inundate project areas.

➔ **Recommendation:**

(a) Describe possible options that were considered for preventing large increases in water level in Kearl Lake, and

(b) Provide justification for the adopted design with a levee that causes a loss of the natural shoreline of Kearl Lake.

3. Cumulative Impacts to the Athabasca River and Delta

Shell discusses changes in water depths and flows in the Athabasca River, but does not discuss the effect of cumulative changes in water depths on the Athabasca Delta. Changes in depth and flow affect the delta and reduce flushing of side channels and perched water bodies. Changes to the delta directly affect residents of that area.

➔ **Recommendations:**

a) Extend the Regional Study Area (RSA) for surface water hydrology from Embarras Portage to the inflow of Lake Athabasca (i.e. encompass the delta),

b) Given that industry was directed under the WMF to reduce water withdrawals when the Athabasca River entered the "yellow zone" in January, 2009, what is Shell's plan for water storage and use when restrictions are imposed in the future (including beyond 30 days planned storage)?

b) Shell should commit to ACFN that they will abide by the lower Athabasca River WMF restrictions, notably during low flow periods.

4. Significant Increase in Open Water Areas

Pit lakes are a major component of the planned future landscape for the area (increasing open water areas from 15 km^2 to 124 km^2) under the application case. Shell assumes that water from the pit lakes will be suitable and available for discharge downstream. No company has yet addressed a scenario where pit lakes do not function to biodegrade contaminants in a timely manner as planned.

➔ **Recommendation:**

What viable options are planned to reduce the reliance on pit lakes in the closure landscape, and to guarantee future adequate clean water flows for the Athabasca River and its tributaries?

5. Monitoring program and research plans not described

One of the approaches of the assessment was that Shell would develop a surface water hydrologic monitoring program and identify management and research plans to ensure the feasibility of the proposed design and mitigation measures (Section 6.4.2). This was not included within this EIA. Reliance on regional committees such as RAMP is insufficient for monitoring and research due to the lack of project specificity, and lack of control over the long-term plans of outside organizations.

➔ **Recommendation:**

Will Shell commit to provide ACFN with the opportunity to review and make recommendations about the hydrologic monitoring and research plans for all phases of the JEMA?

1.4 Conclusions

This project and other oil sands projects in the area will significantly impact the local hydrology of the Muskeg River, smaller local rivers, and Kearl Lake. They will also contribute to cumulative impacts on regional hydrology including the Athabasca River and delta. Pit lakes that are many times the size of existing surface water bodies will be among the local changes that will occur. Mitigation plans are not well described, and monitoring plans are barely mentioned. A number of commitments to ACFN by Shell are recommended for future environmental agreements.

Appendix D-9

Shell Canada Limited Jackpine Mine Expansion Project and Pierre River Mine Project – Environmental Impact Assessment Report - Review for Athabasca Chipewyan First Nation, October 2008, by Dr. Karen McDonald

Shell Canada Limited
Jackpine Mine Expansion Project
And Pierre River Mine Project

Environmental Impact Assessment Report
Review for Athabasca Chipewyan First Nation

By:
Dr. Karen McDonald
October, 2008

Introduction

This review focuses on Volume 3 of the Environmental Impact Assessment dated December 2007 specifically the air quality components.

Overview

Shell Canada Limited has included two interdependent developments in this one application making the breadth of the resulting impacts much more understandable and this open approach is well appreciated. The model selection (CALGRID) and approaches employed in the air quality section are well established and appear well performed by the proponent based on the information supplied. There is little to no concern with the mechanics of the modeling and the maps produced.

In addition, Shell Canada Limited is commended for addressing the encroaching approach to environmental limits in a more judicious manner than other developers. However, it simply does not go far enough towards addressing concerns with the evaluation of significance process since the provincial and national objectives continue to be used as pollute-up-to levels rather than as tools for environmental management towards the goals of health and ecosystem protection. This is particularly disconcerting given the northerly encroachment of this development which necessarily means that the Keeping Clean Areas Clean management policy needs to be applied.

Shell also is clearly committed to utilizing the work of the CEMA working groups and for this section especially that of the NOx-SOx Management Working Group. The literature information and expert conclusions from efforts on sulphur and nitrogen deposition have been appropriately applied and clearly presented. It is appreciated that Traditional

Ecological Knowledge (TEK) is considered. This association is going through some difficulties with membership and funding, yet the results of the work to-date are useful and enlightening about regionally-specific issues. However, it is unfortunate that the only suggested management strategy is to participate in these groups.

Secondary air pollutants continue to be under-studied in the EIAs. Ozone and fine particulate matter are complex issues to be sure, but there is current technology to address these issues. Certainly, secondary PM due to organic compounds has not been addressed at all while the emissions and concentrations of organics are demonstrated to be increasing. While visibility is included in the Terms of Reference, the proponent has not considered regional haze at all and minimally considered plume blight.

Shell Canada Limited addressed climate change in Appendix 3-4 of the EIA but this important issue is not included in the summary to the EIA. The potential for impacts to the project itself have been considered. As with all recent EIAs from the Oil Sands Region, there is little incentive to further reduce or mitigate greenhouse gas emissions to a level that is technologically and economically achievable.

Air Assessment Approach

Approach Review

The approach described in Section 1.2.3 to integrate the two applications is much appreciated. It is clear that these projects are related spatially (Figure 1.1-1) and temporally (Table 1.3-1) and performing the impact assessment of them together is reasonable. It is noted that the development of the Fort McKay lease is not included in this assessment.

The proponent has made it specifically clear in Section 1.3.2 that they are including information from the regional processes through CEMA and WBEA within this assessment. This is also commended given the investment into those efforts on behalf of many stakeholders. However, several key stakeholders no longer participate in the regional initiative and it is unclear how they are to be consulted or represented

The impact scenarios described in Section 1.3.3 are those typically selected: Base Case, Application Case, and Planned Development Case.
As in past assessments, it is clear that the Base Case is far from the current conditions and, therefore, does not reflect the changes that communities may expect from the situation they experience at the present time. Hence, the Application Case necessarily incrementalizes the changes to come from the Oil Sands Region developments as a whole minimizing the perceived impact to someone unfamiliar with the process.

The key questions raised in Table 1.3-3 demonstrate that the impacts from the air quality assessment will be carried into the assessments of ecological and human/wildlife health. One component to which air quality information is not clearly conveyed is the assessment of visual aesthetics. Since the spatial limit to this component is only 20km, at best direct emissions are considered as visible plumes, but regional haze due to enhanced particulate concentrations are not. In addition, the effects of ozone on terrestrial and wetland systems is evaluated, but the assessment does not undertake a modeling scenario including ozone.

The impact descriptions and numerical scorings in Table 1.3-4 are those typically employed. There is no concern with the numerical selections attached to each of the criteria. The concerns arise in the subjective decisions on what is deemed of negligible, low, moderate or high magnitude of impact.

Section 1.3.7 describes the use of Traditional Ecological Knowledge in the assessment. This is valued and valuable.

Key Concerns

Several key concerns were identified with regards to Air Assessment Approach during the review. These include:

6. The three assessment cases do not describe the changes that local community members can anticipate from what they experience today.

Because all three assessment cases are projections to a future condition, there is no way to compare the current existing situation (including monitoring data) with the modeling done for the case studies in the EIA. People living with the changes in the region are not readily able to extrapolate from today's situation to the Base Case and certainly not to the Planned Development Case. The best approach would be to perform another model case of the current situation; it is appreciated that this is done as part of the model evaluation in Appendix 3-8. Another option would be to consider a small change in Table 1.4-1 (and Table 3.3-1) that would provide some assistance to people in the region so that they may compare and better understand the time line of the future situations.

➔ **Recommendation:**

To assist in providing clarity for the people living in the region, please identify the status of projects in the Base Case descriptions in Table 1.4-1. That is, to the ability that you are able, indicate those projects that are presently operating and at what air emission capacity, those that are under construction and when they are expected to begin operation and at what proposed air emission capacity, and those that are approved but pending development with the proposed air emission capacity.

7. The only mechanism for managing air quality in the region is to conform to requirements of the local air working groups.

Of course, it makes sense that any proponent in the region would meet the requirements set out by the local air working groups through the Cumulative Environmental Management Association (CEMA) as described in Table 1.7-1. This agency has added significant information to the capacity for decision-making in the region. However, it is also going through some substantial challenges with membership, funding and related issues. Specifically, key environmental and First Nations groups are no longer participating in the processes. It is not clear, therefore, how or if any needs from these groups will be addressed by the proponent.

➔ **Recommendation:**

Clarify if and how needs of groups not participating in CEMA will be identified, addressed, and managed by the proponent.

Summary of the Environmental Impact Assessment

Summary Review

In Section 2.2.2, it is not a surprise that all 129 parameters assessed are either classified as "negligible" or "low" environmental consequence. The surprise is that in the paragraph following this statement it is stated that "predicted PAI in the Base Case already exceeds the guidelines". These two statements appear to be mutually exclusive. In addition, the project is expected to increase the PAI in 18 of the 20 grid squares.

The regional emissions summary in Table 2.2-1 demonstrates that the dominant emissions with these developments are the organic compounds represented by CO and VOC. Although the magnitude of NO_x increase is greater than 12 t/d, this represents a smaller percent change than the increase in SO_2 at 7.8 t/d.

Consistent with past EIAs, this document removes any consideration of the ambient concentration changes that are within the developed areas. This minimizes the potential change as the total developed area increases with each new development stretching the affected area further. As the maxima within the developed zones increase in magnitude, the extent of the concentration or deposition contour lines broaden as the pollutants disperse.

Table 2.2-2 provides the maximum concentrations outside of the developed areas and further without including the eight highest predictions. It appears that there could be some double removal of higher conditions that needs to be explored. It is not clear if these eight highest are contained within the developed areas removed from consideration or if a further eight of the highest values outside of the developed areas have also been removed. Regardless, the 25-hour and annual NO_2 maxima remain above the Air Quality Guidelines.

The assessment of air quality employs a comparison with Alberta guidelines and the Canada-Wide Standard for $PM_{2.5}$. This comparison does not comply with the principle of Keeping Clean Areas Clean as laid out in that standard for areas that are not covered by the standard (urban areas of greater than 100,000 people). It is generally acknowledged that the CWS are not based only on health but also include economic considerations.

Key Concerns

Several key concerns were identified with regards to the Summary of the EIA during the review. These include:

1. <u>The mechanism for removal of developed areas and maximum concentrations from the assessment is unclear.</u>

Despite repeated statements regarding this concern, the developed areas are excluded from consideration of impact analysis in this EIA as well. The size of the area designated as developed increases and removes more land area from discussion with each new development. The extrapolation of this practice leads to the unacceptable conclusion that any developed areas of Alberta are not subject to the requirement to meet standards and guidelines. Certainly urban areas are "developed" areas as well and have been shown to have some comparable emissions, but are expected to meet the guidelines within their boundaries. Further, Table 2.2-2 stipulates that the eight highest modeled concentrations are also removed from consideration. However, this raises the questions about whether the eight highest are contained within the developed areas and removed anyway or if a further eight highest values are removed from outside of the developed areas. If it is the former, then there is no controversy. However, if it is the latter, then there needs to be some discussion about the appropriateness of this further elimination of cases of maximum values. The eight highest values are removed from consideration in the Alberta Modeling Guidelines because of concern that there can be errors in those values, but if the eight highest values are not within the developed areas already removed, then this concern is not valid and those points should be included.

➔ **Recommendation:**

Clarify that the eight highest values are contained within the developed areas already removed from consideration in the impact assessment. If they are not within this area, then please provide a re-assessment of the air quality including those eight values.

2. <u>Comparison with guidelines and standards does not address environmental health questions or Keeping Clean Areas Clean.</u>

Comparison with existing standards and guidelines is an important part of any assessment. However, in Alberta, these are levels have been identified by stakeholders as concentrations that are not pollute-up-to levels. The provincial government and supporting bodies such as CASA have all employed this protective approach. In addition, it is stated in Section 2.4 that the acute health risks due to air emissions are to be compared with health-based guidelines considered “protective of the most sensitive individuals”. The section then continues to compare maximum concentrations with the CWS – a standard that is not only health based but also includes economic considerations. Lastly, this province has been a national leader in the development of the concept of “Keeping Clean Areas Clean”. It is critical that this commitment be respected and maintained in order to protect health and ecosystems in these areas.

➔ **Recommendation:**

Consider a reassessment of the acute inhalation health risks employing a health-based air quality standard that is considered protective of the most sensitive individuals.

Air Quality

Overview

Generally, this air quality assessment is extremely clear and well-performed. The work from the appendices is linked well with the assessment itself. There is little to no concern with the methodology of the modeling or data analyses performed.

There continues to be concern with the assessment of the impact criteria and the classification of the residual effects. This proponent has made a tremendous improvement of some other recent assessments by recognizing that reaching the Alberta air quality guidelines (or Canadian desirable objective) does result in an increase in the magnitude classification (low-to-moderate) instead of having the separation for negligible-to-low being at the guideline. This change described in Table 3.2-13 is greatly appreciated. Employing the Canadian acceptable air quality objective at the moderate-to-high limit is also a reasonable step forward. However, given that the Alberta government has a goal of staying below its guidelines, this still does not seem to be a deep enough change.

The TEK integration with the air quality in Table 3.3-2 is appreciated. However, none of the references to the text of the assessment actually point to the air quality section but rather only to the impacts sections. In addition, this component is incorporated in the Base Case assessment, but the people living in the region have no way to comment on the Base Case as this is a future condition perhaps never reached. This knowledge may be better compared with the model evaluation scenario and existing air quality.

In the Application Case impact analysis Section 3.4.3, SO_2 is expected to increase in emission by 7.88 t/d but decrease in concentration at all scales in Table 3.4-5. This seems counter-intuitive and is explained through a change in emission redistribution. Yet, these addition tonnes must go somewhere in the sulfur budget for the region. Table 3.4-6 presents the comparison for NO_2

predictions. The issue of greatest concern is the exceedence of the 24-hour NO_2 AQO outside of the developed areas that increases in size by 8 hectares due to the project. For the VOCs, acrolein, benzene, cyclohexane, ethylbenzene and xylenes are all resulting in a “low” environmental consequence based on a change in magnitude due to the project.

The evaluation of $PM_{2.5}$ predictions is based on achievement of the Canada-Wide Standard. This is inadequate given the increasing body of literature that indicates this is a pollutant with no threshold for impacts to human health and that different components of PM have varying impacts on health. In addition, there is no evaluation of organic PM at all since only the CALGRID algorithms were used to assess secondary PM (sulphates and nitrates only). Also, regional visibility degradation due to PM concentrations has not been included in the assessment.

The evaluation of the PAI remains the most concerning. The area due to exceed the 1.0 keq/ha/yr level due to the project alone excluding the developed areas (defined as the Planned Development Area plus existing and approved complexes) is still another 475 hectares on top of the Base Case 3,887 hectares. This is listed as a 12% increase not including the land to be developed in the PDC. In the Ecological Receptors Section 5.5, the impact classification is ranked as negligible though this is difficult to understand given the PAI inputs over large areas of the domain.

Ground-level ozone is weakly evaluated in Section 3.4.5 and an environmental consequence ranking is provided. It is appreciated that Shell accepts that it is not reasonable to rank as negligible an issue that has such a high level of uncertainty as has been done in past EIAs. Nonetheless, although the issue has been raised in every impact assessment over the past decade at least, very little effort has been placed on the understanding and development of a regional conceptual model and resulting physical models to evaluate the oxidizing potential of the air in the region. This remains an issue that requires regional attention to remove this limiting perspective from EIAs.

While Section 3.4.7 clearly indicates that there is little risk of foul odour experiences within Fort Chipewyan yet some of the other receptor points at the cabins can expect foul odours from 2-9% of the time. It is appreciated that no impact classification is given for this, but when integrated with the TEK information, perhaps this issue should be given more thorough consideration.

Section 3.5 outlines the Planned Development Case. It is emphasized that this case contains projects that are unlikely to proceed. However, the current pattern in environmental approvals and proposed infrastructure throughout the province do not support that. Many of the planned projects appear to be extensions of existing operations and so it is highly unlikely that these will be denied approval to ensure effective utilization of the resource. Therefore, this is rather a probable scenario. Given that several of the environmental limits are already exceeded or are being encroached upon through the Base and Application Cases, it is unclear why there is further consideration of more of these emissions without advanced mitigation plans. Specifically, regional annual NO_2 is expected to reach a "high" impact classification even within the conservative nature of the assessment and the forgiving magnitude classification. Acrolein and benzene are also given a "high" impact assessment. The proponent does not assess the impacts on the ecological receptors for the PAI under this scenario because the environmental consequence for the Application Case was negligible.

Key Concerns

Several key concerns were identified with regards to air quality during the review. These include:

1. <u>Magnitude classification levels do not reflect the goal of keeping air concentrations below the Alberta ambient air quality guidelines and Canada-wide standards.</u>

Shell has greatly improved on past assessments by using the AQOs as the low-to-moderate level instead of the negligible-to-low level. However, the evaluation of magnitude classifications still permits (and perhaps even encourages) emissions to increase beyond the AQOs by deeming the impact of doing so as only moderately of concern. Upon reaching the Alberta guideline, the magnitude classification should be "high" in order to demonstrate the commitment to staying below this value. In addition, it is not clear why there is no "moderate" characterization for the VOCs in Tables 3.2-15, 3.2-16, and 3.2-17 since a relative proportion of the single criteria could have been employed as an interim marker pending any future evaluation of these criteria.

➔ **Recommendation:**

To better identify which issues are approaching the environmental limits employed in the EIA, perform a reassessment of the environmental consequences employing the Alberta AAQO or CWS as the limit between the "moderate" and "high" rankings.

2. <u>Secondary pollutants and impacts continue to be weakly evaluated</u>.

The $PM_{2.5}$ assessment is weak based on the CWS value while exposures at some of the cabins are potentially very high as shown in the Appendix 3-9. Visibility degradation is not considered. The ozone evaluation is not performed at all due to uncertainties. Odour is not evaluated due to human interferences. The PAI air assessment is so far from the impact results in the ecological section that questions are raised on both sides of the work. These cases demonstrate that the difficult questions around secondary pollutants (PM2.5 and ozone) and impacts (visibility, odour, and acidification) continue to be poorly constrained in the assessment process.

➔ **Recommendation:**

Describe the current steps underway to support research and monitoring that will enhance the evaluation of impacts for those issues that are not able to be properly evaluated due to uncertainties and other challenges.

Climate Change

Overview

Section 3.4.8 provides the evaluation of greenhouse gas emissions based on information presented in Appendix 3-4. Although the introduction states that an impact assessment has been completed, there is no impact classification provided. It is stated that it is not possible to compare directly with other projects that have integrated mine and upgrading activities, but the Shell contribution is broader than just the mine sites in the Oil Sands Region and should include the upgrading activities in the Heartland Region near Edmonton for a fuller comparison. The potential for impacts to the project due to proposed climate scenarios are evaluated.

Assessment Review and Key Concern

➔ **Recommendation:**

Shell is asked to include all related operations in its consideration of increases in greenhouse gas emissions so that comparisons can be made between the operators in the region.

Appendix D-10

Wildlife Review of the Shell Jackpine Mine Expansion and Pierre River Mine Projects – Review for: Athabasca Chipewyan First Nation, May 2010, by Dave Westworth of Puma Environmental Ltd.

WILDLIFE REVIEW OF THE SHELL JACKPINE MINE EXPANSION AND PIERRE RIVER MINE PROJECTS, May 2010

Review for:
Athabasca Chipewyan First Nation

By:
Puma Environmental Ltd.

Introduction

As a part of its application for approval to expand its current oil sands operations, Shell Canada Limited (Shell) submitted an Application and Environmental Impact Assessment (EIA) for the Jackpine Mine Expansion and Pierre River Mine Project in December 2007. Supplemental information and EIA updates were provided by Shell for the combined project in March 2009. This update contained a revised assessment for yellow rails for the combined project (Environmental Consequence still rated as Negligible) and additional discussion of the effects of the JME on wildlife movement (Environmental Consequence rated Low). In May 2009, supplemental information and an EIA update was provided for the Pierre River Mine Project. This update included an update to the ecological health risk assessment based on additional information collected from the Jackpine Mine area (no changes to original conclusions) and an assessment of impact significance based on federal (CEAA) criteria (no Significant adverse effects predicted for wildlife). In December 2009, supplemental information and an EIA update was provided for the Jackpine Mine Expansion Project. This update contained information on the proposed construction of a dyke around Kearl (Muskeg) Lake and updated information on groundwater drawdown for the Jackpine Mine (impacts on wildlife due to both the dyke construction and increased groundwater drawdown were rated as Negligible).

The following document contains a review of wildlife issues and concerns related to these projects based our review of the above documents. The objectives of this review are to:

- Assess whether the EIA is based on adequate data
- Determine if the analysis and conclusions presented are scientifically sound

- Identify potential issues of concern for the ACFN and make recommendations

The primary purpose of this review is to assist ACFN members in understanding the risks that the proposed projects, together with other existing and planned oilsands projects, could have to regional wildlife populations. Based on information provided to us by the ACFN and through discussions with ACFN elders, we understand that access to healthy, free-ranging wildlife populations is fundamentally important to the traditional rights and culture of the ACFN. ACFN people are concerned about land use changes that affect their ability to harvest wildlife for food, clothing, medicine and commerce, or that may affect the health of animals and their suitability for human consumption. A secondary purpose of this review is to bring any concerns or deficiencies to the attention of regulatory agencies, to ensure that the interests of the ACFN are considered during the review of this application. And finally, it is hoped that this review will assist Shell Canada and their consultants in developing strategies to improve the environmental assessment process and further mitigate long-term, adverse effects of these projects to wildlife populations in the region and to the traditional rights of First Nations people.

Overview

The review attempted to identify specific issues related to the Jackpine Mine Expansion (JEMA) and the Pierre River Mine (PRMA). However, as Shell submitted the application for the two mines as part of a single application with a single EIA, it has proven difficult to distinquish between effects that are specific to either of these mine projects, or in some cases to the Phase 1 Jackpine Mine.

The EIA considers the following three development scenarios:

- Base Case – Includes existing and approved developments (Note that this is somewhat different that the conditions that exist at the present time since it includes projects that have been approved but not yet developed or fully-developed)
- Application Case – The Base Case plus the Project (JEMA and PRMA)
- Planned Development Case (PDC) – the Application Case plus other projects that are planned but have not yet been approved. This represents the Cumulative Effects Assessment (CEA). (Note that the PDC considers projects that had been disclosed by July 2007 and does not include any projects that may have been disclosed over the past two years)

1.2.1 Temporal and Spatial Boundaries

The application called for the start of construction on the JEMA to begin in 2012 and on the PRMA in 2010. Closure would begin in 2065 for the JEMA and in

2049 for the PRMA. The wildlife assessment considered three time periods – pre-development, full development and full closure.

The assessment considered both a Local Study Area (LSA) for assessing effects of the Project and a Regional Study Area (RSA) for the cumulative effects assessment. The LSAs for the two mines were limited to the development areas plus a narrow (up to 500m) buffer. The sizes of the two LSAs are reported to be:

- Jackpine Expansion (JEMA) - 18,348 ha (or 183.5 km^2)
- Pierre River (PRMA) - 21,136 ha (or 211.4 km^2)

A single RSA was used for the two mine projects. For this Project, the RSA is very large (2,277,376 ha or about 22,774 sq. km), extending east as far as Saskatchewan, south to the Clearwater River, west to the west side of the Birch Mountains and north as far as Poplar Point and the McIvor River. The report provides the following explanation for the selection of the RSA: *"The RSA boundary was defined with consideration of the following terrestrial resources:*

- *Ecodistrict boundaries;*
- *Geographic or topographic boundaries such as the eastern shoulder of the Birch Mountains:*
- *Defined woodland caribou habitat areas (e.g., Audet, Firebag and Steepbank caribou areas):*
- *Average distance of two moose home ranges from oil sands developments (about 26 km);*
- *Allowances for the major river systems (e.g., Athabasca and Clearwater Rivers) that act as natural study boundaries; and*
- *Inclusion of the community of Fort McMurray and other areas likely to expand in the future."*

Comments on Validity of Assessment Boundaries

We believe that neither the temporal nor spatial boundaries used in this EIA permit a meaningful assessment of the long-term effects of the proposed projects on wildlife populations in this area. In fact, one of the greatest failures of the CEA process as it is being applied in northeastern Alberta may be the approach that industry and government have collaboratively adopted to establish the analytic baseline for these assessments. These assessments estimate landscape and population changes against a 'Base Case' scenario. The Base Case is a regulatory or administrative reference point for an incompletely-defined, future point in time (the point at which all existing and approved projects will be in place). Using this baseline makes it very difficult for First Nations to understand what the Project is being compared to what the predicted changes actually mean. The predicted changes are meaningless from a wildlife standpoint if we do not also understand how much change has already occurred to wildlife populations and habitat in the region. Our opinion is that it is not possible to conduct a meaningful assessment of either project-specific or cumulative effects without establishing a relevant, pre-industrial reference point. We know that wildlife populations and ecosystems in the boreal forest are dynamic and that the species that exist there have adapted to changing conditions associated with climate, wildfire, disease and other natural factors. The point of a cumulative effects assessment should be to evaluate whether these populations are also able to withstand the man-made changes that are taking place or that are expected to take place on the landscape.

The size of the RSA and the criteria that were used to define it raise some important questions with respect to the effectiveness of the cumulative effects assessment for different wildlife species. The list of wildlife indicators vary widely with respect to home range size and movement patterns. Although moose have large home ranges, smaller animals such as beaver and Canadian toad do not. We do not believe that the 'one size fits all' approach used in this assessment meaningfully addresses effects on all of these species. Some of the criteria used do not seem to apply at all to the wildlife species being assessed for these two projects. Why was the RSA extended to include the Audet, Firebag and Steepbank caribou areas when woodland caribou was not selected as a KIR? Wildlife health risks from air emissions do not seem to explain such a large RSA, as the Terrestrial Air Emissions Effects Study Area (TASA), which the proponent states reflects "the furthest measurable extent of predicted potential impact for PAI, NO_2 and SO^2 emissions for the Base Case, Application Case and PDC", is much smaller than the terrestrial resources RSA (see Figure 5.5-1). Lands traditionally used by the ACFN and other First Nations were apparently NOT used as a criterion in selecting the wildlife RSA.

The spatial boundaries used are not meaningful for understanding the effects of the Project on affected wildlife populations. Analysis at the level of the LSA is not overly helpful because past experience has shown that virtually all land within these LSAa (except the narrow leaseline buffer) is heavily impacted by surface disturbance. This project is no exception. Not even major natural features such as the Muskeg River and the Athabasca River valley are spared from development. The boundaries for the RSA are not meaningful for many (perhaps all) of the species assessed. The large size of the RSA perhaps masks real cumulative effects that could be occurring. We note that the LSAs for both projects comprise less than 1% of the RSA, which increases the probability that the contribution of project-related effects will be assessed as 'negligible' under the effects assessment methodology used.

Although the process of selecting meaningful study boundaries and assessment reference points is complex, it is technically feasible. Intensive development in the oilsands region has occurred relatively recently (little development existed prior to 1970). Our understanding of ecological conditions in the region prior to the current period of intensive development is relatively good, as a result of surveys conducted by provincial government agencies, interagency research programs (AOSERP), university research, and baseline surveys and research conducted by Suncor and Syncrude during the early stages of oilsands development. Traditional knowledge can still be effectively used to define pre-development baseline conditions. Some elders can still speak knowledgeably of conditions in the region during the 1950s and 1960s. The Alberta Oil Sands Environmental Research Program (AOSERP), that conducted a broad range of research on the environment in the oilsands region during the 1970s and 1980s, prior to widespread development, provides an invaluable source of information on the area's ecosystems and wildlife populations. Models can also be developed to characterize the natural range of variation (NRV) associated with pre-development habitat conditions or wildlife populations in the region. Models developed for CEMA's Terrestrial Ecosystem Management Framework for the RM of Wood Buffalo (SEWG 2008) may provide a helpful starting point.

1.2.2 Wildlife Indicators

The EIA focuses on a number of Key Indicator Resources (KIRs) that have been identified by the Cumulative Environmental Management Association (CEMA). It provides a description of the baseline conditions and the potential impacts of the proposed project for each KIR. The wildlife species that were assessed (KIRS) were moose, lynx, black bear, fisher, beaver, barred owl, black-throated green warbler, yellow rail and Canadian toad. The list of KIRS includes several terrestrial species, several aquatic species, several species that depend on old growth forest and several species of importance to First Nations. The major oversight is the failure to include waterfowl or a waterfowl species (e.g., mallard) in the assessment, since geese and ducks (and their eggs) continue to be harvested by aboriginal people and some of the adjacent waterbodies (McClelland Lake, Kearl Lake, Athabasca River) are regionally or provincially important for waterfowl. The ACFN has expressed great concern over the effects of tailings ponds on waterfowl. Waterfowl that migrate through the oilsands region and may become exposed to tailings and process-affected water also pass through the Peace-Athabasca Delta, where they are consumed by local people.

1.2.3 Baseline Surveys

Various wildlife baseline surveys were conducted in the two LSAs during 2006-2007. The survey methods used are standard and were appropriate for these types of inventories. Although most of these surveys are considered adequate, there were some gaps in the survey coverage that should be noted.

SURVEY TYPE	JEMA	PRMA
Winter aerial ungulate	adequate	Northern end not surveyed
Winter track counts	adequate	adequate (note: surveys spread over 2 years – southern half in 2006, northern half in 2007)
Photographic surveys	adequate	adequate

Breeding bird surveys	Few plots within riparian zones of the Muskeg River	North half of LSA sparsely sampled
Owl call-back surveys	adequate	North end of LSA not surveyed
Bat mist netting	Few (only 1) sample points in riparian zones of Muskeg River	North half of LSA and riparian zones along the Athabasca River sparsely sampled
Waterfowl & beaver/muskrat aerial surveys	adequate	No surveys along streams (Big Creek, First Creek) in north half of LSA. Athabasca River was not sampled

The winter aerial surveys are effective primarily for moose. Smaller animals such as deer, wolves and lynx are occasionally seen from the air but ground surveys (track counts and photographic stations) indicate that these animals are more common than indicated from aerial survey results. The only survey method that provides information on bears is the wildlife cameras.

The baseline surveys show similar patterns of wildlife use to those seen in other surveys in the region. From the aerial survey and winter tracking surveys, moose appear to be more abundant in the JEMA than in the PRMA. Within the JEMA, most moose observations were in close proximity to the Muskeg River (Figure 5.3-1). Within the PRMA, most moose were observed close to the Athabasca River.

The baseline surveys strongly indicate that the presence of the Athabasca River and the Muskeg River affects wildlife use of these areas. Wildlife photographic surveys clearly show that most of the wolf, lynx and black bears recorded in the PRMA were along the Athabasca River (Figure 5.3-8 and Figure 5.3-12). Winter track surveys showed that marten and fisher made much more use of habitats adjacent to the Muskeg River (Figure 5.3-13).

1.3 Assessment Review

The EIA assesses the effects of the project on (a) wildlife abundance, (b) habitat loss, (c) wildlife movements and (d) wildlife health. Results of the assessment are summarized below and comments are made on the validity of the modeling results and impact predictions.

1.3.1 Wildlife Abundance

The EIA evaluated the effects of wildlife interactions with infrastructure, site clearing, removal of nuisance wildlife, increased collisions with vehicle and sensory disturbance on wildlife abundance. For the application case, the assessment predicts that residual impacts will be low for black-throated green warbler and negligible for all other species (moose, black bear, lynx, fisher, beaver, barred owl, Canadian toad). Impacts on yellow rail are predicted to be high in the LSA but negligible at the scale of the RSA.

For moose and black bear, Population Viability Analysis (PVA) was conducted to predict population responses of these species to planned development in the RSA. PVA is a modeling technique that can be used to predict changes in population size and the probability of population persistence based on changes in habitat availability. Results of the PVA indicate that moose populations are currently increasing in the regional study area and predict that they will continue to increase under the Application and Planned Development scenarios (Figure 32, Appendix 5.4, Volume 5 EIA). The models predict that the black bear population will also increase over this period of time, although the rate of increase is less than in the case of moose (Figure 34, Appendix 5.4, Volume 5 EIA). Cumulative effects on the abundance of these species were therefore rated as negligible.

These results conflict with the observations of trappers and other First Nations people who consistently report declining moose numbers in the region. They also conflict with results of another recent modeling exercise that suggests that the moose population in the region is declining. Modeling conducted in conjunction with the development of a Terrestrial Ecosystem Management Framework for the RM of Wood Buffalo (CEWG 2008) concluded that several terrestrial ecosystem indicators including moose, black bear, and fisher are already below their natural range of variation (NRV) and will continue to decline given expected rates of landscape modification.

1.3.2 Habitat Loss

The loss of habitat that will be associated with the development of these projects will be very large. Habitat loss is not only associated with the removal of the oil sand, as large areas of habitat will be removed for placement of overburden, external tailings ponds, water storage, and construction of roads and other facilities. When mining is completed these lands will be reclaimed. In many cases they will not or can not be reclaimed to the same type of habitat that existed prior to mining. The proponent uses habitat modeling to predict the long term changes in habitat that will result from these projects. Concerns we have with the accuracy of these predictions are discussed in a later section of this report.

The following paragraph summarizes predicted changes in habitat for three important types of wildlife habitat in the two mine areas - wetlands, riparian habitat and old-growth forest. These three habitat types account for much of the biodiversity in the region.

Wetlands

Wetlands provide important habitat for many species of plants and animals, including some species that are listed as being rare in Alberta. Loss of wetlands is an important conservation issue provincially, federally and globally. Both the Jackpine Mine Expansion and the Pierre River Mine project will result in extensive loss of wetlands. The December 2009 EIA Update report that the combined project (JME and PRM) will affect 20,967 ha of wetlands, including 13,814 ha that will be directly affected by clearing and construction and 7,153 of adjacent wetlands that will be affected by groundwater drawdown. It should be noted that areas that are predicted to be affected by groundwater drawdown do extend beyond the boundaries of the LSA. The report does not separate the overall losses that will be attributed to the two projects.

These are the net losses that are predicted after Closure and reclamation. Some wetland types, including wooded fens and bogs cannot be replaced through reclamation. End pit lakes may have some value as wildlife habitat but they will not provide the same type of habitat as the wetlands that currently exist in these areas. Loss of wetlands will affect many wildlife species, including the yellow rail, which the assessment predicts will experience an 80% loss of high quality habitat.

Riparian Habitat

Riparian habitat includes the forests, shrubland and wetland vegetation that occurs along the sides of creeks and rivers. Many studies have shown that riparian areas are important habitats for wildlife and traditional users often key on riparian areas to trap species such as beaver, mink, otter and fisher and to hunt moose. As discussed in other sections, riparian areas are also important buffers that maintain base flows and the water quality in creeks and rivers and help to maintain the quality of fish habitat.

Both projects will result in substantial loss of riparian habitat. The Jackpine project will result in the complete destruction of the middle reaches of the Muskeg River and some of its tributaries. The Pierre River project will result in loss of riparian habitat along the lower reaches of Pierre River, Asphalt Creek and Eymundson Creek, as well as sections of First Creek and Big Creek in the northern portion of the development area. Of particular importance will be the loss of riparian forest habitat along the Athabasca River from mine development and bridge construction.

The reclamation plan predicts that riparian habitat that will become established along drainage channels on the reclaimed minesite will eventually replace most of the riparian habitat that will be lost:

- Jackpine Expansion- Decrease of 66 ha (2%)
- Pierre River- Increase of 227 ha (13%)

The December 2009 EIA Update indicates that an additional 598 ha of riparian areas could be affected by groundwater drawdown (areas affected are not broken down by mine area). Because of the prescriptive method used to define the riparian zones along streams in the area, it is probable that the estimates of riparian habitat loss are not accurate. In this assessment, only ecosite phases and wetland types within 100m of a watercourse were considered as possible riparian habitat. In reality, the width of riparian zones is typically quite variable depending on topographic and hydrological considerations. Most scientists prefer a functional definition of riparian areas, such as the definition used by the Alberta Riparian Habitat Management Society : "*Riparian areas are the lands adjacent to streams, rivers, lakes and wetlands, where the vegetation and soils are strongly influenced by the presence of water*" (Alberta Riparian Habitat Management Society website). Along much of the Muskeg River for example, the riparian zone extends much more than 100m from the river, as indicated by the presence of willows and other wetland vegetation.

Old Growth Forest

Old growth forest provides important habitat for a diversity of wildlife species, including some species that depend on the availability of large diameter trees, snags and deadfall for nesting or denning. Animals that nest, den or roost in cavities depend on these old forests. These include mammals such as marten, fisher and some species of bats, as well as birds such as pileated woodpeckers and boreal owls. Although lynx prefer younger stands where snowshoe hares are plentiful for foraging, females select older forests with large woody debris for denning. Several sensitive bird species, including the northern goshawk, broad winged hawk, western tanager, black-throated green warbler, Blackburnian warbler and Cape May warbler, depend on old growth forest. Because of the frequency of forest fires, old growth forests are uncommon in the boreal forest of northern Alberta. Additional losses of old growth forest therefore threaten the biodiversity of the region.

Both the Jackpine and Pierre River projects will result in substantial loss of old growth forest:

- Jackpine Expansion Loss of 514 ha (52% of Baseline)
- Pierre River Loss of 710 ha (34% of Baseline)

Because it takes 100 to 140 years for forest to become old growth, effects of loss of old growth forest will extend long after project closure.

Effects of Air Emissions on Wildlife Habitat

In addition to potential effects of airborne contaminants on wildlife health, emissions from oilsands operations can indirectly affect wildlife by reducing the quality of their habitat. The effects of air emissions from the two projects on vegetation and wildlife habitat are addressed in Volume 3, Section 5 of the Application. The study area for the Terrestrial Resources Air Emissions Effects assessment (TASA) is much smaller than the area used for the aquatic resources assessment. The TASA encompasses 484,297 ha of land, an area that includes the footprints of all of the existing conventional oilsands projects (Figure 5.5-1). This boundary reportedly reflects "the furthest measurable extent of predicted potential impact for PAI, NO_2 and So_x emissions for the Base Case, Application Case and PDC".

The assessment focuses on lichens, which are considered sensitive to air emissions. Under the Base Case, the TASA contains 103,182 ha (21% of the study area) of woodland caribou habitat with high lichen food value. The western edges of the Audet and Steepbank caribou areas extend into the TASA. The results of the assessment show that within the TASA there is potential for direct, adverse impacts of air emissions on lichens, as well as on trees, shrubs, herbs and mosses. Under the Application Case, emission levels will exceed safe guideline levels for vegetation; however, the effected area is predicted to constitute a small proportion of the TASA (1,773 ha including 806 ha of high quality caribou habitat). The assessment concludes that the overall effects of the Project (both the JEMA and PRMA) on vegetation health (and wildlife habitat) are negligible. On this basis the proponent concluded that it was not necessary to conduct a cumulative effects assessment for this issue.

1.3.3 Wildlife Movements

The ability to safely move across the landscape to access required habitats is important for the survival of wildlife populations. The role of movement corridors is very well established in science and the effects of oilsands developments on wildlife movements is addressed in considerable detail in this EIA. Steps that were taken in this assessment to evaluate the effects of development on wildlife movements included baseline surveys of wildlife use along river corridors and computer modeling of changes in habitat characteristics that may affect wildlife movements. A modeling technique known as Linkage Zone Analysis was conducted to assess the extent to which habitat fragmentation and the presence of man-made features affected the ability of moose to move across the landscape. Wildlife movements are discussed in Volume 5, Section 7.6.3 of the EIA.

It is clear that both the Jackpine Expansion and Pierre River mine developments will have a significant effect on wildlife movements in the region. With respect to the JEMA, the assessment concludes that "*The removal of the upper reaches of the Muskeg River for the development of the JEMA in combination with the effects of neighbouring developments (i.e., Syncrude Aurora North and Aurora South Mines Imperial Oil Kearl Oil Sands Project, Shell Jackpine Mine – Phase 1, Jusky Energy Inc. sunrise Thermal Project) will create barriers to movement in the upper Muskeg River basin that cannot be mitigated until after reclamation*" (p 7-147).

The report also acknowledges that development in the region is affecting the ability of the Athabasca River valley to function as a regional wildlife corridor, noting that "*before reclamation, planned and approved projects north and south of the PRMA LSA on both banks of the Athabasca River (i.e., Canadian Natural*

Resources Limited Horizon Oil Sands Project, Albian Sands Energy Inc. Muskeg River Mine Expansion, Petro-Canada Oil Sands Inc. Fort Hills Mining Project) are predicted to adversely affect wildlife movement rates along the Athabasca River within the RSA" (p 7-147).

Although the EIA is less clear about the effects that the PRMA is likely to have on wildlife movements along the Athabasca River valley, there is reason for concern that the project will further restrict wildlife movements. Development will occur to within 250 m of the river, resulting in a long (over 7 km), narrow strip of habitat that could be perceived as a barrier by some wildlife species. Disturbance effects of the development will certainly extend more than 250 m from the mine and plant site, reducing the effectiveness of this 'wildlife corridor' (Shell used a 500m buffer around the rest of the LSA to account for possible effects to wildlife). To reduce the barrier effect of the Athabasca River bridge, Shell is proposing to design the bridge to be high and long enough to allow wildlife passage along both banks and will use fencing and vegetation planting to promote wildlife passage under the bridge.

Habitat Isolation and Loss of Connectivity

In Section 6 of the Terrestrial Environmental Setting Report, Golder Associates provide an excellent review of issues related to biodiversity in the oilsands region. The authors note that habitat fragmentation and isolation are important factors affecting biodiversity and comment on the potential role of riparian corridors in maintaining landscape connectivity:

> *In the JEMA LSA and PRMA LSA, riparian communities are potential corridors linking the adjoining landscapes at the regional scale. Wildlife studies along the Athabasca River and major drainages like Muskeg River indicate that ungulates and carnivores make use of these areas as habitat and corridors for movement (Section 5.6.3).*

We agree with these authors that riparian corridors likely serve an important function in linking important habitat across the region. Various authors have commented on the importance of habitats within major river valleys for moose and other wildlife species. In the oilsands region, moose have been documented moving into sheltered, browse-rich riparian forests along the Athabasca and other major rivers during severe winters. Smaller rivers such as the Muskeg River and Ells River may provide important landscape connections between the Athabasca River valley and higher elevation summer habitats near the Birch Mountains and Muskeg Mountain. Habitats within these riparian corridors are also likely important for breeding for many wildlife species. Moose often select islands in rivers or inaccessible riparian areas as secure calving habitat. We also agree with the idea that riparian corridors that link patches of natural habitat may facilitate recolonization of reclaimed lands (CEMA 2006).

Initial results of Wildlife Corridor Monitoring studies (see Section 5.6.3.1) indicate that the functionality of these corridors may already have been impaired by development. Results of monitoring along the Muskeg River adjacent to the Muskeg River Mine Project show lower levels of wildlife use than in either the JEMA LSA or the Athabasca River corridor and that disturbance-tolerant species such as white-tailed deer and coyotes are now common in disturbed areas along the Muskeg River and Athabasca River corridors.

The proposed development plan for the Jackpine Mine Expansion project involves the destruction of the middle reaches of the Muskeg River, eliminating much of this potentially important, regional riparian corridor. While it if fairly clear that the Muskeg River will cease to function as a wildlife corridor over the life of the project, the long-term effects on wildlife and biodiversity are not known.

There is also a great deal of uncertainty about the degree to which the narrow riparian corridor being proposed along the Athabasca River adjacent to the Pierre River mine will function as an effective wildlife corridor. Shell has predicted that a minimum of one migrant per generation of all wildlife species will pass through this corridor, which they feel will be sufficient to maintain genetic connectivity across the regional landscape. While this could be the case, it can be argued that corridors should be designed to function as travel routes for daily and seasonal movements, in addition to dispersal movements. There is concern that an inadequate corridor could act as a population 'sink', drawing animals away from source areas and exposing them to increased mortality (Soule' 1991).

1.3.4 Wildlife Health

The wildlife health risk assessment (Section 5.4, Volume 3) is the best wildlife health assessment we have reviewed to date for the oilsands region. The wildlife receptors selected and the exposure assumptions appear sound. The assessment considered a list of 15 species of mammals and birds covering each of the primary trophic levels. Mammals assessed included beaver, black bear, lynx, fisher, meadow vole, masked shrew, moose and snowshoe hare. Birds included barred owl, great blue heron, mallard, ruffed grouse and spotted sandpiper. The assessment considered exposure through inhalation and ingestion of contaminants. Both acute and chronic exposure were considered.

Our primary concern with the assessment is that Toxicity Reference Values (TRVs) that currently exist may be too limited to conduct a meaningful wildlife health risk assessment. To assess wildlife health risks, the level of exposure at which health risks could occur must be identified. This usually requires controlled studies under laboratory conditions. As noted in the assessment "Virtually no studies could be located in which wildlife was exposed to the COPCs under controlled conditions". As a result, the assessment was based on extrapolation of toxicity information available for laboratory animals. As well, insufficient toxicological information existed to assess health risks for amphibians, which are likely one of the most sensitive groups of wildlife to pollution effects.

The report clearly acknowledges the limitations associated with extrapolating TRVs from laboratory animals and factors were applied to these toxicity data to reflect this uncertainty. As well, the exposure estimates used in this report were quite conservative, reflecting what might be a worst-case condition. The assessment concludes that risks to wildlife health will be low to negligible for each of the Chemicals of Potential Concern (COPC) evaluated. Note: the wildlife health risk assessment addressed the JEMA and PRMA as a combined project; however, we assume that since effects of the combined 'Project' were found to be low to negligible, individual effects of the JEMA and PRMA are also likely to be low to negligible.

Not withstanding this assessment, we continue to have concerns about the long-term water quality in reclaimed wetlands and pit lakes and potential wildlife health effects. At closure, process-affected waters and runoff from the reclaimed mine area will be directed through a series of reclaimed wetlands, pit lakes and a treatment lake before these waters are released to the Muskeg or Athabasca Rivers. These lakes will be designed to have some shallow littoral zones designed to promote biological activity and attract wildlife. Shell (Section 19.7 Volume 1) predicts that pit lake water quality will be non-toxic before the pit lakes start discharging to the Muskeg or Athabasca Rivers. They predict that while some key constituents, including acute and chronic toxicity and labile napthenic acids, will be below aquatic threshold values or within the natural variability of existing waterbodies, that some, including molybdenum and PAH Group 2, will exceed guideline levels, and others such as boron, refractory napthenic acids, PAH Group 6, sodium, potassium, sulphate, strontium and vanadium, will exceed levels in natural surface waters in the region. Shell concludes however that the predicted concentrations will have '"low to negligible effects on aquatic health". Although contaminant concentrations in pit lakes are predicted to decrease with time due to flushing of concentrations from porewater in tailings materials in the landscape (Section 6.1.4.2, Volume 4A), we believe there is likely considerable uncertainty about how long this will take and the effects of these contaminants on aquatic wildlife during the intervening period. Results of research showing that exposure to oil sands process-affected water and sediment is associated with reduced growth of ducklings (Gurney et al. 2005) and reduced growth and survival of amphibians (Gupta 2009, Hersikorn 2009) should raise a red flag about long-term risks to aquatic fauna.

There are also long-term health concerns for terrestrial wildlife. The chemistry of reclamation soils is expected to be considerably different than natural surface soils in the region. In addition to concerns related to the possible bioaccumulation of contaminants in wildlife food chains, there is also concern that elevated levels of certain chemicals (salts, metals, acids) in reclaimed soils could affect the palatability and nutritional value of browse and herbaceous vegetation for moose and other herbivores.

Exposure to Tailings Ponds

> A wildlife concern with all conventional oilsands projects is the risk associated with exposure of wildlife to tailings and to wetlands containing process-affected water. This is both a wildlife health and a wildlife mortality issue. Water birds are particularly at risk during the spring migration period, when tailings ponds may represent the only sources of open water along the migration route. Waterfowl and shorebirds that come into contact with tailings water may be exposed to residual bitumen, napthenic acids and other toxic contaminants. This may cause direct mortality of waterbirds through fouling of plumage with oily compounds or the uptake of contaminants may cause reduced fitness and survival.

Shell briefly addresses this concern in Section 7.5.3.2 (EIA Volume 5). The company forecasts that effects will be of low magnitude, citing a low frequency of bird fatalities recorded at the Muskeg River Mine and Shell's intention to use radar-activated scare canons to discourage birds from landing on the ponds.

We are concerned however, that the proximity of the Jackpine Mine Expansion project to McClelland Lake and Kearl Lake, two regionally significant migration lakes for waterfowl and shorebirds, may pose greater than predicted risk to migratory birds. During development of the mine, an external tailings disposal area and a series of large in-pit fluid tailings cells will be developed in close proximity (2 km) to Kearl Lake and just several kilometers south of McClelland Lake. The tailings ponds will be comparable in size to Kearl Lake.

Construction of external and in-pit tailings ponds on the Pierre River Mine site, also pose a potentially significant risk to birds. Oilsands development in the region has resulted in a network of large tailings ponds along the Athabasca River valley. Although major migratory pathways have shifted away from the Peace-Athabasca Delta during recent history, the Athabasca River continues to serve as an important route for waterfowl migrating to and from the Peace-Athabasca Delta and other northern breeding grounds. To date, we have not seen a review of the cumulative loss of birds from exposure to tailings ponds in the oilsands region.

1.3.5 Validity of Impact Predictions

Shell, like most of the oilsands companies, relies on use of various computer models to predict the impact of its proposed operations on selected wildlife species. Of particular importance are habitat suitability models that are used to predict the amount of suitable habitat that currently exists (Base Case) and the amount of habitat that will remain when mining is completed and disturbed areas are reclaimed (Closure). Although habitat models are potentially useful tools for measuring changes in habitat supply over time, they are complex and difficult to understand. If they have not been properly tested and validated, they can also give very misleading results. The following paragraphs are intended to provide the ACFN with a basic understanding of how habitat models are being used and how various weaknesses in the models may be affecting the validity of the company's impact predictions.

In the most commonly used habitat models, habitat availability is expressed in terms of 'habitat units', which is the term that modelers use to provide a combined measure of the quantity and quality of habitat that exists in an area (or is expected to exist in the future). The habitat suitability models predict habitat suitability for each ecosite phase (vegetation community type) as a fractional value between 0 and 1, where 0 represents habitat of no value and 1 represents the best habitat that is available in the region. For example, if a project results in the loss of 100 hectares of a particular habitat type (e.g., Ecosite phase b1), and the habitat suitability model indicates that Ecosite phase b1 is only of average quality (given a value of 0.5) for a particular species, then the habitat loss would be given as 50 Habitat Units (100 hectares X 0.5 = 50 HU).

The impact ('environmental consequence') ratings used in the assessment are largely based on a mathematical comparison of the number of Habitat Units that the models predict that exist now (Base Case) and following reclamation (Closure). Use of habitat suitability models has been widely criticized, primarily because the biologists that have been using the models have had difficulty proving that they actually work. This is termed model validation. To validate a model, biologists need to prove that the model predictions are reasonably comparable to field data showing the extent to which each habitat type is actually used by wildlife. In an effort to improve the reliability of their habitat models, Shell's consultants have incorporated the use of a newer modeling technique called Resource Selection Functions or RSF for some species. With this approach the consultants used field data (e.g., winter track counts) to construct and test habitat models for moose, lynx and fisher.

Whether or not the use of Resource Selection Function analysis represents a significant improvement over previous approaches to habitat suitability modeling remains to be seen. There are however, a number of important assumptions that the proponent uses in conducting the wildlife assessment that the ACFN and regulatory agencies should be aware of:

- In predicting changes in habitat supply the proponent is assuming that a particular habitat type (Ecosite phase) established on reclaimed lands will have the same value to wildlife as a natural, undisturbed ecosite phase. Given the diversity and complexity of natural ecosystems, this assumption seems highly unrealistic, at least under the time frames that are being predicted (e.g., 80 years). Where is the evidence to support this assumption? Although research is continuing on many fronts to improve our understanding of soil development and plant propogation on reclaimed oilsands sites, this research is clearly in its early stages and a number of serious problems have been discovered that must be overcome (see CONRAD Reclamation and Environmental Research Symposium, 2007). These assessments assume the most optimistic possible outcome despite the fact that research conducted to date has not yet shown that lands affected by oilsands mining and tailings can be reclaimed to ecosite phases that have comparable biodiversity and support the same ecological functions as the natural ecosites they are intended to replace. Shell notes that while the reclamation goal is to "*achieve maintenance-free, self-sustaining ecosystems with a capability equivalent to predevelopment conditions",… "the target vegetation communities identified in the C&R Plan are conceptual, and **it is not currently possible to predict ecosystem succession over time**"* (Volume 1 Project Description). Recent reclamation guidelines for the oil sands region (Alberta Environment 2010) also acknowledge this uncertainty, noting that "*The long-term effects of these anthropogenic disturbances on wildlife populations are not known".* That report includes a summary of wildlife monitoring work conducted on reclaimed sites (i.e., Tar Island Dyke) at Suncor. Reclamation work at Suncor, which was initiated several decades ago, represents the earliest reclamation work in the oil sands region. Monitoring results have shown that many wildlife species now use the reclaimed area but that many of these species are much less abundant than they are in natural forests (Alberta Environment 2010). Deer and coyote were found to make greater use of reclaimed areas, whereas boreal species such as moose, fisher, marten and lynx were much less abundant than in natural habitats. This may change over time as more native species colonize reclaimed sites; however, the degree to which reclaimed sites will converge with natural habitats and the time scales that will be required are not known. Given these uncertainties, the assumptions made in the wildlife assessment appear overly optimistic and may not be realistic. We note that the models adopted by the Sustainable Ecosystem Working Group (SEWG) for the development of CEMA's Terrestrial Ecosystem Management Framework (TEMF) assumed that the wildlife habitat value of reclaimed surface mining footprints would be only 50% of the value of natural (pyrogenic) plant communities (SEWG 2008).

- Although it is seldom reported in EIAs, there is also an error rate associated with the classification and mapping of ecosite phases. An ecosite phase is actually a vegetation association (a group of vegetation species that have a high likelihood of occurring together). Another modeling technique is used to portray ecosite phases as mappable units. We understand that in many cases it is common for error rates (misclassified polygons) to be as high as 20-40%. There are also serious questions about whether these mapped units represent meaningful habitat divisions, at least for some wildlife species. This might be one of the reasons that biologists have had trouble validating their models using real field data.

- For some species, including moose, different RSF models are used to predict habitat suitability at the LSA and RSA scales. Because of differences in the availability of data on landscape attributes, different models were developed for the LSA and the RSA. The RSF models for the LSA were based on vegetation cover data available from the Alberta Vegetation Inventory (AVI), along with GIS data on distance to landscape features such as rivers and forest edges. In contrast, the models for the RSA used Landsat data for habitat classification and topographic information (slope, aspect, elevation) available from Digital Elevation

Model (DEM) data. The resulting models for moose in the LSA and RSA are very different, showing no overlap in the habitat/landscape variables selected. Not surprisingly, the results of the two models are also very different.

When model results were validated against the portion of winter track count data not used for model development (one-quarter of the data was set aside for model validation), results showed just a moderate correlation with the LSA models and a low correlation with the RSA models. The authors concluded that the RSA model lacked the necessary detail in terms of habitat and landscape features to achieve a good correlation with sampled field data. If they are correct, then conclusions based on the regional habitat model could be wrong. Although the moose habitat model for the LSA showed a better correlation to winter track count data than did the model for the RSA, the LSA model predictions did not correlate strongly with the field data. As a result, conclusions based on the LSA model may also be wrong.

The conclusion that habitat in the Jackpine Mine Expansion LSA (which comprises much of the central portion of the Muskeg River watershed) represents low quality habitat for moose conflicts with previous information provided by the Alberta Fish and Wildlife Division, which classified the broad floodplain of the Muskeg River as a Key Wildlife Area for moose in northeastern Alberta. It also contrasts with earlier TEK information that indicated that the Muskeg River watershed contained important moose habitat. Information provided by ACFN elders Pat Marcel and Charlie Voyageur in 2004 (see Muskeg River Mine Application) indicated that the riparian zones along the Muskeg River upstream of Jackpine Creek are used by cow moose during the spring calving period and that the Kearl Lake area contains important habitat for moose. These elders reported that moose move into the Muskeg River watershed in autumn from higher elevation ranges in the Muskeg Mountain area. Similar movements by radiocollared moose were previously reported by Hauge and Keith (1981). Hauge and Keith (1981) documented movements of moose from summer ranges in the Birch Mountains and Muskeg Mountain areas to lower elevation winter ranges near the Athabasca River and Muskeg River. They attributed these movements as a response to snow depths, with snow depths in the Birch Mountains and Muskeg Mountain averaging 10-15 cm greater than they were on winter ranges near the Athabasca and Muskeg Rivers. By late winter, these higher elevation summer ranges were almost devoid of moose. This research suggests that, during severe winters, access to these low elevation winter ranges could be vital for the regional moose population. It also supports the provincial government's previous classification of lowlands along the Athabasca and Muskeg Rivers as key moose winter range.

Although winter is believed to be a critical period for moose, habitat models that reflect only winter habitat use might not adequately reflect the overall value of an area for moose. For example, both TEK and the scientific literature recognize that moose require a number of different habitat types and that habitat use changes throughout the year. Habitat modeling may therefore require consideration of the availability of each of these habitat types within the home range of a moose. The approach used in this assessment, which relies on data from winter track counts, may not identify some important habitats. An example would be shallow waterbodies (lakes, marshes and streams) which provide important habitat during spring and summer. Moose often enter water to avoid predators, forage on aquatic plants or to avoid biting insects. Moose often calve on islands or along the shorelines of waterbodies to provide increased protection to new-born calves. Habitat assessment for ungulates based strictly on winter data is standard practice in the industry and in this assessment Golder clearly states that the modeling results apply only to winter habitat use. Our point is that this approach may not realistically reflect the value of particular areas to moose.

One technical concern we have with the RSF modeling approach used is that the models apparently did not consider distances to industrial disturbance other than major roads. The authors indicate that the available GIS disturbance layers showed only estimated disturbance footprints and not actual disturbance that existed at the time of the surveys. Since most of these data would have been collected from proposed development areas and baseline winter wildlife surveys are frequently conducting following or coincident with exploratory seismic and drilling activity, a potentially large source of error could be introduced to the modeling (and validation) results. In other words, displacement of moose because of either current or previous industrial activities would affect winter tracking results, which in turn could compromise modeling results. From the report it was not clear whether efforts were made to include baseline data only from relatively undisturbed locations.

Another important concern relates to the use of the habitat models for predicting changes in habitat suitability from Base Case to Closure. Despite the fact that results of the model validation showed that the habitat models for moose, lynx and fisher for the RSA had a poor correlation to winter track count data, these models were used for the cumulative effects assessment (regional planned development scenario). A further complication is that different habitat models were used to estimate habitat supply within the LSA at Base Case and Closure for these three species. Because some of the variables that were found to be the strongest predictors of habitat quality in the LSA at Base Case (e.g., stand age, distance to edge, distance to disturbance features) were not available for Closure, the RSA models were used to predict habitat suitability at Closure.

- A failure of this and many other EIAs conducted in the oilsands region may be the unproven assumption that populations or ecosystems will respond linearly to cumulative impacts. In actuality, the consequence of incremental habitat loss may increase as these losses accumulate. For example, it is evident that a relatively large proportion of the key moose wintering habitat in the oilsands region has already been lost to development. The remaining portion may therefore have increased importance to the regional moose population. In other words, loss of a further 10% of the key moose winter range may have a much greater consequence than did the loss of the initial 10%. Similar concerns may exist with respect to loss of secure calving habitat. As previously remote calving areas, such as riparian areas along the Muskeg River and Kearl Lake, are lost to development, remaining calving areas may be exposed to increased predation risk, particularly by black bears. Previous studies have shown that black bears are a major predator of moose calves. As secure calving sites disappear or become smaller and narrower, calf mortality rates could increase, adversely affecting the regional population. The same kinds of arguments apply to other species, including the species discussed above that depend on old growth forest for denning or roosting.

- Another concern with the habitat modeling approaches used in this and other oilsands applications is the failure to state the risks and level of uncertainty that are associated with the model predictions. Model predictions can never be made with total certainty and biologists should use sensitivity analysis or other tools to assist decision makers in understanding the risks and uncertainty that may be associated with model predictions (SEWG 2008). If, as some researchers have suggested, reclaimed areas only have 50% of the habitat value as natural habitats, how would the impact predictions change?

1.4 Key Concerns

The following table summarizes key wildlife issues and recommendations applicable to the Jackpine Mine Expansion and Pierre River Mine Projects.

Issue	Concern	Project	Recommendations
Assessment boundaries	The temporal and spatial boundaries used in this EIA do not permit a meaningful assessment of the long-term effects of the proposed projects on wildlife populations in this area. The assessment does not consider a pre-development baseline. Inappropriate criteria are used for selecting the RSA.	JEMA & PRMA	Identify changes to wildlife KIRs resulting from past (existing) development. Determine natural range of variation (NRV) for each KIR
Wildlife Indicators	Although these mines are situated adjacent to regionally or provincially significant waterfowl habitats (e.g., McClelland Lake, Kearl Lake, Athabasca River) and ducks and geese are consumed by First Nations members, no waterfowl species were selected as KIRs.	JEMA & PRMA	The assessment should be expanded to include mallard or another appropriate waterfowl species.
Baseline	Gaps in baseline surveys prevent full understanding of wildlife	JEMA	Conduct additional sampling of breeding birds and bats in

Surveys	resources that might be at risk		riparian habitats associated with the Muskeg River
		PRMA	Conduct additional sampling for breeding birds and owls Conduct additional sampling of bats in the north half of the LSA and along the Athabasca River Complete waterfowl and beaver/muskrat surveys in north half of LSA
Accuracy of Population Viability Analysis	Results of PVA, which predict growth in moose and black bear populations under all development scenarios, disagree with TEK and another modeling study that projects declining populations for these species.	JEMA & PRMA	Rationalize differences in model predictions. Review assumptions and data requirements for PVA analysis and refine population models.
Validity of habitat models.	Some of the RSF models developed to assess regional changes in habitat supply and habitat suitability of reclaimed lands at closure were not shown to be accurate when validated against field data. This may affect the validity of all impact predictions based on these models.	JEMA & PRMA	Explain the implications of using an apparently invalid model to assess cumulative effects and the value of reclaimed lands for wildlife. RSF may have advantages over HSI models for some species. Further work to refine/develop accurate models is strongly recommended. Consider expanding the assessment for moose to include calving/post-calving habitat as well as winter habitat.
Habitat loss	Assessment predicts large net loss of wetland and old-growth habitat. (note that loss of riparian habitat question removed)	JEMA & PRMA	Additional mitigation and compensation measures should be considered to offset permanent habitat losses.
Disruption of wildlife movements	The proposed JEMA will remove the middle section of the Muskeg River, eliminating what might be a regionally significant riparian corridor.	JEMA	A conservation corridor of reasonable width (e.g., at least 400m) should be maintained along the mainstem of the Muskeg River. In addition to current corridor monitoring efforts, radiotelemetry studies should be initiated to fill critical

			knowledge gaps in our understanding of the potential role of riparian corridors in supporting wildlife movements in a fragmented landscape.
	The proposed PRMA could restrict wildlife movements along the Athabasca River, which is recognized as a major regional wildlife movement corridor.	PRMA	Shell's proposed setback of 250m from the Athabasca River should be increased to at least 400m to protect vital riparian habitats and maintain wildlife movements.
Wildlife health risks	The concern is that the lack of research and toxicity reference data directly applicable to wildlife (as opposed to laboratory animals) may affect the validity of the assessment. It is also not clear to what extent the assessment considered potential long-term, residual effects of exposure of wildlife to contaminants in process-affected wetlands and end pit lakes. Effects of changes in soil chemistry on the palatability and nutritional value of browse are not identified.	JEMA & PRMA	Explain the possible risks associated with extrapolating toxicity data from lab animals to wildlife. Clarify risks to wildlife resulting from long-term exposure to process-affected water.
Exposure to tailings ponds	Because of the proximity of these mines to regionally or provincially significant migratory staging areas (McClelland Lake, Kearl Lake, Athabasca River) risks of exposure of migrating waterbirds to tailings might be increased. Cumulative effects of tailings ponds in the oilsands region have not been assessed.	JEMA & PRMA	Conduct a detailed, cumulative effects assessment dealing with exposure of migratory birds to the expanding network of tailings ponds in the oilsands region.
Validity of reclamation assumptions	The wildlife impact predictions are based on the assumption that reclaimed lands will have the same wildlife habitat value as the undisturbed ecosite phases they are modeled after. No evidence is presented to support this assumption. The assessment fails to identify the risks or levels of uncertainty that are associated with habitat model predictions.	JEMA & PRMA	Provide a detailed review of monitoring research that supports this assumption. Use sensitivity analysis or another appropriate technique to identify levels of uncertainty associated with the models and variables that might affect the accuracy of these predictions.

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Appendix D-11

Jackpine Mine Expansion and Pierre Rive Mine Project - Environmental Impact Assessment Report - Review for Athabasca Chipewyan First Nation – Vegetation, Wetlands and Forest Resources Component, April 29, 2010 (revised), by C. Dana Bush of Bush Ecology

Jackpine Mine Expansion and Pierre River Mine Expansion

Environmental Impact Assessment Report
Review for Athabasca Chipewyan First Nation
Vegetation, Wetlands and Forest Resources Component
By:

C. Dana Bush (Bush Ecology)

April 29, 2010

Introduction

This section focuses on the Terrestrial Vegetation, Wetlands and Forest Resources Impact Analysis. To ensure that this review adequately covers the impacts to vegetation, portions of the Air Emissions, the Conservation and Reclamation Plan, and Traditional Land Use Sections were read.

- Undated Concerns and Requests, and those dated September 2007 refer to:
    - Environmental Impact Assessment: Volume 5, December 2007;
    - Environmental Setting Report, December 2007;
    - Environmental Assessment Update, May 2008 (excluding the Fort McKay lease and separating the JME and PRM).
- Concerns and Requests dated October 2008 refer to:
    - PRM Supplemental Information with an EIA update, May 2007;
- Responses to ACFN refer to Shell's responses to ACFN's first Information Requests (Technical Request Response Table);
- Concerns and Requests dated April 2010 refer to:
    - Pierre River Mine Project Supplemental Information, May 2009;
    - Jackpine Mine Expansion Supplemental Information, December 2009;
    - Shell Jackpine Mine Expansion and Pierre River Mine Project EIA Update, December 2009.

Most of this review focused on problems with the methods of the assessment, which are relevant for both mine areas. Issues with site specific data and data analyses are contained in the final sections.

Overview

This environmental assessment uses methods similar to many other Environmental Impact Assessments (EIAs), and has the same inherent problems. In brief, the methods serve to obscure the impacts of the project by:

- using a large regional study area relative to the footprint, resulting in low magnitude and negligible environmental consequence in the Regional Study Area (RSA),
- defining reversibility as "a site is considered to be restored if natural processes are restored". Species richness is not included in the definition, therefore an impoverished but native and self-sustaining site will be considered restored,
- defining the Environmental Consequences (EC) in a way that makes it difficult to score a high EC for vegetation in the RSA,
- assessing the loss/alteration of a resource relative to the Local Study Area (LSA), not the resource.

Several unsupported assumptions about reclamation potential also affect the final assessment:

- reclamation of jack pine forests will include enough lichen to be a valuable resource for caribou within a meaningful time frame (to caribou),
- non-treed wetlands are ecologically equivalent (similar) to peatlands,
- rare plants will re-colonize reclaimed landscapes,
- shrubs and trees alone will restore an ecosystem,
- direct placement of 1/3 of the topsoil will be sufficient to supply native seed, propagules and mycorrhizae.

In addition, there are a few sections that have weak science supporting the methods and assumptions:

- assessing traditional use potential and rare plant potential instead of actual species,
- assuming that 16% of the RSA is old growth without the data to support it,
- calculating species richness using non-native species,
- inferring that aspen communities will eventually develop into spruce forests,
- assuming (by omitting any discussion) that weeds and non-native invasive species will not be introduced or spread during construction and reclamation,
- classifying large areas as burn rather than as ecosite phase or wetland class
- not presenting the accuracy of the maps.

Assessment Methods

Environmental Consequence Rating System

Volume 5, Section 1.3.6.2, page 1-37: The Environmental Consequence rating combines the results of the impact criteria into one rating, based on magnitude, geographic extent, duration, reversibility and frequency (Table 1.3-4). Each criterion is given a score. Adding the scores gives you the environmental consequence.

Impact Description Criteria

Magnitude (Severity)	Geographic Extent	Duration	Reversibility	Frequency
Negligible: < 1% change (0)	Local: LSA (0)	Short-term: < 3 years (0)	Yes (-3)	Low: occurs once (0)
Low: < 10% (+5)	Regional: RSA (+1)	Medium-term: 3 to 20 years (+1)		Moderate: occurs intermittently (+1)
Moderate: 10-20% change (+10)	beyond regional (+2)	long-term: >20 years (+2)	no (+3)	High: occurs continuously (+2)
High: > 20% change (+ 15)	-	-	-	-

Environmental Consequence

- Negligible: 0 to 5
- Low: 6 to 10
- Moderate: 11 to 15
- High: greater than 15.

The CEAA guidelines recommend that environmental impact assessments discuss and assess the impacts using these criteria, but it does not describe how the criteria are to be used to assign consequence or significance. Each environmental consulting company develops it's own methods. The methods used in this assessment means that it is very difficult to score a high environmental consequence for vegetation. In addition, the criteria are used for each separate KIR (i.e. rare plants, old growth forests, wetlands, riparian areas), so it is difficult to picture the overall impact. There are three fundamental problems: the use of percentages for magnitude, the definition for reversible, and the methods used to score the criteria.

SIR Response
PRM Vol. 2, AENV SIR 390 and JME AENV SIR 374 questions the application of a (-3) reversibility value. Shell responded with "A numeric score of (0) for

reversibility would not account for the ecological endpoint's potential ability to recover, and would overstate the environmental consequence for the endpoint".

Concern - October 2009
The Impact Description Criteria denotes(0) as no or negligible impacts for magnitude, geographic extent, duration, and frequency, however (0) for reversibility is partially reversible. The consequence of this scale is that a 'reversible' impact (+3) outweighs the impact of a regional geographic extent (+2), long term impacts (+2), or continuous frequency (+2). A negative environmental impact, therefore could become a positive impact if it is deemed reversible.

➔ ***Request - October 2009***
Please explain, in biological terms, how a reversible impact could be a positive force, rather than a neutral force.

Magnitude

Using percentages to establish magnitude ranking is a standard method; the problem is that the larger the study area, the smaller (and less significant) the impact. For example, if you disturb 21 ha in a 100 ha study area, you will have a 21% loss which is a high magnitude. However if you increase the study area to 125 ha, then the loss is only 17% which is a moderate magnitude.

Because the LSA is generally slightly larger than the development area, the local impact of clearing all vegetation will almost always be high. In this project, the LSA includes the mining area plus a 500 m buffer zone. The project will result in a total disturbance of 32,495 ha in an LSA of 50,640) which is 65%. Projects such as SAGDs, which cover a large area but disturb less of the landscape may have a low impact in the LSA.

The regional study area is 2,277,376 ha. The larger study area enables the proponent to assess the other projects that are approved and planned for the area, and allows impacts to be assessed for large roaming mammals such as moose and caribou. However, the more projects in an area, the larger the regional study area must be to include all the projects, and the less likely an individual project will be significant. In this case the project will result in a total disturbance of 32,495 ha in an RSA of 2,277,376 ha which is 1.4% (low). However, if the regional study area had been set at 227,737 ha, then the disturbance would be 14.2% (moderate); at 150,000 ha, the disturbance would have been 22% (high). Because Shell has used a large RSA, none of the KIRS relying on area calculations will ever rank higher than low magnitude.

Reversibility

Except for peatlands, rare plants, and to some extent old growth forests, and the areas that will be converted to endpit lakes; impacts to vegetation communities are considered reversible. "Because ecosystems are dynamic, a site is considered to be restored if natural succession processes are restored. Reversibility does not necessarily require the establishment of a mature stage of the successional pattern, but can be achievement of a development stage that can be assumed to be moving towards an acceptability stage of maturity" (EIA Section 1.3.6.1). This is a reasonable definition of reclamation (see below), but will result in a noticeably different landscape, with more large hills and lakes, fewer peatlands, and far fewer species than the original forest. It may be reclaimed: it is not, however, restored.

Land Reclamation: The process of improving disturbed land (soil, vegetation, water) to achieve land capability equivalent to the predisturbed condition or for a specified end land use.

Ecosystem Restoration: The process of manipulation an ecosystem (soil, vegetation, water and wildlife) to achieve composition, structure and function similar to the predisturbed condition (Department of Renewable Resources, University of Alberta. (www.ales.ualberta.ca/rr/landreclamation.cfm).

By using a low diversity reclaimed landscape in an unspecified time-line as a goal, the EIA can confidently claim that reclamation will be successful, as long as the dominant species are native and soil formation is occurring.

SIR Response - PRM May 2009, JME December 2009
PRM ERCB SIR 379b and JME SIR 363b asked the proponent to "*Discuss the capability of reclaimed lands to support the pre-disturbance range of forest vegetation communities, species diversity, and productivity".*

Shell responded that "The time frame required to such a return [to equivalent pre-development capability] has not been established because of a lack of precedent in oil sands reclamation. …one rotation age is expected for most species to return…Full diversity will eventually return, based on positive reclamation results over the last 30 or more years. The time line to achieve full diversity is not yet known with certainty."

PRM AENV SIR 384a and JME AENV SIR 368 *asks the proponent: "Based on the definition of reversibility criteria provided does Shell consider that all of the disturbances caused by the Project can be reversed?*

Shell responded with "Shell is committed to reclaiming disturbed areas in a manner that supports and maintains natural successional processes, and provides functional ecosystem processes….The definition of reversibility criteria does not assume that only one successional pathway is available. For any reclaimed ecosystem, there are a number of potential pathways."… "Reversibility indicates the potential for recovery of an ecological end point"

JME AENV SIR 368a mentions that the timeline of the assessment is 80 years.

Concern - October 2009

Our conclusion still stands: “By using a low diversity reclaimed landscape in an unspecified time-line as a goal, the EIA can confidently claim that reclamation will be successful”, as long as Shell can demonstrate that the ecosystem is on a successional pathway where basic ecosystem functions will be established. There is an implied commitment to ensure that the reclaimed landscape will be dominated by native species, but it will look distinctly different from the original. Shell has provided no support for their assurance that the species diversity will recover in a meaningful timeline (i.e. to aboriginal users).

This is a reasonable assumption to make, given the current knowledge of reclamation. However, when coupled with the assumption that impacts to most vegetation communities are reversible, it leads to the conclusion that there will be no impacts, when very likely there will be long-term losses in biodiversity in upland as well as peatland vegetation communities.

Concern-April 2010

Shell correctly states that for any reclaimed ecosystem, there are a number of potential pathways**.** These pathways are unpredictable, depending on the initial disturbance, climate change, the disturbance regime (i.e. fire), nitrogen addition, invasive species, biotic limitations (pollinators, symbiotic interactions of plans with mycorrhizae, dispersal limitations, and microsite limitations (Choi et al 2008; Johnson and Miyanishi 2008). The problem is that after clearly stating that there are a number of potential pathways, the EIA then assumes that ecosite phases will be restored, and that this will mitigate the losses in habitat and species diversity. There is a serious gap in logic here.

➔ ***Request -April 2010***

Explain why ecosite phases are used in the assessment calculations and wildlife models even though Shell admits that it is not possible to predict the final community type.

If Shell maintains that ecosite phases will be restored (including the dominant forbs) then provide specific targets (number of species, species composition, cover etc.) for each ecosite phase/wetland type so that the success of reclamation can monitored and evaluated.

If Shell admits that ecosite phases will not be restored, then re-analyze the data using “ecosite analogues” or some other category that indicates the lack of similarity and unpredictability of the final landscape.

Choi, Y.D., V.M. Temperton, E.B. Allen, A. P. Grootjans, M. Halassy, R.J. Hobbs, M.A. Naeth, K. Torok. 2008. Ecological Restoration For Future Sustainability In An Changing Environment. Écoscience 15(1):53-64.

Johnson, E.A. and K. Miyanishi. 2008. Creating New Landscapes and Ecosystems: The Alberta Oil Sands. Ann. N.W. Acad. Sci. 1134:120-145.

Environmental Consequence:

The method to determine environmental consequence will almost never result in a high environmental consequence for vegetation as a whole. In the example below, I have used a worse case scenario to determine the environmental consequence of clearing all vegetation for a mine.

I assumed that the RSA is relatively small. Clearing vegetation on 20% of the area would be a high magnitude impact (Table 2) and regional in the RSA. The duration of a mine is greater than 20 years, therefore it would be long-term. Reclamation for most of the vegetation is theoretically possible (although not for peatlands and only somewhat for old growth forest), therefore three points are removed. The final criterion is frequency. Although frequency is important for wildlife species who may be affected by frequent road traffic or occasional helicopter surveys over pipelines, impacts to vegetation are generally low: the vegetation is cleared once and then reclaimed. Frequency is almost always scored 0 for vegetation.

As you can see from this worst case scenario (Table 2), the only time that general vegetation impacts could score high, is if it is deemed irreversible (e.g. peatlands, old growth forest, rare plant populations), if the geographic extent is beyond regional (e.g. nationally listed rare plant species), or the frequency was intermittent or continuous. The actual size of the project is more or less irrelevant, because the RSA is generally 80% larger than the project, but it has the heaviest weighting in the system.

Table 2: Example of environmental consequence

Criteria	**Rank**
Magnitude: > 20% change	+15
Geographic Extent: Regional	+1
Duration: long-term	+2
Reversibility: yes	-3
Frequency: low	0
Environmental Consequence	**15 = moderate**

Three KIRs that were assessed as having greater than negligible environmental consequence at the local level, are evaluated for the RSA in the impact assessment: wetlands, old growth forests, and high rare plant potential. All of them are rated low environmental consequence, because they are all negligible or low magnitude, primarily because the total area disturbed is only 1.4% of the RSA. It is unclear why the frequency is rated high in this assessment, as it is low in the LSA (Volume 5, Table 7.5-34). The explanation (Volume 5,Section 7.6.2.1, page 7-142) reads “As clearing to vegetation will occur into the future, the frequency is considered to be high”, however frequency refers to the number of occasions to the same KIR, so the time lag should be irrelevant.

➔ ***Request - September 2008***
Explain why frequency is high in the RSA and low in the LSA.

Table 7.6-7: Residual Impact Classification for Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area: Planned Development Case

Component Criteria	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Wetlands (including peatlands)	Negative	Negligible (3,606 ha) (0)	Regional (+1)	Long-term (+2)	Irreversible (+3)	High (+2)	Low (+8)
Old growth forests	Negative	Low (+5)	Regional (+1)	Long-term (+2)	Irreversible / reversible (0)	High (+2)	Low (+10)
High rare plant potential	Positive	Low (+5)	Regional (+1)	Long-term (+2)	n/a/	High (+2)	Low (+10)

Response to ACFN #52
The difference in frequency rating referred to above is due to the difference between the Application Case and Planned Development Case (PDC), and is not the result of scale issues between the LSA versus the RSA. The difference in frequency rating is due to timing or rate of clearing in each case. In the Application Case, the only source of change to the environment is a single development (the Project) that will be cleared, and it is assumed that the entire area is cleared at once. Thus, the frequency rating is low for both the LSA and RSA at the Application Case. For the PDC, each planned or approved project is assumed to be 100% cleared as an individual event, thus the clearing of all developments are considered to be different events on the specific resource in the PDC. Therefore, a frequency rating of high is assumed for the PDC.

➔ ***Request #52***
Please explain how clearing for different events, in different locations will be biologically relevant to vegetation.

Calculation Percentage of Loss/Alteration in the RSA

Vegetation loss can be presented as the % loss within the LSA, or the % loss to the resource in the LSA, with very different numbers and meanings.

ESR, page 7-74, and Table 7.5-18 Old Growth Forests in the Local Study Area: “The project will result in the removal of 1,223 ha of the old growth forest, representing a loss of 2% of the LSA.” However, the table indicates that 40% of the old growth forest in the LSAs will be removed. This is a more meaningful measure.

➔ ***Request #53***
Please correct Table 7.5-34 Residual Impact Classification to show that the Magnitude of the impact in the LSA is high (>20%), and therefore the Environmental Consequence is high (+17). If not, then explain why using a 2% loss of the LSA is more biologically relevant than using a 40% loss of the resource.

Response to ACFN #53
Magnitude of impacts is rated in terms of a geographic area in order to provide a scale of reference. Consider the following two scenarios:

- Scenario 1 – 1 ha of Old Growth Forest (OGF) in 1,000 ha study area; 100% of it removed by a project.

- Scenario 2 – 900 ha of OGF in a 1,000 ha study area; 100% of it removed by a project.

If the impact assessment was based on the percent of OGF affected, the result for both scenarios would be 100%. This determination would not provide information relating to the contribution of OGF to the overall ecosystem function in the study area. In Scenario 1, the contribution of OGF to the study area is 0.1% as compared to 90% in Scenario 2. It follows that the impact in Scenario 2 should be rated higher than the magnitude of effect in Scenario 1. This perspective is achieved by assessing the impact relative to the study area. While environmental consequence is not scored on percent of the resource, the change in amount of the resource is provided as an added perspective for the reader.

Concern #53
This is a disagreement over method. Perhaps both methods should be used throughout the assessment, as they reveal different issues.

Shell’s method does not show the impacts to uncommon ecosite phases, such as forested bogs, open bogs, shrubby bogs, wood bog with islands, wooded bots with collapsed scars, forested fens, meadows. The loss of these communities would result in a decrease in biodiversity in the RSA. Consider these two scenarios:

- Scenario 1 - 25 ha of Old Growth Forest (OFG) in 1,000 ha study area: 23 ha/25 ha removed = 92% of resource (2.3% of study area)

- Scenario 2 - 250 ha of OGF in 1,000 ha study area: 23 ha/ 250 ha removed = 9% of resource (2.3% of study area)

Scenario 1 would have large affects on the OGF and on biodiversity, while Scenario 2 may not. This difference is not reflected in % of study area.

Table 7.5-11 does shows % of LSA and % of Resource, but neither the % of the resource or the discussion of impacts make it to the final assessment.

Vegetation - Reclamation

Lichen Jack Pine Communities

ESR: Section 3.3.6.1: "Lichen jack pine communities were selected as a community-level KIR because of their importance for caribou habitat and due to their restricted spatial distribution in the region."

EIA update: Section 2.7.3.2: Lichen jack pine communities are predicted to increase by 450 ha (1%) from Base Case at closure with the exclusion of the Fort McKay Lease (Table 2.7-4) for the two LSAs. However, this assumes that reclamation will be successful is a meaningful time frame for caribou. Clearing begins before 2010 (C&R update, Section 3.4.1, Table 30), revegetation begins in 2029 (C&R update, Section 3.4.2, Table 31) and jackpine reclamation begins in 2034 (Volume 1, Table 20-10). If we assume that lichen develops on the jack pine in 50 years (a wild guess on my part), then the lichen jack pine community will not be useable for caribou until 2084. The loss/alteration to the lichen jack pine communities is up to 25% of the resource for approximately 75 years.

JMEA Table 2.2-2 (EIA update): Environmental Consequence = low (+7), and positive. (long term (+2). Reversibility n/a

➔ ***Request September 2008***
Please provide evidence that:

1) Lichens will re-colonize the jack-pine communities, especially when they are isolated from contiguous stands by early seral reclamation communities, and in what time-frame;

2) 75 years of reduced lichen will not affect caribou and therefore the impacts to lichen jack pine communities will not have a negative environmental consequence,

3) explain why Reversibility is not applicable.

Wetlands

Impacts to wetlands (including peatlands) are ranked as a low environmental consequence. Six percent of the treed fens and four percent of the treed bog/poor fens will be lost in the RSA (a low magnitude), and there will be an increase of 16% in non-treed wetlands, such as marshes, after reclamation. In the assessment, these numbers are combined together, and presented as a total loss of < 1%. The environmental consequence assumes that non-treed wetlands are ecologically equivalent (similar) to peatlands, which is not supported in the report. If the assessment looked at peatlands only, the environmental consequence in the RSA would be moderate (magnitude +5, regional +1, long-term +2, irreversible +3, frequency 0 = +11).

➔ ***Request #54***

Support your assumption that reclaimed non-treed wetlands are ecologically equivalent to peatlands and explain why the increase in non-treed wetlands was used to offset the decrease in peatlands.

Response to ACFN #54

Although non-treed wetlands are not identical to peatlands, the two wetland types are similar in many respects. As the identified KIR was all wetlands, the results were reported correctly. The assumption is that non-treed wetlands and peatlands reasonably fit into the same "wetland" category. Although they are not considered to be ecologically equivalent to peatlands in all respects, they are also not entirely ecologically distinct either. They have similar ecological functions with respect to many environmental components – examples include certain aspects of surface water hydrology, water quality, vegetation, wildlife habitat, traditional land use and biodiversity. The shift from peatlands to non-peat forming wetlands and wet area types is fully assessed in the respective EIA components.

➔ ***Request #54***
Peatlands and marshes are markedly dissimilar in vegetation, traditional land use and biodiversity. Please provide research supporting the assumption that reclaimed non-treed wetlands are ecologically equivalent to peatlands.

Rare Plants

The report assumes that reclamation will compensate for the loss of rare plants by increasing the rare plant habitat, which is an assumption based on hope not fact.

➔ ***Request:***
Please support your assertion that rare plants will re-colonize reclaimed landscapes.

Reclamation Goals

JPM Volume 1: Project Description: "Shell's reclamation goal is to achieve maintenance-free, self-sustaining ecosystems with a capability equivalent to predevelopment conditions. This goal is shared with other oil sands mining operators, such as Canadian Natural (Horizons Oil Sands Project), Suncor (Voyageur South Project) and Imperial (Kearl Oil Sands Project)."

"The target vegetation communities identified in the C&R Plan are conceptual, and it is not currently possible to predict ecosystem succession over time."

Section 20.2: "C&R activities for the first 10 ears of activity on the expanded Jackpine Mine will be limited to soil salvage and stockpiling. …."

Section 20.3, Table 20-5: Upland Surface soil and subsoil reclamation material; salvage begins in 2010, but placement does not begin until after 2019.

Table 20-10: Jack pine revegetation starts 2034

Page 20-22: "Direct placement of suitable material to reclamation areas enhances site revegetation. This is because dormant, in situ, native seed and viable root fragments are transferred with the soil amendment. Spreading the material on a reclamation area in early spring usually results in various native forbs, wildflowers, grasses, and woody-stemmed species emerging over the late spring and summer. Direct placement will be implement wherever practical."

Section 20.4: "Progressive reclamation will be implemented, including direct placement of the reclamation material*, when salvage and reclamation can occur concurrently."*

Reclamation material stockpiles will remain intact until after 2019,and some will still be stored in stockpiles by 2049.

EIA: Appendix 5-1 Section 3.3.2, Table 27: According to this table, only 1/3 of the topsoil will be used for direct placement. The other 2/3s will be stored in reclamation material sites (RMS), where the seeds, propagules and mycorrhizae are not likely to survive in sufficient quantities to enhance site revegetation.

➔ ***Request - September 2008***
Please estimate the area that will have topsoil placed directly on it, not stored in the RMS.

Vol 1, Section 2020, Table 20.5: Upland Surface Soil and Subsoil Reclamation Material Balance: The Stockpile Balance is the existing Stockpile Balance plus the Annual Salvage for each year. The Stockpile Balance is 8513,120 in 2019. The addition of 28,389,494 of Annual Salvage in 2049, minus 27,416,900 Annual Placement should equal 9,485,714 for the Stockpile Balance not 1,091,340 as shown in the table.

➔ ***Request - October 2009***
Please explain the discrepancy.

➔ ***Request - September 2008***
Explain what you will do to enhance biodiversity in the areas where direct placement is not possible.

SIR Response:
ERCB SIR 397, Pierre River Mine Supplemental Information Volume 1: "The proposed Pierre River Mine plan does not include areas planned for reclamation

(including direct placement) for the first 10 years of operation. However, if such areas become available, direct placement will be applied, where possible."

PRM 2009 - ERCB SIR 397, Pierre River Mine Supplemental Information Volume 1: "Whenever possible, direct placement is the preferred choice for salvaging any reclamation soils….current…monitoring… indicate that in salvaged upland soil that has been in stockpile for one year, vegetation regeneration is proceeding effectively."

PRM 2009 - ERCB SIR 400: "The potential for Labrador Tea establishment will be provided throughout the direct placement of 149 ha of muskeg soils at the Pierre River Mine".

JME 2009 - AENV 384a: "The potential for Labrador Tea establishment will be provided through the direct placement of approximately 5,045 ha of muskeg soils at the Jackpine Mine Expansion."

PRM 2009 - AENV SIR 403a: "About 35% of the soil salvage materials will be directly placed for reclamation. The remainder will be stored in reclamation material stockpiles".

PRM 2009 - ERCB SIR 410 and AENV SIR 410: "Ecosite planning does not differentiate between directly placed soils and those coming from stockpiled areas, as care has been taken to minimize the stockpiled time of reclamation salvage materials."

EIA Update: Section 3.4, Table 29. The Target Ecosite Phase Planting Prescription specifies native trees and shrubs. Forbs and shrubs will be used in two shrublands (Table 29).

The success of reclamation is based on several factors: the site conditions, the weather conditions during the establishment years, and the seed source available in the establishment years. Reclamation sites that are relatively small, and that are surrounded by vegetation communities with high species richness (a high number of native species) are likely to reclaim to rich/diverse communities. Reclamation sites that are large, such as mines, have large areas that are distant from seed sources. The centres of the reclamation areas, therefore, tend to have low species richness unless forbs (flowers, grasses and sedges) are seeded.

➔ ***Request - October 2009***
If, as you explain, reclamation soils are valuable, and direct placement is preferred, where else can this reclamation soil be used (i.e. other projects in the RSA). Please explain how Shell is working with other mine operators to maximize the direct placement of reclamation soils.

➔ ***Request - October 2009***

Research shows that "stockpiles of LFH materials lose much of their viability after only three to six months" (New Trail, Autumn 2009 "Anne Naeth, Professor of Ecology and Land Reclamation). Please estimate the amount of reclamation soils that will be 'directly' placed within one year of salvage.

➔ ***Request - September 2008***
Please explain how you intend to enhance the species richness if you are directly placing only 1/3 of the topsoil and you are not seeding forbs (other than in two shrublands).

➔ ***Combined Request #55***
Estimate the area that will have topsoil placed directly upon it, rather than stored in the reclamation material sites. Explain how biodiversity will be enhanced in the areas where direct placement is not possible. Explain how species richness will be enhanced with the direct placement of one third of the topsoil and lack of seeding forbs (other than in two shrublands).

Response to ACFN #55
The Reclamation Goals and Principles stated in Section 1.2 of the Closure, Conservation and Reclamation (CC&R) plans for both the JPME EIA Update (May 2008) and PRM (Appendix 5-2) clarify the revegetation strategy. For information on enhancing biodiversity, see Volume 5, Section 7.1.

➔ ***Request #55***
Shell did not answer the question. The cited sections are overviews stating direct placement will be done where practicable, native species will be used where practicable, and biodiversity will be enhanced. Please answer the question.

➔ **Request #59**
Provide evidence of the assertion that rare plants will re-colonize in reclaimed landscapes.

Response to ACFN #59
The reclaimed landscape is predicted to provide the potential for the natural re-colonization of rare plants. Direct placement of reclamation materials will be undertaken whenever practical to maximize potential viability of native seed banks and propagules, which has the potential to include rare plants. Direct placement will account for approximately 2,500 ha of the reclaimed area for JPME and approximately 1,100 h for PRM. Natural invasion of native vegetation (including rare plants) will be encouraged in ecologically-receptive areas. The successful restoration of a river valley in Denmark provides one example of the natural invasion of two rare aquatic plant species in a reclaimed riverine landscape (Pedersen et al. 2007).

Concern #59
The likelihood of rare propagules surviving direct placement of reclamation materials is small. In some cases, rare plants are adapted for specific ecological conditions which will not be re-created immediately (if at all). The time lag will diminish the probability of the few surviving propagules germinating and establishing.

Shell cites (incompletely) a single scientific article about a very different ecosystem as evidence that all rare plants will re-colonize these projects. This single article does not inspire confidence that rare plants can be successfully re-colonized in reclaimed landscapes. (As a side note, the research cited describe the restoration of 19 km of the Skjern River and 22 km^2 of the cultivated river valley in Denmark, and included a comprehensive monitoring program including hydrology, nutrients, fish, meadow vegetation, amphibians as well as rivermorphology, in-stream habitats, macrophytes and macroinvertebrates). This is an inadequate response.

➔ ***Request - April 2010 #59***
Please provide scientific evidence, using multiple species with different habitat requirements and reasons for rarity, that rare plants will indeed move into reclaimed habitats.

Weeds and Non-Native Invasive Species

The EIA assumes (by omitting any discussion) that weeds and non-native species will not hinder successful restoration (or reclamation). This unspoken assumption leads the reader to picture the final landscape to be vegetated with native species. In fact, non-native species are common throughout the RSA, along roads and pipelines, in borrow pits and wellpads. Although not documented in this EIA (Section 3.5.1.7, Table 3.5-11), non-native invasive grasses such as smooth brome (Bromus inermis) and timothy (Phleum pratense) occur throughout the boreal forest, and can cause problems for reclamation, along with Kentucky bluegrass (Poa pratensis) and curled dock (Rumex crispa). Non-native invasive species and listed weeds can be introduced by construction and reclamation equipment and in reclamation seed mixes.

➔ ***Request - September 2007 #56***
Please explain how you intend to control the introduction and spread of invasive non-native species during construction and reclamation. Support your contention that your control programme will indeed be successful. and what the environmental consequences will be if you are not completely successful.

Response to ACFN #56
Please refer to PRM SIR #350, 381 and 511.

➔ ***Request #56***
Shell did not answer the question:

 # 381 refers to weed seed management plan, and does not describe how contractors are to clean their vehicles.

#350 refer to vegetation reclamation and to the monitoring program (Vol 5 Sect. 7.1)

#511 simply says that Shell will survey, treat and control weeds, and educate it's personnel about weed issues.

Please answer the question.

SIR Response PRM May 2009 and JME December 2009
AENV SIR 381 and AENV SIR 365: *Will the vehicle was, serve and tire change facility also serve as the steam cleaning location used to remove potential weed seeds for new vehicles entering the site?*

Response: "…only clean equipment is allowed access for delivery and use on the sites. Contractors or personnel with vehicles new to the site must ensure that the vehicles are clean before entry."

Concern
Shell deferred the question by referring to the weed seed management plan for Muskeg River Mine and Jackpine Mine, but did not answer the question. The road from Fort McMurray north is gravel and is often extremely muddy. In addition, the roadsides have been revegetated with smooth brome, other agronomic grasses, and weeds. Contractors and personnel driving along these roads will arrive carrying mud and grass seeds on their vehicles.

➔ ***Request***
Please clarify if the vehicle wash facility will serve as the steam cleaning location, or if not, how contractors will ensure that their vehicles are clean upon entering the site.

Vegetation – General Questions

Traditional Plant Potential

ESR report: Section 3.3.2.6, referring to Table 3.3-1 Traditional Resource Uses: "Some of the information presented in the above studies was consolidated to create Table 3.3-1 which summarizes the plant and animal species used as part of a traditional lifestyle of the region, as identified by the community of Fort McKay. Rankings (high, medium and low) were give to the individual species based on the number of times that species were referred to and the number of times it was shown on the traditional land use maps or in tables that accompany the studies. *These rankings are not meant as a reflection of the importance of specific resources, nor to imply that certain species are important….*" [my italics].

EIA Section 7.5.2.2: These plants were then assigned to vegetation type and scored according to presence and cover, and the Traditional Plant Potential was assessed (Table 7.5-31). This method assumes that all of the plants are equally important to all the Aboriginal communities, which is clearly not correct. Most communities collect large quantities of blueberries, bog cranberries (locally known as low-bush cranberries or lingon berries), rat root, and mint (Bush and Dersch 2008; Garibaldi pers. comm. 2007). Some communities also highly value balsam fir, valerian, pitcher plant, sweetgrass, and diamond willow fungus, and most of the tastier berries. Although kinnikinnick, dogwood, juniper, plantain, jackpine etc. were historically collected, few Aboriginal communities collect these in large or even moderate quantities. Including these species obscures the data by assuming that a community with red current is as valuable as one with bog cranberry. For example, ecosite phase e2 has 39 species and is scored high, containing balsam fir and low-bush cranberry (locally known as mooseberry) which are commonly collected, and buffalo berry which is occasionally collected, and numerous other species that are rarely collected. However, ecosite phase a1 which has high numbers of blueberry and bog cranberry and is considered valuable a collecting site, only has 19 and therefore scores low. In addition, rat-root, which is one of the most important species, has not been assigned a vegetation type at all.

Ann Garibaldi, Ethnobotanist. CE Jones and Associates, Sidney, British Columbia V8L 5X4. Tel 250.655.5373

Dersch, Ave, and C. Dana Bush. 2008. *Identifying Traditionally Used Plants in the Regional Municipality of Wood Buffalo*. Prepared for the Cumulative Environmental Management Association, Sustainable Ecosystems Working Group, Traditional Use Plants Task Group, Fort McMurray, AB.

➔ ***Request - September 2007, #57***

Please re-analyze the impacts on the species considered most valuable to the Aboriginal communities.

Response to ACFN, #57

This request appears to be a statement of disagreement with Shell's methodology and conclusions, as opposed to a request for clarification that would allow ACFN to complete its Technical Review of the EIA. As such, this may be more appropriately discussed following completion of ACFN's technical review of the EIA.

Shell funded ACFN to complete a TEK study for the EIA of the Projects.

➔ ***Request, #57***

Recommend Shell describe which species are considered important by the Aboriginal communities, and then assess the impacts on those species.

A TEK study does not assess potential impacts. What threshold/criteria did Shell use for assessing potential impacts on traditional uses / Section 35?

Rare Plant Potential

Impacts to high rare plant potential evaluates the areas that *might* have rare plants. Rare plants are…rare and it is difficult to predict their occurrences accurately (AXYS 2004; Gould 2007; Robson 1997). Rare plants may be rare for a number of different reasons; they may be associated with rare habitats, their populations may be controlled by insects or disease, and/or they may be remnant or peripheral populations. Pollination and seed movement of rare plants is limited by the distance between populations, by insect pollinators, and by carriers for the seeds or roots, making migration and re-colonization difficult (Primack and Miao 1992).

Simply adding the number of species that could occur in an ecosite phase will overestimate the area in which rare plants are actually found. This method has very little science to support it. There is no evaluation of how many documented occurrences have actually been removed by approved projects, which would be more accurate. For example: northern slender ladies'-tresses (*Spiranthes lacera*) is ranked S1 in Alberta, indicating that there are five or fewer occurrences in Alberta. The EIA documented 3 occurrences in the LSA and 3 in the RSA (Table 7.5-26) (ANHIC may consider these to be fewer than 6 occurrences if they are within 1 km of each other). Two of the three occurrences in the LSA will be lost due to the project and an unknown number may have been removed by other projects. Because small infrequent populations are often susceptible to chance events (fire, flooding etc.) and inbreeding depression (the loss of genetic variability because of inbreeding), the removal of two populations might affect the genetics of the provincial population resulting in a larger than regional impact, with the potential for a high environmental consequence for the species.

AXYS Environmental Consulting Ltd. (Bush, C. Dana, J. Doubt, N. DeCarlo), 2004*. Rare Plant and Special Plant Communities: Mapping and Literature Review.* Presented to the Cumulative Environmental Management Association, Fort McMurray. Accessed May 29, 2008. Available at: http://www.cemaonline.ca/component/option,com_frontpage/Itemid,1/.

Gould, Alice Joyce. 2007. *A habitat-based approach to rare vascular plant conservation in the northern Rocky Mountains of Alberta.* A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Conservation Biology. University of Alberta, Edmonton, AB.

Robson, Diana Bizecki. 1997. *Ecology Of Rare Vascular Plants In Southwestern Saskatchewan.* Thesis, Department of Crop Science and Plant Ecology, University of Saskatchewan, Saskatoon, SK.

Primack, R. B. and S.L. Miao. 1992. Dispersal can limit local plant distribution. *Conservation Biology* Vol. 6(4):513-519.

➔ Request - September 2007, #60

Provide support for your assertion that rare plant potential accurately predicts rare plant occurrences.

Using the ANHIC records evaluate the impacts on actual rare plant occurrences.

Response to ACFN #60

Rare plant potential (RPP) does not predict rare plant occurrences, but identifies those ecosite phases and wetlands types that have been identified as more likely to contain rare plants based on extensive field work in the Oil Sands Region. RPP is derived from an assessment of over 3,000 vegetation plots collected by Golder in the Oil Sands Region. This includes Project-specific vegetation plots accounting for 145 detailed and rare plant vegetation plots, 81 aerial survey plots and 18 rare plant plots in the JPME LSA and 214 detailed and rare plant vegetation plots, 169 aerial survey plots and 13 rare plant plots in the PRM LSA. Rare plant frequency of occurrences was calculated for each ecosite phase or wetlands type, resulting in a rare plant potential ranking calculated for each (refer to Terrestrial Vegetation, Wetlands and Forestry Resources ESR, Volume 3, Section 3.3.6.2, Page 3-45 for Method Summary).

Information on existing rare plant occurrences and rare plant habitat was acquired from ANHIC for the JPME and PRM LSAs and the Project RSA. Rare plant occurrences and habitat data from ANHIC and rare plant occurrences documented during Project field work within the LSA is presented in the ESR (Volume 3, Section 3.3.6.2, Page 3-45 for methods and Section 3.5.1.4, Page 3-86 and Section 3.6.1.4, Page 3-138 for occurrence data). Tables 7.5-26, 7.5-27 and 7.5-28 in the EIA (Volume 5, Section 7, Pages 7-82, 7-83 and 7-84) provide specific information on the vascular, bryophyte and lichen species to be affected by the Project.

Rare plant data collected in the LSAs and acquired from ANHIC are integrated in to the rare plant assessment and subsequently used in the EIA (Volume 5, Section 7, Table 7.5-34, Page 7-94) to evaluate residual impacts in the LSA.

Concern #60

It is agreed that Rare Plant Potential does not predict rare plant occurrences. However, the method for evaluating rare plant potential is still based on weak science. Having some data does not assume biologically relevant methods or conclusions.

The evaluation or rare plant potential has four problems:

1) Overestimation of areas of rare plant habitat. Mapping rare plant frequency by ecosite phase assumes that any particular spot within the ecosite phase will have the same chance of having a rare plant. Because the factors governing the rarity of most species are unknown, assumptions cannot be made. For example, knowing that rare plant A occurs in BM-d1 is almost meaningless, given how much d1 occurs in the boreal forest.

2) Inability to distinguish between very rare species with only one or two occurrences and somewhat rare species with 20 occurrences.

3) Actual impacts to existing rare plant populations are not assessed.

4) Difficulties in predicting impacts when considering common/large ecosites versus uncommon/small ecosites. Common/large ecosite phases with several rare species are considered to be of greater importance than uncommon ecosite phases with fewer rare species, but the impact may be very different.

Scenario 1 - an uncommon ecosite with 3 rare species/occurrences: 50 ha/50 ha = 100% loss and the loss of 3 rare species/occurrences.

Scenario 2 - a common ecosite (i.e. BM-d1) with 5 rare species/occurrences: 50 ha /1,000 ha = 5% loss. The loss of rare species is unknown, but probably low given the large area in which they may occur.

The response is inadequate.

Rare Plant Occurrences

SIR Response - PRM May 2009:
Vol. 2 SIR 438 (re. small butterwort and hairy-fruited sedge)

Response
Small butterwort is ranked S1 (less than five occurrences in Alberta *or especially vulnerable to extirpation because of other factors)* (Kemper 2009), with 12 occurrences (sub-populations?) noted in ANHIC.

An Element Occurrence (EO) is described and tracked by ANHIC and may include several sub-populations. Sub-populations are considered to be within the same EO if they are within 1 km of each other, or within 2 km if there is appropriate habitat between the sites (NatureServe website 2007).

➔ ***Request***
Clarify if the 12 butterwort occurrences in ANHIC database are separate element occurrences as defined by ANHIC or are sub-populations. Assess the impact of the loss of one occurrence out of ?? occurrences on the provincial population.

SIR Response - JME December 2009
JME December 2009 AENV SIR 453 - "There are a number of species presented in the rare vascular plant, bryophyte, and lichens table that are not reported elsewhere in the RSA. Provide the results of additional directed surveys…."

Shell responded by acquiring more data from ANHIC and other oil sands operators and reporting it in Table 453-1.

Concern April 2010
An Element Occurrence (EO) is described and tracked by ANHIC and may include several sub-populations. Sub-populations are considered to be within the same EO if they are within 1 km of each other, or within 2 km if there is appropriate habitat between the sites (NatureServe website 2007).

➔ ***Request - April 2010***
Explain how 'occurrence' is defined and used in Table 453-1. Is 'occurrence' used in the sense of NatureServe, or as synonym for 'rare plant observation'? If it means observation then explain how this might change the assessment.

➔ ***Request - April 2010***
Table 453-2 in the JME Supplemental Information (December 2009) shows updated information for rare plant. Please explain the second to last column

(Total Number of Occurrences Outside of the Jackpine Mine and Pierre River Mine LSAs). Logically this would be a sum of the ANHIC Occurrences and Other Recent Occurrences in the Oil Sands Region, but that is obviously incorrect. Please explain the additional occurrences.

Rare Plant Surveys

The ANPC Rare Plant Survey Guidelines recommend that surveyors for rare plants should have:

- Experience as a botanical field investigator
- The taxonomic experience to identify, in the field, most plant species they come across in the survey area, and the remainder later through taxonomic determination.
- A knowledge of plant ecology
- A knowledge of the local flora and of potential rare species in the habitats surveyed.

In addition, the guidelines recommend that the botanists should be identified in the reports.

➔ ***Request:***

Please identify the botanists and their qualifications.

Explain if these botanists were on all the detailed inventory surveys as well as the rare plant surveys.

Table 3.6-1: explain what the brackets indicate.

Estimating Area of Old Growth

ESR, Section 3.3.6.1: The area of old growth forest is assumed to be between 20% and 28% of the forested land base, resulting in an estimate of 16% of the regional study area, This number is based on a modelling study by Andison (2003), using an 80 year fire cycle, and a study by Schneider (2001) who based his analysis on Phase 3 inventory and the current rate of burning of 0.4% per year. However, the AVI mapping in JEMA shows that only 5% of the JEMA LSA is old growth (ESR Table 3.5-19), and the total old growth forest in the LSAs (Table 7.5-18) is 6% of the LSA.

Research in Wood Buffalo National Park (based on pollen records) shows that the mean fire interval may be 34 years (Larson and MacDonald 1998); or 25-49 years prior to 1959, and 59-89 years between 1860 and 1989 (Larson 1997). Research in Prince Albert Saskatchewan (based on time since fire maps developed from basal tree cores) show that less than 5% of the area has gone more than 125 years without a fire (Weir, Johnson and Miyanishi 2000). The more frequent the fires, the smaller the area of old growth remains, therefore using 80 years versus 34 years may overestimate the amount of old growth in the RSA.

Andison, D.W. Bandaloop Landscape-Ecosystem Services. 2005. *Natural Levels of Forest Ageclass Variability on the RSDS Landscape of Alberta.* Prepared for Cumulative Environmental Management Association (CEMA), Fort McMurray, AB.

Larsen, C.P.S. & G.M. MacDonald, 1998. Fire and vegetation dynamics in a jack and black spruce forest reconstructed using fossil pollen and charcoal. Journal of Ecology 86(5): 815-828.

Larsen, C.P.S. 1997. Spatial and Temporal Variations in Boreal Forest Fire Frequency in Northern Alberta. *Journal of Biogeography,* Vol. 24, No. 5: 663-673).

Schneider, R. 2001. *Old-Growth Forests in Alberta: Ecology and Management.* Alberta Centre for Boreal Studies. Available from http://www.borealcentre.ca/reports. Accessed February 19, 2002.

Weir, J.M.H., E.A. Johnson, and K. Miyanishi. 2000. Fire frequency and the spatial age mosaic of the Mixed-Wood Boreal Forest in Western Canada. *Ecological Applications,* Vol. 10, No. 4: 1162-1177.

Using a 6% estimate in the RSA in Table 7.5-19 gives and Estimated Base Case Old Growth in the RSA of 96,604 ha rather than 374,433 ha, resulting in a 1.3% loss of the resource. This is still a low magnitude, so the Environmental Consequence in the RSA will not change.

ESR, page 7-74, and Table 7.5-18 Old Growth Forests in the Local Study Area: “The project will result in the removal of 1,223 ha of the old growth forest, representing a loss of 2% of the LSA.” However, the table indicates that 40% of the old growth forest in the LSAs will be removed. This is a more meaningful measure.

➔ ***Request***

Support your use of Andison and Schneider’s work over other researchers in the field, and support your estimate that 16% of the regional study area is old growth forest. Explain why there is only 5 or 6% old growth in the LSAs and 16% in the RSA, or re-write the background section using the 6 (or 5%) estimate, and recalculate the impact table using a lower estimated occurrence of old growth in the RSA.

Calculating Species Richness

Table. 7.2-3, p 7-23: Total species richness includes native and non-native vascular plant species, bryophytes, and lichens: Including non-native species in total species richness undermines the point of the indicator. Species richness is used to identify natural areas that have a high diversity. By including non-native species, disturbed areas with a high diversity of weeds may be identified as worthy of protecting.

➔ ***Request - September 2007, #58***

Please recalculate species richness excluding non-native species.

Response to ACFN #58
As stated in Biodiversity Environmental Setting Report (Section 6.4.3, Page 6-25), Shell recognizes that non-native species can be detrimental to the natural balance of ecosystems. Relative to the total number of plant species, few non-native or exotic species occur in the Oil Sands Region and they tend to be associated with disturbed areas. Golder's vegetation database for the Oil Sands Region contains information on twenty-eight plant species that are provincially classified as exotic (ANHIC 2006). Excluding these species from the 'total species richness' calculation does not affect the overall biodiversity ranking of vegetation types because most non-native plant species were recorded in disturbed areas, which are automatically ranked low for biodiversity potential. Furthermore, this biodiversity indicator is based on relative plant species richness rather than absolute richness values and no natural vegetation type had a disproportionate number of non-native plant species. In reviewing the rankings, excluding non-native plant species from the species richness calculation did not change the ranking score. The overall assessment of biodiversity for the Project is not affected by the exclusion of non-native plant species from the species richness index for biodiversity potential.

➔ ***Request #58***
Response to the questions was adequate; however, we recommend that in future, calculations of species richness not include non-native species.

Forest Succession

ESR, Section 3.6.1.3., page 3-145. "Forest succession relationships are illustrated with the mean ages of 'b' ecosite phases of both Natural Subregions. Among these vegetation types, stand age increases as forest succession progresses from an aspen state (both "b2" ecosites phases, 74 and 78 years) to a mixedwood state (both 'b3" ecosite phases, 85 and 91 years) and finally towards a pure coniferous state (both "b4 ecosites phases, 115 and 129 years)."

There are problems with the assumption that aspen stands are early seral stands of white spruce (Johnson and Miyanishi 2008). Aspen may be self generating (Cummings, Schmiegelow and Burton 2000), and white spruce is limited by seed source (Albani, Andison and Kimmins 2005), terrain, and proximity to water bodies. In addition, tree cores taken at breast height (DBH) are not effective methods for correctly aging trees, as aspen cores are very difficult to count, and white spruce trees need to be cored at the base to capture the early years growth (Gutsell and Johnson 2002). DBH cores may, therefore, understimate the ages in either species.

Gutsell, S.L. and E.A. Johnson. 2002. Accurately ageing trees and examining their height-growth rates: implications for interpreting forest dynamics. *Ecology* 90:153-166.

Albani, M. D.W. Andison and J.P. (Hamish) Kimmins. 2005. Boreal mixedwood species composition in relationship to topography and white spruce seed dispersal constraint. Vol. 209(3): 167-180.

Johnson, E.A., K. Miyanishi. 2008. Testing the assumptions of chronosequences in succession. *Ecology Letters* 11(5):419-431.

➔ ***Request***
Please support your statement that b ecosites are successional states.

Accuracy of Map Products

ESR Section 3.3.1, page 3-16 describes the methods used to map the LSA and the RSA. There is no discussion of the accuracy of the maps, therefore no way to evaluate the accuracy of the assessment.

➔ ***Request #62***
Please describe the accuracy of the AVI data used, the LSA map and the RSA map.

Response to ACFN #62
The most recent AVI data was purchased from Alberta Pacific Forest Industries Inc. (AlPac) and reviewed/approved by Alberta Sustainable Resource Development (ASRD). This data reflects the most up-to-date conditions on the ground and is further refined during the Local Study Area Mapping process. Although accuracy validation has not been conducted on this data set, accuracy is greater than that of the original AVI.

For additional information on vegetation mapping in the LSA, refer to Volume 3, Section 3.3.2.2.

For the RSA, an overall accuracy assessment of 80% was determined for the Landsat imagery classification.

➔ ***Request #62***
Two uncertainties remain: the accuracy of the original AVI, and the accuracy of the model used to convert the AVI to Ecosite Phase. Apparently we do not know how accurate the LSA maps are, nor the resultant analysis.

Request #62 - April 2010
Was the accuracy of the RSA determined by ground data or from air photo interpretation?

Effects of Air Emissions on Vegetation *(Volume 3, Section 5.5.4.3)*

Acidification - Potential Acid Input (PAI)
"Nitrogen absorbed in terrestrial ecosystems does not contribute to the acidification of soils or surface waters. This assessment uses a more refined approach the estimate of potential acid input for both aquatic and terrestrial resources, by incorporating the retention of N by terrestrial ecosystems."

This author does not have the background to critique the methods used by the air emission specialist, however the above statement makes biological sense and should represent the impacts more fairly than previous assessments.

EIA Figure 5.5-4: The figure shows that baseline PAI is already high enough to potentially affect sensitive vegetation in both the Pierre River Mine and the Jackpine Expansion Mine LSAs, and is high around the Syncrude/Suncor leases south of Fort McKay, and the leases north of Fort McKay. 1,836 ha are estimated to be above the critical load, primarily in townships 95-6 (16% of the township) and 96-11 (8% of the township). The total is less than 1% of the Terrestrial Resources Air Emissions Effects Study Area (TASA).

Table 5.5-10 shows that 304 ha of vegetation communities that are sensitive to PAI (aspen-balsam poplar, aspen-white spruce, jack pine – aspen, and jack pine) may be affected by acid deposition, and 660 ha of moderately sensitive communities (white spruce, jack pine-black spruce and treed bog/poor fen).

"Of the 1,780 ha potentially affected, 806 ha is considered woodland caribou habitat with high lichen food value." This area remains unchanged with the addition of the project, and the total area potentially affected declines somewhat because the mine fleet was relocated.

Sulphur Dioxide (SO_2)
Both the base case SO_2 concentrations and the project concentrations exceed the WHO (World Health Organization) recommended guidelines for SO_2. There is the potential for direct, chronic impacts from SO_2 on sensitive lichen species, and also forest trees, shrubs, herbs and mosses. The areas with high base case SO_2 levels occur appear to occur around Suncor, and north of Fort McKay near the Albian Sands, Horizon, Fort Hills, and Aurora mines (EIA, Figure 5.5-5, and Project Description, Figure 1.4-1) Table 5.5-7 predicts that 327 ha of vegetation communities with high lichen cover may be affected by SO_2. These communities (jack pine, jack pine-black spruce and treed bog/poor fens) are considered to be caribou habitat.

Application Case: The project will not increase the maximum values, but will increase the area affected by 7 ha. The EIA suggests "that there is a possibility of chronic effects on vegetation from SO2 emissions".

Nitrogen Dioxide
Annual and 24-hour base case already exceeds provincial criteria.

Eutrophication
The European research on nitrogen deposition (Bobbink, et al. 2002) uses kg/ha/a to establish recommended critical loads for nitrogen deposition, rather than keq N/ha/yr as is used in the EAI, therefore I am unable to compare it to their recommended loads.

Bobbink, R., M. Ashmore, S.Braun, W.Fluckiger and I.J.J. Van den Wyngaert. 2002 Empirical nitrogen critical loads for natural and semi-natural ecosystems: 2002 update. Accessible at: www.iap.ch/german/pages/nworkshop-background.pdf Accessed January 14, 2005

At baseline, 35,270 ha of treed bog/poor fen may respond to 0.25 keq N/ha/yr, and 117 ha of treed bog/poor fen may potentially be negatively affected by 2.0 keq N/ha/yr.

The application shows a decline in the area affected by the lower N levels because the Jackpine mine fleet was relocated. There will be a marginal increase in the treed bog/poor fen areas exceeding the 2.0 keq N/ha/yr level by 2 ha, although the maximum deposition rate will double from 3 keq N/ha/yr to 6 keq N/ha/yr (Table 5.5-20).

The increase in nitrogen causing eutrophication is a concern, as nitrogen accumulates in the environment causing long-term to permanent changes. Nitrogen is a naturally occurring nutrient, however many northern vegetation communities are adapted to low nitrogen levels. The addition of nitrogen to treed bogs and poor fens may result in a shift in species; potentially an increase in sedges and shrubs and a decrease in mosses and lichens (depending on the species). Plant species particularly adapted to low nutrient conditions, such as pitcher plant, which is both rare and collected by aboriginal users, may be out-competed in a more nutrient rich environment. Although the area potentially affected is small, the long term impacts may be noticeable to aboriginal users and wildlife.

The combined effects of acid deposition, sulphur dioxide, nitrogen dioxide and eutrophication on treed/poor bogs may cause more permanent changes than anticipated. The interrelationships between these elements and northern Canadian ecosystems are not well understood, therefore the confidence level is reasonable but not high.

➔ ***Request # 63***
Please interpret the impacts of combined air emissions on the vegetation KIRs.

Response to ACFN #63
There is no accepted model to assess the effects of combined air emissions on Canadian boreal ecosystems. The models used to assess the potential effects of air emissions on vegetation are based on comparing reviewed vegetation sensitivities to applicable critical loads, objectives and guidelines. These standards have been adapted from recommendations by leading authorities (CASA, WHO and the provincial and federal governments). The scientific basis

behind these standards results in a reasonable level of confidence to the assessment.

For a review of the available knowledge of the effects of air emissions, see Appendix 3-13, Sections 2 and 3.

➔ ***Request # 63***
Please write a qualitative description of how air emissions (PAI, SO2, NO2 and eutrophication) might affect reclaimed landscapes.

Burn Areas

Table 3.5-1 classifies 6 % of the JME area LSA as burned upland and 10% as burned wetland.

Concern - April 2010
Given that tree, shrub and forb regeneration begins shortly after a fire, it is feasible to classify the burn areas to ecosite phase. By classifying these as burn, the assessments underestimate the area of ecosite phases.

➔***Request - April 2010***
Please classify the burn areas to ecosite phase or justify why they should not be classified.

Table 3.4-15 and the text on page 3-113 analyzes the landscape heterogeneity of disturbed areas and includes burned areas as a disturbance.

➔***Request - April 2010***
Please explain why burns are considered a disturbance in Table 3.5-15 but not in table 3.5-1.

Monitoring

EIA Section 7.1.3: Shell will monitor the Project by expanding its existing, Alberta Environment (AENV) approved, Jackpine Mine - Phase 1 monitoring programs (Volume 5, Appendix 5-6). Shell will also design a wetlands monitoring program for areas adjacent to the Project to determine the effects of surficial aquifer drawdown. The lenticular patterned fen southeast of McClelland Lake is proposed to be included in the wetlands monitoring program*. Lisa's note: Shell responded that "Since EIA submission, Shell has updated drawdown information for the Jackpine Mine Expansion showing that the drawdown due to the project goes farther into the lenticular patterned fen that originally predicted. Based on the updated drawdown information, Shell no longer proposes to include the lenticular patterned fen in the wetlands monitoring program.*

Shell will continue to actively participate in CEMA Working Groups and be involved in research programs such as the Canadian Oils Sands Network for Research and Development (CONRAD).

Concern - April 2010
The proposed monitoring programme is to vague to comment on. More details are required to assess the efficacy.

➔Request - April 2010
Please provide details on the vegetation reclamation, biodiversity, and wetland monitoring programmes.

Pierre River Mine

Overview

Resources
The Pierre River Mine (PRM) LSA is in both the Central Mixedwood Natural Subregion and the Athabasca Plain Natural Subregion. The PRM LSA is on the west side of the Athabasca River, and covers 21,136 ha. The Athabasca Plain Natural Subregion is warmer and has sandier soils than the Central Mixedwood Natural Subregion, and therefore has more upland forest than is typical in the Boreal Forest. It includes a higher proportion of merchantable timber, and the Calamut Old Growth Forest, and the Eymundson Sinkhole Environmentally Significant Areas. Two thirds (66%) of the PRMA LSA is upland.

Jackpine Mine Expansion

Overview

Resources
The Jackpine Mine Expansion (JME) LSA is in the Central Mixedwood Natural Subregion. The LSA covers is along the Muskeg River and covers 18,348 ha, based on the project development area plus a 500 m buffer zone. The JMEA "is primarily composed of a large, intricate wetlands complex that follows the Muskeg River, which is bound by the Fort Hills to the north and uplands near Kearl Lake to the south. The wetlands complex is primarily fens, but also includes bogs and non-peatland wetlands", including a patterned fen in the NE. Only 13% of the LSA is upland, with 59% of the area wetlands (mostly peatlands), 17% burn, and 11% disturbances such as cutblocks, borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines.

EIA, Section xx, page 7-86: "The lenticular patterned fen special plant community) was found in the northeast corner of the JEMA, about 4 km southeast of McLelland Lake….The Project development area overlaps 37 ha (6%) of the southern edge of this lenticular patterned fen." Clearing, pit construction, and drawdown are "predicted to be high, affecting 124 ha (21%) 0f the lenticular patterned fen"…"There is limited regional information on these special plant communities and their distribution within the RSA".

The impact to this special plant community is considered local, although the lack of data indicates that it may be uncommon or rare in the boreal forest. It will have a high Environmental Consequence in the LSA, but negligible in the RSA. Losses or alterations to regionally rare plants or communities may have a regional impact, not just local.

➔ ***Request - September 2008***
Please explain why impacts to a special plant community that may be provincially rare, is considered negligible.

SIR Response - JME December 2009
AENV SIR 454a - Shell notes the presence of a large lenticular patterned fen special plant community in the northeast corner of JME…Confirm the presence of other, similar lenticular patterned fend communities within the RSA that are not currently slated for development."

Shell responded with "Shell is not aware of any other similar lenticular patterned fen communities within the regional study area."

➔***Request April 2010***
Please explain why impacts to a special plant community that is regionally rare is considered negligible.

Peatlands

SIR Response - JME December 2009
SIR 373a Given that 80% of the peatlands (13,819 ha) will be lost, and since successful creation of peatland after mining has not been demonstrated, on what basis will environmental consequences be negligible or low.

Shell responded that "The project will have a high environmental consequence for wetlands (including peatlands and patterned fens) at the local level, but negligible at the regional level.

Concern - April 2010
Several wetland classes appear to be uncommon in the RSA (covering less than 3 percent of the LSA in 10 recent EIAs): BFNN, BONN, BONR, BTNI, BTNR, BTXC, FOPN, FTNI, FTNR, FTPN, MONG, and SFN***N.***

➔***Request - April 2010***

Please present data showing the number and area of peatlands in the RSA and assess the loss of peatlands due to the JME relative to this number. Assess the cumulative loss in the RSA due to other projects in the RSA, as well as the anticipated drawdown, and the levee at Kearl Lake.

SIR JME AENV SIR 378a
Under reclamation Shell states that it will be monitoring surficial aquifer drawdown effect….

Shell responded that "Since EIA submission, Shell has updated drawdown information for the Jackpine Mine Expansion showing that the drawdown due to the project goes farther into the lenticular patterned fen that originally predicted. Based on the updated drawdown information, Shell no longer proposes to include the lenticular patterned fen in the wetlands monitoring program.

➔***Request - April 2010***
Is this a typo? It appears that because the impact is greater, Shell will no longer monitor the effect. Please explain.

SIR response - JME December 2009
AENV SIR 455b - "If all the wetland losses in the Muskeg River watershed as a consequence of currently approved and disclosed mines are added together, what percentage of the RSA is affected?

Shell responded that "48% of wetland in the Muskeg River watershed will be affected (prior to reclamation), but only 4% of wetlands in the RSA, and only 2% of the RSA.

Concerns - April 2010
This is clearly a scale issue. The magnitude is high in the watershed, but low in the RSA because the RSA is so much larger than the LSA.

➔***Request - April 2010***
Explain why a 48% impact on a watershed is not biologically significant.

SIR response - JME December 2009
AENV SIR 455c - If all wetlands for all currently approved and disclosed projects within the RSA are added together, what percentage of the RSA is affected?".

Shells response is that "In the PDC, all existing currently approved and disclosed projects are predicted to affect 200,980 ha (17%) of wetlands from the baseline conditions before oil sands developments in the RSA"… After closure, "treed bog or poor fen wetlands are predicted to decrease 107,179 ha (18% of this resource) while treed fens are predicted to decrease 44,603 ha (14% of this resource)"…

"Environmental consequence ratings are determined based on the incremental change of the project and planned developments from existing conditions, including existing oil sands developments. As the response to this question reflects baseline conditions before oil sands developments, it has no bearing on environmental consequence scoring for the project, and analysis is provided solely for this response."

Concern - April 2010
Interesting response. It appears that Shell is unaware of the definition of cumulative impacts, or of their responsibility to conduct a cumulative impact assessment. Cumulative effects should identify other past, present, and reasonably foreseeable future actions within the space and time boundaries that have been, are, or could contribute to cumulative effects (stresses) on the VECs or their indicators (Canter and Ross, IAIA). This custom of conducting cumulative impact assessments based on current baseline conditions ignores the basic premise of cumulative impacts - that they are the result of many small impacts that overlap in both time and space. Cumulative impact assessments would more effectively evaluate impacts if they were conducted first, to assess the cumulative impacts of prior developments, i.e. how has the vegetation been affected by development and is it already significant. If the impacts are already significant, then additional developments, even if less than 1 %, will contribute a small incremental increase to an already significant impact. It should be noted that other EIAs have used pre-development baselines to assess cumulative impacts.

➔ ***Request - April 2010***
Explain how Shell defines cumulative impacts and why past impacts from oil sands operations and other developments are not relevant.

Kearl Lake Levee and Drawdown Zone

Shell Jackpine Mine Expansion and Pierre River Mine Project EIA Update, December 2009: The proposed integrate stream diversion system from Shell Jackpine Mine -Phase I, JME, Syncrude's Aurora South Mine, and Imperial Oil's Kearl Oil Sands Project will divert water into Kearl Lake. As a result, the inflows and consequently the water levels in Kearl Lake and the proposed Imperial Oil Kearl Compensation Lake will be increased, which will cause flooding around the lakes. Two of channels will be built to convey the lake outflows to the Muskeg River, which will then be replaced by three 1.5 m diameter pipes. (from 2032 to mine closure). The pipelines have a lower flow capacity compared to ditches and will result in the lake storing more flood waters. To prevent flooding the surrounding areas (include all three adjacent mines), Shell plans to build a levee around Kearl Lake.

Flows through the channels and then the pipelines will be managed by Shell to minimize changes to Kearl Lake and the compensation lake. "However, the JME and drainage integration will result in changes to Kearl Lake water levels compared with pre-development conditions….The predicted changes to lake levels are less than 0.30 m on average between 2032 and Closure." Shell contends that "changes in the mean annual water levels are negligible."

The effects of the impoundment on soils and vegetation are uncertain, “therefore the impoundment area was considered as permanently disturbed rather than assessing the potential for altered plant communities”.

In addition, the effects on groundwater drawdown in the JME area were underestimated in the EIA and have been re-calculated in this EIA Update. The drawdown zone will affect wetlands both in and outside the LSA.

The Kearl Lake Levee and the increased water drawdown area is predicted to disturb riparian communities, old growth forest, peatlands (fens and bogs), patterned fens, economic forests, rare plants, and traditional plant potential, however the additional impacts do not change the overall ratings. Overall, the changes (loss of wetlands and increase in uplands due to the levee) “are less than 1% of the total clearing in the Project Application”.

➔ ***Request - April 2010***
Please calculate the cumulative impacts of the JME, the Kearl Lake Levee, and the increased drawdown area, as well as the impacts of other developments in the RSA on the vegetation KIRs.

Rare Plants - Table 2.4-4
Table 2.4-4 shows the rare plant observations in the Kearl Lake Area. Of the 12 species listed, 7 are considered rare (S1 or S2 on the ANHIC tracking list (Kemper 2009)).

➔ ***Request - April 2010***
Please estimate the impacts of the loss of these rare plant locations on a provincial level, using the NatureServe definition of Occurrence. For example, what is the impact of loosing a large population of an S1 species like white water-lily (Nymphaea tetragona)? Logically, if there are only 5 known occurrences, but 2 have been removed from previous projects, and 1 is lost for the levee, then only 2 out of 5 would remain. The cumulative impact of the loss of more than have the occurrences could justifiably be argued to be significant.

Traditional Land Use - Section 2.4.2.1
Members of the Fort McKay First Nation report that rat root grows in Kearl Lake.

➔***Request - April 2010***
What is the impact to First Nations of losing rat root, an important medicinal plant that grows in a limited number of areas.

Conclusions

The field methods and the description of the baseline data appears to use standard, accepted techniques. The assessment methods and assumptions may also be currently accepted, but serve to bias the assessment in favour of the proponent by masking the environmental impacts. Impacts at the local level range from negligible to high, but all impacts at the regional level are considered negligible, based on several unsupported assumptions, and an arbitrary method for determining Environmental Consequence.

The science of environmental assessment is relatively young and the methods and details evolve as we learn what works and what doesn’t. Each assessment is an opportunity to improve the methods so that they reflect the real impacts to the landscape in a biologically meaningful way.

Appendix D-12

Review of the Shell Jackpine Mine Expansion: Terrain, Soils, and Reclamation – Review for: Athabasca Chipewyan First Nation, July 2010, by Len Knapik of Pedocan Land Evaluation

REVIEW OF THE SHELL JACKPINE MINE EXPANSION: TERRAIN, SOILS, AND RECLAMATION

Review for: Athabasca Chipewyan First Nation

By: Pedocan Land Evaluation Ltd. (Len Knapik)

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1. Jackpine Mine Expansion

Shell has submitted an application and supplemental information to the Alberta Energy and Utilities Board and Alberta Environment for an approval to expand the Jackpine Mine. The planned size of the soil and vegetation disturbance area will increase from 7839 ha to 20,555 ha (approximately 51,000 acres).

This is a very large expansion. The mine area is located in townships 95, 96 and 97, ranges 8 and 9, west of the 4^{th} M. It extends from southwest of Kearl Lake to the Fort Hills and the McClelland Lake Wetland Complex, east of the Athabasca River.

This mine expansion will mine out a large portion of the Muskeg River mainstem. The Muskeg River flow will be routed through pipelines during the mining operation, and will be diverted through a new canal after mining.

Extensive areas of wetlands, including bogs and fens will be removed. Large patterned fens will be removed or altered by dewatering in the McClelland Lake Wetland Complex. Bogs and fens will not be replaced in the reclaimed landscape.

The tailings management plans include two additional large external tailings ponds and large end cut lakes with fluid tailings capped with water. Fluid tailings will be transferred from earlier mining phases to the end cut pits.

The expanded mine will operate until 2049, plus closure and reclamation time. However it seems likely that future expansions of the mine size and life could be announced. Shell estimates the time required for reclamation to reverse impacts and achieve a state of equivalent capability and sustainable ecosystems will be 80 years. A more conservative estimate might be hundreds of years for many landscape elements, and that many impacts are not reversible. The planned closure landscape will be very different from the natural landscape.

2. Closure and Reclamation Land Use Goals and Assumptions

Surface mining causes complete disruption of the landscape, the soils, the creeks and lakes, the wetland areas, and the vegetation and wildlife habitat. The impacts are extensive for the life of the mine and beyond. Shell claims that reclamation will be successful and almost all impacts are reversible.
The following discussion focuses on the closure and reclamation plans, and on the assumptions used to assess impacts of mining and the predicted reversal of impacts by reclamation.

The reclamation goals and assumptions used in the reclamation planning and impact assessment are the same for both the Expanded Jackpine Mine and the Pierre River Mine, and the review comments apply to both projects.

Shell has identified the following end land use goals for the closure landscapes

1. Reclamation of the landscape to an equivalent capability, optimizing the value of watershed, timber, wildlife habitat, fish habitat, recreation or other resources;
2. Returning equivalent pre-development levels of forest productivity;
3. Promoting the aesthetic qualities of the landscape;
4. Providing for traditional land uses; and
5. Leaving open the opportunity for other land uses.

2.1 Comments on Land Use Goals 1 and 2

1. **Reclamation to an equivalent capability for a variety of land uses.**
2. **Returning equivalent pre-development levels of forest productivity.**

Shell's reclamation goal is to achieve maintenance-free, self-sustaining ecosystems with a capability equivalent to pre-development conditions.
The closure planning process identifies a number of guiding principles and assumptions.

The following discussion evaluates the likelihood that the land use goals will be achieved by the closure, conservation and reclamation plan. The guidelines and assumptions used in estimating closure landscape quality and performance are critical to assessing adverse effects. Issues and questions are identified. Since the assessment of impacts to terrain and soils and land use is predicated on reclamation success or failure, the reclamation issues and questions are critical to the process.

2.1.1 Landscape Design

Shell will design landforms and landscapes using the CEMA Landscape Design Checklist (revised May 2005).

Concern: The Landscape Design Checklist is a checklist of design items and required actions, but actual landform design requires guidance documents that will be included in a Proposed Landscape Design Manual. The manual will not be prepared until research and development fills technology gaps, and monitoring provides feedback to improve designs, and adaptive management results in designs and construction methods that are successful. The current situation is that major knowledge and technology gaps exist in many essential design areas, and planners do not have the models and descriptions of best practices that are needed to design or construct landforms.

The technology to stabilize and cap fine tailings and build stable, predictable landforms is not currently available. Design requirements for large scale hydrologic landscapes constructed on tailings dikes and beaches and on fine tailings that are dewatering, with various soil substrates, with expectations for erosion control and integrated wetlands and biodiversity are very complex. The building blocks are not available. Models of geomorphic and hydrologic processes are required to design topography and soil landscapes that will support desired ecosites. Understanding of changing climate and evapotranspiration and moisture deficits and soil water budgets and shallow groundwater systems in reclaimed landscapes are essential, but missing elements. The response of soil performance and function to landform is unknown. The response of plant communities to landform - controlled site conditions and processes is not known.

2.1.2 Adaptive Management

Uncertainties in landscape performance and technology will be dealt with using the principles of adaptive management, and knowledge gaps will be filled through research programs.

Concern: The knowledge gaps are very large and the issues are very complex. It will take many years of intensive research to develop trial systems that must be monitored and provide feedback to validate understanding and adjust designs and management and then test again. Reclamation trials have been going on for almost 40 years in the oil sands and the surface is barely scratched. It is unlikely that sufficient new knowledge will be available to fill the necessary gaps before end of mining. A high-quality knowledge base is an essential requirement, but it will take several decades of research to put in place.

Most of the reclamation research and development of guidelines and manuals (adaptive management) is done through the Cumulative Effects Management Association (CEMA). However there has been a widening gap between the needs and expectations for cumulative effects management and the results delivered by CEMA. The growing gap is documented in EUB and Joint Panel decisions (Kennett 2007). The Athabasca Chipewyan First Nation withdrew from CEMA because of their concerns about lack of progress. If CEMA is always several years behind in providing critical information on cumulative effects and methods of mitigation several critical thresholds and limits of acceptable change could be crossed before they are identified. As oil sands development grows at a rapid pace the gap between needs and knowledge also grows.

Shell has not demonstrated that they understand the pre-mine terrestrial ecosystems in the area. In order to support an ecosite-based reclamation plan it is essential that the reclamation scientists understand the natural ecosites they hope to mimic. This means there must be intensive inventories of the pre-disturbance ecosites, done in an integrated fashion, to develop data and models to understand the synecology of the ecosites. An integrated team of soil scientists, vegetation ecologists, wildlife biologists and traditional scientists working together to gather data on the same plot at the same time can develop the integrated models that are needed. Shell has not used an integrated approach, and in fact they appear to rely on surrogate information more than actual field plot data. The ecosite phase inventory was done by an interpretation of the AVI data. Soil mapping was done as a single discipline effort. Several soil series were not sampled for characterization analysis on–site; rather published data from elsewhere was used. Understanding of soils and ecosystem function requires an understanding of effects of groundwater and fluctuations of depth to the saturated zone. Integration of soils and ecosite phase with groundwater information does not seem to be available.

The adaptive management approach is favored by Alberta Environment in its Regional Sustainable Development Strategy (RSDS) and by CEMA in several documents, and is a major strategy in Shell's approach to reclamation planning and impact assessment. In order for the adaptive management approach to work the knowledge gaps must be filled in timely fashion by research results and proven mitigation methods. If the management information is not available when needed, we cannot adapt until it is likely too late. The regulatory framework and policy decisions must also be in place when they are needed. The knowledge base needed by regulators and stakeholders at the application stage is not sufficient to evaluate claims that terrestrial impacts can be reversed. Closure plans that promise equivalent capability and forest productivity and wildlife habitat based on ecosite phases that will establish on the reclaimed land is not based on scientific information or demonstrated ability; it is based on "adaptive management".
There is a widening gap between expectations for management and research and development results. Relying on adaptive management when the rate of knowledge growth is not keeping up with needs is not a wise management approach.
The EUB-CEAA Joint Panel on the Albian Sands Muskeg River Mine issued its decision in 2006, and stated its belief that "cumulative effects is the biggest issue facing the oil sands region". It would be logical to slow the pace of growth and to not approve new mines until scientific research, management methods and stakeholder input results in a more complete framework for addressing the effects of development.
Shell promises to conduct monitoring of reclaimed areas. Terrestrial systems monitoring should be highlighted as a major activity at all stages of a mine project. Monitoring natural systems before they are mined out is necessary to understand how the systems work in that area with local climate. Monitoring effects of drainage on ecosites; effects of salvage and storage on soil quality; effects of mining on land use; effects of alternate methods on reclamation success; early soil and site development, structure and limitations to use; maturing landscapes structure, function and use. The information gained from monitoring response to management is essential to the adaptive management approach. The monitoring results should be shared with the public, in a form that can be accessed easily. We do not see a framework in place that provides this information now.

Table 1. Background Re: Reclamation Technology Gaps.

Summarized from Syncrude (2006), Barbour et al. (2007) and other sources

Wetland reclamation

- See Harris (2007) Guideline for Wetland Establishment Section 7 – Addressing Uncertainty

Drainage Basin / Landform grading, shaping and drainage.

- How to construct vegetated waterways
- How to control salinity

Ecosite Ecology

For each landform / material / soil type (ecosite):

- What are the water and energy balances (capital and circulation rates, where and how much water is in the landscape, how is it moving around and why);
- What are the salt balances, including inorganics, organics, ions, nutrients, metals (capital and circulation rates);
- What are the plant and ecological responses to water, energy and salt balances;
- What are the vegetation succession sequences of reclaimed ecosites;

- Identify best management practices for establishment of boreal plant communities in closure landscapes, including tailored planting**,** selective LFH and topsoil salvage and placement, and propagation techniques for plant species of concern.

Soils Capping Research Needs

- Suitability of capping prescriptions for tailings sands for drier than mesic sites with water tables > 1.5 m bgs.
- Macro and micro nutrient cycling and dynamics, including effects of fertilization in undisturbed and reconstructed soils.
    a. Order of priority: Nitrogen, phosphorous, micronutrients.
    b. Impact of moisture regimes on nutrient dynamics.
- Capping options other than “low risk” should be examined to raise level of confidence in long-term performance:
    c. Effects of climate cycling on salt and water balances on sand,
    d. Effects of climate cycling on salt and water balances on SSOB,
    e. Effects of elevated pH on ecosystem development,
    f. Improved understanding of trajectories for plant community development on reclaimed sites to build confidence that reclaimed areas are moving towards desired end points,
    g. Slope and aspect effects on water and salt balances, and
    h. Desodification of sodium impacted soils. Flushing rates of dominantly mineral soil profiles.

Recommendations:
Shell should:

1. Clearly identify the limits of demonstrated reclamation technology to replace equivalent capability (using a comprehensive definition of equivalent capability).
2. Discuss the technology gaps that prevent or put into question the successful reclamation of sustainable landscapes to provide the ecological goods and services to meet land use goals.
3. Discuss the potential for reclamation success or degree of success that is likely for various closure landscape areas, based on current knowledge and research programs.
4. Discuss the issues specific to stabilization and reclamation of fine tailings.
5. Review impact assessments and confidence ratings based on demonstrated reclamation success.

The key to using adaptive management to reach a goal of successful reclamation is thorough knowledge and understanding of the pre-disturbance ecosystem. This requires extensive monitoring before and during the anticipated disturbance. The ecosystem should not be destroyed before it has been thoroughly monitored and understood.

2.1.3 Use of previous EPEA Approval Conditions

Shell states that the detailed reclamation planning process is designed considering the following:

- **Reclamation practices detailed in the draft EPEA Approval conditions for the Muskeg River Mine Expansion will be used as the basis for soil salvage, reconstruction and revegetation.**

Concern: The CEMA SVGA Forest Productivity Task Group (2008) recommends "it would not be valid to suggest that all reclamation practices can now be shifted to the minimum treatments required by approvals, and still result in restoration of productive forest ecosystems. There are a number of reasons why variation in soil depths, layering and materials may be important to ultimate reclamation objectives, but these reasons are not fully understood or explored at this time.

2.1.4 Equivalent Capability using the LCCS

- **The goal of equivalent capability will be met by using methods outlined in the Land Capability Classification System for Forest Ecosystems in the Oil Sands (2006).**

Concern: Shell states they will reclaim disturbed lands to meet or exceed equivalent land capability for forestry. This expectation is a fundamental cornerstone in the EIA process. Replacement of equivalent land capability is also a legislated requirement under EPEA.

Shell states they will use the Land Capability Classification System for Forest Ecosystems (LCCS) to ensure reclamation to equivalent capability standards will result (C&R Plan Section 20; CCR Plan, Section 2.3).

However; use of the LCCS **<u>does not</u>** ensure replacement of equivalent land capability. Note the following statements excerpted from the LCCS Field Manual, Third Edition (June 2006), Purpose of Manual and Statement of Limitations (page ii):
"*The first round of monitoring of the long term plots has not resulted in establishment of a clear correlation between LCCS-predicted forest site productivity and measured forest site productivity, particularly on reclaimed sites."*

"Because the link between LCCS rating and forest productivity is currently undemonstrated, the LCCS should be considered as one in a suite of tools for site evaluation and reclamation planning, rather than a comprehensive system that alone will ensure replacement and documentation of equivalent land capabilities."

And, in Section 1.1 (page 1) of the manual:
"The use of the LCCS as a tool to calculate minimum soil requirements (i.e., thickness) necessary for the achievement of particular capability classes in the design of reclaimed soils is not recommended"

Reviews of the LCCS system by J.S. Thrower (2004, 2005) found the system has low ability to distinguish site index differences between one soil capability class and another. Therefore the LCCS does not suit the intended purpose of predicting productivity / capability by the indirect method of measuring soil site parameters.
Analysis of the relationships between site index and LCCS ratings on reclaimed and natural plots by Timberline (2008) found that the LCCS is not effective in predicting site index on reclaimed sites.

The CEMA Soils and Vegetation Sub Group (SVSG) Forest Productivity Task Group (in Timberline 2008) made the following recommendation: "A comprehensive analysis of data collected to date indicates that the LCCS does not have value for predicting tree growth performance (site index) on reclaimed sites, and that the LCCS should no longer be viewed as a predictive tool for tree height growth performance. The LCCS should be "de-coupled" from its stated task of predicting forest productivity classes."

The Forest Productivity Task Group also recommended a more holistic definition of forest productivity such as "Long-term ecosystem productivity is the capacity of the site to support forest ecosystems over generations of humans and trees, as measured against some defined references." The Task Group stated that assessing restoration of ecosystem productivity on reclaimed sites may include evaluation of a wider suite of productivity indicators (e.g. assessing/modeling carbon assimilation, net primary productivity, below-ground biomass production, etc.).

The Government of Alberta accepted the recommendations of the SVSG and does not accept use of the LCCS to predict forest productivity or equivalent capability.

Shell appears to rely solely on the LCCS system to predict that: reclamation will meet equivalent capability requirements; and soil classes will equate to forest productivity levels. This approach appears to ignore the stated purpose and limitations of the LCCS, results of peer reviews and the position of the SVSG and the Alberta government. If Shell has no other data or information to support their assumption of attaining equivalent capability and forest productivity the assumption appears to be highly questionable. It needs to be backed up by scientific information and there should be a risk analysis of non-performance.

2.1.5 Reconstructed Soil Performance

- **Reconstructed soil performance will mimic natural soils over time.**

Concern: Shell provided no estimate of time frame or references or background for this assumption in the C&R Plan. In response to supplementary information requests Shell related a communication by L.Leskiw that some surface soil structure has developed in 20 to 30 years on reclaimed soils at Syncrude. Shell expects reclaimed soils to develop to a stage of equivalent capability in 80 years.

Research by Naeth and students at the University of Alberta is finding that the organic matter in soils constructed with peat / mineral soil mix is very different from natural soil organic matter in form and function.

Review of the LCCS system and correlation of nutrient regime to tree growth showed differences between natural and reclaimed soils (Timberline 2008). The differences were attributed to different form and function of organic matter derived from peat replacement compared to natural soil organic matter.

Soil biogeochemistry research on reclaimed soils is in the early stages but the weathering rates and products from overburden and tailings sand and effects on macro and micro nutrient cycling and dynamics are unknown and cannot be estimated with confidence. Effects of fertilizers on constructed soils are unknown. Effects of climate on salt and water balances on soils built on sand are unknown. Effects of high pH in constructed soils on growth of plants adapted to low pH and on ecosite development are unknown. Effects of salts, organic compounds, metals, and methane from tailings and process affected water are unknown. These unknowns were identified as soils capping research needs by Barbour et al. (2007).

Soils constructed with a coversoil mix of peat and sand or clay placed over tailings sand have many different physical and chemical properties from natural soils. Weathering of minerals and low grade bitumen in geological materials placed in the upper soil zone will take many tens or hundreds of years before the system mimics a natural soil.

Most research has focused on mesic moisture regime soils. There has been no research on constructing sandy soils that would support a blueberry – jackpine (b1) ecosite phase, a

type of interest to First Nations people. The soil processes and function in natural b1 sites are unknown. There is also no knowledge base of soil processes and function and ecosite response on wet soils, both natural and constructed.
Shell has not demonstrated understanding of carbon assimilation or net primary productivity or nutrient pools and flux rates in reclaimed systems.
If we recognize that constructed soils will have several different properties from natural soils, and that properties usually correlate to function, we should expect that constructed soils will function differently than natural soils. We do not know how the reconstructed soils will function in terms of carbon and nitrogen cycles and water balance and ecosite development. Successional development of ecosite phases might be affected in ways we cannot anticipate.

2.1.6 Wetlands Reconstruction

- **Wetlands reconstruction practices will follow the 2007 draft Guideline for Wetland Establishment on Reclaimed Oil Sands Leases**

Concern: The Guideline for Wetland Establishment (2007) is an update of the state of knowledge regarding reclamation of wetlands in the oil sands region. It is not a "how to build a wetland" manual. It is focused on planning needs and issues, and it identifies many critical knowledge gaps.
The Guideline for Wetland Establishment emphasizes the need for involvement of First Nations people in the planning and construction process (see Land Use Goal #3 comments).

2.1.7 End Land Use Constraints

Shell states that the end land use options available will be constrained by the type of landforms to be constructed.

Concern: The use of surface mining rather than in-situ methods constrains the land use options. The final landscape and landforms are determined largely by the mining plan and bitumen extraction/tailings technology. The large overburden dump forms a large upland plateau because the miners do not want to replace it or distribute it across the landscape due to handling costs. The large external tailings pond is a result of extraction and wet tailings technology. The pond would be unnecessary if the miner converted to a dry tailings system. The landforms built on wet fine tailings have many long-term problems that could be avoided with a dry tailings system. Economics and currently available technologies drive this system.
The landscapes and landforms described in the closure plans will be very different from natural landscapes and landforms. The overall morphology of constructed plateau uplands with terraced sides and sand dykes and beaches with straight lines and square corners are designed to meet engineering standards. The landforms will not appear to mimic natural landforms. There will be a very small extent of wetlands in the landscape, which may or may not be wet all summer. The drainage channels will be constructed and are unlikely to appear natural.

There does not appear to be meaningful involvement of First Nations people and requirements for traditional use in the design of the landforms. Considerations of societal values in landform design would include aesthetic/spiritual values, trail access to hunting and gathering areas and camping locations near good water. If these options are not possible because of the constraints that relate to mining methods perhaps the mine plan should change.

2.2 Comments on Land Use Goals 3 and 4

3. Promoting the aesthetic qualities of the landscape.
4. Providing for traditional land uses.

2.2.1 Visual Qualities of Terrain and Landforms

The closure landscapes will be very different in macro form and appearance from the baseline landscapes. The closure landscapes will have several high (200 feet high) hills made up of overburden dumps (overburden plateaus) and out-of-pit tailings ponds (tailings sand plateaus). These hills will have a constructed box appearance with straight sides and square corners. These terrain changes are the same as for the other mines (see Suncor and Syncrude for examples) in the area. There will be an extensive pattern of square hills with flat tops over a large part of the region. The land between the hills will be nearly flat, reclaimed tailings ponds with a few end pit lakes. The new landforms will not have natural appearance. There will be very few wetlands and no bogs or fens. These changes cause negative visual impact and the effects are cumulative in nature. In addition to visual changes, the changes will result in unnatural landscape influence on water movement and distribution of ecosites. The effect of these changes seems to be ignored in the environmental impact assessment.

There should be concerted effort made to design closure landscapes to mimic natural terrain. Terrain and landform design should consider form, pattern, color and diversity of upland and lowland, water, wetlands and creeks. Techniques for landscape analysis that document the components of the physical terrain and the aesthetic qualities could be employed. First Nations people should have input to design and construction of the terrain.

2.2.2 Traditional Land Uses and Values

The goal of meeting traditional land use was not developed in the application.
The conversion of the natural landscape with approximately 65 percent wetlands including extensive bogs and fens, to a closure landscape with no wetlands, including bogs or fens, is a major impact on aesthetic qualities and on traditional use potential.

<u>Importance of wetlands to First Nations</u>
As stated in the CEMA "Guideline for Wetland Establishment on Reclaimed Oil Sands Leases (Harris 2007)":

"*Natural boreal wetlands are a critical habitat for many important wildlife species, including woodland caribou, moose, muskrat, waterfowl (particularly diving ducks) and amphibians. They are linked to the traditional way of life of local Aboriginal people, because of the economic importance of fur-trading and the cultural significance of many wildlife species (moose, muskrat, beaver) and wetland plants (sphagnum moss, rat root, bog cranberry). Aboriginal knowledge and interpretations of wetland systems are based on long term empirical evidence and have much to contribute to western scientific research findings."*
"Wetlands in the oil sands region are indelibly linked to the traditional way of life".
"People of the Fort McKay, Anzac, and Fort Chipewyan communities continue to use wetlands for subsistence hunting and trapping, for food and medicinal plant collection, and for spiritual well-being".

<u>Importance of Wetlands for Alberta</u>
The Alberta Water for Life strategy gives wetlands, as fundamental components of watersheds, a high priority for conservation. It is to be expected that the structural and functional health of reclaimed wetlands will be considered within a landscape-scale action framework" (Guideline for Wetland Establishment, p.20).

A Wetland Policy was to be established by 2007, which would require restoration or compensation and replacement but Alberta cannot seem to obtain buy-in by stakeholders and move past a draft policy level.

The CEMA Guideline for Wetland Establishment on Reclaimed Oil Sands Leases recommends a watershed : wetlands ratio of 2:1 is required to create sustainable ecosystems in the oil sands region. This means 33% of the reclaimed watershed should be wetlands, but the JPME closure plan shows zero percent.

The Jackpine Mine Expansion area has 9,279 ha of wetlands. The planned closure landscape has no wetlands. Most of the pre-disturbance wetlands are bogs and fens.

Shell considers the loss of peat-forming wetlands to be irreversible. This same pattern of loss of large landscape-sized wetlands is happening at every oil sands mine. The total area deemed suitable for surface mining is approximately 253,500 ha, and about 50 percent is wetlands. If all of the area is mined about 125,000 ha of wetlands (mostly bogs and fens) will be impacted. That is a very large cumulative loss of wetland, especially bogs and fens. There is no compensation planned for irreversible loss of wetland. The EIA considers the environmental consequence of loss of wetlands to be low.

There are no bogs or fens planned for the reclaimed landscape. The result is the loss of wetlands, loss of biodiversity; and loss of habitat for rare plants, traditional use plants and wildlife. Effects on the ecohydrology of the area are unknown. The importance of peat in holding and slowly releasing water in an area with net deficit evapotranspiration should not be underestimated. If climate change results in warmer and drier summers shallow open water wetlands with no peat will not retain water unless they have flow-through or are fed by seepage (Guideline for Wetland Establishment 2007).

First Nation societal values are not being incorporated into planning guidelines. The Guideline for Wetland Establishment 2007 states "this guideline has not emphasized the values placed on wetlands. However, wetlands in the oil sands region have traditionally been highly valued for indigenous cultural and spiritual growth, and for economic prosperity as habitat for furbearers. There has been limited investigation of how reclaimed wetlands may be used to contribute to these community needs."

3. Closure Landforms

3.1 Capped Tailings Closure Landforms

The tailings ponds will be the most difficult landforms to reclaim. The closure landscapes will have large areas of reclaimed fine tailings, including the external ponds and the in-pit ponds. The proposed reclamation requires stabilizing the tailings and capping them with 3 to 5 meters of overburden or sand capping. The degree of expected success in stabilizing and reclaiming the fine tailings is uncertain, as new technology is required, and successful reclamation has not been demonstrated.

Syncrude (2006) identified several technology gaps related to fine tailings reclamation, including:

- Methods of overburden or sand placement over tailings.
- Appropriate landscape design and special technologies to reclaim soft, mature fine tailings.
- Creation of swale and ridge topography on the sand cap for water table control.
- Wet tailings sand trafficability.

The groundwater surface will be close to the reclaimed ground surface. The groundwater will be of poor quality, with high dissolved salts, high sodium, high pH, hydrocarbons and napthenic acids. This will result in salt-affected soils (saline and sodic soils) over an unknown percentage of the capped tailings areas. The soils may also be contaminated with hydrocarbons and trace elements. These soils have very different characteristics from the baseline soils, and the differences are seen to be negative for soil quality and productivity. When surface water infiltrates it is likely to mix with the process-affected water and raise the water table in swales and lower slopes, resulting in salt-affected soils. There are essentially no salt affected soils in the pre-mine landscapes. Saline – sodic soils are essentially non-productive.
For example, at the Jackpine Mine Expansion Project: Most of the closure land capability on reclaimed tailings (C&R Plan, Figure 20-1) is rated as "low capability" or "conditionally productive." It would seem likely that if the actual quality of reclaimed soils is slightly less than hoped for, much of the area could be "non-productive."

Shell should document the state of knowledge regarding reclamation of oil sands tailings, and identify the knowledge gaps and research efforts that are underway to answer the many questions. Information requirements include:

-anticipated properties of the tailings and the associated fluids,
-methods to be used to cap the tailings,
-schedule for capping,
-the time-strength trajectory of capped tailings and associated subsidence and effects on the closure landscape and soils,
-management of surface water and near-surface water table in the reclaimed landscape to avoid development of saline-sodic soils,
-risk of contamination by organic compounds, salts, and released methane and hydrogen sulfide and effects on soil biology in reclaimed soils,
-detailed soil reconstruction prescriptions to meet various ecosite targets,
-soil water and nutrient dynamics in various ecosite types,
-schedule for reclamation milestones for various ecosite types,
-soil and vegetation parameters that will be monitored, and standards for assessing reclamation success, and
- assessment of the risk that reclamation will not meet planned targets and there will be substantial long-term adverse effects.

Tailings Management and Implications for Reclamation

The ERCB issued Directive 074 in 2009. This directive specifies performance criteria for the reduction of fluid tailings and the formation of trafficable deposits. Large and growing inventories of fluid tailings that require long-term containment are causing growing public concern.

Decision reports issued by the EUB and joint panels of the EUB and CEAA identified several long-term objectives respecting tailings management:

- To minimize and eventually eliminate long-term storage of fluid tailings in the reclamation landscape.
- To create a trafficable landscape at the earliest opportunity (within 5 years) to facilitate progressive reclamation.
- To eliminate or reduce containment of fluid tailings in an external tailings disposal area during operations.
- To reduce stored process-affected water volumes on site.
- To maximize process water recycling.
- To minimize resource sterilization associated with tailings ponds.
- To ensure that the liability for tailings is managed through reclamation of tailings ponds.

Suncor and Syncrude have announced new technologies to dewater tailings and have dry, reclaimable tailings within seven to ten years.

The Jackpine Expansion plans identify two new external tailings ponds and a plan to transfer large volumes of fluid tailings to the end cut pits from earlier mining phases. Shell does not appear to meet the objectives of recent joint panel decision reports and requirements of ERCB Directive 074. Major and fundamental changes are required, which will affect closure and reclamation plans and time schedules.

What changes is Shell proposing to eliminate external tailings ponds; eliminate long-term storage of wet tailings in the reclaimed landscape and in end pit lakes; and allow reclamation of tailings within five years?

3.2 Tailings Sand Dikes and Beaches Closure Landforms

Reclamation of the tailings sand dikes and beaches presents many unsolved challenges. In addition to the limitations related to the stability and erosion control of tailings sand materials, there is the challenge of controlling the water table and seepage of process-affected water on the slopes. Long-term seepage is likely to result in saline – sodic soils on the slopes and toe berms. The moisture and nutrient regimes of an ecosite established on these locations are likely to differ from what was planned. Rates and processes of erosion are unknown and slope failures are a significant risk. Existing mines have a history of revegetation failures on the tailings sand slopes.

Syncrude (2006 and 2008) identified several reclamation concerns and technology gaps after many years of operational practice and much research effort) related to:

- Lack of methods to assess and improve the performance of the tailings sand slopes.
- Uncertainty re rates and processes of erosion on closure landforms and effect on the landscape.
- Migration of salts in water and effects on soils and vegetation.

There appears to be significant risk that at least part of the reclaimed tailings sand slopes will not support planned ecosites, and will not contribute to equivalent capability for various closure land uses. The likelihood and extent of unexpected reclamation results has not been reported by Shell.

Shell should identify their state of knowledge and uncertainties regarding reclamation methods and risk of failure on tailings pond dikes.

Stream Channels, Wetlands and Water Bodies Closure Landforms

The reclaimed landscape will include a number of low areas, a constructed channel for the Muskeg River, runoff channels and streams, wetland areas with high water table, and ponds. Poor groundwater quality due to seepage of process-affected water from tailings seems likely to result in saline wetlands with contamination by salts, hydrocarbons, napthenic acids, and hydrogen sulfide.

How will Shell estimate the location of the long-term water table and seepage areas in an area when groundwater is being affected by other mines and climate change is likely but unpredictable?

How will surface water be separated from process-affected water in the fine tailings?

4. McClelland Lake Wetland Complex

The McClelland Lake watershed and the wetland complex within it represent an area with tremendous diversity of terrain and biological components. A dissected kame, an esker, sinkhole lakes, numerous types of fens, bogs, lakes and creeks combine to form a unique resource. The McClelland Lake Wetland Complex (MLWC) includes several environmentally significant features, including the McClelland Lake Fen, McClelland Lake and the McClelland Lake Sinkholes (Alberta Parks Heritage Information Centre; Westworth 1990). The wetland is home to many species of concern. First Nations people recognize the beauty and significance of the area, and have traditionally gathered pitcher plants in the wetlands for medicinal use (Charlie Voyageur, ACFN Elder, pers. comm.). The MLWC was protected under the IRP for the area until the Alberta Cabinet amended the IRP in 2002 to allow True North (Fort Hills Mine) to apply for approval to mine into the wetland complex.

The EUB True North Decision 2002-089 documents the evidence provided at the hearing and recognized "that without mitigation, the combined effects of chemical contamination and water table changes associated with mining the southwest portion of the MLWC may destroy bryophyte communities to the northeast, interrupting peat production". The Board decision was that the bitumen underlying the wetland complex represents a significant resource that should be recovered "as long as it can be done in a manner that minimizes damage to the rest of the complex". The Board supported Alberta's intention to require True North to provide an acceptable mitigation plan prior to mining in the MLWC.

Shell proposes to mine into the McClelland Lake Wetland Complex, on the southeast side, in the location of a large patterned fen. The mining and associated dewatering would impact approximately 2500 ha (or more?) of the wetland complex (SIR round 2 responses, questions 13 and 22). Shell states that the mitigation methods proposed by Fort Hills are unlikely to be effective in protecting the patterned fens. Shell does not propose alternative mitigation to protect the wetland complex.

It seems to be apparent that this project will produce irreversible, adverse cumulative, environmental effects that threaten the ecological integrity of the McClelland Lake Wetland Complex.

The extensive loss of wetlands from the entire mined area will not be mitigated. These losses must also be considered to be irreversible, adverse, cumulative environmental effects.

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Appendix D-13

Shell Canada Limited Jackpine Mine Expansion and Pierre River Mine Projects Environmental Impact Assessment Report – Review for Athabasca Chipewyan First Nation – Traditional Land Use and Traditional Knowledge, October 2008, by Janelle Baker of Little Seed Consulting

Shell Canada Limited Jackpine Mine Expansion and Pierre River Mine

Environmental Impact Assessment Report Review for Athabasca Chipewyan First Nation

Traditional Land Use & Traditional Knowledge

By:
Janelle Baker, Little Seed Consulting
October, 2008

Introduction

The Athabasca Chipewyan First Nation (ACFN) Industry Relations Corporation (IRC) requested that DS Environmental provide a review of the Shell Canada Limited Jackpine Mine Expansion and Pierre River Mine Environmental Impact Assessment (EIA). Both projects are included in one EIA and Shell submitted the application to Alberta Environment in December 2007 and an update in May 2007.

Overview

Information regarding traditional land use is provided for both projects in a combined fashion in this EIA so that is it not possible to separate the information provided according to each proposed project development. For that reason, both mines are included as one in this review. ACFN members were not directly consulted in regard to their traditional lands and therefore detailed nation-specific information is lacking in this EIA. Traditional land use for the ACFN is a way of life that includes spiritual, cultural, linguistic, medicinal, and subsistence activities. The many components of traditional land use are inseparable and crucial for the continuation of the way of life for the ACFN people.

Traditional Land Use

Overview

Traditional land use for the Jackpine Mine Expansion is discussed in several sections of the EIA including Human Environment (Volume 5, Section 8) and Public Consultation (Volumes, Section 15). More specifically, there are sections on traditional land use in sections 8.3 and 8.7.7 of the Human Environment component of the EIA. The traditional knowledge and land use section is required by the terms of reference for this EIA. The terms of reference (January 2008) for traditional ecological knowledge and land use are as follows:

Provide details on the consultation undertaken with Aboriginal communities with respect to traditional ecological knowledge and traditional land use. Determine whether there will be implications on traditional land use resulting from the Project. Discuss:

a) the extent of traditional land use and cultural use in the Study Area. Discuss the vegetation and wildlife used for nutritional, cultural and medicinal purposes and identify cabin sites, spiritual sites and graves;

b) Project and cumulative effects of development on traditional uses and mitigation strategies to prevent or minimize effects; and

c) identify how Traditional Ecological Knowledge was incorporated into the EIA report.

The regional study area (RSA) for the ACFN is based on their traditional territory identified in the published books: “Traditional Land Use Study” and “Footprints on the Land”. The RSA is calculated as a total for both proposed projects in the EIA. The effects of the projects on traditional land use were evaluated in the local study areas based on the boundaries of six Registered Fur Management Areas that will be directly affected by the project. The band membership of the RFMA trappers is not revealed in the EIA.

The EIA identifies the following resources to be in the ACFN RSA:

- ACFN regional study area: 4,373, 856 ha
- Area that has already been disturbed: 449, 998 ha (10%)
- The RSA includes land available for hunting, trapping and plant harvesting
- Eymundson Sinkholes and other environmentally sensitive areas

The EIA identifies the following impacts:

- On a regional level, the project will increase the area of disturbances of ACFN traditional territories
- The activities associated with project construction and operation will result in a direct loss of land (either temporarily or permanently) that is available for hunting, trapping, and plant gathering with in each of the RFMAs
- Planned developments will affect 482,492 ha (14%) of the ACFN RSA
- Two trap cabins (RFMA #1716 and #1714) will be relocated
- Two berry harvesting areas will be disturbed (Jackpine Mine expansion)
- Eymundson Sinkholes will be disturbed
- Increased population pressure might also result in low impacts on hunting, fishing, berry picking and recreation throughout the regional study area because of increased competition for resources
- Increasing levels of planned regional development are likely to have a negative effect on the potential to sustain the traditional way of life as an option for community members…with the temporary loss of land available for trapping and other traditional activities, and the attractiveness of opportunities outside the traditional life (i.e., wage labour), the Aboriginal communities face a challenge in maintaining a pool of traditional practitioners to sustain their cultural identity and to be able to face the time when industry leaves the region

The EIA lists the following trappers' concerns*:

- Loss of wildlife habitat
- Noise, air, and light emissions and increased traffic negatively affect wildlife abundance
- A reduction in fish health and size due to industrial developments in the area
- A loss of enjoyment of their traplines due to industrial noise and odours and increased vandalism due to increased access into the area
- A concern that development makes it hard to pass on trapping skills to future generations
- In addition to dwindling animal populations outside hunters are increasing hunting pressure, especially for black bear and moose

The EIA lists the following mitigations:

- While reclamation should replace habitat with wildlife and traditional plant potential, this will take place until the Far Future
- Shell will provide compensation to trappers directly affected by the project
- Shell will continue to consult with all Aboriginal stakeholders
- Shell will facilitate access across the project area by trappers to their trapline
- Shell is committed to providing a system for cultural diversity awareness training for its employees and contractors to foster respect for traditional resource users, traplines, cabins, trails and equipment
- Shell will continue to actively participate in regional multi-stakeholder planning and research initiatives that consider the long-term sustainability of effective traditional land use including: CEMA, RWG, SEWG
- Incorporating resource use values, such as recreational, fishing, hunting, trapping and berry picking capabilities in reclamation plans

*Note: The affected trappers provided detailed traditional environmental knowledge and listed their concerns regarding noise, air, and light pollution. This information can be found in the following sections: noise assessment (volume 3, section 4), air quality assessment (volume 3, section 3), and visual aesthetics assessment (volume 5, section 8.5).

Discussion

The proposed mitigations do not address the listed impacts and concerns. Reclamation in the “far future” and financial compensation to trappers in the project area do not address the loss of traditional territory and associated use for the ACFN in its entirety. The term “far future” is not defined and so no timeline for reclamation is provided. Damage to wildlife populations and associated cultural activities is not mitigated. Also, engagement with CEMA is stated as a mitigation, but ACFN is not a member of that organization.

Assessment Review

The major flaw in this application is that ACFN members were not directly consulted in regard to their traditional lands. The EIA traditional land use components are based on ACFN’s published documents and interviews with the six affected trapline holders (and their band memberships are not made clear). In the consultation sections of the EIA the following activities regarding ACFN traditional lands are listed:

- In the Jackpine Mine Expansion Public Consultation Section (Volume 1, Section 15) ACFN Council discussed “infringement of treaty rights related to not being able to access and use traditional lands”. They also “request site visits with Elders and youth before areas are disturbed”. These concerns are not identified in the traditional land use and associated mitigations sections of the EIA.
- In the Pierre River Mine Consultation Section (Volume 2, Section 15) it was on the agenda in a meeting on August 16, 2007 for Shell to “request for permission to use existing TLU information”, but it states that the opportunity to discuss the topic did not arise. There is no other mention of this topic being discussed in the consultation records therefore one could assume that permission was not granted to use the books that are listed as the only sources for information from ACFN in the EIA.

Reclamation is listed as a main mitigation, however no timeline for reclamation is provided. The EIA does not comply with the terms of reference which state the EIA will discuss, “ the extent of traditional land use and cultural use in the Study Area” and “Project and cumulative effects of development on traditional uses and mitigation strategies to prevent or minimize effects” since ACFN was not fully consulted on these topics.

Key Concerns

Several key concerns were identified with regards to traditional land use during the review. These include:

8. <u>ACFN members were not consulted regarding impact of the project on their traditional lands</u>

Only the six impacted trappers were interviewed, and their band membership is not made clear. Information regarding ACFN’s traditional territory in the project area is taken from published documents (without permission or an information sharing agreement).

➔ **Recommendation:**

Engage members of ACFN in a traditional land use assessment of the project areas. Invite Elders and youth to assess project area before construction as ACFN requesting in August 16, 2007 meeting.

9. <u>Direct loss of traditional territory</u>

The EIA states that a section of ACFN's traditional territory will be disturbed and not reclaimed until the far future. No actual timeline is provided for reclamation and only trappers were consulted regarding the loss of traditional territory.

➔ **Recommendation:**

Consult ACFN regarding the loss of their traditional territory. Work with ACFN to find mutually beneficial solutions to this problem. Some possibilities are to help ACFN preserve other traditional areas in exchange and fund traditional youth camps to continue the transmission of important traditional environmental knowledge.

Update on Pierre River Mine Project Supplemental Information May 2009

According to Shell's supplemental information on the Pierre River Mine Project, Shell has supported Athabasca Chipewyan First Nation (ACFN) in the collection of traditional land use (TLU) and traditional environmental knowledge (TEK) as it relates to the projects. The TLU and TEK study has been completed since the application was produced. The study contains project-specific TLU and TEK information provided by community members, as documented by consultants selected by ACFN. At the request of the ACFN, Shell has not included or cited material from its report in the Project Update.

Shell responded to the technical review clarification questions regarding by referring to the above-mentioned TLU and TEK work and by claiming that funding the technical review is a part of consultation. Shell also says that they are consulting ACFN on the potential impacts of the project on ACFN's traditional lands and Aboriginal and Treaty rights.

Follow-up Questions:

- How will the TLU and TEK information that ACFN has provided be considered in the project planning and operation?
- Will any identified sites be avoided or mitigated?
- Does the TEK information provided correspond with the scientific information in the EIA?
- How will Shell address ACFN member's concerns about TLU in the project area?

Appendix D-14

Human Health Risk Assessment: Review of Jackpine Mine Expansion Project and Pierre River Project EIAs, September 28 2008, by Dr. John Dennis, of SolAero Ltd.

Human Health Risk Assessment: Review of Jackpine Mine Expansion Project and Pierre River Mine Project EIA

Submitted to ACFN IRC through DS Environmental
Sept 28 2008

By
John Dennis, PhD
SolAero Ltd

Introduction

This review of the Human Health Risk Assessment (HHRA) of the Jackpine Mine Expansion & Pierre River Project is intended as a critically objective review of the content and limitations of the HHRA within the EIA. This review has a specific focus on health impacts of the proposed Jackpine Mine Expansion & Pierre River Project on the Fort Chipewyan and specifically the ACFN community residing in Fort Chipewyan.

Documents reviewed include:

- Project Descriptions and EIA. CD, 12/07, with specific focus on section 5.3
- Environmental Settings Report. CD 12/07
- EIA Update May 2008

This review is presented in two sections.

Section A critically reviews the HHRA and highlights areas which are considered weak.

Section B introduces an important area of Human Health Impact which is entirely absent from the Jackpine Mine Expansion & Pierre River HHRA portion of the EIA.

Section A. Critical Review of the Jackpine Mine Expansion & Pierre River EIA's HHRA.

A.1 Introduction

The project application describes the construction and operation of a large industrial facility in the south of ACFN traditional territory. The Human Health Risk Assessment within the Environmental Impact Assessment (EIA) uses a traditional approach which seeks to identify emissions chemicals and estimated emission concentrations, models exposure pathways and exposure concentrations to human receptors, and, in comparison to established or developed 'safe' exposure limits ultimately seeks to quantify the expected health risk.

Further, within the EIA for the Jackpine Mine Expansion & Pierre River Project, 3 scenario cases are developed for the HHRA:

- Base Case (current, existing levels of emissions)
- Application Case (Base Case + Project emissions)
- Planned Development Case (Application Case + emissions from planned projects)

The sections in the EIA which pertain directly to the HHRA is primarily Volume 3 Section 5.3 pages 5-26 through 5-152 along with supporting references, cross-references and appendices. The HHRA is summarized in section 2.4.1.1 as follows:

> *Overall, the Project emissions alone, and in combination with other sources of COPCs are not expected to result in a noticeable increase in health risks in the Oil Sands Region …*

Further, throughout the EIA there are numerous statements made that conservative assumptions were routinely employed within the HHRA.

So, in summary, the HHRA portion EIA concludes that the project alone, and in conjunction with additional future industrial development are not expected to increase health risks in the oil sands region, and that conservatism has been widely applied in the HHRA in determining health risk.

A.2 Critical Review of the HHRA

A.2.1 Challenging use of Conservative Assumptions within the HHRA

The project HHRA identifies a large number of chemicals and chemical groups which will be emitted to air as part of normal plant development and operation. This inventory list of chemicals and chemical groups is presented in Table 5.3-2.

A count of the COCs within Table 5.3-2 indicate that some 60-70 individual chemicals have been specifically identified and undergone a risk assessment process.

Some 50 or so chemicals were also not assessed directly, but lumped together with a 'surrogate' which was assumed to have similar toxicity. – Table 5.3-14 suggests in its Discussion of Conservatism (2nd row from last) that this is represents a conservative assumption. In fact, the result of not including such a great number and range of chemical moieties will produce quite the opposite as conservatism is not promoted.

Table 5.3-2 describes a great many chemicals identified as COPCs – around 250 in number – that have little literature describing a safe exposure limits. All of these were routinely excluded from the risk assessment process. This is evident in footnote 'a' in all the Tables reporting Risk Quotients summaries in all tables reporting risk quotients (Table 5.3-15 onwards). In the HHRAs discussion of Conservative Assumptions, summarized in table 5.3-15, no mention is apparent relating to the omission of these chemicals within the risk assessment process. While it may be true that there exists little information to include these chemicals in the risk assessment process, the HHRA should at the very least highlight the need for conservatism given the very real lack of information and impossible to predict nature of the

Further, for the minority of chemicals which have been identified and followed through within the HHRA, an impressive number of sequential steps have then been used to derive an estimate of risk to human health. These include:

i. estimation of emission concentrations to various media (mainly air)
ii. estimation of dilution rates
iii. estimation of exposure dose (inhalation, ingestion, absorption)
iv. estimation of 'safe' exposure limits – these are often derived from a combination of sources from Canada, US, Europe and international organizations (e.g. WHO), and are more often than not based on occupational exposure risks relating to health and safety of the work-force
v. estimation of risk to human health from individual chemical and chemical group exposures
vi. estimation of risk to human health from exposure to mixtures of chemicals

A great many estimates are made within the HHRA process. Estimates are needed because of the HHRA process incorporates so many unknowns and uncertainties. HHRA is not an exact science, it is more a best guess prediction based on science. Because of the consequences of getting a HHRA wrong, conservatism should be built into a responsible HHRA process as a priority.

The manner in which the HHRA has dealt with chemical mixtures is worth discussion. The HHRA includes consideration only of potential additive effects of a chemical mixture. There is no mention of the potential for synergistic effects on health. This is a serious limitation and the absence of any reference to synergism does not support the 'conservative' nature adopted within this HHRA.

As with all traditional HHRA there are a great many estimated factors to take into account before concluding the presence or absence of significant risk to human health. Because health risk assessment is an imprecise science, conservative safety factors are built into the process. For example, extrapolating toxicity data between chemicals of similar molecular structure & therefore assumed similar toxicity (itself often a leap of faith); extrapolating toxicity data from laboratory animal test species to human beings; extrapolating healthy worker health based limits to the general population (including young, old and sick). Safety factors are needed to 'offset' the potential of synergistic interaction between chemicals which may have disproportionately high impact on health compared to chemicals acting in simply an additive manner. Ideally, conservative risk assessment will introduce large safety factors (e.g. >10-fold) to err well on the side of caution and safety. However, the realities of multiple estimates often preclude use of large safety factors as they will inevitably lead to a high provisional estimate of risk. Thus, smaller safety factors may be adopted within the step-by-step approach to HHRA (e.g. 3-fold). The choice of what safety factors to incorporate is a controversial one, as higher or lower adopted factors can easily lead to different conclusions on estimated health risk, and the choice of what safety factor to use is influenced by the driving purpose behind the risk assessment. For example, an environmental or public health group may opt for higher safety factors to be employed to ensure public health protection is more likely to be achieved, whereas industry proponents may argue for lower safety factors to be used to ensure industrial developments are approved. That this HHRA is undertaken on behalf of industry cannot be ignored in considering the choice of multiple safety factors incorporated within the HHRA process. Particularly as the discussion of conservatism summarized in Table 5.3-14 seems to enhance discussion of legitimate safety factors used in the HHRA, while sidelining very real aspects of this HHRA which increase the margin of error such as use of surrogates, and ignoring a great many COCs for which little or no literature exists.

HHRA is an imprecise science as evidenced by many well accepted uncertainties used within the HHRA derivation, including:

- estimation of underlying emissions, dilutions, and exposure estimations
- lack of human epidemiological data on exposure effect
- knowledge gaps in toxicity of common chemicals
- large knowledge gaps in toxicity of uncommon chemicals, leading to
- uncertainties in use of chemical surrogates
- uncertainties in the extrapolation of toxicity data for individual chemicals to exposure matrices involving many 100s of different chemicals
- potential for synergism between different chemical moieties as they interact with human biochemistry
- Selection of low-fold and high-fold safety factors within the HHRA process and the necessity to balance pressures to ensure public safety with the perceived need for industrial development.

Given that this background in western science underlies the traditional HHRA approach, we are not able to define human health risk with certainty. To conclude, at best HHRA is an educated guess which attempts to estimate the real risk to human health from complex exposure matrices to industrial chemicals.

With this background, the overall conclusion of the HHRA embodied in the Jackpine Mine Expansion & Pierre River EIA dismisses the underlying uncertainty of the HHRA. It is good HHRA practice to err on the side of caution and safety when assumptions are made. The same conservative philosophy should be maintained in interpreting HHRA and summarizing conclusions – otherwise public safety is not served.

This HHRA review presents a biased view of the extent of its imbedded conservatism. While it promotes some legitimate inclusion of conservative assumptions, it ignores important aspects of prudent HHRA including:

- exclusion of a great number and diversity of COCs which are difficult to assess
- excludes any discussion of potential synergism between COCs resulting in enhanced health impact

- Excludes a realistic presentation of the complex series of sequential estimates which are embedded within the HHRA and are the basis for the argument to adopt conservatism objectively, meaningfully and responsibly.

Finally, the summary statement of this HHRA in section 2.4.1.1 is difficult to understand. The question should be whether the project will have a human health impact in the region. The Risk Assessment process indicates that some COPCs demonstrate an impact, so risk is increzed to some degree. However, the concluding statement reads as follows:

> *Overall, the Project emissions alone, and in combination with other sources of COPCs are not expected to result in a noticeable increase in health risks in the Oil Sands Region ...*

It is not clear to this reviewer what is a noticeable *increase in health risk* is supposed to mean. It is not clear who decides what is noticeable, and who if anyone, is monitoring health risk. It is predicting potential health impacts the HHRA is addressing - health risk assessment is the tool employed to predict if a health impact is expected to occur. This concluding statement is poorly constructed, unclear, and should be rephrased.

Section B. Holistic Impact on Human Health related to Jackpine Mine Expansion & Pierre River on ACFN Community

Human health is not solely related to the presence or absence of toxic chemicals in the environment. Medical textbooks will define health in relation to key determinants. These include the following:

- Income and Social Status
- Social Support Networks
- Education and Literacy
- Employment/Working Conditions
- Social Environments
- Physical Environments
- Personal Health Practices and Coping Skills
- Healthy Child Development
- Biology and Genetic Endowment
- Health Services
- Gender
- Culture
- Mental Well-being

Within the EIA the primarily purpose of the HHRA must be to determine an estimate for the likely health impact on human health from the Jackpine Mine Expansion & Pierre River Mine Project.

For the sake of argument, let us accept at face value the HHRA conclusions (which can never have absolute certainty) that there are categorically no acute or long-term health risks associated with the project.

The general public at large, and the ACFN community members in particular, have persistent concerns over their health relating to development of industry within the Alberta Oil Sands. It would be unreasonable to expect any community in the air and water shed of the Alberta Oil Sands not to be concerned. These concerns are evident in interviewing the ACFN community members. ACFN community members are under considerable stress because of rapid industrial development within their traditional lands, and fear or pollution on their health. This fear has been fed by various reports including:

- rare cancers (Dr John O'Conner)
- Arsenic in moose-meat (Suncor EIA & Hearing)
- tailing ponds contaminating migrating wildfowl (Syncrude tailing ponds issues widely reported in the press)
- contaminated water and health effects (Dr Kevin Timoney)

These and other issues have emerged in 'scientific' reports and provincial and national press over the past 12 months alone.

Discussions with many ACFN community members indicate that there is real fear within the community about widely reported health issues and contaminated wildlife. Aboriginal community members more than others rely on land use as an anchor to their traditional culture. Harvesting traditional foods has been, and remains, a fundamental part of the ACFN community identity. The sense of community and culture surrounding traditional food harvesting and sharing runs deep in the ACFN community as it does with many aboriginal peoples in Canada.

The very serious concerns within the ACFN community relating to the health of the land, water, air and wildlife act to increase stress within individuals, between family members, and within the community at large. Stress is very much related to health (blood pressure, mental well-being, social and cultural stability). Examination of all health determinants is an unconventional addition in the current EIA paradigm to the traditional HHRA approach, but none-the-less a valid and important consideration. The determinants of health listed above cannot be disputed, and the impact the planned projects have on these health determinants has not been assessed as part of the HHRA within the Jackpine Mine Expansion & Pierre River EIA. Further, it is evident from interviewing and listening to the ACFN family that they have serious concerns over the human health impact of Shell's proposed Jackpine Mine Expansion & Pierre River Project. These concerns are affecting and will continue to affect the mental and physical health of ACFN community members

Other national and international organizations recognize the wider approach, including the US CDC[1], the World Health Organization[2], as well as Health Canada[3].

Assessment of these wider health effects within the HHRA can be guided by the general principal and use of adopting conservative safety factors inherent in responsible HHRA when the underlying science is unknown or poorly understood. The ACFN will be constantly reminded of the physical presence of the Jackpine Mine Expansion & Pierre River during construction and operation. Prudent HHRA should lead to the 'conservative' conclusion that the very presence of this large industrial development within ACFN traditional lands, and contributing to the air-shed and water-shed of the Fort Chipewyan community will impact health of ACFN members. Further prudent HHRA leads to conservative assumptions erring on the side of safety that this health impact will be significantly negative.

To date, much effort has been put behind documenting a paper based HHRA. Correspondingly little effort has been devoted to a communication plan with provision of evidence to allow the ACFN to have secure knowledge they will be 'safe'. There is no plan for effectively convincing the ACFN they will be safe, let alone feel safe.

HHRA Review Conclusions

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[1] http://www.cdc.gov/healthyplaces/hia.htm
[2] http://www.who.int/hia/en/
[3] http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/index_e.html

1) The HHRA summary conclusion is unclear and does not address potential health impact.
2) The HHRA does not incorporate conservative assumptions to the extend it suggests. Therefore the results of the HHRA overstate the certainty of the absence of health risk, and is unnecessarily dismissive of potential health impacts to ACFN community members.
3) The HHRA includes no assessment of the wider impacts on health from the proposed development on ACFN other than a narrow focus on chemical exposure.

HHRA Review Recommendations

1) The potential for increased health impacts as a result of the HHRA be made clear.
2) That the HHRA is recognized as being over-confident in relation to the uncertainties inherent in risk assessment. Conservatism has not been adopted throughout this HHRA. The proponent should accept the uncertainties in HHRA and accept when conservatism has not been adopted.
3) That the wider impacts on health of the ACFN community be taken into account.
4) that the wider impacts of health of the ACFN be mitigated through an effective communication program which results in ensuring that the ACFN community should be able to 'feel safe' in their own homes, in their own community, at large on ACFN traditional lands, and harvesting and consuming traditional foods. Effective risk communication should be developed in collaboration with ACFN IRC.
5) Shell representatives be invited to actively and constructively participate in initiatives designed to promote health (to offset indirect negative health impacts). An example of a suitable program would be the Community Based Monitoring program being initiated through ACFN IRC.

Appendix D-15

Acrolein Issue within the Shell Pierre River Mine Project and Jackpine Mine Expansion Project HHRA, by Dr. John Dennis, of SolAero Ltd.

Acrolein Issue within the Shell Pierre River Mine Project and Jackpine Mine Expansion Project Human Health Risk Assessments

In page 5-84, the HHRA summarizes the risk assessment for acrolein. In part, the HHRA relies on a 2005 Golder report 'Acrolein Monitoring in the Oil Sands Region'. The HHRA claims this 2005 Golder report indicated no detectable concentrations of acrolein were detected in all laboratory samples collected 'where MDL ranged between 0.04 and 2.6 ug/m3' (page 5-87 2nd para). The HHRA argues that the absence of detectable concentrations of acrolein within the 2005 Golder report provides further demonstrations that their modeled estimates of acrolein are 'overly conservative' as evidenced in the (1st bullet point) conclusion on page 5-90

> *'Based on measured air concentrations of acrolein in the region (Golder 2005), it is likely that the predicted ground-level air concentrations overestimate acrolein concentrations in the region'*

There are some serious errors in both the fundamental science within the 2005 Golder report and Shell's interpretation of the findings of the 2005 Golder report.

Critical errors in the 2005 Golder Report

The 2005 Golder report contains 23 pages which introduce and summarizes lab results from dozens of airborne acrolein measurements taken in the oil sands region June 13- July 2, 2005. All laboratory results were reported as 'BDL' or Below Detection Limit. These BDL values were quoted in units of 'ug' (e.g. 0.15 ug or 2.00 ug). This, in and of itself, does not imply airborne acrolein was necessarily low, as this would very much depend on the sampled volume of air. For example, on page 13 of the Golder 2005 report, Table 1 indicates that an acrolein sample taken at the Suncor Borealis Camp had a 'BDL' lab result with detection limit of 2.00 ug. The sampling time was 256 minutes at a flow rate of 2.0 L/min yielding a calculated sample volume of 512 L – this equates to 0.512 m3. In order to determine what airborne concentration this detection limit might imply one must divide the detection limit, in this case 2.00 ug, with the sample volume, in this case 0.512 m3 as follows:

DL/sample volume m3 = 2.00 ug / 0.512 m3 = 3.9 ug/m3

3.9 ug/m3 would be the implied airborne detectable concentration of acrolein

The 2005 Golder report did not carry out calculations for any of the airborne detection equivalent concentrations. Nor did the 2005 Golder report explore the important consequences of not calculating these concentrations.

This calculation can be readily repeated for all the data points presented in the 2005 Golder report. As part the HHRA review on behalf of ACFN the values have been calculated, yielding average values between 1-2 ug/m3, but including higher values above 20 ug/m3. In comparison, the US EPA reference concentration value used in the HHRA is 0.02 ug/m3.

The USEPA exposure limit is 2-3 orders of magnitude BELOW the calculated minimal detectable concentration limits embodied in the 2005 Golder report. This implies that the limitations in laboratory detection limits embodied in the design of 2005 Golder report, from the very start, insured that little if any detectable amounts of acrolein would be found in the sampling program unless values were very high - 100 or 1,000 times the accepted safe limit!.

Thus the 2005 Golder report is critically flawed and its contents at best meaningless, and at worst a serious and deliberate misinterpretation of the risks presented by acrolein in the oil sands region. Fort example, it is possible the actual acrolein concentrations is more than 10-fold the EPA limit and the Golder 2005 report was note designed to detect this excedence!!!!!

It is difficult to justify any rational explaining why these values were not calculated and compared to established limits within the 2005 Golder report. The 2005 Golder report should not have made any conclusions what-so-ever in relation to airborne concentrations of acrolein in the oil sands – the report basically contains meaningless information embodied in 'non-detects' without any meaningful exploration of what the 'non-detects' may be hiding. Finally, it is disturbing that the poor science embodied within the 2005 Golder report, and the misleading results it contains, has passed whatever internal control systems within Golder which should be in place within such a major consultancy purporting expertise in the field of environmental pollution.

Shell misinterpretation of the 2005 Golder Report

First, Shell's HHRA seems to have confused units within the 2005 Golder report. Detection limits quoted in the Golder report are in units of 'ug'. To determine an estimate of airborne diction limit some mathematical manipulation is required: the sample air volume (L) needs to be converted to m3, and this needs to be divided into the 'ug' MDL to arrive at a MDL airborne concentration factor in 'ug/m3'. That the HHRA has quoted the MDL in the Golder 2005 report in units of 'ug/m3' is a serious error as they are quoted in the 2005 Golder report in units of 'ug'– it being left up to the reader to determine the relevancy of the stated detection limit (as discussed above).

Second, the 2005 Golder report is referenced as an important piece of scientific monitoring conducted in the oil sands for airborne acrolein concentrations. Shell should have critically reviewed such an important reference before relying on its flawed contents within its HHRA. Evan a cursory read of the 2005 Golder report by someone knowledgeable in the field would have uncovered these critical limitations. The main finding of the 2005 Golder report is summarized in the final sentence of the executive summary as follows:

> *''The results of this monitoring program, where all of the samples were below detection limits, suggest that the assumptions made with respect to possible acrolein emissions … are likely very conservative.''*

However, as discussed above, examination of content within the Golder 2005 report contradicts the conclusion of its executive summary. The 2005 Golder report findings are in fact, at best essentially meaningless and tell us very little about airborne concentrations of acrolein in the region, and at worst a cynical attempt to falsely assure readers that an important regional industrial pollutant is seemingly under control.

Finally, given that the Human Health Risk Assessment of Shell's Pierre River Mine and Jackpine Mine Expansion Project relied on the critically flawed 2005 Golder report as a key reference to support its case that HHRA is low, raises a question over how many other HHRA references are similarly fatally flawed.

Possible Recommendations:

Shell re-evaluates the integrity of the measurements contained in the 2005 Golder report, and validity of its conclusions, and review it's HHRA for acrolein

Shell re-writes it's HHRA for acrolein with particular attention to a more realistic statement of conservatism.

Shell provide assurances that other Golder reports are not similarly flawed

Shell seek an explanation from Golder & Associates on the limitations of the 2005 Golder report

Shell accepts that conservatism is not as inherently strong in their HHRA as 1st suggested.

Shell accept that confusion and erroneous reports falsely promoting safety increase anxiety and perceived risks, and that Shell strongly support ACFN initiatives to promote health ….?