

# Under-Mining the ENVIRONMENT

THE OIL SANDS REPORT CARD



SIMON DYER • JEREMY MOORHOUSE • KATIE LAUFENBERG • ROB POWELL

*January 2008*

Oil  
SANDS  
Fever  
SERIES



THE PEMBINA  
Institute 

# Under-Mining the Environment

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Simon Dyer  
Jeremy Moorhouse  
Katie Laufenberg  
Rob Powell

January 2008



## About The Pembina Institute

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**The Pembina Institute** creates sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy

research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. More information about the Pembina Institute is available at [www.pembina.org](http://www.pembina.org) or by contacting [info@pembina.org](mailto:info@pembina.org).

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World Wildlife Fund Canada (WWF-Canada) was founded in 1967 and has become one of the country's leading conservation organizations, enjoying the active support of more than 150,000 Canadians. As a member of the WWF global network, we actively contribute to the achievement of the organization's mission. WWF-Canada employs a range of tools to achieve its conservation results. These include field research, scientific mapping, policy initiatives,

market solutions and public education. WWF-Canada works closely with local communities and others who share the common goal of protecting the natural world. WWF-Canada's head office is located in Toronto, with regional offices in British Columbia, Alberta, Nova Scotia and the Northwest Territories. More information about WWF-Canada is available at [www.wwf.ca](http://www.wwf.ca).

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## Table of Contents

<b>Executive Summary</b> .....	<b>vii</b>
<b>Introduction</b> .....	<b>1</b>
Audiences for this report .....	2
What are the oil sands?.....	2
The need for this performance survey .....	3
Projects included in the survey .....	5
Transparency and company feedback .....	6
Methodology .....	7
Caution and Disclosure .....	12
<b>Survey Results</b> .....	<b>13</b>
General Environmental Management .....	13
Land .....	19
Air Emissions.....	25
Water .....	35
Climate Change.....	45
<b>Summary</b> .....	<b>51</b>
<b>Recommendations</b> .....	<b>54</b>
Government .....	54
Industry .....	55
<b>Endnotes</b> .....	<b>57</b>

# Table of Contents

## List of Figures

Figure 1 Average annual reclamation rate.....22 (predicted after 20 years for non-active mines)	22
Figure 2 Project comparison of nitrogen oxide emissions on a per barrel basis.....27	27
Figure 3 Project-specific sulphur dioxide emissions on a per barrel basis.....30	30
Figure 4 Project-specific VOC emissions on a per barrel basis.....32	32
Figure 5 Project-specific water consumption on a per barrel basis .....37	37
Figure 6 Project-specific mature fine tailings production on a per barrel basis.....40	40
Figure 7 Project-specific water storage in days .....43	43
Figure 8 Project-specific greenhouse gas emissions on a per barrel basis .....47	47

## List of Tables

Table 1 Summary of total project scores.....viii	viii
Table 2 Detailed project scores .....xi	xi
Table 3 Companies included in the oil sands performance survey.....5	5
Table 4 Activities included in air emissions calculations .....7	7
Table 5 General environmental management scoring summary table.....13	13
Table 6 Summary of land scores per project.....19	19
Table 7 Activities included in air emissions calculations .....25	25
Table 8 Summary of air emissions scores per project .....26	26
Table 9 Summary of scores for the water section .....36	36
Table 10 Summary of climate change scores per project.....46	46
Table 11 Summary of total project scores .....51	51
Table 12 Immediate improvement opportunities.....53	53

## Executive Summary



▲ *Oil sands mining has a substantial impact on the environment.*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

Citizens of Alberta, the rest of Canada and abroad are waking up to the reality of the environmental impacts of oil sands mining. The oil sands are the world's second largest oil reserve, but the hydrocarbon resource is in the form of bitumen – tar mixed with sand, clay and water. The technologies used to mine, extract and upgrade the bitumen to synthetic crude make the product among the most environmentally costly sources of transport fuel in the world.

Information about the actual and proposed environmental performance of individual oil sands operations is not easily accessible. This report represents the first attempt to compare the environmental performance of all ten of Alberta's operating, approved and applied for oil sands mines.<sup>1</sup> The companies were asked to respond to questions in five categories: general environmental management, land, air, water, and climate.



# Executive Summary

The leading operation in our survey was the Albian Sands Muskeg River Mine, scoring 56%. The weakest operations were Syncrude and the proposed Synenco Northern Lights Mine with

scores of 18%. The average score among all oil sands projects was 33%, demonstrating substantial room for improvement across the oil sands mining sector.

Operation	Percentage Score
<b>Albian Existing</b> (Muskeg River Mine)	56
<b>Total E&amp;P</b>	43
<b>Petro-Canada</b>	37
<b>Shell</b>	37
<b>Suncor</b>	34
<b>Imperial Oil</b>	33
<b>Canadian Natural</b>	31
<b>Albian Expansion</b> (Muskeg River Mine Expansion)	26
<b>Syncrude</b>	18
<b>Synenco</b>	18
<b>AVERAGE SCORE</b>	<b>33</b>

 Existing Projects
  Proposed and Approved Projects

▲ Table 1 Summary of total project scores.

# Executive Summary

The majority of companies lagged in several key areas. For example,

- While the majority of oil sands operations have comprehensive environmental policies in place, only Albian Sands and Imperial Oil provided evidence of having an independently accredited environmental management system such as ISO 14001.
- With the exception of the existing Albian Muskeg River Mine, no operation has voluntary targets to limit absolute greenhouse gas emissions.
- No project or company has publicly reported water intensity reduction targets.
- Despite over 40 years of oil sands development, not a single hectare of land has been certified as reclaimed under Government of Alberta guidelines.
- No project scored well across all areas.
- The proposed expansion of the Albian Muskeg mine is set to perform to lower standards than the existing Albian Muskeg operation.

Clearly, there is substantial room for improvement in the environmental performance of oil sands mining operations.

One set of questions was designed to determine which projects demonstrate a progressive approach to environmental management through their participation in exemplary management practices such as independent performance verification, mitigation and monitoring efforts, and voluntary performance targets in the absence of clear regulatory requirements. By this measure, there are three leading operations: the current Albian Sands Muskeg River project, Suncor's current operation and Shell's Jackpine mine. Even these projects did not realize environmental excellence overall. The environmental performance of the industry as a whole could be improved dramatically if the progressive management practices of the leaders were adopted across the board. Given the relatively inconsistent application of voluntary best practices by the oil sands sector, the Pembina Institute and WWF-Canada recommend that government play a more active role in ensuring the environment is protected during oil sands mining.

The lack of ambition and regulatory drivers is demonstrated by the fact that the proposed expansion of the Albian project scores lower than the existing operation.

# Executive Summary

Another set of questions was designed to examine the environmental impacts of producing a barrel of bitumen in terms of water use and the production of emissions and mature fine tailings. We discovered that projects that led in one category were often not the leaders in another. Albian Sands' existing Muskeg River project and Shell's Jackpine project reported the lowest emissions of NO<sub>x</sub>, SO<sub>2</sub> and VOCs per barrel of bitumen, Total E&P's Joslyn North project reported the lowest mature fine tailings production per barrel, Petro-Canada Oil Sands Fort Hills anticipates the lowest water use and Canadian Natural's Horizon project reported the lowest greenhouse gas emission intensity. A degree of caution must be applied in comparing the numbers supplied to us by the companies because most are estimates for not-yet-built projects rather than proven measured values. Certainly, minor

differences may be more apparent than real. Nevertheless, the range of values for some of the environmental impacts is substantial. We estimate that if all projects improved their operations to match the performance of the current industry leaders, the industry as a whole could make significant reductions in pollution and water use. See chart, Page xii.

Oil sands companies can use this report to compare their environmental performance to that of their peers. The Pembina Institute and WWF-Canada hope this comparison will inspire all companies to achieve what the current leading performers have achieved or have indicated they can achieve based on existing technologies and best practices. Beyond this immediate step, there is a need to improve environmental performance in the oil sands further and develop new strategies to limit cumulative impacts on the environment.

►  
*The boreal forest of northern Alberta will be dramatically affected if plans to exploit oil sands on 140,000 km<sup>2</sup> are carried out.*

PHOTO: DAVID DODGE,  
THE PEMBINA INSTITUTE



# Executive Summary

## Project Scoring Summary Table

Project	Environmental Management				Land				Air Emissions				Water					Climate Change			Σ	÷	Final Score
	Policy	Management System	Public Reporting	Regulatory Compliance	Certified Land	Reclamation Liability	Reference Site	Bio Monitoring	Reduction Targets	NO <sub>x</sub>	SO <sub>2</sub>	VOC	Water Intensity	Water Intensity Targets	MFT Intensity	Withdrawal	Water Storage	GHG Absolute Reduction Targets	GHG Intensity Per Barrel	Emission Intensity Targets	Total Company Score	Total Points Possible	%
<b>Albian Sands Energy Inc</b> – MUSKEG EXISTING	1	1	1	1	N/A	0.5	0	1	0	0.5	1	1	0	0	0	0	0	N/A	1	1	10.00	18	56%
<b>Total E&amp;P Canada</b> – JOSLYN NORTH MINE PHASES 1 & 2	1	0	N/A	N/A	N/A	1	0	1	0	0.5	1	0.25	1	0	1	0	0.5	0	0	0	7.25	17	43%
<b>Petro-Canada Oil Sands Inc.</b> – FORT HILLS	1	0	N/A	N/A	N/A	0.5	0	1	0	0.25	0.5	1	1	0	0	0	1	0	0	0	6.25	17	37%
<b>Shell Canada Ltd.</b> – JACKPINE PHASE 1	1	0	N/A	N/A	N/A	1	0	1	0	1	0.25	1	0.25	0	0.5	0	0	0	0.25	0	6.25	17	37%
<b>Imperial Oil Resources Ventures Ltd.</b> – KEARL P1,2 & 3	1	1	N/A	N/A	N/A	0.25	1	0	0	0	0.5	0	1	0	1	0	0	0	0	0	5.75	17	34%
<b>Suncor Energy Inc.</b> – CURRENT OPERATIONS	1	0	1	0.5	0	0	1	1	0	N/A	N/A	N/A	N/A	0	0.5	0	0	0	N/A	0	5.00	15	33%
<b>Canadian Natural</b> – HORIZON	0.5	0	N/A	N/A	N/A	0.25	0	0	0	0	1	0	1	0	1	0	0.5	0	1	0	5.25	17	31%
<b>Albian Sands Energy Inc.</b> – MUSKEG EXPANSION	1	1	N/A	N/A	N/A	0.5	0	1	0	0	0	1	0	0	0	0	0	0	0	0	4.50	17	26%
<b>Syncrude</b> – CURRENT OPERATIONS	1	0	1	0	0	0.25	0	0	0.5	N/A	N/A	N/A	N/A	0	0	0	0	0	N/A	0	2.75	15	18%
<b>Synenco Energy Inc.</b> – NORTHERN LIGHTS PHASES 1 & 2	0	0	N/A	N/A	N/A	0.5	0	0	0	0	0.5	0	1	0	1	0	0	0	0	0	3.00	17	18%

▲ Table 2 Detailed project scores

## The immediate performance gap

The results of our survey show a broad range of performance across many indicators. If all oil sands mining operations could match the environmental performance of the current industry leader, there would be substantial ecological benefits. Assuming all mines at full production:

- If all mines had the same greenhouse gas emissions intensity proposed by Canadian Natural Horizon (23.34 kg CO<sub>2</sub>e (carbon dioxide equivalent) per barrel of bitumen produced), Alberta would avoid 6,339,662 tonnes CO<sub>2</sub>e each year – a savings of 66%. This represents almost 3% of Alberta's annual GHG emissions!<sup>2</sup>
- If all mines had the same Volatile Organic Compound emissions proposed by Petro-Canada (86 grams per barrel of bitumen), annual emission rates would be reduced by 47% from 96 kt to 50 kt annually.
- If all mines had the same NO<sub>x</sub> intensity proposed by Shell Jackpine (113 grams per barrel of bitumen),

annual emission rates would drop almost 80%, from 75 kt to 15 kt annually.

- If all mines had the same SO<sub>2</sub> intensity as Canadian Natural Horizon (14 grams per barrel of bitumen), annual emission rates would be reduced by 47%, from 15 kt to 8 kt annually.
- If all oil sands mines adopted the dry tailings technologies proposed by Synenco Northern Lights and Total Joslyn, the environmental hazard of mature fine tailings at the end of a mine's life would be completely eliminated.
- If all mines had the same water intensity proposed by Petro-Canada (0.20 m<sup>3</sup> of water per barrel of bitumen produced), oil sands mines could reduce water consumption by almost 60% annually.

All figures in this best performer section assume mines at maximum production and do not include data from the Suncor or Syncrude mine operations since they do not report impacts based on barrels of bitumen produced.

*Potential annual environmental benefit through oil sands operations meeting performance standards of current industry leaders*

**15,000 tonnes of NO<sub>x</sub>**

**8,500 tonnes of SO<sub>2</sub>**

**50,000 tonnes VOCs**

**6,000,000 tonnes GHGs**

**73,500,000 cubic metres of water**

## Introduction

**W**WF-Canada and the Pembina Institute have collaborated to assess the environmental performance of oil sands companies and to provide this information to the public. The assessment presented in this report is based on a survey sent to all the proposed and active oil sand mining projects in northeastern Alberta. It includes an examination of the commitments and activities undertaken by oil sands companies to minimize the cumulative effects of mining project developments on land, air, water and climate through emissions of greenhouse gases. We also examined the actual and anticipated environmental costs of

producing a barrel of bitumen for built and proposed projects respectively.

A survey was sent to all the proposed and active oil sands mining projects in northeastern Alberta. The Pembina Institute and WWF-Canada intend to repeat the survey in the future with the hope of charting progress toward more responsible oil sands development.

The Pembina Institute and WWF-Canada researchers completed the survey with as much detail as possible from publicly available sources such as Environmental Impact Assessments, Corporate Social Responsibility and Sustainability reports and other public documents. It should be noted that project plans are constantly being updated.



▲ Toxic tailings ponds filled with liquid mine wastes already cover more than 50 square kilometres

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

The information we collected could become outdated, and not reflect on-the-ground improvements in environmental performance. In order to account for this, we provided completed copies of the surveys to all the companies assessed in this report in June and requested that the information be checked and updated if necessary. After updating the results, we provided a summary of all the results to all oil sands companies in September and provided a second opportunity to comment on the results. In total, six out of nine oil sands companies participated in the survey.

## Audiences for this report

Key audiences for this report include the investment community, particularly socially responsible investment companies. All Albertans and Canadians who could be impacted by oil sands operations may have an interest in these results, as well as First Nations and Métis communities in the vicinity of and downstream from the Fort McMurray region. These findings should be of interest to government departments charged with monitoring oil sands environmental performance. Other interested individuals may be the employees of oil sands companies and consumers, who may wish to make informed decisions about the upstream source of their petroleum products, such as gasoline.

The survey may also be of use to individual companies for stewardship reporting and benchmarking purposes, and for providing quantifiable objectives

and performance measures that are of interest to external stakeholders. We hope that this report will prompt dialogue about what constitutes an acceptable level of environmental performance for oil sands companies. Improvements in environmental performance are badly needed across the oil sands mining industry.

## What are the oil sands?

Oil sands are composed of sand, silt, clay, water and about 10-12% bitumen, a tar-like substance that can be upgraded into synthetic crude oil. Upgrading occurs either in Fort McMurray, in the Fort Saskatchewan region of central Alberta or outside Alberta. In order to consistently compare the impacts and environmental management systems of oil sands mining companies, the scoring in this assessment compares the mining and extraction of oil sands only.

Oil sands underlie more than 140,000 km<sup>2</sup> of the province of Alberta – an area greater than the size of Florida.<sup>3</sup> Currently 54,000 km<sup>2</sup> of lands in Alberta have been leased for oil sands development,<sup>4</sup> with more lands leased in government “land sales” every two weeks.<sup>5</sup>

The Alberta oil sands include 173 billion barrels of recoverable bitumen.<sup>6</sup> Where oil sands are close to the surface (< 100 m), they are strip-mined from open pits. Most of Alberta’s oil sands are deeper and must be heated so the bitumen can flow to a well and be pumped to the surface. This is called in situ (Latin for “in place”) extraction.

The majority of Alberta's oil sands production currently comes from oil sands mining, but in situ production will become the dominant extraction method in the coming decades. The Pembina Institute and WWF-Canada have plans for a future survey that will assess the environmental performance of in situ oil sands operations.

A typical oil sands mine project in Alberta involves billions of dollars of capital investment,<sup>7</sup> has an operations workforce of over a thousand people<sup>8</sup> and a lifespan of over 50 years.<sup>9</sup> As easily accessible conventional sources of oil are depleted worldwide, there is an increasing focus on unconventional sources of oil. This analysis considered 10 oil sands mining projects, proposed and operated by nine companies, together representing a potential maximum production of approximately two million barrels of bitumen per day.

## The need for this performance survey

Citizens of Alberta, the rest of Canada and abroad are waking up to the reality of the environmental impacts of oil sands mining. Some examples include the following:

- In over 40 years of oil sands mining operations not a single hectare of land has been certified as reclaimed by the Government of Alberta. Nonetheless, 3,000 km<sup>2</sup> of boreal forest has been leased for oil sands mining.
- Roughly 500 square kilometres of land surrounding current oil sands

operations are at risk from acidifying emissions from current and approved projects. This will increase to 1,000 km<sup>2</sup> if all planned projects go forward.<sup>10</sup>

- Oil sands mining operations are licensed to divert 349 million m<sup>3</sup> of water per year from the Athabasca River, twice the amount of water used by the City of Calgary.
- Currently Syncrude's and Suncor's mining operations are the 3rd and 6th largest emitters of greenhouse gases in all of Canada.<sup>11</sup>

Mining and extracting bitumen produces a host of environmental problems that contribute to the cumulative environmental degradation of the oil sands region. A full description of the environmental impacts associated with oil sands extraction can be found in the Pembina Institute Report, *Oil Sands Fever: The Environmental Implications of Canada's Oil Sand Rush*, available at [www.pembina.org/pub/203](http://www.pembina.org/pub/203). The challenge of managing the cumulative effects of the industry has not been helped by the weak regulatory environment in Alberta, which emphasizes voluntary efforts on the part of industry over regulatory requirements. Companies that have adopted voluntary measures deserve credit for their progressive approaches. Nevertheless, even the more responsible companies may be contributing to irreversible damage to Alberta's natural capital. A summary of the Pembina Institute's perspective on the appropriate management of the cumulative environmental and social impacts





▲ *The oil sands are Canada's fastest growing source of greenhouse gas emissions*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

of oil sands development is presented in *A Blueprint for Responsible Oil Sands Development*, available at [www.pembina.org/pub/1404](http://www.pembina.org/pub/1404).

Other resource industries have implemented mechanisms to enable significant third-party scrutiny and validation of environmental performance. There are currently no third-party mechanisms in place to monitor or validate environmental performance in the oil sands industry. The operators employ a range of strategies with varying environmental consequences.

Despite these concerns, reliable information about the environmental impacts of the oil sands industry is difficult to find. There is little compar-

ative information about the actual and proposed environmental performance of individual oil sands operations and far too little discussion of best practices available to oil sands developers.

The Canadian Association of Petroleum Producers (CAPP) produces an annual stewardship report that compiles a number of industry-wide social and environmental indicators.<sup>12</sup> This is not a comprehensive set of environmental indicators and does not report on a project-specific basis. Our report provides a reasonably comprehensive assessment of project-specific approaches to environmental management and environmental performance measures.

# Introduction

▼ Table 3 Companies included in the oil sands performance survey.

Company	Project	Startup Date	Status	Production (bitumen bbl/d)	Participated in survey (Y/N)
<b>Albian Sands Energy Inc.</b> <sup>13</sup>	Muskeg River Existing	2002	Operating	150,000	Yes
	Muskeg Expansion	2010	Approved	120,000	
<b>Canadian Natural</b>	Horizon – Phase 1	2008	Construction	135,000	No
	Phase 2 & 3	2011	Approved	135,000	
<b>Imperial Oil Resources Ventures Ltd.</b> <sup>14</sup>	Kearl Lake Phase 1	2010	Approved	100,000	Yes
	Phase 2	2012	Approved	100,000	
	Phase 3	2018	Approved	100,000	
<b>Petro-Canada Oil Sands Inc.</b> <sup>15</sup>	Fort Hills Phase 1 & 2	2011	Approved	100,000	Yes
	Fort Hills Phase 3 & 4	2014	Approved	90,000	
<b>Shell Canada Ltd.</b> <sup>16</sup>	Jackpine Phase 1A	2010	Construction	100,000	Yes
	Jackpine Phase 1B	2012	Approved	100,000	
<b>Suncor Energy Inc.</b>	Current	1987	Operating	260,000 <sup>17</sup>	Yes
<b>Synchrude Canada Ltd.</b> <sup>18</sup>	Current	1978	Operating	214,000 <sup>17</sup>	No
<b>Synenco Energy Inc.</b> <sup>19</sup>	Northern Lights Phase 1	2010	Application	57,250	Yes
	Phase 2	2012	Application	57,250	
<b>Total E&amp;P Canada</b> <sup>20</sup>	Joslyn Mine Phase 1	2013	Application	50,000	No
	Phase 2	2016	Application	50,000	
<b>TOTAL PRODUCTION</b>				<b>1,918,500</b>	

## Projects included in the survey

Oil sands projects that were operating, approved or seeking approval in January 2007 were included in this survey. Table 3 summarizes the projects.

The Suncor Voyageur South, Shell Jackpine Expansion and Pierre River Mines announced after this survey was begun are not included in the 2007 assessment but will be included in subsequent surveys.

## Transparency and company feedback

The Pembina Institute provided completed copies of the survey to all companies in June 2007. After providing the results to all the oil sands mining companies, staff of the Pembina Institute contacted all companies by



▲ *Oil sands companies must remove 4 tonnes of material to produce a single barrel of oil.*

PHOTO:  
© JIRI REZAC, WWF-UK

telephone and by electronic mail to solicit feedback on the accuracy of the data presented. Canadian Natural contacted the Pembina Institute and raised concerns about omissions from the report, which were addressed. Petro-Canada Oil Sands Inc., Albion Sands Energy Inc., Shell Canada Ltd., Suncor Energy Inc, Synenco Energy Inc and Imperial Oil Ltd. all verified the information in the survey and provided additional information about their operations. Syncrude Canada Ltd. and Total E&P Canada did not respond to requests to participate in the survey. After incorporating changes and contacting the Government of Alberta for further information, the companies were ranked according to the methodology described below in the methodology section. A number of

questions were dropped from the final assessment due to the poor quality of information. A draft copy of the assessment results, including all the raw data used in the assessment, was provided to companies in September 2007 to provide a second opportunity to clarify company commitments or provide updated information on environmental performance.

As a condition of oil sands approvals, companies submit annual summaries of their environmental performance to the Alberta government. Unfortunately, the government does not make this information readily available to the public. The Government of Alberta does not provide an online summary of oil sands project environmental performance, and it is difficult for the public to obtain this information. Staff of the Pembina Institute visited the Alberta Environment library in Edmonton to view some of the publicly available information. The very limited summary information about oil sands environmental performance that is presented by government is often out of date. For example, the Oil Sands Reclamation graph on Alberta Environment's State of the Environment website is complete to only December 2003 – almost four years out of date.<sup>21</sup>

Information on Alberta government environmental enforcement actions, which formed part of our assessment, can be obtained for a fee from the Environmental Law Centre.<sup>22</sup> The Government of Alberta was unable to provide summaries of ambient air exceedances for the oil sands region. This information was obtained from companies directly or from their annual reports.

Oil Sands Operations Emission Sources		
Mine Fleet	Mine Face	Fugitive Emissions
Processing Plants	Electricity Production (on or offsite)	Offsite Natural Gas Production
Tailings Ponds	Facility Heating	

▲ *Table 4  
Activities  
included in  
air emissions  
calculations.*

## Methodology

### SURVEY DEVELOPMENT

We hoped to receive feedback from each of the companies included in this survey. Nonetheless, the survey was designed so it could be completed in the event that the companies were unable or unwilling to provide feedback. With this constraint in mind, the survey is broken down into five broadly recognized areas of environmental performance and management: general environmental management, land management, air pollution, water management and climate change:

#### 1 General Environmental Management

This section concerns principles of environmental management that are valid for any natural resource-based company or project. These include development of an effective environmental policy, a strong legal compliance record with respect to environmental issues, a third-party validated environmental management system and transparent public reporting of environmental aspects associated with a project.

#### Land Management

2

The oil sands are overlain by Alberta's boreal forest. The boreal forest is a mixture of deciduous and coniferous trees on upland sites and wetlands. The Mineable Oil Sands Area (MOSA)<sup>23</sup> defined by the Alberta government is approximately 3,000 km<sup>2</sup>, an area approximately four times the surface area of the city of Calgary. To mine the bitumen in the oil sands, rivers must be diverted, wetlands drained and all vegetation and non-oil-bearing overburden removed. This section contains indicators relating to reclamation strategies and performance, monitoring of impacts on biodiversity and company leadership in supporting establishment of protected areas in the boreal forest.

#### Air Emissions

3

Oil sands projects are major emitters of many chemical pollutants. Air emissions of particular importance in the oil sands include nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>) and volatile organic compounds (VOCs). All three emissions types contribute to smog, have potential human health impacts and in the case of NO<sub>x</sub> and SO<sub>2</sub> are contributors to acid rain. This section reports on project emission levels and voluntary company targets to reduce air pollution.

One of the goals of this survey was to quantify NO<sub>x</sub>, SO<sub>2</sub> and VOC emissions for each project in order to highlight best practices. For this analysis to be meaningful the data collected for each project had to be comparable. This proved to be more challenging than expected for several reasons.

One challenge is that all operations are designed slightly differently and do not contain the same facilities onsite. For example, the Albion Muskeg River Mine Expansion will obtain electricity from the Alberta electrical grid, unlike the current Albion Muskeg River Mine, which has an onsite cogeneration facility to produce electricity and process heat. If we had included only onsite emission sources, the expansion project would look significantly better, but this would obscure the fact that air pollution is being emitted elsewhere to supply the expansion project. To address this concern, we developed a list of emission sources associated with activities that all mines have in common. Taking this approach ensures that the air emission values we calculated are comparable between projects. Table 4 contains the list of activities considered.

Secondly, both Suncor and Syncrude operate not only oil sands mines but also upgraders and in the case of Suncor in situ operations as well. The companies report these emissions as a single number making it impossible to determine air emissions for just their mining operations. Suncor's and Syncrude's air emissions are therefore not comparable with the other projects here and have not been scored relative to the other projects on NO<sub>x</sub>, SO<sub>2</sub> and VOC emissions.

## Water Management

4

Oil sands operations are large users of fresh water. It takes 2-4.5 barrels of water to extract and upgrade a single barrel of oil from an oil sands mine.<sup>24</sup> Approved oil sands mining operations are licensed to divert 349 million cubic metres of fresh water from the Athabasca River per year; this is expected to increase to more than 500 million cubic metres per year if proposed projects are also approved.<sup>25</sup>



Winter flows in the Athabasca River have declined in recent decades and are sometimes low enough to impact fish habitat and fish populations,<sup>26</sup> yet oil sands companies are currently allowed to withdraw water even when river levels are dangerously low. Current and proposed projects would be responsible for withdrawing up to 15.7% of the river flow during low flow periods.<sup>27</sup> This section concerns oil sands company water use, management strategies in place to protect the Athabasca River during periods of low flow and management of liquid mine wastes, known as mature fine tailings (MFT).

▲  
*The number of operating mines in the Fort McMurray region is set to increase rapidly over the next several years.*

PHOTO:  
© JIRI REZAC, WWF-UK

## 5 *Climate Change*

Extracting bitumen from the oil sands is very energy intensive; and, as a result, oil sands mine operations are major emitters of greenhouse gases (GHGs). Syncrude's and Suncor's oil sands mining operations are Canada's 3rd and 6th largest emitters of GHGs respectively.<sup>28</sup> Syncrude emitted 10.3 million tonnes of GHGs in 2005, equivalent to the emissions of 2.7 million personal vehicles.<sup>29</sup>

The data used for this section of the report are derived in the same manner as that discussed in the air emissions section.

Disciplinary specialists in emissions, water, land management and industrial waste at the Pembina Institute created representative questions addressing environmental performance and

commitments to continually minimize environmental effects. Although the survey does not address all aspects of environmental performance, the Pembina Institute and WWF-Canada are confident that the indicators selected are representative of the environmental management challenges facing the oil sands and comprehensive enough to meaningfully rank oil sands company commitments and environmental performance. The Global Reporting Initiative (GRI) seeks to improve consistency in company reporting on sustainability performance.<sup>30</sup>

Many of the indicators in this survey are consistent with GRI performance, while other indicators are related to specific oil sands mine-related environmental management issues. With each question, we describe whether this is a measurement also recommended by GRI.



▲ *Air quality problems are increasing around the oil sands.*

PHOTO: © JIRI REZAC, WWF-UK

## Project Names

For ease of reading, from now on in the report the operations will be referred to as abbreviations of their lead company name (e.g., Imperial, for Imperial Oil Resources Ventures Limited). Albian Sands Energy Inc. has two projects that will be referred to as Albian Existing and Albian Expansion, Petro-Canada Oil Sands Inc. Fort Hills project will be referred to as Petro-Canada, Shell Canada Ltd. – Jackpine will be referred to as Shell, Syncrude Canada Ltd. will be referred to as Syncrude, Suncor Energy Inc. will be referred to as Suncor, Synenco Energy Inc. – Northern Lights will be referred to as Synenco and Total E&P Canada – Joslyn Mine will be referred to as Total E&P.

## Scoring

For each environmental indicator we identify leaders and laggards and score the projects accordingly. For yes/no questions, a project receives either 1 or 0 points. In limited circumstances we provide 0.5 points for partially achieving an indicator. The appendices provide a summary of the data included in the survey. For more information on the quantitative data included in this report, please contact the Pembina Institute at <http://www.pembina.org>.

For continuous indicators, such as GHG emissions per barrel of bitumen, projects were ranked in quartiles from highest to lowest performer. Projects within 25% of the top performer were granted full points for that question.



▲ In total more than 3,000 square kilometres of forests and wetlands are projected to be mined to extract bitumen from the oil sands.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

# Introduction

Projects performing within 25-50% of the top performer were granted 0.5 points, projects performing within 50-75% of the top performer were awarded 0.25 points and projects in the bottom quartile were awarded zero points. Using this relative scale clearly distinguishes the leaders and laggards among projects, but it does not indicate whether the best performer is truly a leader in an absolute sense. For example, the lowest greenhouse gas intensity project is awarded full marks under this methodology. However, this does not mean the top project cannot improve further; it is simply the best relative to its peers.

Our intention was to have five questions in each of the five sections: general environmental management, land, air, water and climate. However, data limitations and technical difficulties inherent in comparing existing projects with proposed projects forced us to abandon some questions. There are now 20 questions with 3 to 5 per section.

One set of yes/no questions was designed to determine which projects and companies demonstrate a progressive approach to environmental management by participating in exemplary management practices such as independent performance verification, mitigation and monitoring efforts, and voluntary performance targets in the absence of clear regulatory requirements. An operation that has adopted a number of these management practices is clearly making an effort to address its environmental impacts.

The remaining questions consider the environmental impact associated with the production of a barrel of bitumen from each operation, in terms of water

use, air emissions, land impacts and GHG emissions.

We aggregated the scores from the individual questions to facilitate overall comparisons among projects and among companies. We calculated an overall project score for each project as the percentage of the possible total for all questions. Where a project was scored as not applicable (N/A) on any question, that question was not included in the calculation. This was particularly relevant to proposed projects that have not demonstrated a legal compliance record.

Syncrude and Suncor are integrated projects that do not segregate the emissions and impacts of their mining operations from their upgrading operations in their company reports. Suncor's and Syncrude's data for GHG production, water use and air emissions are presented as intensities per barrel of synthetic crude oil (SCO) for mining and upgrading. Suncor's data also includes emissions from its in situ operation, Firebag. This made it difficult to compare these operations with other active and proposed mines for some of our questions. Suncor and Syncrude were not penalized for this since these questions were not included in the calculation of their final scores. However, their scores are based on far fewer questions than the other projects. We believe Suncor and Syncrude should disaggregate their data and report the impacts associated with mining operations separately. In order for a company to manage its impacts effectively and identify areas needing improvement, it must be able to distinguish between the different aspects of its operation.



## Caution and Disclosure

Oil sands development in Alberta is in a state of rapid expansion. Of the companies assessed in this report, Albian, Suncor and Syncrude have active mining operations, other mining companies have project approvals and are at the construction phase, and further companies have applications seeking regulatory approval.

We believe that this report represents the most comprehensive and rigorous assessment of comparative environmental performance of oil sands mining operations that is publicly available. This report focuses on the projected and current environmental performance of oil sands mine operations only. It does not consider corporate governance issues, the health and safety of employees, or the performance in consultation and accommodation of aboriginal interests by oil sands companies. For information

about other indicators, readers are encouraged to examine other sources such as Jantzi Research<sup>31</sup> or Innovest Strategic Value Advisors.<sup>32</sup> The survey is based on a broad assessment of potential environmental impacts and company mitigation strategies.

This report should be considered a snapshot of environmental performance, based on data that was available during our analysis period. Companies update their performance regularly. For example, Syncrude released a new Sustainability Report in late 2007, after our analysis for this survey was completed.

In addition to its research and advocacy role, the Pembina Institute provides corporate consulting services to industry, government and First Nations. Since 2006, Pembina Corporate Consulting has provided work for Suncor Energy Ltd. and Shell Canada Ltd. This has neither influenced the development nor the results of this survey.

**T**his section concerns principles of environmental management that are valid for any natural resource-based company or project. These include development of an effective environmental policy (question 1); a third-party validated environmental management system (2); a strong legal compliance record with respect to environmental issues (3); and transparent public reporting of environmental aspects associated with a project (4). Mines currently operating are scored

based on all four questions. Proposed and approved (but not operating) mines are scored on questions 1 and 2 only.

## General Environmental Management Summary

Table 5 summarizes the score per project per indicator and provides the total per project score for this section.

**Only active** projects were scored on all four questions.

▼ Table 5 General environmental management scoring summary table.

Project	Environmental Policy	Environmental MS	Public Reporting	Regulatory Compliance
<b>Albian Existing</b>	1	1	1	1
<b>Albian Expansion</b>	1	1	N/A	N/A
<b>Canadian Natural</b>	0.5	0	N/A	N/A
<b>Imperial</b>	1	1	N/A	N/A
<b>Petro-Canada</b>	1	0	N/A	N/A
<b>Shell</b>	1	0	N/A	N/A
<b>Suncor</b>	1	0	1	0.5
<b>Syncrude</b>	1	0	1	0
<b>Synenco</b>	0	0	N/A	N/A
<b>Total E&amp;P</b>	1	0	N/A	N/A



Existing Projects



Proposed and Approved Projects

## 1 ENVIRONMENTAL POLICY

***Does your company have an environmental policy that commits to continuous improvement in environmental performance?***

### RATIONALE

The environmental policy is the foundation of a company's environmental management system and its construction.<sup>33</sup> A key aspect of an environmental policy compliant with ISO 14001 is that it includes a commitment to continuous improvement in environmental performance.<sup>34</sup>



### ★ LEADERS

**Albian, Imperial, Petro-Canada, Shell, Suncor, Syncrude, Total E&P**

The majority of oil sands companies had comprehensive environmental policies that made an explicit commitment to continuous improvement in environmental performance.

### ❖ MIDDLE

**Canadian Natural**

Canadian Natural has a Corporate Statement of Environmental Protection, but it does not address continuous improvement in environmental performance.

### ⌘ LAGGARDS

**Synenco**

Synenco states that it is still in the process of developing a comprehensive Corporate Responsibility Policy.<sup>35</sup>

◀ *Oil sands companies acknowledge that many wetland habitats cannot be restored after mining.*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

## 2 ISO 14001 CERTIFICATION

***Does your oil sands operation have an environmental management system that has been accredited by an independent third-party, such as ISO 14001 or equivalent?***

### RATIONALE

ISO 14001 is an internationally recognized standard for an environmental management system. It has clear requirements for establishing an environmental policy, determining environmental risks and setting goals to reduce environmental impacts. Third party validation of an environmental management system provides external evidence of the rigour of the environmental management system. Although ISO 14001 does not provide standards for environmental performance, it does provide a globally recognized framework for developing an environmental management system.

### ★ LEADERS

#### **Albian, Imperial**

Albian has the only project-specific oil sands mine environmental management system that appears to be independently accredited to the ISO 14001 standard. Imperial's Corporate Operations Integrity Management System is also ISO 14001 accredited.

### ❖ MIDDLE

None

### ⌘ LAGGARDS

No other company provided evidence that they have independently accredited environmental management systems. Shell does, however, have a commitment to have all major plants certified to ISO 14001 or similar.<sup>36</sup>

◀ *Most oil sands mining operations do not have independently accredited environmental management systems that would help minimize impacts to the environment.*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE



## 3 PROJECT-SPECIFIC INDICATORS

***Do you publicly report annual project-specific environmental indicators, e.g. greenhouse gases, nitrogen oxides, sulphur dioxide, volatile organic compounds and water use?***

### RATIONALE

Public reporting in this sense means making project-specific environmental parameters directly available to the public through company websites and annual sustainability reports. Public reporting by companies is important because they have an obligation to be transparent. **Only active projects** are included in this indicator.

### ★ LEADERS

**Albian Existing,  
Suncor, Syncrude**

All the active oil sands mine companies produce sustainability reports that summarize environmental impacts. However, because of operational differences between projects, it remains difficult to compare the data from different companies. Suncor and Syncrude, for example, do not break out environmental indicators for individual mining operations. However, they do report on environmental indicators for their entire oil sands operations.

### ❖ MIDDLE

None

### ⌘ LAGGARDS

None



▲ *Lack of consistency in reporting between oil sands operators and a shortage of comparative information provided by Government makes it challenging to compare the environmental performance of oil sands mines.*

PHOTO: © JIRI REZAC, WWF-UK

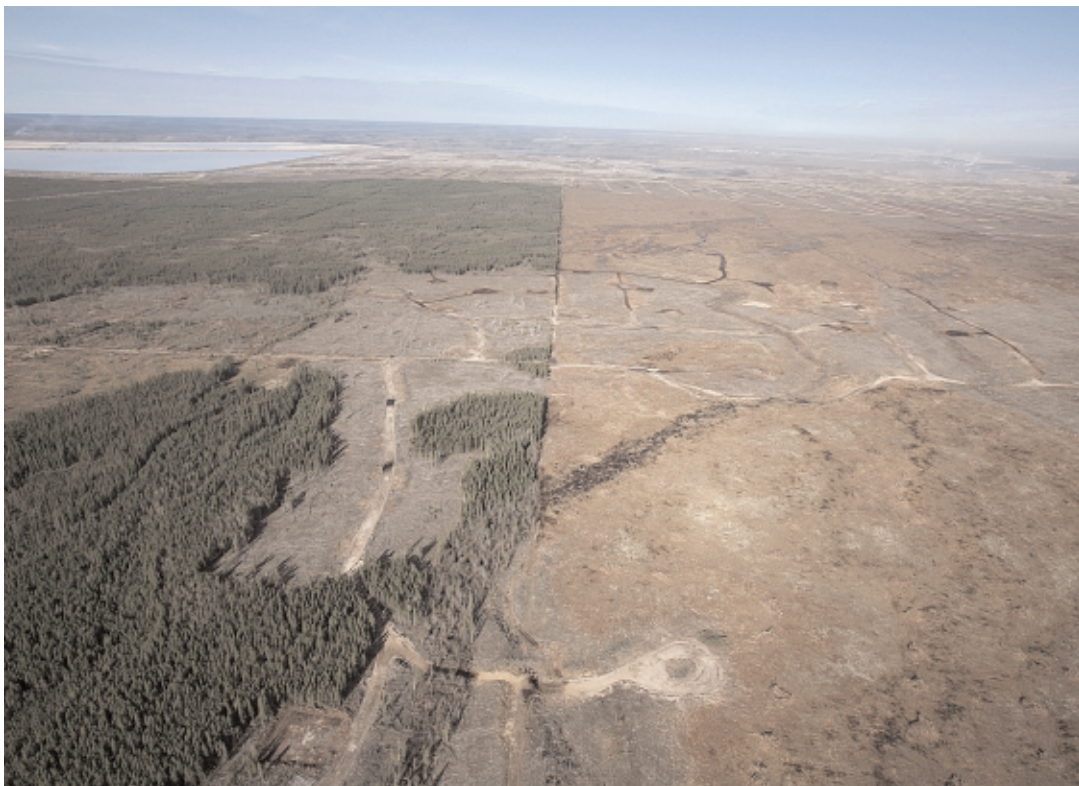
## 4 REGULATORY COMPLIANCE

***Please summarize all ambient air exceedances and all environmental enforcement actions (including warning letters, prosecutions, fines, etc.) in 2005-2006 for this oil sands operation.***

### **RATIONALE**

Meeting all applicable environmental laws is a key component of environmental management for any oil sands company. This is a recognized metric and is included in the global reporting

initiative guidelines.<sup>37</sup> Only active mines are considered in this indicator. We used the period 2005-2006 for reporting of this indicator because this corresponds with recent available data during the analysis period.



▲ Oil sands operations remove rivers, forests and wetlands in order to access the oil sands beneath.

PHOTO: © JIRI REZAC, WWF-UK

## 4 REGULATORY COMPLIANCE

### ★ LEADERS

#### Albian Existing

Albian had no environmental regulatory enforcement actions in 2005/2006 and reported no ambient air exceedances.

### ❖ MIDDLE

#### Suncor

Suncor received one warning in 2005. Suncor received this warning letter in response to a low free-chlorine residual found in treated water in the clearwell. This contravened its approval.<sup>38</sup>

In 2005 Suncor reported 30 air quality exceedances and showed an increasing trend of 240 air quality exceedances in 2006.<sup>39</sup>

### ⌘ LAGGARDS

#### Syncrude

Syncrude had two regulatory enforcement actions in 2005/2006, including an Environmental Protection Order to halt operations from a Flue Gas Desulfurization Unit due to an uncontrolled release of ammonia. The company also received a warning letter for late reporting of NH<sub>3</sub> and SO<sub>2</sub> releases. In 2005, the last year for which data was available during our data collection period, the company also reported 46 ambient air exceedances for H<sub>2</sub>S and 1 ambient air exceedance for SO<sub>2</sub>.<sup>40</sup>



▲ Meeting all applicable laws is a key component of environmental management.

PHOTO: THE PEMBINA INSTITUTE

**T**he oil sands are overlain by Alberta's boreal forest. The boreal forest is a mixture of deciduous and coniferous trees on upland sites and wetlands. The Mineable Oil Sands Area (MOSA)<sup>41</sup> defined by the Alberta government is approximately 3,000 km<sup>2</sup>, an area approximately four times the surface area of the city of Calgary. To mine the bitumen in the oil sands, rivers must be diverted, wetlands drained and all vegetation and

non-oil-bearing overburden removed. This section contains indicators relating to reclamation strategies and performance, policy leadership in supporting establishment of protected areas on public lands and monitoring of impacts on biodiversity.

## Land Summary

Table 6 summarizes the results per project for the Land section.

▼ Table 6: Summary of land scores per project.

Project	Certified Reclamation	Reclamation Rate	Support for Protection	Biodiversity Monitoring
<b>Albian Existing</b>	N/A	0.5	0	1
<b>Albian Expansion</b>	N/A	0.5	0	1
<b>Canadian Natural</b>	N/A	0.25	0	0
<b>Imperial</b>	N/A	0.25	1	0
<b>Petro-Canada</b>	N/A	0.5	0	1
<b>Shell</b>	N/A	1	0	1
<b>Suncor</b>	0	0	1	1
<b>Syncrude</b>	0	0.25	0	0
<b>Synenco</b>	N/A	0.5	0	0
<b>Total E&amp;P</b>	N/A	1	0	1



Existing Projects



Proposed and Approved Projects



## 5 CERTIFIED RECLAMATION

***What is the current ratio of total mine disturbance to certified reclamation?***

### RATIONALE

Reclamation is presented as a significant element in mitigating the land impacts of oil sands development. The Government of Alberta requires mining operations to reclaim disturbed land to an “equivalent land capability.” Reclaimed land that complies with that standard is certified ‘reclaimed’ by the government and returned to Albertans. The Government of Alberta is responsible for certifying that lands have been reclaimed. This indicator applies only to Suncor and Syncrude because their operations are the only projects that have been in operation long enough to have lands certified as reclaimed.

Under the GRI guideline, companies are required to report on whether their reclaimed lands meet third party certification.

In this case, the Alberta government is the third party.

### ★ LEADERS

None

### ❖ MIDDLE

None

### ⌘ LAGGARDS

#### **Suncor, Syncrude**

Despite operating for 40 years and 29 years respectively, none of the land disturbed by Suncor and Syncrude has been certified as reclaimed by the Government of Alberta.



▲ Although companies are attempting to reclaim landscapes after disturbance, no lands have been certified as reclaimed by the Alberta Government in 40 years of oil sands mining.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

## 6 RECLAMATION RATE

***What is the current ratio of total mine disturbance to reclamation according to your operation's definition of reclamation?***

### **RATIONALE**

This indicator was developed by the Pembina Institute and WWF-Canada and is not an established metric under the GRI or other environmental reporting guidelines. However, the balance between the rate of land disturbance and reclamation is a key indicator of company environmental performance. For companies that have not commenced mining operations, mine reclamation schedules provide evidence of the expected rate of reclamation. For companies active more than 20 years, the actual average annual rate of reclamation is presented. For projects that have not commenced mining, or have been in operation for a very short period, such as the Albion Muskeg River Mine, proposed average annual reclamation standardized after 20 years of activity is presented.

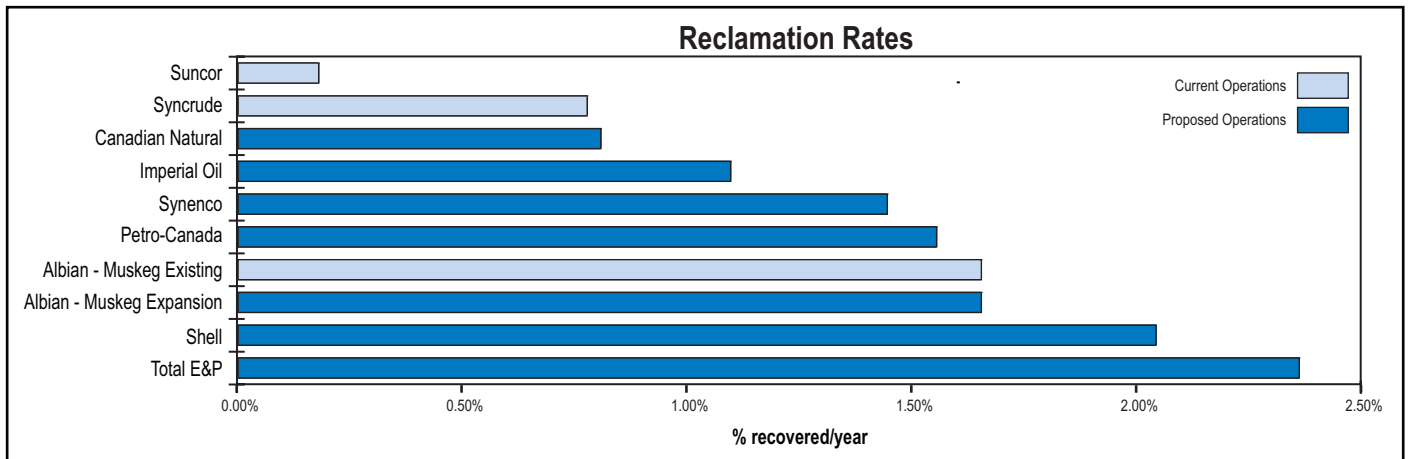
Companies report reclamation based on their own definitions. Although not as rigorous an indicator as certified reclamation, it provides an indicator of what companies consider to be reclaimed.

However we still believe that companies should be aiming for certified reclamation, rather than trying to redefine the goals.

Reclamation schedules provide a useful indicator of the focus on progressive reclamation that a company may make. Since the vast majority of oil sands approvals do not regulate acceptable reclamation rates,<sup>42</sup> or tie future disturbance to adequate reclamation performance, companies are free to set their own reclamation schedules.

## 6 RECLAMATION RATE

▼ Figure 1 Average annual reclamation rate (predicted after 20 years for non-active mines).



### RESULTS

Figure 1 presents the actual and expected annual rate of reclamation for the projects considered in this report.

### ★ LEADERS

#### Total E&P

Total has projected the most progressive reclamation schedule for its project. Its proposed use of dry tailings technologies substantially increases the rate at which land can be reclaimed. Total's projected reclamation rate is 13 times faster than the slowest recorded reclamation rate and approximately 75% faster than the average proposed reclamation rate.

### ◆ MIDDLE

**Albian Existing and Expansion, Canadian Natural, Imperial, Petro-Canada, Shell, Syncrude, Synenco**

Albian, Shell, Petro-Canada and Synenco's operations are expecting to have slightly higher than the average (1.36%) reclamation rate after 20 years. Imperial's operations on the other hand are expecting to have slightly lower than average reclamation rates after 20 years. Syncrude and Canadian Natural have annual reclamation rates of 0.78% and 0.81% respectively.

### ⌘ LAGGARDS

#### Suncor

Suncor, the company with the longest legacy in the oil sands region, has actual reclamation rates far slower than those proposed by other companies, just 0.18%. In 40 years of oil sands development, Suncor has disturbed 13,093 ha of lands and reclaimed only 949 ha.<sup>43</sup> Suncor's 2007 Sustainability Report claims that the "rate of reclamation will accelerate significantly over the next several years."

**7 SUPPORT FOR PROTECTION**

***Does your company publicly support the protection of some areas of unallocated forest in north-eastern Alberta, to keep as reference sites for comparison to landscapes disturbed by oil sands projects? Documentation would include evidence of public support, CEO quote to the media, etc.***

**RATIONALE**

Currently only 13.2% of Alberta’s Boreal Forest Natural Region has been legally protected from industrial activity.<sup>44</sup> Fifty-seven percent of Albertans believe that too much of Alberta’s boreal forest is open to industrial development,<sup>45</sup> and there is strong public support for the establishment of protected areas in Alberta. Companies can demonstrate corporate leadership by actively supporting conservation proposals to protect portions of Alberta. This metric was developed specifically for this survey.

**★ LEADERS**

**Suncor, Imperial**

Suncor is a member of the Boreal Leadership Council<sup>46</sup> and a signatory to the Boreal Conservation Framework, which supports a goal of protecting 50% of Canada’s boreal forest from industrial

activity.<sup>47</sup> Suncor provided further evidence of support for the establishment of protected areas in northeastern Alberta. Imperial provided written support for the establishment of specific protected areas in the application for approval of the Kearl Oil Sands Project.

**❖ MIDDLE**

None

**⌘ LAGGARDS**

**Synenco, Shell, Albion Existing and Expansion, Petro-Canada, Canadian Natural, Total E&P, Syncrude**

No other projects or companies have demonstrated public support for establishment of protected areas in northeastern Alberta.

## 8 BIODIVERSITY MONITORING

***Does your company provide support (financial or other) to the Alberta Biodiversity Monitoring Program in order to provide meaningful, longterm information about changes in biodiversity in the oil sands region? If so, please describe this support.***

### RATIONALE

Effective monitoring for changes in wildlife species is an essential component of oil sands management. The Alberta Biodiversity Monitoring Institute (ABMI) delivers one of the world's most advanced biodiversity monitoring programs.<sup>48</sup> It is capable of providing statistically rigorous information about regional-level changes in biodiversity and has protocols that can be adapted to determine site-specific changes at the level of a single oil sands mine. The Pembina Institute represents Alberta's environmental community on the board of the ABMI. The ABMI is supported by both government and voluntary industry funding. Support for the ABMI is a key indicator of the oil sands companies' commitment to meaningful biodiversity monitoring.

### ★ LEADERS

**Shell, Albian, Total E&P  
Petro-Canada, Suncor**

These companies are all financial supporters of the Alberta Biodiversity Monitoring Institute.

### ❖ MIDDLE

None

### ⌘ LAGGARDS

**Imperial, Synenco,  
Syncrude, Canadian Natural**

These companies are not public supporters of the Alberta Biodiversity Monitoring Institute.

Oil Sands Operations Emission Sources		
Mine Fleet	Mine Face	Fugitive Emissions
Processing Plants	Electricity Production (on or offsite)	Offsite Natural Gas Production
Tailings Ponds	Facility Heating	

▲ Table 7 Activities included in air emissions calculations.

Oil sands projects are major emitters of many chemical pollutants. Air emissions of particular importance in the oil sands include nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>) and volatile organic compounds (VOCs). All three emissions types contribute to smog, have potential human health impacts and in the case of NO<sub>x</sub> and SO<sub>2</sub> are contributors to acid rain. This section reports on project emission levels and voluntary company targets to reduce air pollution.

*Oil sands projects are major emitters of many chemical pollutants.*

PHOTO:  
THE PEMBINA INSTITUTE

One of the goals of this survey was to quantify NO<sub>x</sub>, SO<sub>2</sub> and VOC emissions for each project in order to

highlight best practices. For this analysis to be meaningful, the data collected for each project must be comparable, that is we must be comparing apples to apples. This proved to be more challenging than expected for several reasons.

For one, all operations are designed slightly differently and do not contain the same facilities onsite. For example, the Albian Muskeg River Mine Expansion will obtain electricity from the Alberta grid, unlike the current Albian Muskeg River Mine, which has an onsite cogeneration facility to produce electricity and process heat. If we had included only onsite emission sources, the expansion project would look like a significantly better performer, but this would obscure the fact that air pollution is being emitted elsewhere to supply the expansion project with energy. In order to address this concern, we developed a list of emission sources associated with activities that all mines have in common. Taking this approach ensures that the air emission values calculated are comparable between projects. Table 7 contains the list of activities considered.

Second, both Suncor and Syncrude operate not only oil sands mines but also upgraders and, in the case of



Suncor, in situ operations as well. Air emissions for these operations are integrated into a single number making it impossible to determine air emissions for just their mining operations. Suncor's and Syncrude's air emissions are therefore not comparable with the other projects here and have not been scored relative to the other projects on NO<sub>x</sub>, SO<sub>2</sub> and VOC emissions.

The final three scores below compare each company based on their NO<sub>x</sub>, SO<sub>2</sub> and VOC emission intensities. The first score compares each company's reduction targets.

## Air Emissions Summary

Table 8 summarizes the scores for each project for the air emissions section.

- If all mines had the same Volatile Organic Compound emissions proposed by Petro-Canada (86 grams per barrel of bitumen), annual emission rates would be reduced by 47% from 96 kt to 50 kt annually.
- If all mines had the same NO<sub>x</sub> intensity proposed by Shell Jackpine (113 grams per barrel of bitumen), annual emission rates would drop almost 80%, from 75 kt to 15 kt annually.
- If all mines had the same SO<sub>2</sub> intensity as Canadian Natural Horizon (14 grams per barrel of bitumen), annual emission rates would be reduced by 47%, from 15 kt to 8 kt annually.

Project	Reduction Targets	NO <sub>x</sub>	SO <sub>2</sub>	VOC
<b>Albian Existing</b>	0	0.5	1	1
<b>Albian Expansion</b>	0	0	0	1
<b>Canadian Natural</b>	0	0	1	0
<b>Imperial</b>	0	0	0.5	0
<b>Petro-Canada</b>	0	0.25	0.5	1
<b>Shell</b>	0	1	0.25	1
<b>Suncor</b>	0	N/A	N/A	N/A
<b>Syncrude</b>	0.5	N/A	N/A	N/A
<b>Synenco</b>	0	0	0.5	0
<b>Total E&amp;P</b>	0	0.5	1	0.25



Existing Projects



Proposed and Approved Projects

▲ Table 8 Summary of air emission scores per project.

## 9 NITROGEN OXIDE EMISSIONS

***What are your overall project-specific nitrogen oxide (NOx) emissions?<sup>49</sup>***

### RATIONALE

Nitrogen oxides (NOx) are emitted in large volumes by oil sands mining operations from the combustion of fossil fuels including natural gas, diesel, gasoline and, in some instances, petroleum coke for oil sands operations. In 2005, active operations in the oil sands released 70,000 tonnes of NOx; this is projected to increase to 196,000 tonnes by 2015.<sup>50</sup> Nitrogen oxides can have adverse impacts on human health and the environment. NOx can cause respiratory problems and may combine with VOCs and sunlight to form ground level ozone. NOx is a contributor to smog and is a major component of acid rain. Acid rain can result in changes in soil and water chemistry, impacting forests, vegetation, lakes and fish populations.

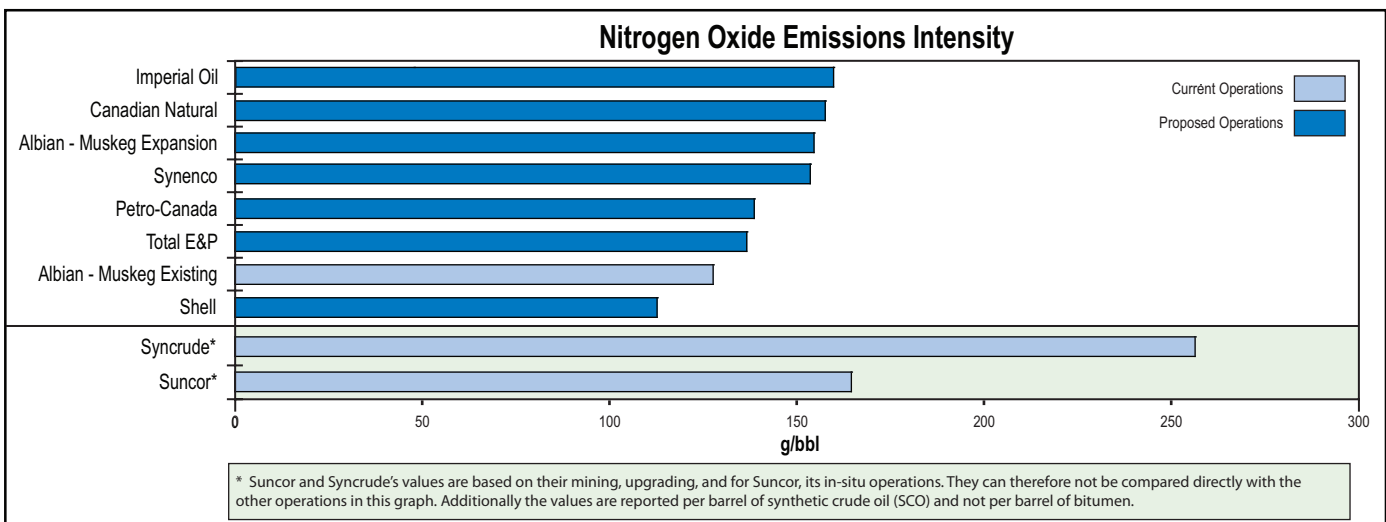
The reporting of NOx emissions is also required under the GRI guideline;

however we adapted this metric and reported it on an intensity basis as opposed to annual or daily emissions to facilitate comparison among the mining operations. NO<sub>2</sub> emissions from approved and existing oil sands projects are already expected to exceed Alberta's Air Quality Objectives over a 24-hour period. Additional projects will go further over this guideline.<sup>51</sup>

### RESULTS

The results presented in Figure 2 include emissions from the mine fleet, processing equipment, electricity generation (whether on or offsite) as well as upstream natural gas production on a per barrel basis. Offsite emissions have been included in order to compare all operations equivalently. Please refer to appendices documents for a more detailed explanation of sources and assumptions.

Figure 2  
Project comparison of nitrogen oxide emissions on a per barrel basis.





## 9 NITROGEN OXIDE EMISSIONS



▲ *Acid rain caused by oil sands emissions is projected to impact soils and vegetation in the Boreal Forest.*

PHOTO: THE PEMBINA INSTITUTE

### ★ LEADERS

#### Shell

The approved Shell mine has the lowest NO<sub>x</sub> intensity of all the projects at 113 grams per barrel of bitumen (g/bbl). There is no clear indication as to why this project has the lowest NO<sub>x</sub> intensity of all the projects considered. One possible explanation is that Shell states that its mine fleets will meet U.S. Environmental Protection Agency (EPA) Tier 1, Tier 2, Tier 3 and Tier 4 emission standards at some date in the future.<sup>52</sup> Tier 4 NO<sub>x</sub> emissions standards are approximately 38% lower than Tier 3 emission standards and not all projects have committed to meeting Tier 4 standards. As the mine fleet

is the primary source of onsite NO<sub>x</sub> emissions, this commitment may result in reduced intensities. However, to date there is no regulated approach to estimating emissions from mine fleet vehicles.<sup>53</sup> Without a single approach, it is difficult to determine whether a lower reported emissions intensity is a result of an innovative approach to reducing NO<sub>x</sub> emissions or simply a reflection of a different calculation methodology.

### ◆ MIDDLE

#### Albian Existing, Total E&P, Petro-Canada

These projects have projected NO<sub>x</sub> intensities ranging from 128 g/bbl to 139 g/bbl.

## 9 NITROGEN OXIDE EMISSIONS

### ⌘ LAGGARDS

#### **Synenco, Canadian Natural, Imperial, Albian Expansion**

Synenco, Canadian Natural, Imperial and Albian Expansion are project to emit the most NO<sub>x</sub> per barrel of bitumen produced with intensities ranging from 154 g/bbl to 160 g/bbl. There is no clear indication as to why these projects have higher emission intensities. One reason may be the way in which NO<sub>x</sub> emissions are calculated. For example, in comparison to Albian, Imperial states that their mine fleet NO<sub>x</sub> emissions are based on Tier 2 EPA emission standards. Imperial also assumed a more conservative (higher) load factor or average operating horsepower of its mine fleet in comparison with Albian and Shell. The load factor has “the most significant effect on NO<sub>x</sub> and carbon

monoxide emissions.”<sup>54</sup> It is therefore not clear if Imperial’s reported emission value reflects a prediction of relatively poor performance or a more conservative estimate in comparison with other projects.

This demonstrates the need for a common reporting framework, which should be required by the government and adopted by industry.

Suncor’s and Syncrude’s operations are major emitters of NO<sub>x</sub>, but since these values include upgrading, in addition to mining operations, and, in the case of Suncor, also in situ operations, they are not directly comparable with the other projects. They have therefore not been scored for this indicator. In the future, we hope that Suncor and Syncrude will disaggregate this information so their operations can be compared with other mining operations.



▲ Oil sands mine truck fleets are a major source of NO<sub>x</sub> emissions.

PHOTO: THE PEMBINA INSTITUTE

## 10 SULPHUR DIOXIDE EMISSIONS

***What are your overall project-specific sulphur dioxide (SO<sub>2</sub>) emissions in tonnes per calendar day?<sup>55</sup>***

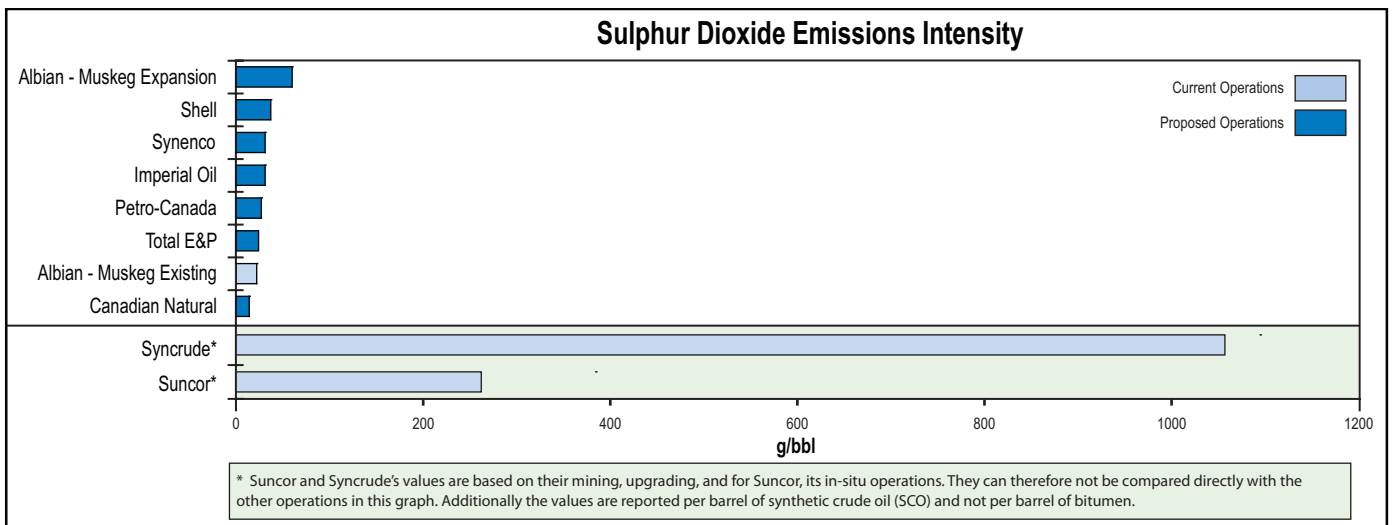
### RATIONALE

Sulphur dioxide (SO<sub>2</sub>) is a major component of acid rain and can contribute to the formation of smog and haze. Environment Canada states that in 2005 oil sands operations emitted 147,000 tonnes of SO<sub>2</sub>. SO<sub>2</sub> emissions are expected to increase to 166,000 tonnes a year by 2015. This amount of SO<sub>2</sub> pollution will exceed 24-hour Alberta Air Quality Objectives and those established by the World Health Organization.<sup>56</sup> As with NO<sub>x</sub> emissions, the reporting of SO<sub>2</sub> emissions is a recognized metric under the GRI guideline.

SO<sub>2</sub> intensity is used here to compare projects more effectively.

### RESULTS

Emissions sources incorporated in the values presented in Figure 3 include those from the mine fleet, processing equipment, electricity generation (whether on or offsite) as well as upstream natural gas production on a per barrel basis. Offsite emissions have been included in order to compare all operations equivalently. Please refer to appendices documents for a more-detailed explanation of sources and assumptions.



▲ Figure 3 Project-specific sulphur dioxide emissions on a per barrel basis.

## 10 SULPHUR OXIDE EMISSIONS

### ★ LEADERS

#### Canadian Natural, Total E&P, Albian Existing

Oil sands companies have substantially reduced onsite SO<sub>2</sub> emissions per barrel of bitumen produced in the oil sands. However, SO<sub>2</sub> emissions are primarily a result of offsite upstream natural gas production as well as offsite electricity production. Those projects with onsite power production have lower natural gas intensity and relatively low onsite SO<sub>2</sub> emissions; therefore they have the lowest SO<sub>2</sub> emissions intensity. Canadian Natural's Horizon meets all of these criteria resulting in the lowest SO<sub>2</sub> intensity of all the projects at 14 g SO<sub>2</sub>/bbl. The Albian Existing and Total mines are both below the average of 31 g/bbl with SO<sub>2</sub> intensities of 22 g/bbl and 24 g/bbl respectively.



### ❖ MIDDLE

#### Petro-Canada, Imperial, Synenco, Shell

Petro-Canada's SO<sub>2</sub> intensity is just below average at 27 g/bbl, while both Imperial and Synenco match the industry average intensity of 31 g/bbl. The Shell Jackpine Mine has a slightly higher SO<sub>2</sub> intensity of 37 g/bbl. This is primarily a result of the mine's relatively high natural gas intensity.

### ⌘ LAGGARDS

#### Albian Expansion

For bitumen extraction projects only, the projected emissions of the Albian Muskeg River Expansion Project are the highest. This is largely a result of offsite power production requirements that result in higher system SO<sub>2</sub> emissions of 60 g/bbl.

The integrated Suncor and Syncrude projects are major sources of SO<sub>2</sub> pollution but were not included in the ranking analysis because they include emissions from upgrading processes as well. Refer to the beginning of this section for a complete description of this problem.

◀ *Very few oil sands operations have voluntary targets to reduce air pollution.*

PHOTO: THE PEMBINA INSTITUTE

## 11 VOLATILE ORGANIC COMPOUNDS

***What are your overall project-specific volatile organic compound (VOC) emissions in tonnes per calendar day?***

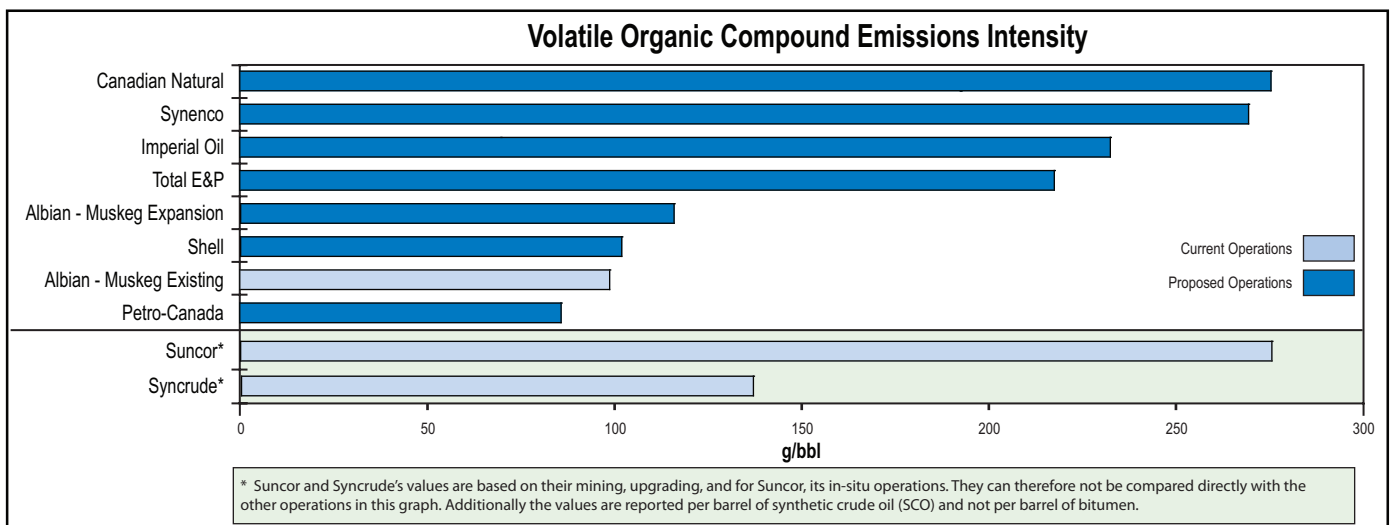
### RATIONALE

Volatile organic compounds (VOCs) are a large group of chemicals that participate in atmospheric photochemical reactions.<sup>57</sup> Individual VOCs may be toxic to humans and may combine with NO<sub>x</sub> in the presence of sunlight to form ground level ozone.<sup>58</sup> In addition, Environment Canada projects that VOC emissions from the oil sands will increase by more than 500% from 59,000 tonnes in 2005 levels to 300,000 tonnes per year in 2015.<sup>59</sup>

As with NO<sub>x</sub> and SO<sub>2</sub> emissions, VOC emissions are a recognized metric under the GRI guideline. VOC intensity is used as opposed to total emissions in order to compare projects more effectively.

### RESULTS

The results presented in Figure 4 include emissions from the tailings ponds (the primary emissions source), the mine fleet, processing operations, mine face, electricity production (on or offsite) as well as offsite natural gas production. During the analysis of this data, the Pembina Institute researchers found significant variations between the methodologies used by the companies to calculate their project VOC emissions. An attempt has been made to correct for these differences; the method is outlined in the VOC section of Appendix 3 – Air Emissions.



▲ Figure 4 Project-specific VOC emissions on a per barrel basis.

## 11 VOLATILE ORGANIC COMPOUNDS

### ★ LEADERS

#### **Albian Existing and Expansion, Petro-Canada, Shell**

Albian's existing and expanded operations as well as Petro-Canada's and Shell's operations all produce significantly less VOCs per barrel than the other oil sands projects. The VOC intensity for these projects is 86 g/bbl, 99 g/bbl, 102 g/bbl and 116 g/bbl for Petro-Canada, Albian's existing project, Shell's Jackpine and Albian's expansion project respectively.

### ❖ MIDDLE

#### **Total E&P**

The Joslyn North Mine is projected to have a VOC intensity of 218 g/bbl, which is slightly higher than the average of 186 g/bbl.

### ⌘ LAGGARDS

#### **Canadian Natural, Synenco, Imperial**

The Canadian Natural, Synenco and Imperial mines are projected to emit VOCs at 276 g/bbl, 270 g/bbl and 233 g/bbl respectively. These values are significantly higher than the other projects. Other than Albian's existing operations, only the VOC intensities of Suncor and Syncrude are based on actual emission values. Suncor and Syncrude have emission intensities of 275 g/bbl of synthetic crude oil (SCO) and 137 g/bbl SCO respectively, but these are not scored because of differences in reporting.

▼ *Bitumen from the oil sands must be upgraded to produce synthetic crude oil.*

PHOTO: © JIRI REZAC, WWF-UK



## 12 VOLUNTARY TARGETS

***Do you have voluntary targets to reduce or offset NO<sub>x</sub>, SO<sub>2</sub> or VOCs? If so, what are your targets?***

### RATIONALE

The compounds have been identified by Environment Canada as criteria air contaminants that affect human health. The Pembina Institute and WWF-Canada encourage companies to take a leadership role and commit to voluntary reduction targets because these targets result in real emissions reductions. This metric is not included under the GRI guideline; however, setting internal targets is considered to be an essential component of an environmental management plan.<sup>60</sup>

### ★ LEADERS

No projects have publicly stated voluntary air emission reduction targets for the range of emissions identified in this survey.

### ❖ MIDDLE

#### **Syncrude**

The Syncrude Emissions Reduction Project (SERP) involves the retrofit of a flue gas scrubbing system into the operation of Syncrude's two original cokers. In combination with scrubbing technology also incorporated into a new coker built as part of Syncrude's upgrader expansion project, it will reduce stack emissions of sulphur compounds by 60% from current approved levels of 245 tonnes per day. It is important to note that Syncrude's SO<sub>2</sub> emissions intensity is currently greater than the combined emissions of all the other mines included in this survey (see Figure 3).

### ⌘ LAGGARDS

#### **Synenco, Imperial, Shell, Albion, Petro-Canada, Canadian Natural, Total E&P, Suncor**

None of these companies has publicly available voluntary emission reduction targets.

**O**il sands operations are large users of fresh water. It takes 2-4.5 barrels of water to extract and upgrade a single barrel of oil from an oil sands mine. Approved oil sands mining operations are licensed to divert 349 million cubic metres of fresh water from the Athabasca River per year; this is expected to increase to more than 500 million cubic metres per year if proposed projects are also approved. During some winter periods, flow in the Athabasca River is low enough to impact fish habitat and fish populations.

Oil sands companies are currently allowed to withdraw water even when river levels are dangerously low. Current and proposed projects would be responsible for withdrawing up to 15.7% of the river flow during low flow periods. This section concerns oil sands company water use, management of liquid mine wastes, known as mature fine tailings, and management strategies in place to protect the Athabasca River during periods of low flow.



▲ *Oil sands operations pose a serious risk to the Athabasca River.*

PHOTO: DAN WOYNILLOWICZ, THE PEMBINA INSTITUTE



## Water Summary

Table 9 summarizes the results for the water section.

- If all oil sands mines adopted the dry tailings technologies proposed by Synenco Northern Lights and Total Joslyn, the environmental problem of mature fine tailings at the end of

a mine's life would be completely eliminated.

- If all mines had the same water intensity proposed by Petro-Canada (0.20 m<sup>3</sup> of water per barrel of bitumen produced), oil sands mines could reduce water consumption by almost 60% annually.

▼ Table 9 Summary of scores for the water section.

Project	Water Intensity	Water Intensity Targets	MFT Intensity	Withdrawal Commitment	Water Storage
<b>Albian Existing</b>	0	0	0	0	0
<b>Albian Expansion</b>	0	0	0	0	0
<b>Canadian Natural</b>	1	0	1	0	0.5
<b>Imperial</b>	1	0	1	0	0
<b>Petro-Canada</b>	1	0	0	0	1
<b>Shell</b>	0.25	0	0.5	0	0
<b>Suncor</b>	N/A	0	0.5	0	0
<b>Syncrude</b>	N/A	0	0	0	0
<b>Synenco</b>	1	0	1	0	0
<b>Total E&amp;P</b>	1	0	1	0	0.5



Existing Projects



Proposed and Approved Projects

## 13 FRESHWATER CONSUMPTION

***What is your average freshwater consumption per barrel of bitumen produced (m<sup>3</sup>/bbl)? We are looking for long-term withdrawal rates during steady state operations (i.e., once operations have commenced).***

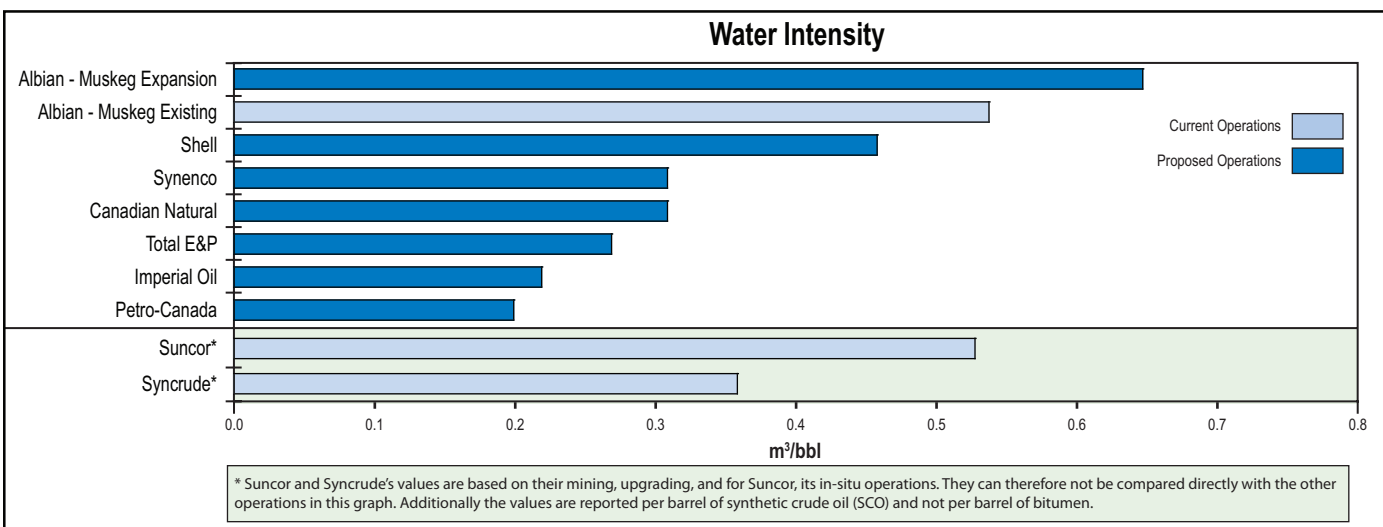
### RATIONALE

Oil sands mines are major consumers of freshwater from the Athabasca River. There are growing concerns that oil sands water use from the Athabasca River is unsustainable. Given these constraints, it is essential that oil sands mines minimize their fresh water consumption per barrel of bitumen produced. In addition, total water withdrawal is a recognized metric required by the GRI guideline.

Water intensity is used here in order to compare operations effectively.

### RESULTS

Actual water use intensities vary considerably over a given project's life. In order to compare projects on an equivalent basis, the results presented in Figure 5 are based on onsite makeup water use intensity during steady state or typical operational periods only.



▲ Figure 5 Project-specific water consumption on a per barrel basis.

## 13 FRESHWATER CONSUMPTION

### ★ LEADERS

#### Imperial and Petro-Canada

Petro-Canada Fort Hills and Imperial Kearnl mines are projected to be the least water intensive of all the mines with water intensities of 0.20 cubic metres of water per barrel of bitumen produced (m<sup>3</sup>/bbl) and 0.22 m<sup>3</sup>/bbl respectively.

### ❖ MIDDLE

#### Synenco, Total E&P, Canadian Natural

The Northern Lights, Joslyn and Horizon mines are expected to have water intensities slightly below the 0.36 m<sup>3</sup>/bbl average at 0.31 m<sup>3</sup>/bbl, 0.27 m<sup>3</sup>/bbl and 0.31 m<sup>3</sup>/bbl respectively.

### ⌘ LAGGARDS

#### Albian Existing and Expansion, Shell

The most water intensive projects are the current Muskeg River, Muskeg River Expansion and Jackpine mines with water intensities of 0.54 m<sup>3</sup>/bbl, 0.65 m<sup>3</sup>/bbl and 0.46 m<sup>3</sup>/bbl.

Suncor and Syncrude's values also include their upgrader water requirements and, in the case of Suncor, in situ operations as well. They are therefore not comparable with the other projects listed here. However, based on the fact that their water intensity values are lower than some of the other projects, we can assume that their water intensities for just mining operations will be lower than these projects.



▲ Oil sands mines use substantial amounts of freshwater to extract bitumen from the oil sands.

PHOTO: DAVID DODGE, THE CANADIAN PARKS AND WILDERNESS SOCIETY

**14 FRESHWATER CONSUMPTION**

***Do you have targets to reduce water intensity and consumption in your operations? If so, what are your targets?***

**RATIONALE**

Given that water use by oil sands companies is considered one of the most urgent environmental issues in the oil sands region, formal targets to reduce water use provide evidence of a commitment to reduce impacts on aquatic ecosystems. As discussed in the air emissions section, targets also serve to drive innovation within a company to reduce water use and can lead to real reductions in water use. ISO 14001 recognizes internal water reduction targets as a key component of a complete environmental management system<sup>65</sup>.

**★ LEADERS**

None

**❖ MIDDLE**

None

**⌘ LAGGARDS**

**Synenco, Imperial, Shell, Albion Existing and Expansion, Petro-Canada, Canadian Natural, Total E&P, Suncor, Syncrude**

With the exception of Syncrude, no company publicly reports water intensity targets. Syncrude does report water intensity and absolute water use targets; however, they are projected to increase by 5% and 70% respectively. Syncrude has therefore not been awarded a point for these increasing targets.<sup>62</sup>

## 15 MATURE FINE TAILINGS

***What is the average volume (m<sup>3</sup>) of mature fine tailings (MFT) produced per barrel of bitumen?***

### RATIONALE

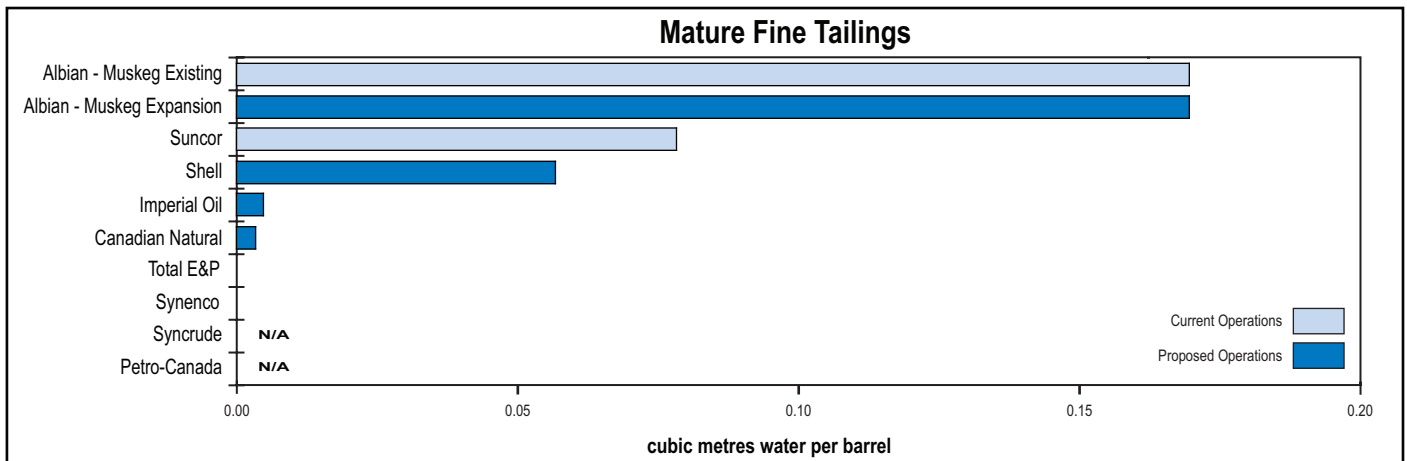
Management of liquid mine wastes from conventional oil sands extraction processes is one of the most significant liabilities facing the oil sands industry. The National Energy Board describes the problem of tailings management as a daunting challenge.<sup>63</sup> Mature Fine Tailings (MFT) are the suspended fine particles of sediment created by most oil sands extraction processes; they end up in the massive waste lagoons seen north of Fort McMurray. MFT that can be consolidated will be incorporated into the terrestrial landscape. The plan for the long-term disposal of the remaining MFT is to place them in End Pit Lakes. Given the uncertainty around MFT management, extraction processes

that prevent or minimize the creation of MFT and strategies to reduce the long-term persistence of MFT are considered preferable from an environmental perspective.

The long-term impact and uncertainty surrounding residual MFT necessitated the creation of a customized metric for this report. No other environmental guidelines require reporting on this metric.

### RESULTS

The Pembina Institute derived the values presented in Figure 6 by dividing the total MFT expected at closure by the total bitumen production over the life of the respective project.



▲ Figure 6 Project-specific mature fine tailings production on a per barrel basis.

## 15 MATURE FINE TAILINGS

### ★ LEADERS

#### **Synenco, Total E&P, Imperial, Canadian Natural**

Both Synenco and Total propose using a filtered tailings technology known as the BITMIN<sup>64</sup> process. The BITMIN process produces a dry tailings and thickened tailings stream. The dry tailings stream can be transported offsite by truck or conveyor belt and used for reclamation or backfill. The remaining thickened tailings are placed in tailings ponds but do not result in the creation of MFT.<sup>65, 66</sup> BITMIN Resources Inc. successfully demonstrated this technology in 2005 at the Fort Hills Demonstration Plant; however, it has yet to be proven commercially for oil sands application.

Both Imperial and Canadian Natural have projected very low, relative to the average, MFT intensities of 0.0048 m<sup>3</sup>/bbl and 0.0034 m<sup>3</sup>/bbl respectively.

### ❖ MIDDLE

#### **Shell, Suncor**

The Jackpine mine is projected to have an MFT intensity of 0.057 m<sup>3</sup>/bbl, just below the average. Suncor's current MFT intensity is 0.0785 m<sup>3</sup>/bbl, slightly above the average. However, this is based on actual data unlike the majority of other projects.

### ⌘ LAGGARDS

#### **Albian Existing and Expansion, Petro-Canada, Syncrude**

The current Albian Muskeg River Mine and Muskeg River Mine Expansion project both have projected MFT intensities of 0.17 m<sup>3</sup>/bbl. This intensity is significantly higher than any other project. Petro-Canada did not provide this information in its original EIA, and stated that MFT volumes will be confirmed during the operation of the Fort Hills Mine. We were unable to locate any publicly available information on MFT intensities for Syncrude.

◀ *Management of tailings waste is a major liability for the oil sands industry.*

PHOTO: THE PEMBINA INSTITUTE



## 16 HALT WATER WITHDRAWALS

***Do you commit to voluntarily halting water withdrawals during low flow periods on the Athabasca River?***

### RATIONALE

The current government management framework governing oil sands water withdrawals from the Athabasca River does not require companies to halt water withdrawals during low flow periods, even when fish and fish habitat may be impacted.<sup>67</sup> It is already anticipated that the current planned development case (i.e., all projects existing, approved, in the application stage and planned) will require average annual withdrawal rates of 16.7 m<sup>3</sup>/s<sup>68</sup> from the Athabasca River. This value is 10% higher than the suggested 15 m<sup>3</sup>/s winter maximum cumulative withdrawal rate stated in the water management framework.<sup>69</sup> This indicator reports on whether oil sands companies have voluntary strategies in place to halt water flows to reduce impacts on the Athabasca River during critical periods.

This metric was designed specifically for this report in order to identify those companies that have addressed this concern by committing to voluntarily halt fresh water withdrawals from the Athabasca River.

### ★ LEADERS

No oil sands company has made a voluntary commitment to halt water withdrawals during low flow periods on the Athabasca River, even if fish and fish habitat are being damaged. Without this commitment, oil sands production will be given precedence over protection of the aquatic habitat of the Athabasca River during periods of low water flow.

### ❖ MIDDLE

None

### ⌘ LAGGARDS

**Synenco, Imperial, Shell, Albion, Petro-Canada, Canadian Natural, Total, Suncor and Syncrude**

All the companies are considered laggards for this indicator.

## 17 DAYS OF WATER STORAGE

***How many days of water storage do you have (on-site or off-site) associated with your oil sands project?***

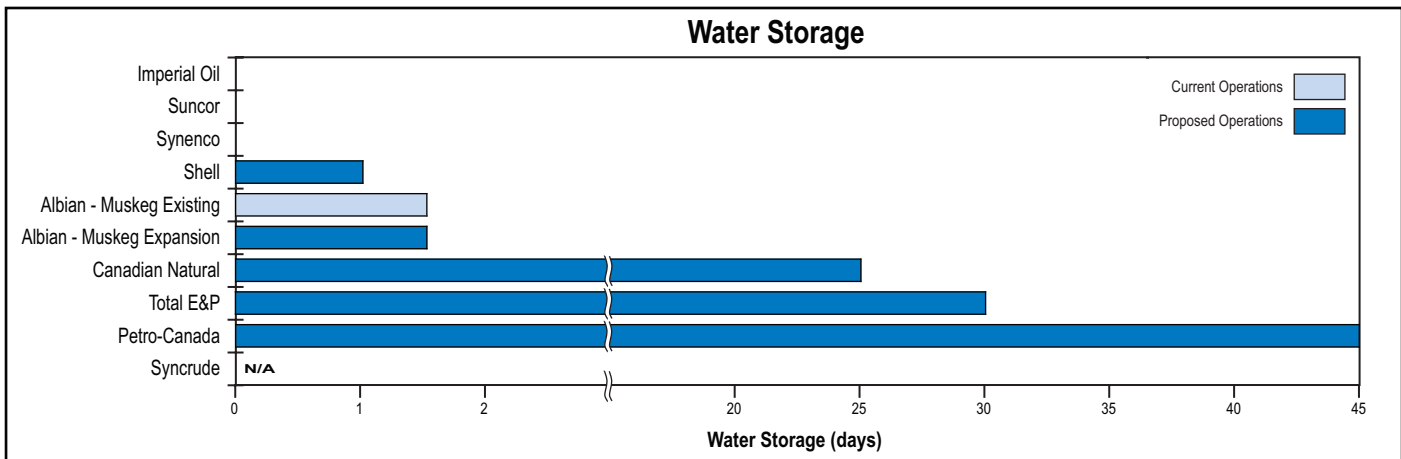
### RATIONALE

As discussed in question 16, the Athabasca River has varied flows throughout the year and is at its lowest during the winter months. Curtailing withdrawals during low flow periods is necessary to protect fish and fish habitat. Sufficient on-site water storage at oil sands operations is essential to provide process water when withdrawals from the Athabasca are not possible. The greater the number of days of water storage engineered into project design,

the better able a company is to prevent potentially damaging withdrawals during low flow periods. This metric was also custom designed for this project in order to highlight those companies that have designed their operations to operate temporarily without water from the Athabasca River.

### RESULTS

The values reported in Figure 7 are based on water storage capability for each facility.



▲ Figure 7 Project-specific water storage in days.



## 17 DAYS OF WATER STORAGE

### ★ LEADERS

#### **Petro-Canada**

The Petro-Canada Fort Hills project has the most flexibility with respect to water withdrawals because it was designed for on-site storage of 45 days. This would enable Petro-Canada Oil Sands Inc. to potentially avoid withdrawals for the longest amount of time during low flow periods on the Athabasca River.

### ◆ MIDDLE

#### **Canadian Natural, Total E&P**

Canadian Natural and Total E&P have some flexibility to deal with low flows in the Athabasca River, with projects capable of storing water for 25 and 30 days of operations respectively.

### ⌘ LAGGARDS

#### **Synenco, Imperial, Suncor, Shell, Albian**

Suncor has no ability for on-site storage of water. Suncor would therefore have to shut down its operations if required to halt water withdrawals. Both Synenco and Imperial have water storage on-site, but the mines must maintain continual withdrawals from the Athabasca River when in operation. Shell and Albian also have very limited capacity to store water at 1 and 1.5 days respectively. No publicly available information on the water storage capacity of Syncrude was identified.



▲ *The ability to store water is essential if companies are to prevent their operations damaging the Athabasca River during low flow periods.*

PHOTO: DAVID DODGE, THE CANADIAN PARKS & WILDERNESS SOCIETY

**E**xtracting bitumen from the oil sands is very energy intensive, and, as a result, oil sands mine operations are major emitters of greenhouse gases (GHGs). Syncrude and Suncor are Canada's 3rd and 6th largest emitters of GHGs respectively.<sup>70</sup> Syncrude emitted 10.3 million tonnes of GHGs in 2005, equivalent to the emissions of 2.7 million personal vehicles.<sup>71</sup>

Canada is faced with the challenge and international legal obligation, under the Kyoto Protocol, of reducing absolute GHG emissions by 6% below 1990 levels by 2008-2012. Because of years of inaction by government and industry, current projections suggest that, by 2010, emissions will be 32% higher than 1990 levels. This trend of rapidly increasing GHG emissions stands in stark contrast to the urgent need to

significantly reduce GHG emissions worldwide. Developed countries such as Canada need to reduce emissions by 80% or more below the 1990 level by 2050 – and, by 2020, be well on track to doing so – if we are to limit average global warming to 2°C above the pre-industrial level and thereby avoid the worst impacts of climate change.<sup>72</sup>

Research from the Tyndall Centre commissioned by WWF shows that the intensity based targets proposed by the Canadian Government fail to provide a framework that will provide the necessary reductions.<sup>73</sup> In fact these targets would provide a perverse incentive, whereby companies could receive up to \$700 million in credits just by delivering expected efficiency gains, but with absolute carbon emissions doubling or tripling.



▲ Oil sands projects are among the largest single emitters of greenhouse gases in Canada.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

Annual GHG emissions from oil sands plants and upgraders in 2007 are expected to be 39.3-41.4 million tonnes of CO<sub>2</sub> equivalent.<sup>74</sup> The oil sands are projected to be the single largest contributor to the increase in GHG emissions in Canada, contributing close to one-half of the projected business-as-usual growth in national emissions between 2003 and 2010.<sup>75</sup>

In the report Carbon Neutral 2020, a Leadership Opportunity in Canada's Oil Sands, the Pembina Institute articulated a strategy that could enable oil sands operators to be net-zero emitters of GHG pollution for the cost of a few dollars per barrel of oil produced. This section examines GHG intensity and company targets to reduce absolute amounts of GHG pollution.

The methodology used to derive the data presented in this section is the same as that discussed in the air emissions section. The questions concern greenhouse gas emissions (question 18) and targets for reductions (19 and 20).

## Climate Change Summary

Table 10 summarizes the per project scores for the Climate Change Section.

- If all mines had the same greenhouse gas emissions intensity proposed by Canadian Natural Horizon (23.34 kg CO<sub>2</sub>e per barrel of bitumen produced), Alberta would avoid 6,339,662 tonnes CO<sub>2</sub>e each year – a savings of 66%. This represents almost 3% of Alberta's annual GHG emissions!<sup>76</sup>

▼ Table 10 Summary of climate change scores per project.

Project	GHG Absolute Reduction Targets	GHG Intensity Per Barrel	Intensity Targets
<b>Albian Existing</b>	1	1	N/A
<b>Albian Expansion</b>	0	0	0
<b>Canadian Natural</b>	0	1	0
<b>Imperial</b>	0	0	0
<b>Petro-Canada</b>	0	0	0
<b>Shell</b>	0	0.25	0
<b>Suncor</b>	0	N/A	0
<b>Syncrude</b>	0	N/A	0
<b>Synenco</b>	0	0	0
<b>Total E&amp;P</b>	0	0	0



Existing Projects



Proposed and Approved Projects

## 18 GHG EMISSION INTENSITY

***What is your operational greenhouse gas emission intensity in kilograms (kg) per barrel (bbl) bitumen?***

### RATIONALE

Over 40% of the increase in Canadian greenhouse gas emissions between 2003 and 2010 is projected to be as a direct result of new oil sands development.<sup>77</sup>

If Canada is to achieve the necessary deep reductions in its overall GHG emissions, emissions from oil sands operations must also be reduced in absolute terms.

Greenhouse gas intensity of oil sands operations is, however, a useful method to compare the efficiency of companies.

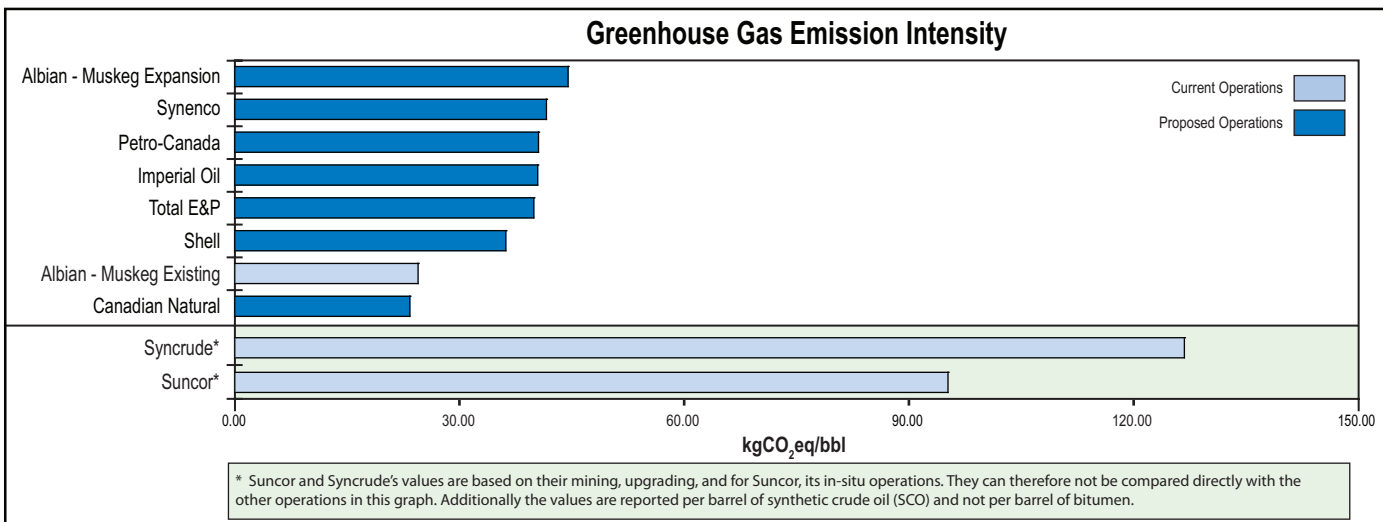
The GRI guidelines recognize greenhouse gas emissions as an important environmental metric and require participating companies to report them. This survey includes onsite as well as offsite emissions including those associated with upstream natural gas production. Reporting GHG emissions associated with upstream natural gas production is not a standard

practice but is included here because of the considerable amount of natural gas used by oil sands mining companies and to enable a fair comparison between oil sands operations.

### RESULTS

The results presented in Figure 8 include operational onsite emissions from the mine fleet, processing operations, tailing ponds, the mine face, electricity generation (on or offsite), heating and upstream natural gas production. No attempt has been made to account for transfers of CO<sub>2</sub> from the biosphere to the atmosphere due to the destruction to the boreal wetlands and forests. These impacts, although of concern, are many times less than the direct GHG emissions associated with oil sands extraction.

Figure 8  
Project-specific greenhouse gas emissions on a per barrel basis. ▼



## 18 GHG EMISSION INTENSITY

### ★ LEADERS

#### **Albian Existing, Canadian Natural**

Both Canadian Natural and Albian Muskeg's existing operations have significantly lower greenhouse gas (GHG) intensities of 23.34 kgCO<sub>2</sub>eq/bbl and 24.44 kgCO<sub>2</sub>eq/bbl in comparison with the other projects.

### ❖ MIDDLE

#### **Synenco, Petro-Canada, Imperial, Shell, Total E&P**

The Synenco Northern Lights, Fort Hills, Kearl, Jackpine and Joslyn mines have GHG intensities of 41.56 kgCO<sub>2</sub>eq/bbl, 40.50 kgCO<sub>2</sub>eq/bbl, 40.39 kgCO<sub>2</sub>eq/bbl, 36.14 kgCO<sub>2</sub>eq/bbl and 39.87 kgCO<sub>2</sub>eq/bbl respectively.

### ⌘ LAGGARDS

#### **Albian Expansion**

The Albian Muskeg River Mine Expansion project will produce relatively more emissions per barrel than the other mine projects with a GHG intensity of 44.44 kgCO<sub>2</sub>eq/bbl. It is disappointing that this expansion is projected to perform to a lower standard than the existing Albian Muskeg development. The Albian Muskeg River Mine Expansion project will use grid electricity to power its operations, which accounts for its higher emission intensity. Although Syncrude and Suncor's operations cannot be directly compared with other operations because of data limitations, they are currently the third and sixth largest individual greenhouse gas emitters in Canada.<sup>78</sup>



▲ Producing a barrel of oil from the oil sands produces substantially more GHG emissions than conventional oil production.

PHOTO: THE PEMBINA INSTITUTE

## 19 ABSOLUTE REDUCTION TARGETS

***Do you have absolute greenhouse gas (GHG) emission reduction targets? If so, what are they?***

### RATIONALE

A public opinion poll of Albertans conducted by Probe Research in April 2007 showed that 92% of Albertans polled felt that oil sands companies should reduce greenhouse emissions in all their plants. The same poll showed that 70% of Albertans felt that absolute reductions in greenhouse gases were appropriate, compared to only 20% of Albertans polled that preferred targets that reduced intensity of greenhouse gas emissions per barrel only.<sup>79</sup>

Voluntary targets are recognized by ISO 14001 as a necessary component of an environmental management system.<sup>80</sup>

however a closer look at the methods for achieving the reduction indicates they will include offsetting emissions. This means that the actual amount of reduction is lower, and any shortfall of the 50% reduction target will be met through offsets. WWF only recognizes offsets which are accredited to the Gold Standard, which is not met by some of the offsets proposed by Shell Canada.<sup>82</sup> While we recognize that Albian having a target is unique in the sector, the absolute reductions achieved by Albian, as opposed to through offsets are not yet clear.

### ★ LEADERS

#### **Albian Existing**

The Albian Muskeg River Mine has a target to cut annual emissions from its oil sands business by 50% below start up emissions by 2010. This represents a reduction of 1750 kt/yr of CO<sub>2</sub>.<sup>81</sup> This commitment applies to the integrated Albian Sands Athabasca Oil Sands Project, which includes upgrading;

### ❖ MIDDLE

None

### ⌘ LAGGARDS

**Shell, Synenco, Imperial, Petro-Canada, Canadian Natural, Total E&P, Suncor, Syncrude, Albian Expansion**

No other oil sands companies have publicly available absolute greenhouse gas reduction targets.

## 20 INTENSITY TARGETS

***Do you have voluntary project-specific greenhouse gas emissions intensity reduction targets? If so, what are they?***

### RATIONALE

Absolute emissions reduction targets are preferable to intensity targets. A company that complies with an absolute emission reduction target reduces its GHG emissions; a company that complies with an intensity target could well increase its GHG emissions. Nonetheless voluntary intensity targets can still lead to a reduction in emissions relative to a business-as-usual case.

### ★ LEADERS

#### **Albian Existing**

Albian's commitment to reduce absolute greenhouse gas emissions to 50% below those estimated at project start-up<sup>83</sup> results in an intensity target as well. This applies to the Athabasca Oil Sands Project, including upgrading. Since the existing project is granted a point for this target in the absolute reductions section, it is not scored here to prevent double counting.

### ◆ MIDDLE

None

### ⌘ LAGGARDS

**Shell, Synenco, Imperial, Petro-Canada, Canadian Natural, Total E&P, Suncor, Syncrude, Albian Expansion**

No other company in our survey reported voluntary greenhouse gas intensity reduction targets.



▲ *There are existing technologies available that would enable oil sands companies to substantially reduce greenhouse gas emissions. Only one operation in our survey reported a voluntary greenhouse gas reduction target.*

PHOTO: THE PEMBINA INSTITUTE

## Summary

**W**WF-Canada and the Pembina Institute believe that this environmental performance survey represents the most thorough and rigorous attempt to date to report to the public on the comparative environmental management and performance of proposed and active oil sands mining projects in Alberta.

The proposed and actual environmental performance of the oil sands mining industry is generally poor. The average score in our survey was 33%. The overall scores for projects ranged from 56% for the Albian Sands Muskeg River Mine to 18% for the Synenco Northern Lights Project and Syncrude. The following is a summary of the major findings from our report.

Operation	Percentage Score
<b>Albian Existing</b> (Muskeg River Mine)	56
<b>Total E&amp;P</b>	43
<b>Petro-Canada</b>	37
<b>Shell</b>	37
<b>Suncor</b>	34
<b>Imperial Oil</b>	33
<b>Canadian Natural</b>	31
<b>Albian Expansion</b> (Muskeg River Mine Expansion)	26
<b>Syncrude</b>	18
<b>Synenco</b>	18
<b>AVERAGE SCORE</b>	<b>33</b>

Existing Projects
  Proposed and Approved Projects

▲ Table 11 Summary of total project scores.



## **1** *There is substantial room for improvement in oil sands mine environmental management.*

One set of survey questions was designed to determine which projects and companies demonstrate a progressive approach to environmental management by participating in exemplary management practices such as independent performance verification, mitigation and monitoring efforts, and voluntary performance targets in the absence of clear regulatory requirements. An operation that has adopted a number of these management practices is clearly making an effort to address its environmental impacts. By this measure, there are four leading operations: the current operation and expansion of the Albian Muskeg project, Suncor and Shell Jackpine; however, none of these operations is achieving environmental excellence overall.

## **2** *Best practices are inconsistently applied.*

Although it is often stated that technological breakthroughs are necessary to improve oil sands environmental performance, there are a host of currently feasible strategies and best practices that could improve

performance if they were consistently applied in the oil sands region. Current industry objectives, such as Albian's existing operation's 50% greenhouse gas reduction target, Suncor's terrestrial offset mitigation or Total's proposed tailings management strategy that produces no MFT could be implemented by all oil sands companies. Instead these leading strategies represent rare examples of best practices for this industry. The Government of Alberta does not require oil sands companies to implement best practices to mitigate environmental impacts associated with oil sands development.

## *The environmental performance of this industry could be substantially improved if all operations improved their performance to match the current industry leaders.*

**3**

Our analysis provides a quantitative comparison of the proposed and actual environmental performance of oil sands mine projects. We estimate that if all the companies matched the level of performance currently achieved by currently operating leaders or promised by leading operations under development, the performance of the industry as a whole could be substantially improved:

# Summary

Air					
NOx Emissions Avoided (tonnes/yr)	Savings (%)	SO <sub>2</sub> Emissions Avoided (tonnes/yr)	Savings (%)	VOC Emissions Avoided (tonnes/yr)	Savings (%)
15,604	79%	8,439	47%	50,847	47%

Water				Climate	
MFT Avoided (m <sup>3</sup> /yr)	Savings (%)	Fresh Water Saved (m <sup>3</sup> /yr)	Savings (%)	CO <sub>2</sub> e Avoided (tonnes/yr)	Savings (%)
21,769,818	100%	73,566,924	59%	6,339,662	66%

▲ Table 12 Immediate improvement opportunities.

(Assumes maximum production of all mines; does not include Suncor and Syncrude.)

The scope for improving environmental performance is not limited to adopting the strategies of the current leaders. In many instances, there are technologically and economically feasible mitigation strategies that surpass the performance of the current industry leader.

## 4 Voluntary improvement targets appear rare for oil sands companies.

Although almost all companies have environmental policies that commit to continuous improvement, few have publicly committed to reduce greenhouse gas pollution, water intensity or air emissions. The government relies on voluntary efforts by oil sands companies. The survey shows that only a few operations have voluntarily adopted progressive management practices, and very few have adopted targets to improve their intensity-based environmental performance.

## 5 There is a lack of easily accessible information available on environmental performance.

Although all active mining companies produce some form of sustainability report, these reports are generally not comprehensive enough to assess the total environmental performance of each oil sands project. We appreciate the efforts of those companies that voluntarily provided information on request (Suncor, Shell, Albion, Synenco, Canadian Natural, Imperial and Petro-Canada). Despite this cooperation, it has taken substantial time to assemble comparative information. Although all active oil sands companies make annual submissions to the Government of Alberta, this information is neither easily available nor presented in a manner that would enable Albertans to compare environmental performance among oil sands companies.

## Recommendations

**W**WF-Canada and the Pembina Institute make the following recommendations to improve environmental management of oil sands mining operations in Alberta:

### Government

**1** *Government needs to enforce acceptable standards of environmental performance and continuously improve regulations to reflect continuous improvement in companies' abilities to reduce environmental impacts.*

The relatively weak performance by oil sands companies in this survey demonstrates the need for government to protect the public interest by providing the right regulations and incentives to ensure that impacts on the environment are minimized. The Government of Alberta has recently announced the creation of a new oil sands division to address the “big challenge” of oil sands environmental management.<sup>84</sup> We argue that there are substantial, economically viable improvements to oil sands environmental management that could be implemented simply through regulatory approvals mandating best practices. Our survey clearly shows that a reliance on voluntary implementation of best practices is not resulting in adequate environmental management in the Fort McMurray region.

Companies should not be expanding operations unless they can demonstrate how they can operate within the limits

of ecosystems and communities. Currently there is no clear trend of improvement.

**2** *Government needs to report on environmental impacts to public lands.*

The Government of Alberta should ensure environmental performance data for oil sands companies are easily accessible to the public. The Pembina Institute and WWF-Canada strongly urge the Government of Alberta to make company annual environmental submissions readily available to the public through government websites to improve public reporting of oil sands environmental impacts and the state of the environment in the Fort McMurray region.

**3** *Government must request segregated information to enable comparison of environmental performance.*

The Government of Alberta and the Government of Canada should ensure that data provided to them is based on consistent industry-wide standards and segregated sufficiently to provide for meaningful comparisons among mining operations. It is currently not possible to rank Suncor and Syncrude's operations relative to the other projects. Intensity measures based on a barrel of bitumen are also more useful because future projects will not necessarily produce their own synthetic crude oil.

## Industry

**1** *Companies need to implement best available practices and focus on developing and implementing new technologies and processes that lead to step-wise reductions in environmental impacts.*

The expectations for environmental management in this survey are not unreasonable. The survey shows that some operations, even those in the planning stages, will not achieve a level of environmental performance already achieved by the better existing operations or anticipated in regulatory approvals. A rapid improvement in environmental performance of the industry as a whole could be achieved if companies adopted existing solutions demonstrated by their peers and explored new ways to reduce environmental impacts. The Pembina Institute and WWF-Canada look forward to working with companies to substantially improve environmental performance in the oil sands.

A public opinion poll conducted in 2006 found that 87% of Albertans polled felt that oil sands companies could afford to do more to protect the environment. This finding is consistent with the results of this report. Clearly, the reputations of oil sands companies and their social license to operate are at risk if these companies are not seen to implement best practices to protect the environment and to minimize the environmental footprint of their operations.

Companies should not be expanding operations unless they can demonstrate how they can operate within the limits of ecosystems and communities. Currently there is no clear trend of improvement.

**2** *Companies should make project-specific oil sands environmental performance information more widely available and in a consistent format.*

Although all active mining companies in this survey provide some form of sustainability reporting, there is substantial room for improvement in terms of how this information is presented. No company provided enough publicly available information for the Pembina Institute and WWF-Canada to complete the survey without substantial additional research and correspondence.

## The Future

We hope that this report acts as a catalyst to start a dialogue on what represents appropriate environmental performance for oil sands companies as they develop natural resources on public lands belonging to all Albertans. WWF-Canada and the Pembina Institute are committed to working with companies to minimize the environmental impacts associated with oil sands development. We intend to repeat this survey in the future and hope to be able to report improvements in environmental performance among oil sands mine projects in the Fort McMurray region.

## Appendices

Full data and references for every question are downloadable from the Pembina Institute's website [www.pembina.org](http://www.pembina.org).

## Endnotes

- 1 Note that some companies have ownership stakes in multiple oil sands operations.
- 2 Based on data from Environment Canada (2007) National Inventory Report, Alberta's 2005 emissions of CO<sub>2</sub>e were 233,000 kt CO<sub>2</sub>e. [6339662/233000000=.027].
- 3 Alberta Energy, *Oil Sands*, <http://www.energy.gov.ab.ca/89.asp> (accessed on Aug. 27th 2007).
- 4 Department of Energy, Talk about Tenure: Facts on Oil Sands Tenure (Calgary, Alberta: Government of Alberta 2006). Available online at <http://www.energy.gov.ab.ca> (accessed on August 13, 2007).
- 5 Alberta Energy, *About Petroleum and Natural Gas Tenure*, <http://www.energy.gov.ab.ca/3067.asp> (accessed on August 13th, 2007)
- 6 Alberta Energy and Utilities Board, *Alberta's Energy Reserves 2006 and Supply/Demand Outlook 2007-2016*, (2006).
- 7 Imperial Oil Limited, *Imperial Kearl Oil Sands Mine Application*. (Calgary, Alberta: Imperial Oil Ltd., 2005), Volume 1, 2–25.
- 8 Imperial Oil Limited, *Imperial Kearl Project. Environmental Impact Assessment*. (Calgary, Alberta: Imperial Oil Ltd., 2005), Volume 1, 2–38
- 9 Imperial Oil Limited, *Imperial Kearl Project. Environmental Impact Assessment*. (Calgary, Alberta: Imperial Oil Ltd., 2005), Volume 2, 9–19
- 10 Albion Sands Energy Inc., *Environmental Impact Assessment Appendices for the Muskeg River Mine Expansion*, Appendix 2-9, Air and Noise Modelling Methods (April 2005), Table 27 and Table 28, pp. 107 and 108.
- 11 According to Environment Canada's Facility GHG reporting system, 2005 emissions from Syncrude's Mildred Lake and Aurora Plant site and Suncor Energy Inc. Oil Sands total 10,357,330.28 and 7,694,457.67 tonnes CO<sub>2</sub>e respectively. Source: [http://www.ec.gc.ca/pdb/ghg/online\\_data/table\\_e.cfm?sortCol=11&sortDir=DESC&&year=2005&select\\_gas=All&npri\\_id=&location=prov&province=48&city=22%20km%20NE%20of%20Fort%20McMurray&NAICS\\_4\\_digit=All&cas\\_number=&srcNaics=sreNaics](http://www.ec.gc.ca/pdb/ghg/online_data/table_e.cfm?sortCol=11&sortDir=DESC&&year=2005&select_gas=All&npri_id=&location=prov&province=48&city=22%20km%20NE%20of%20Fort%20McMurray&NAICS_4_digit=All&cas_number=&srcNaics=sreNaics)
- 12 Canadian Association of Petroleum Producers, *Stewardship Progress Report 2006*, (2006), Available at <http://www.capp.ca>.
- 13 Albion Sands Energy Inc. Albion Sands Energy Inc. operates both phases of the Muskeg River Mine. The Muskeg River Mine and the Scotford Upgrader together comprise the Athabasca Oil Sands Project – a joint venture of Shell Canada Limited, Chevron Canada Limited (a wholly owned subsidiary of Chevron/Texaco Corp.) and Western Oil Sands Inc. Source: <http://www.albionsands.com>.
- 14 The Kearl oil sands project is a potential oil sands mining, pipeline and upgrading project in Alberta, proposed by Imperial Oil Resources Ventures Limited (Imperial Oil) and ExxonMobil Canada Properties (ExxonMobil Canada). Imperial Oil Resources is the designated operator. Source: <http://www.imperialoil.ca>.
- 15 Petro-Canada, UTS Energy Corporation, Teck Cominco Limited and Fort Hills Energy are partners in the Fort Hills Oil Sands Project. Petro-Canada Oil Sands Inc, a wholly owned subsidiary of Petro-Canada, is the contract operator of the Project. Source: <http://www.petro-canada.ca>.
- 16 Shell Canada Limited is wholly owned by Royal Dutch Shell plc. Source: <http://www.shell.ca>.
- 17 Suncor Energy Inc.'s and Syncrude Canada Ltd.'s production values are in barrels of synthetic crude oil (SCO).
- 18 Syncrude is a joint venture undertaking among Canadian Oil Sands Limited, Conoco-Phillips Oil Sand Partnership II, Imperial Oil Resources, Mocal Energy Limited, Murphy Oil Company Ltd., Nexen Oil Sands Partnership and Petro-Canada Oil and Gas, as the project owners and Syncrude as the project operator. Source: <http://www.syncrude.com>.
- 19 Synenco and Sinopec, China's largest refiner and marketer of petroleum products, formed the Northern Lights Partnership to develop the Northern Lights Project. Synenco is the managing partner and holds a 60% partnership interest in the Northern Lights Partnership. Source: <http://www.synenco.com>.
- 20 Total E&P Canada Ltd. is a wholly owned subsidiary of the global oil and gas company Total SA. Source: <http://www.total-ep-canada.com>.
- 21 Alberta Environment, *Oil Sands Development and Reclamation*, [http://www3.gov.ab.ca/env/soe/land\\_indicators/41\\_oilsands\\_reclamation.html](http://www3.gov.ab.ca/env/soe/land_indicators/41_oilsands_reclamation.html), (accessed on August 27, 2007).
- 22 Details about the Environmental Law Centre's enforcement search service are available at: <http://www.elc.ab.ca/enforcement/index.cfm>.
- 23 Government of Alberta, *Alberta Mineable Oil Sands Strategy*, [http://www.oilsandsconsultations.gov.ab.ca/MOSS\\_TOC.html](http://www.oilsandsconsultations.gov.ab.ca/MOSS_TOC.html), (accessed on August 27, 2007).
- 24 Mary Griffiths et al, *Troubled Waters, Troubling Trends. Technology Options to Reduce Water Use in Oil and Oil Sands Development in Alberta* (Calgary, Alberta: The Pembina Institute for Appropriate Development, 2006), 16.
- 25 Golder Associates Ltd., *A Compilation of Information and Data on Water Supply and Demand in the Lower Athabasca River Reach*, prepared for the Cumulative Environmental Management Surface Water Working Group, (Calgary, Alberta: Golder Associates Ltd., 2005).
- 26 D.W. Schindler, W.F. Donahue and J.P. Thompson, "Future water flows and human withdrawals in the Athabasca River" in *Running Out of Steam? – Oil Sands Development and Water Use in the Athabasca River-Watershed: Science and Market Based Solutions*. (The Munk Center for International Studies, University of Toronto and the Environmental Research and Studies Centre, University of Alberta, 2007). 1-38.
- 27 Imperial Oil Limited, *Imperial Kearl Oil Sands Mine Application*, (no. 1408771 & 1414891, volume 4), (Calgary, Alberta: Imperial Oil Ltd., 2005), 3-31
- 28 National Pollutant Release Inventory, *On-Line Data Search*, [http://www.ec.gc.ca/pdb/npri/npri\\_online\\_data\\_e.cfm](http://www.ec.gc.ca/pdb/npri/npri_online_data_e.cfm), (accessed on August 27, 2007).
- 29 Based on Syncrude emissions of 10.357 million tonnes CO<sub>2</sub>e in 2005, the average car consumes 10.2 L/100km and travels 15,400 km a year and the combustion of gasoline emits 2.44 kg/L CO<sub>2</sub>e.
- 30 <http://www.globalreporting.org/Home>.
- 31 <http://www.jantziresearch.com/> (accessed on August 27, 2007).
- 32 <http://www.innovestgroup.com/> (accessed on October 23, 2007).
- 33 Global Environmental Management Initiative (GEMI), *ISO 14001 Environmental Management System Self-Assessment Checklist*, <http://www.gemi.org/docs/PubTools.htm>, (accessed on August 29, 2007).
- 34 Ibid.
- 35 Synenco Energy Inc., *Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application*, (2006), Volume 3, Section 3.0 and personal communication, Ken Dilling, June 15th, 2007.

# Endnotes

- 36 Shell Canada Inc., *2006 Sustainability Report*, (2007), 31.
- 37 For more information on the Global Reporting Initiative, go to <http://www.globalreporting.org/AboutGRI/>.
- 38 Source: [http://www3.gov.ab.ca/env/protenf/compliance/pubs/QuarterlyReport\\_Jan-Mar2005.pdf](http://www3.gov.ab.ca/env/protenf/compliance/pubs/QuarterlyReport_Jan-Mar2005.pdf) (accessed October 11, 2007).
- 39 Suncor Energy Inc., *Report on Sustainability 2006: A closer look at our journey toward sustainable development*, (2007) 56.
- 40 Syncrude Canada Limited, *Sustainability Report: A New Generation of Opportunity*, (2005), 57.
- 41 Government of Alberta, *Alberta Mineable Oil Sands Strategy*, [http://www.oilsandsconsultations.gov.ab.ca/MOSS\\_TOC.html](http://www.oilsandsconsultations.gov.ab.ca/MOSS_TOC.html), (accessed on August 27, 2007)
- 42 An exception is the approval for the True North (now Petro-Canada) Fort Hills Project. The EUB directed True North to limit the amount of disturbed land at any one time to 5000 hectares. Surprisingly, no other oil sands approvals include a similar mechanism to assure accountability for reclamation performance. EUB Decision Report 2002-089. True North Energy Corporation. *Application to Construct and Operate an Oil Sands Mine and Cogeneration Plant in the Fort McMurray Area*. October 22, 2002.
- 43 Suncor Energy Inc., *A Closer Look at our Journey towards Sustainable Development: 2007 Report on Sustainability*, (2007), 40.
- 44 R. Reeves, R. and H. Walsh, *The State of Alberta's Parks and Protected Areas: An analysis of the challenges and opportunities for ensuring ecological integrity*. (Canadian Parks and Wilderness Society, 2007) 22.
- 45 The Pembina Institute, *Probe Research 2006 Pembina Institute Oil Sands Survey. Final Report* (May 1, 2006), Available at: <http://www.pembina.org/pub/1446>.
- 46 The Canadian Boreal Initiative (CBI) is working with a wide range of conservation organizations, First Nations, industry and other interested parties to link science, policy and conservation activities in Canada's boreal forest. On December 1, 2003 the CBI released the Boreal Forest Conservation Framework — the most extensive national conservation vision ever. The framework was developed in concert with leading conservation organizations, resource companies and First Nations. Convened by the CBI, this group forms the Boreal Leadership Council, committed to the conservation and sustainable development of Canada's boreal forest region.
- 47 Canadian Boreal Initiative, *The Boreal Forest Conservation Framework*, [http://www.borealcanada.ca/framework\\_e.cfm](http://www.borealcanada.ca/framework_e.cfm), (accessed on August, 29, 2007).
- 48 Alberta Biodiversity Monitoring Institute, <http://abmi.biology.ualberta.ca/index.htm>, (accessed on August 29, 2007).
- 49 Emissions estimates reported as tonnes per year were converted to grams per barrel of bitumen (g/bbl) to facilitate comparison using an intensity-based measurement.
- 50 Environment Canada, *Nitrogen Oxides (NOx) Emissions for Canada*, [http://www.ec.gc.ca/pdb/cac/Emissions1990-2015/EmissionsSummaries/NOx\\_e.cfm](http://www.ec.gc.ca/pdb/cac/Emissions1990-2015/EmissionsSummaries/NOx_e.cfm), (accessed on September 11, 2007).
- 51 The World Health Organization's one-hour and annual NO<sub>2</sub> concentration guideline is set at 40 ug/m<sup>3</sup> (World Health Organization, *Use of the air quality guidelines in protecting public health: a global update*, <http://www.who.int/mediacentre/factsheets/fs313/en/>, (accessed on September 22nd, 2007). The Alberta Air Quality Objectives state a 200 ug/m<sup>3</sup> and 60 ug/m<sup>3</sup> NO<sub>2</sub> concentration for one 24-hour and annual periods. (Alberta Environment, *Alberta Ambient Air Quality Objectives*, <http://environment.gov.ab.ca/info/library/5726.pdf>, (accessed on Sept. 22nd, 2007). The Muskeg River Mine Expansion project states that all existing and approved NO<sub>2</sub> emissions will result in NO<sub>2</sub> concentrations of 261.5 ug/m<sup>3</sup> and 63.7 ug/m<sup>3</sup> during a 24-hour and annual period of time respectively (Albian Sands Energy Inc., *Muskeg River Mine Expansion Application*, (2005), Air Quality and Noise Assessment, Table 3.1-3, pg. 3-8). These concentrations are above the guidelines.
- 52 Shell Canada Ltd., *Application for the Approval of the Muskeg River Mine Expansion Project (Application for Approval)*, (2005), Volume 2, Appendix 2-9, 73-53 Imperial Oil Resource Ventures Ltd. *Kearl Oil Sands Project - Mine Development: Regulatory Application*, (2005), Volume 5, Appendix 2B.1.5, 2B-71
- 54 Ibid.
- 55 Emissions estimates reported as tonnes per year were converted to grams per barrel of bitumen (g/bbl) to facilitate comparison using an intensity-based measurement.
- 56 The World Health Organization 24-hour SO<sub>2</sub> concentration guideline is set at 20 ug/m<sup>3</sup> (World Health Organization, *Use of the air quality guidelines in protecting public health: a global update*, <http://www.who.int/mediacentre/factsheets/fs313/en/>, (accessed on September 22nd, 2007). The Alberta Air Quality Objectives state a 150 ug/m<sup>3</sup> SO<sub>2</sub> concentration over a 24-hour period. (Alberta Environment, *Alberta Ambient Air Quality Objectives*, <http://environment.gov.ab.ca/info/library/5726.pdf>, (accessed on Sept. 22nd, 2007). The Muskeg River Mine Expansion project states that all existing and approved SO<sub>2</sub> emissions will result in SO<sub>2</sub> concentrations of 176.5 ug/m<sup>3</sup> during a 24-hour period (Albian Sands Energy Inc., *Muskeg River Mine Expansion Application*, (2005), Air Quality and Noise Assessment, Table 3.1-3, 3-8).
- 57 Environment Canada, *Guide for Reporting to the National Pollutant Release Inventory*, [http://www.ec.gc.ca/pdb/npri/2006Guidance/Guide2006/toc\\_3.cfm](http://www.ec.gc.ca/pdb/npri/2006Guidance/Guide2006/toc_3.cfm), Appendix 3 (accessed on August 29, 2007).
- 58 Dan Woynillowicz, Chris Severson-Baker, Marlo Reynolds, *Oil Sands Fever: The Environmental Implications of Canada's Oil Sands Rush*, (Calgary, Alberta: The Pembina Institute, 2005), 45.
- 59 Environment Canada, *Volatile Organic Compounds (VOC) Emissions for Canada*, [http://www.ec.gc.ca/pdb/cac/Emissions1990-2015/EmissionsSummaries/VOC\\_e.cfm](http://www.ec.gc.ca/pdb/cac/Emissions1990-2015/EmissionsSummaries/VOC_e.cfm), (accessed on September 11, 2007).
- 60 Global Environmental Management Initiative (GEMI), *ISO 14001 Environmental Management System Self Assessment Checklist*, <http://www.gemi.org/docs/PubTools.htm>, (accessed on August 29, 2007).
- 61 Global Environmental Management Initiative (GEMI), *ISO 14001 Environmental Management System Self Assessment Checklist*, <http://www.gemi.org/docs/PubTools.htm>, (accessed on August 29, 2007).
- 62 Syncrude Canada Limited, *Sustainability Report: A New Generation of Opportunity*, (2005), 57.
- 63 National Energy Board, *Canada's Oil Sands: Opportunities and Challenges to 2015*, (2004), 68.
- 64 More information on this process can be found at [http://www.bitminresources.com/Process/bitmin\\_process.htm](http://www.bitminresources.com/Process/bitmin_process.htm).
- 65 Synenco SinoCanada Partnership, *Northern Lights Mining and Extraction Project Application: Submitted to Alberta Energy and Utilities Board and Alberta Environment*, (2006), Volume 2, Section 8.0, Tailings Management.
- 66 Deer Creek Energy Limited, a wholly owned subsidiary of Total E&P Canada Ltd., *Joslyn North Mine Project. Alberta Energy and Alberta Energy and Utilities Board Integrated Application*, (2006), Section B 5-10.
- 67 Alberta Environment and Fisheries and Oceans Canada, *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River*, (2007).
- 68 Calculated average from 2012 to 2034 based on the planned development case in the Imperial Oil Resources Ventures Ltd. *Kearl Oil Sands Project – Mine Development*, (2006), Volume 6, Section 4, Table 4-45, 4-98.
- 69 Alberta Environment and Fisheries and Oceans Canada, *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River*, (2007).
- 70 National Pollutant Release Inventory, *On-Line Data Search*, [http://www.ec.gc.ca/pdb/npri/npri\\_online\\_data\\_e.cfm](http://www.ec.gc.ca/pdb/npri/npri_online_data_e.cfm), (accessed on August 27, 2007).

# Endnotes

- 71 Based on Syncrude emissions of 10.357 million tonnes CO<sub>2</sub>e in 2005, the average car consumes 10.2 L/100km and travels 15,400 km a year and the combustion of gasoline emits 2.44 kg/L CO<sub>2</sub>e.
- 72 Matthew Bramley, *The Case for Deep Reductions: Canada's Role in Preventing Dangerous Climate Change* (Calgary, Alberta: The Pembina Institute, 2005). Also available online: <http://climate.pembina.org/pub/536>.
- 73 The Tyndall Centre & WWF. *Climate Change Policy and Canada's Oil Sands Resources*, (UK/Canada, WWF, 2007). Also available online: <http://wwf.ca/resources/pdf/TyndallFinalJointReport.pdf>
- 74 The Pembina Institute, *The Climate Change Implications of Canada's Oil Sands Development: Background*, (Calgary, Alberta: The Pembina Institute, 2006), 5. Also available online: [http://www.pembina.org/publications\\_item\\_.asp?id=213](http://www.pembina.org/publications_item_.asp?id=213).
- 75 Ibid, 3.
- 76 Based on data from Environment Canada (2007) National Inventory Report, Alberta's 2005 emissions of CO<sub>2</sub>e were 233,000 kt CO<sub>2</sub>e. [6339662/233000000=.027].
- 77 Ibid.
- 78 National Pollutant Release Inventory, *On-Line Data Search*, [http://www.ec.gc.ca/pdb/npri/npri\\_online\\_data\\_e.cfm](http://www.ec.gc.ca/pdb/npri/npri_online_data_e.cfm), (accessed on August 27, 2007).
- 79 Probe Research, *Pembina Institute 2007 Alberta Oil Sands Survey: Final Report*, (2007) Available at: <http://www.pembina.org/pub/1446>.
- 80 Global Environmental Management Initiative (GEMI), *ISO 14001 Environmental Management System Self Assessment Checklist*, <http://www.gemi.org/docs/PubTools.htm>, (accessed on August 29, 2007).
- 81 Shell Canada Limited, *Sustainable Development Report*, (2006), 35.
- 82 The Gold Standard – Quality Assurance for CDM and JI Projects. WWF. Available at [http://www.panda.org/about\\_wwf/what\\_we\\_do/climate\\_change/solutions/business\\_industry/offsetting/gold\\_standard/index.cfm](http://www.panda.org/about_wwf/what_we_do/climate_change/solutions/business_industry/offsetting/gold_standard/index.cfm)
- 83 Shell Canada Limited, *Sustainable Development Report*, (2006), 35.
- 84 Government of Alberta, *Take on the World*, <http://www.takeontheworld.gov.ab.ca/>, (accessed on August 27, 2007).