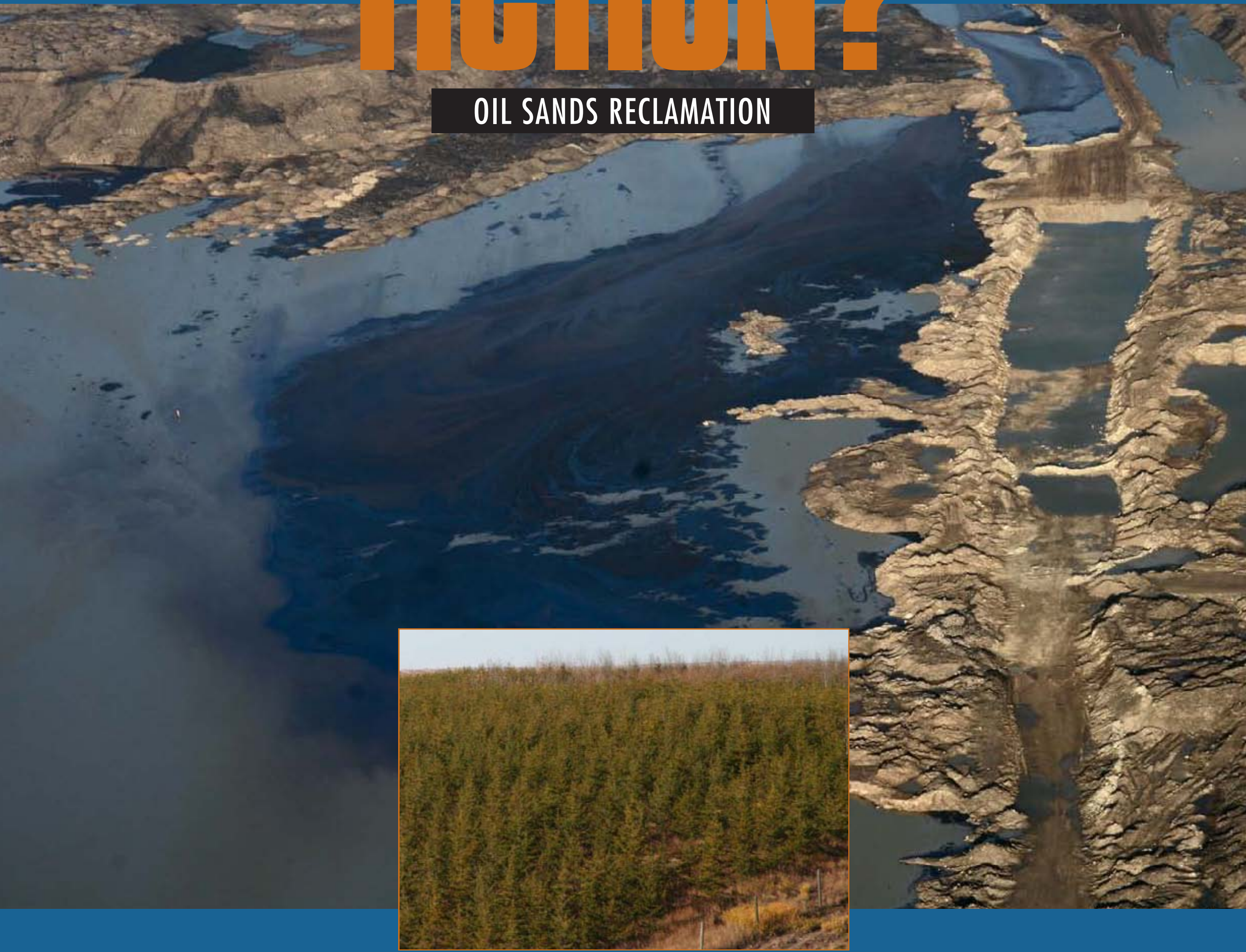
Fact or FICTION?

OIL SANDS RECLAMATION



JENNIFER GRANT

SIMON DYER • DAN WOYNILLOWICZ

May 2008

Oil SANDS Fever SERIES

the PEMBINA institute

Fact or Fiction

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Sustainable Energy Solutions

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About the Pembina Institute

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 or by contacting info@pembina.org.

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Fact or Fiction

Oil Sands Reclamation

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Summary

Surface mining for oil sands is radically transforming the Athabasca Boreal region of northeastern Alberta. The feverish expansion in oil sands development is based on the untested assumption that mined landscapes can be recovered to something close to the pre-development ecosystem after mining is complete. Reclamation is the final step mining companies are required to complete before mine closure. Defined in Alberta as the “stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land,” reclamation is an essential component of responsible oil sands development. However, an assessment of the current policies and practices governing oil sands mine reclamation reveals an alarming range of challenges, uncertainties and risks that deserve immediate attention and broader public discussion. This report explores these issues to help demonstrate what is fact and what is fiction about oil sands mine reclamation.

Figure 1: Natural boreal forest (left) is converted into a mined landscape (centre). What will be left when the mining is done?

Photos: David Dodge, CPAWS

Mineable oil sands deposits underlie almost 3,500 square kilometres of boreal forest in Alberta. The mineable portion of the Athabasca Boreal region currently produces approximately 856,000 barrels of bitumen per day. Output is expected to increase to over three million barrels per day within the next decade. Available data shows that the cumulative disturbance for oil sands mine development from 1967 to 2006 was 47,832 hectares of boreal forest. To date, the Government of Alberta has certified as reclaimed land only 0.2% of the total land base disturbed by mines. It does not include tailings materials — notorious waste byproducts from oil sands mining that companies propose to incorporate into the reclaimed landscape. Tailings waste is being produced at a rate of 1.8 billion litres a day.

Despite these challenges, the public expects that reclamation will return areas to close to their pre-disturbance states, but the regulations don’t require anything that specific. There are few reclamation standards, and the current vague requirement by the provincial government is to return land to equivalent land capability. This approach favours economic, utilitarian values rather than pre-developmental, natural conditions. In addition, there is much uncertainty about what truly can be reclaimed, and what habitats types will be permanently lost after mining.

The reclamation of peatlands (fens or bogs) in the Athabasca Boreal region has not yet been demonstrated; bog reclamation may prove very difficult to achieve. Reclaiming liquid waste materials is uncertain. The provincial regulatory authorities have said that two primary initiatives to remediate and manage tailings waste — end pit lakes and consolidated tailings — are acceptable, but neither has been adequately demonstrated to meet expectations for long-term reclamation. The historical data about using end pit lakes as toxic waste dumps are insufficient to determine whether or not they are a safe, long-term tool for reclaiming tailings waste. A fully realized end pit lake has yet to be constructed. The migration of tailings toxins (such as naphthenic acids) through the groundwater system present serious risks to the boreal landscape and beyond. Toxins may also leak to the surrounding soil and surface water.

Tailings ponds already cover an area greater than 50 square kilometres, and there are a total of 5.5 billion cubic metres of impounded tailings on the landscape. Including new approvals and planned projects, tailings ponds will occupy over 220 square kilometres. This area is five times the size of Alberta’s Sylvan Lake.

These environmental uncertainties and risks are a potential environmental and fiscal liability for Canadians, yet the current oil sands mine reclamation security program is a closed process lacking transparency. Information about reclamation costs, the calculation of liability bonds and the frequency (if any) of government validation of reclamation plans are not publicly available or readily accessible. Our research found that the total security value for oil sands mining represents only approximately $11,000 per hectare. Independent sources suggest that this value is insufficient to reclaim the landscape.

A lack of transparency means that the true costs of reclamation are unknown and it is uncertain as to whether or not the current security deposits are adequate. If they are not, Albertan and Canadian taxpayers could end up shelling out for the reclamation of thousands of square kilometres of mine pits and toxic tailings lakes.

Recommendations

The Governments of Alberta and Canada should suspend new approvals for oil sands mines and halt the granting of new oil sands leases until sound reclamation policies and practices are implemented that address the most significant risks and uncertainties.

Managing oil sands development responsibly requires that reclamation be credible, transparent and most importantly possible. The Government of Alberta should adopt and implement the following seven recommendations to improve oil sands reclamation:

1) Require restoration of oil sands mines to self-sustaining boreal forest

To fulfill the expectations of Albertans, oil sands operators should be required to return areas to self-sustaining ecosystems with approximately the same proportion of ecosites that existed prior to disturbance.

2) Establish a set of transparent reclamation standards

A common set of reclamation standards should exist for oil sands mining. New research and the demonstration of progressive technologies and practices are needed, and they should be integrated with existing information to reduce uncertainty and minimize risk. Reclamation standards that consider aboriginal, aquatic and wildlife values need to be established and integrated into Alberta Environmental Protection and Enhancement Act (EPEA) approvals and reclamation guidelines.

3) Prohibit the creation of liquid tailings

Responsible oil sands development should prevent the creation of toxic tailings, thereby eliminating the need for managing these wastes through end pit lakes. While end pit lakes are common practice in the mining industry, it is not common practice to deposit toxic waste at the bottom of them. The Government of Alberta should clearly communicate to the industry that it will not approve any new oil sands mine projects that result in end pit lakes for mitigating and managing toxic waste. Instead, the province should encourage industry to develop new processes that prevent the creation of tailings.

4) Reform the reclamation security policy to protect Canadians

The lack of transparency associated with the current oil sands mine reclamation security program forces the public to blindly trust that the current bonding policy is adequate. An independent review is needed to establish the true costs of oil sands reclamation and to recommend clear guidelines for how companies calculate their reclamation liability, including consideration of reclamation uncertainty. An independent review will ensure clarity for Canadians and oil sands operators alike. It will ensure that sufficient money is collected to protect Canadians from potential liabilities.

5) Institute a total disturbance area cap for each project to ensure reclamation occurs at the same time as development

To ensure industry accountability for progressive reclamation — reclamation as you go — Alberta Environment should develop and implement a consistent approach for including quantitative reclamation targets and timelines in EPEA approvals for oil sands mine operations. Alberta Environment should apply this approach to both existing EPEA approvals, by re-visiting and revising these approvals, and to any future EPEA approvals for oil sands mining.

6) Increase public transparency of corporate reclamation performance

Alberta Environment should post on its website the annual conservation and reclamation activity reports it receives from companies. Further, when the Government of Alberta certifies reclamation it should publish its analysis of the reclaimed land and its rationale for issuing the certificate and assuming liability for the land. Finally, the government could increase Albertans' confidence in oil sands reclamation by providing a report every two to five years that provides a full account of the land that has been disturbed versus reclaimed.

7) Require environmental compensation to offset mining impacts

Reclamation lag times and uncertain success of reclamation challenge the adequacy of reclamation as the primary form of terrestrial mitigation. Residual or unavoidable effects can be addressed by environmental compensation through conservation offsets. Alberta Environment should rapidly implement a compensatory mitigation policy, for both wetlands and terrestrial habitats, to help mitigate terrestrial disturbance in northeastern Alberta.

1. The Challenge: Can We Reclaim What Was Lost?

1.1 Transforming the Boreal for Bitumen

In the northeastern quarter of Alberta, large deposits of oil sands, estimated at 173 billion barrels of recoverable oil,[1] lie underneath the boreal forest. The bitumen in the oil sands is a thick, tar-like substance bound with sand, clay and water. Underneath the almost 3,500 square kilometres (km^2) of boreal forest in the Athabasca formation, the oil sands deposits are close enough to the surface (less than 100 metres deep)[2] to be mined.[3] Companies from all over the world have been given the green light to surface mine (strip mine) for oil sands in the Athabasca Boreal region of Alberta on the assumption that they can and will fully reclaim the land. A radical transformation of the land is now well underway, but companies are just starting to find out if it is even possible to adequately reclaim the land after mining has been completed.

Before mining can begin, the forest, wetlands and mineral soil are cleared, drained and removed. Rivers and streams are diverted and forests are clear cut, with merchantable timber being harvested and the remainder being piled and burned. In addition, the layers of wetland or muskeg (water-soaked vegetation that consists of mainly decaying plant material) must be drained and excavated.

Figure 2: Forests are clear cut in preparation for dewatering

Photo: David Dodge, CPAWS

The muskeg layer lies about 1–3 metres (m) thick above the overburden (the material that overlies the ore deposit). Prior to the muskeg layer's removal, it must be drained of its water content, a process known as dewatering that can take up to three years to complete.[4] The overburden is then mined with large shovels and moved by dump trucks to be placed in above ground waste dumps (called overburden dumps) or mined out pits.[5] The overburden may also be compacted into large dykes, creating dams that will eventually contain tailings.

With the boreal forest and overburden removed, the oil sands ore is exposed and can then be mined. The bitumen deposits are 40–60 m thick and sit above limestone.[6] Typical medium-grade oil sands from the Athabasca deposit contain 83% sand, 3% clay, 4% water and 10% bitumen. Each grain of sand is surrounded by a water film that contains silt and clay, which in turn is surrounded by a layer of bitumen.[7] This means that a large amount of oil sands — nearly 2,000 kilograms (kg) — must be removed to produce a single barrel of oil. This amount is in addition to the removal of an average of 2,000 kg of overburden per barrel of oil to access the bitumen-saturated sand.[8,9]

The dominant method of oil sands mining is the truck and shovel method. Large shovels dig oil sand ore and load it into the back of large hauler trucks. A single shovel is capable of digging 43 cubic metres of material with each scoop.[10] Trucks transport the oil sands ore to crushers where it is broken down in smaller chunks, and the extraction process, which will be addressed in more detail later, begins.

Figure 3: Nearly 2,000 kg of oil sands ore are mined for each barrel of oil produced
Photo: David Dodge, CPAWS

1.2 Mine First, Reclaim Later

Over the past 40 years the singular focus of both oil sands companies and the Government of Alberta has been to increase the production of oil sands mine operations as quickly as possible while paying only token attention to reclamation.

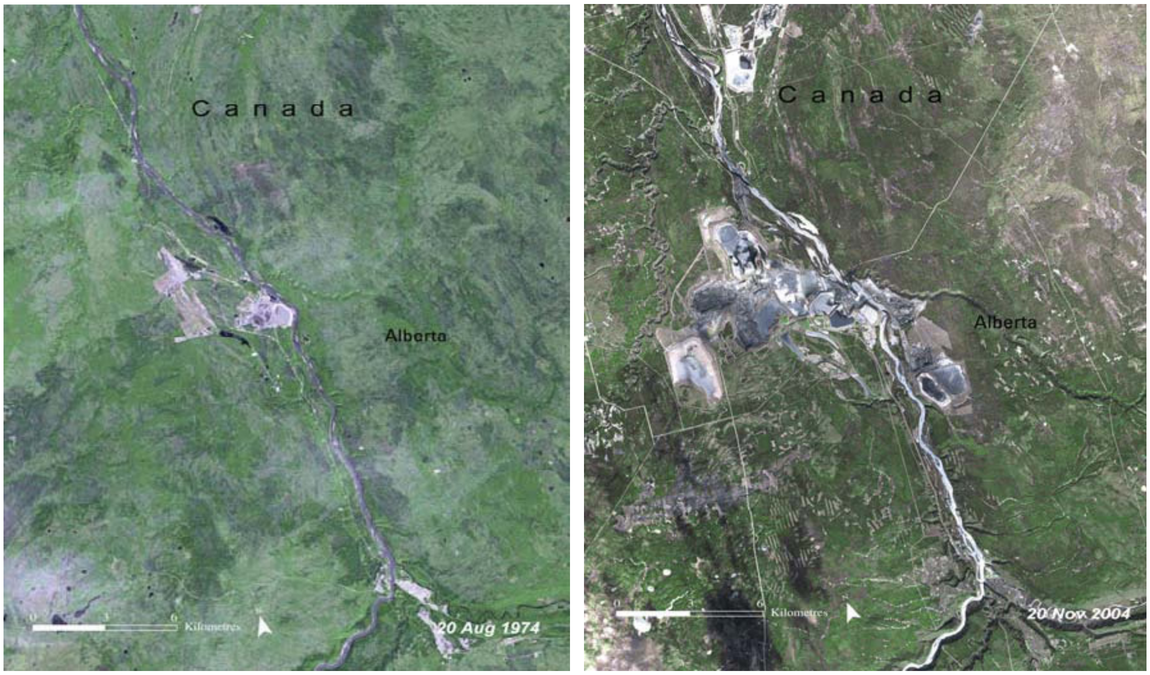

Figure 4: Because of the rate at which oil sands development changed the boreal forest from 1974 (left) to 2004 (right), the United Nations identified the region as a global hot spot of environmental change

Photos: United Nations Environment Program, Global Resource Information Database, Souix Falls, South Dakota, na.unep.net/digital_atlas2/webatlas.php?id=261. Also see “Flying around the Globe on a Time Machine,” www.unep.org/Documents.Multilingual/Default.asp?DocumentID=487&ArticleID=5350&l=en.

Oil sands mining in the Athabasca region began in 1967. The cumulative disturbance from 1967 to 2006 for oil sands mine development was 47,832 ha (Figure 5).[11] This is only 14% of the potential surface mined area. As of 2006, only 13.6% (6,498 ha) of this disturbed area is considered reclaimed by oil sands operators’ standards.[12] Because of a lack of regulated standards and transparency, this claim has not been verified. Until very recently, none of the industry-reclaimed land was certified by the Alberta government and subsequently returned to the public. In the Athabasca Boreal region only one company has applied for reclamation certification to date.

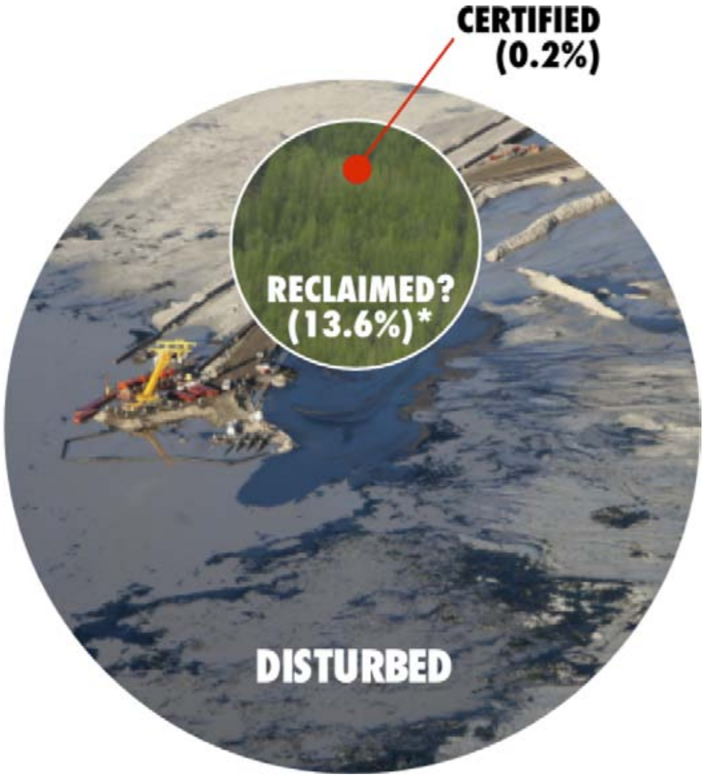

Figure 5. Land disturbed, reported as reclaimed by oil sands companies and certified as reclaimed by government, up until 2006

* This area is considered reclaimed by oil sands operators' standards. Because of a lack of regulated standards and transparency, this claim is unverified.
Data Source: C. Powter of Alberta Environment. Data include the following mines: Syncrude Mildred Lake (data start 1977); Suncor (data start 1978); Fort Hills (data start 1995); Syncrude Aurora (data start 1998); Albian (data start 2000); CNRL (data start 2004); Jackpine (data start 2005).

The land disturbance that has occurred over the past three decades is much smaller than the extent of change that is coming with the increased oil sands development already approved by the Governments of Alberta and Canada. In 2006, Alberta produced an average of 1.25 million barrels of bitumen per day, with surface mining accounting for 61% of this total.[13] The Government of Alberta has approved every oil sands mining and in situ drilling project that has been proposed to date. Oil sands production is projected to approach 3 million barrels per day by 2015,[14] and as much as 5–6 million barrels per day by 2030.[15] Surface mining projects will remain the dominant approach to oil sands development, accounting for more than 50% of production in 2015.[16]

The focus of this report is surface mining reclamation. While in the long term only 20% of Alberta's oil sands are recoverable using this method, the reclamation uncertainties and environmental consequences that accompany this method are plentiful and pose serious environmental risks. The failure to demonstrate reclamation success is a significant concern when considering the new and pending approvals for mine operations in the Athabasca Boreal region. In 2008 the mineable portion of the Athabasca Boreal region will produce approximately 856,000 barrels of bitumen per day.[17] Factoring in projects under construction, new mine approvals and publicly disclosed projects, this number will increase to over 3 million barrels within the next decade.[18]

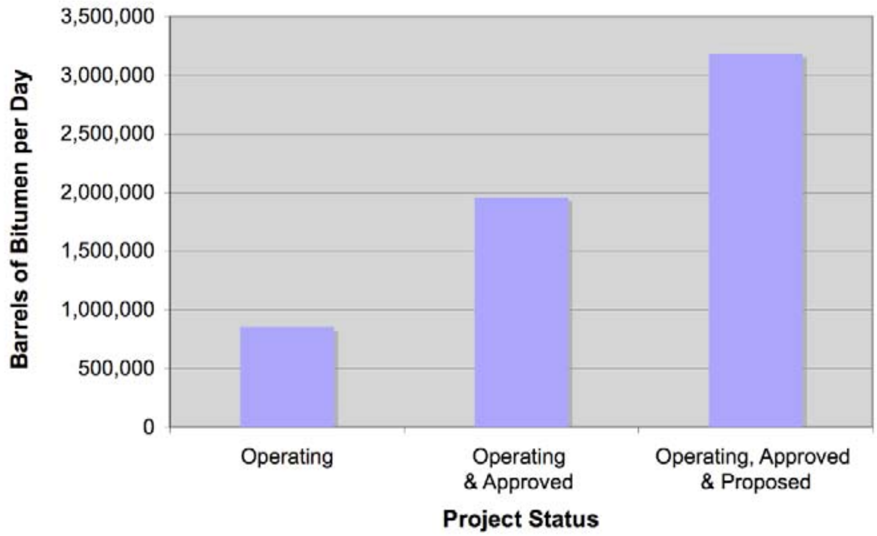

Figure 6: Projected bitumen production from current and future oil sands projects

Data Source: These numbers are estimated from Strategy West's Oil Sands Projects summary table. Bob Dunbar, *Existing and Proposed Canadian Commercial Oil Sands Projects*, Strategy West Inc., www.strategywest.com/downloads/StratWest_OSProjects.pdf.

Within the Athabasca Boreal region, there are three active surface mining operations: Suncor Energy Inc., Albian Sands Energy Inc. and Syncrude Canada Ltd. The current footprint approved for these three operations totals 61,762 ha.[19] Approved mines that have yet to become fully operational will add another 72,317 ha of disturbance while mines that are currently in the application process will result in a cumulative disturbance footprint of over 191,000 ha.

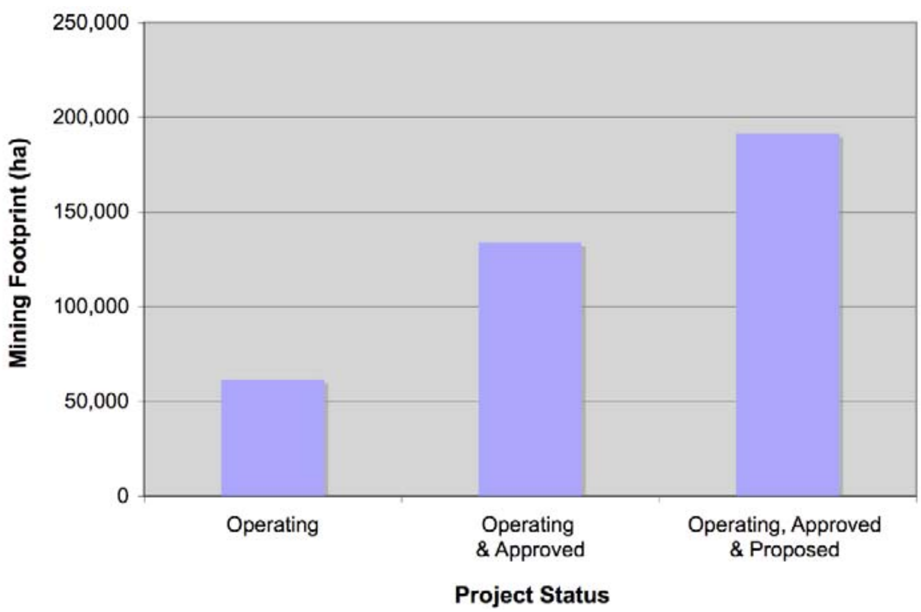

Figure 7: Terrestrial footprint of mines in the Athabasca Boreal region

Data Source: These numbers are estimated from Strategy West's Oil Sands Projects summary table. Bob Dunbar, *Existing and Proposed Canadian Commercial Oil Sands Projects*, Strategy West Inc., www.strategywest.com/downloads/StratWest_OSProjects.pdf. This graph is a conservative estimate because it does not include the footprint of disclosed projects for which there was no publicly available data. Disclosed projects include expansions of CNRL's Horizon mine, Syncrude's Mildred Lake and Aurora mines, and Total's Josyln mine.

Gateway Hill: 40 years in the making

It took more than 40 years of oil sands mining for the Government of Alberta to issue Alberta's first oil sands reclamation certificate. In March 2008, Syncrude Canada Ltd. received a reclamation certificate for the 104-hectare (ha) parcel of land known as Gateway Hill, which is approximately 35 km north of Fort McMurray.[20] Syncrude first submitted its application for Gateway Hill in 2003.[21] After Alberta Sustainable Resource Development and Alberta Environment conducted an initial technical review in March 2004, the government decided that additional information was needed and then denied certification. Alberta Environment requested that Syncrude clarify the following: depth of reclamation cover, wildlife habitat use and drainage volumes for runoff. Alberta Sustainable Resource Development requested a survey plan to delineate the reclaimed area apart from mining areas.[22] On March 19, 2008, the site was formally certified as reclaimed.

The Gateway Hill site originally had low-lying wetlands. Syncrude used the site to store overburden material that was removed during oil sands mining. By the early 1980s, Syncrude no longer needed the area and began to replace topsoil and plant trees and shrubs. Today Gateway Hill is a forested area that extends as high as 40 m above Highway 63 north of Fort McMurray.[23]

While it is encouraging to know that reclaimed land is being certified and returned to Albertans, it is equally disconcerting to consider the challenges that lie ahead. Gateway Hill represents 0.2% of the total land base disturbed by mines. Gateway Hill did not include tailings materials — notorious waste byproducts that are proposed to be incorporated into the reclaimed landscape. Stakeholder concerns regarding the reclamation of tailings waste are far from being resolved. Finally, Gateway Hill confirmed that northeastern Alberta may be permanently transformed from a rich wetland-dominant low-lying landscape to hilly forested uplands. Clearly what was lost is not being replaced.

1.3 Alberta's Boreal Forest

Alberta's boreal forest is a verdant mosaic of wetlands and forests, lakes and rivers. Aboriginal Peoples continue to live and rely on Alberta's boreal for both subsistence and traditional uses. The boreal forest also supports a range of other commercial and recreational uses. Home to an abundance of wildlife and birds, the boreal forest performs important ecosystem services, such as purifying water and storing carbon. But the social, traditional and ecological value of the intact boreal forest has received surprisingly little attention amidst the rush to maximize oil sands production. Equally ignored is the immense challenge of how the boreal forest can be restored after the oil sands have been exploited, or whether it is even possible.

The 3,500 km^2[24] mineable oil sands region is situated in the Central Mixedwood Natural Subregion of Alberta, where upland forest communities and wetlands dominate. Trembling aspen, white spruce and pine forests, interspersed with rivers, lakes and wetlands, create a patchwork of diverse habitats for wildlife. Natural disturbances such as frequent forest fires have strongly influenced the boreal forest's current distribution, composition and structure of natural forest communities.[25] These disturbances provide a natural mosaic of forest ages, from young stands to old stands greater than 150 years old. Alberta's boreal plant communities are equally complex — conservative estimates indicate a rich diversity of species, including 600 vascular species, 17 ferns, 104 mosses, 13 liverworts and 118 lichens.[26]

Figure 8: Upland forest communities and wetlands dominate the Central Mixedwood Natural Subregion of Alberta

Photo: David Dodge, CPAWS

Northeastern Alberta consists of traditional lands for Aboriginal Peoples. Fish and wildlife are harvested from these lands, and many different aboriginal communities continue to use the region today.

The Athabasca Boreal region falls within the boundaries of the traditional lands of several Aboriginal Peoples. Five First Nations continue to live in northeastern Alberta: the Athabasca Chipewyan First Nation, Chipewyan Prairie First Nation, Fort McKay First Nation, Fort McMurray No. 468 First Nation and Mikisew Cree First Nation. These First Nations comprise more than 5,000 native Cree and Chipewyan people. In addition, several Métis communities continue to rely on the Athabasca region.

Alberta's boreal mixedwood forest includes 327 animal species: 40 fish, 5 amphibians, 1 reptile, 236 birds and 45 mammals.[27] Characteristic mammals include snowshoe hares, southern red-backed voles, black bears, moose and ermine. Less common mammals that depend on the boreal forest include Canada lynx, fishers, wolverines, river otters, grey wolves and woodland caribou. Listed as "Threatened" both provincially and nationally, woodland caribou depend on forested and wetland habitats in the Boreal Forest Natural Region, where they are typically found in treed fens and bogs dominated by black spruce and larch.[28]

Figure 9: The bald eagle is among the 236 bird species that reside in Alberta's boreal mixedwood forest

Photo: David Dodge, CPAWS

Alberta's boreal forest landscape is topographically, climatically and biologically diverse. The topography ranges from broad lowland plains to undulating hill systems. The climate is characterized by short, warm summers and long, cold winters. Alberta's boreal landscape supports numerous small lakes, rivers and streams, which largely feed into the Athabasca River and its tributaries.[29] As one of the largest natural regions in Alberta, the Boreal Forest Natural Region provides essential ecosystem services. Lakes and wetlands purify our water, produce oxygen and moderate our climate — all vital ecosystem services upon which we depend for life.[30]

1.4 Bitumen Extraction and Waste Management — A Toxic Task

After the oil sands are mined, they must be either thinned or heated to move through a pipeline. The ore is mixed with hot water (and sometimes caustic soda) to wash oil from sand.[31] The slurry is then pumped via pipeline to the extraction plant.[32] The extraction process separates the bitumen from the oil sand. The slurry mixture from the hydro-transport pipeline goes into tanks, which are called primary separation vessels, where it settles into layers. In these vessels, the bitumen floats to the surface, the sand settles to the bottom and in between the two floats a murky water layer (called middlings).

The sand and middlings make up the waste byproduct called tailings, which consist of water, sand, silt clay, unrecovered hydrocarbons and water with dissolved components.[33] The bitumen froth is skimmed off the top and sent to froth treatment, the middlings are fed into a secondary separation vessel to undergo more separation, and the sand, mixed with water, is pumped into large settling basins called tailings ponds — more appropriately referred to as tailings lakes.[34] The water associated with these tailings is, to a large extent, recycled. Despite this fact, however, there is still an accumulation of tailings on the landscape.

Ponds or Lakes?

Tailings are stored on site in what is commonly called a pond. Given the magnitude of these bodies of water, some of which exceed over 10 km^2 in size, it is more appropriate to refer to these liquid storage sites as tailings lakes.

The recycled water and the water remaining in the pore spaces of the sand, silt and clay is known as process-affected water, and it is contaminated by unrecovered hydrocarbons. Oil sands mining companies must operate under a zero-discharge policy — none of the tailings material or water is discharged to the environment. Despite this policy, it has been reported elsewhere that tailings ponds are indeed leaking into the Athabasca River.[35]

Figure 10: Despite a zero-discharge policy, it has been reported elsewhere that tailings ponds are indeed leaking into the Athabasca River

Photo: David Dodge, CPAWS

Given the toxic composition of tailings, tailings waste must be held and managed on site. The tailings sand slurry is pumped hydraulically to deposition sites where it is left to separate and settle. The slurry is poured into cells and beaches where the coarser sand settles and is compacted to form containment dykes. The water and suspended fine materials (silts and clays) flow down the beach slopes into large settling basins. This settling could take anywhere from a few decades to as much as 125–150 years, depending on the tailings management and technologies employed and the proportion of fine materials in the mined oil sands.[36] Tailings systems at each oil sands operation are slightly different and change over time as new technologies become available. However, it is estimated that 2–2.5 m^3 of total tailings material is produced on a per barrel basis. As a result, there are a total of 5.5 billion m^3 of impounded tailings on the landscape.[37]

When mining projects first start operating it is necessary to build tailings ponds outside of the mine pits, through the construction of large dykes. Tailings are transported hydraulically and deposited into the tailings facilities. Once deposited, they separate into coarse sand, a denser fluid and water. The coarse sand fraction settles quickly to form beaches. Most of the fine silts and clays enter settling basins to form a stable suspension that requires a long time to fully consolidate. As this suspension settles, it is referred to as mature fine tailings (MFT).[38] MFT settle to become less liquid and more dense over time, reaching approximately 30% by weight of fine sand and clays. The remaining 70% is composed of water that cannot be recycled because of the suspended sediments.[39]

Since 1968, oil sands tailings lakes have been growing. There have been a total of 2.6 billion barrels of bitumen produced. Between 2–2.5 m^3 of total tailings material is produced on a per barrel basis. As a result, there are a total of 5.5 billion m^3 of impounded tailings on the landscape. This amounts to 2,200,000 Olympic swimming pools of toxic waste.[40] Of this amount, 0.25 m^3 per barrel is mature fine tailings. This amounts to about 650 million m^3 of mature fine tailings on the landscape that requires management.[41]

The production of MFT (also referred to as fluid fine tailings) ties up water and therefore limits the availability of recycled water for mine operations. Similarly, the coarse sand beach, which is created when tailings are deposited, stays wet as the space left by the removal of the bitumen is filled by water that sits between the sand grains. The amount of MFT that will be made at any particular plant is dependent on the amount of fine materials in the ore that is mined. The more fines in the ore, the more MFT generated from the extraction process. On average, approximately 1.5 barrels of MFT accumulate for every barrel of bitumen produced.[42] With four expansion projects underway, bitumen production is expected to triple to more than 3 million barrels per day by 2015.[43] If current extraction and tailings management practices remain unchanged, total tailings and mature fine tailings amounts will also triple, which means that approximately 7.5 million m^3 of toxic tailings would be produced on a daily basis.

In other jurisdictions, mine tailings storage has been associated with significant incidents of containment losses, which cause major ecological disasters and result in significant financial losses for companies.[44] Tailings lakes may become major public liabilities in the event that a company cannot cover the cleanup itself.[45] While the oil sands tailings lakes are actively monitored and maintained, and the potential for a catastrophic failure of a tailings dyke is considered low, the long-term viability of these dykes will remain an ongoing concern long after operations cease. Any future failure of containment dykes could allow a release of unstable materials into the Athabasca River and would be catastrophic to the affected aquatic ecosystem.[46]

> "If any of those (tailings ponds) were ever to breach and discharge into the river, the world would forever forget about the Exxon Valdez"[47]
>
> — Dr. David Schindler, Department of Biological Sciences, University of Alberta

1.5 Defining Success and Meeting Expectations

1.5.1 What Does Success Look Like?

Recovery of landscapes after mining should be the foremost priority in mining planning. Before the required planning can take place, operators, government and stakeholders need to agree on what reclamation actually means. Clarifying expectations at the onset is important; confusion often occurs between the two terms reclamation and restoration despite their many differences. Historically speaking, the term reclamation is commonly used in the context of mined lands in North America and the United Kingdom.[48] In Alberta, reclamation is defined simply as the "stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land,"[49] which is a very different goal to restoration, which is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability.[50]

> Reclamation is "returning mined areas to a natural state." The aim is to restore disturbed land, so that it is as productive or more productive than it was before it was mined.[51]

Oil sands companies are also known to create their own reclamation definitions. Albian Sands Energy Inc. states that "the overall objective of reclamation in the Athabasca Boreal region is to produce sustainable ecosystems that will fall within the natural range of variability in terms of productivity of forest ecosystems in the region."[52] The definition from the Society for Ecological Restoration describes reclamation to be "the stabilization of the terrain, assurance of public safety, aesthetic improvement and usually a return of the land to what, within the regional context, is considered to be a useful purpose."[53] Golder Associates, which is one of the leading consultants for oil sands companies, states that the goal of reclamation is "to achieve maintenance-free, self-sustaining ecosystems with capabilities equivalent to or better than pre-disturbance conditions."[54] The National Energy Board defines reclamation as the act of "returning disturbed land to a stable, biologically-productive state."[55]

> "We are working toward reclamation success. What does success mean? It will mean something different from a personal point of view and perhaps from an employment point of view. Is it acceptable? There again, you have a very qualitative term. Or is it sustainable?"[56]
>
> — Proceedings from CEMA 2003 Creating Wetlands in the Oil Sands Workshop

The common thread between these varying definitions is one of utility. The term reclamation describes the general process whereby the land surface is returned to some form that is of beneficial use to humans. Here lies the distinction between reclamation and restoration: restoration is far less associated with the utility of the landscape and is guided by ecological principles to promote the recovery of ecological integrity.[57] A restored ecosystem contains a characteristic assemblage of the species that occurred in the reference ecosystem. The restored physical environment must be capable of sustaining populations of the species that are necessary for the ecosystem's continued stability or development along the desired trajectory. This definition is compatible with a recommended action item from the Alberta Oil Sands Multistakeholder Committee. Vision 3, Strategy 8, Action 8.4 reads, "Define a reclamation standard that describes final certification requirement where site conditions are clearly self-sustaining, and where natural succession to a typical boreal ecosystem would occur."[58]

1.5.2 Big Promises, But Can Industry Deliver?

Despite the enormity of disturbances caused by the mining process — the altering of natural hydrological systems, the volumes of earth that are dug up and moved, and the capacious creation of wastes — companies assure Albertans that mitigation of these terrestrial disturbances through reclamation is guaranteed.

Syncrude Canada Ltd.

"We pledge to return the land we disturb to a stable, biologically self-sustaining state. This means creating a landscape that has productive capability equal to if not better than its condition before mining began."[59]

Suncor Energy

Developed lands shall be reclaimed with viable ecosystems compatible with pre-development, including forested areas, wetlands and streams. The reclaimed lands will provide a range of end uses, including forestry, wildlife habitat, traditional use and recreation.[60]

Synenco Energy Ltd.

"The body of reclamation research on reclamation performance in the oil sands region is growing as oil sands mines, universities, consultants and governments establish and monitor collaborative research programs. Studies of reclamation performance are by their nature long-term because biological systems take decades to develop and mature. A number of useful studies do exist to provide a reasonable degree of confidence in the proposed reclamation measures."[61]

1.5.3 Will Public Expectations Be Met?

Albertans' expectations to return the Athabasca region to an ecologically viable state are high:

- The Mikisew Cree First Nation "are concerned about the rate of development and both the short- and long-term effect on their traditional lands and culture. Fundamental to Mikisew's understanding in these hearings is a search for certainty. Certainty that the natural capital representing one of their key assets, traditional lands, is preserved and restored — that the liability of the landscape so altered as to be functionally useless is not returned to their future generations."[62]
- "There is strong concern about the utility of sharing traditional knowledge and the communities getting little in return regarding a functioning usable landscape following reclamation."[63]
- "The First Nations of Fort McKay stated that the boreal forest is unique and valuable. Muskeg is spiritually important to First Nations people, and it is part of their way of life. … Research on muskeg should be a high priority; research needs to be implemented soon and results need to be seen. Too much muskeg has already been destroyed and not replaced. The hope of the First Nations is that reclamation will benefit our great grandchildren in the next seven generations."[64]

- “The Mikisew Cree First Nation stated that it was concerned that there were no reclaimed pits in the oil sands region and that the government continued to approve mining projects. MCFN questioned when government would certify that the land could be reclaimed.”[65]

The Alberta public also appear to have much higher expectations for oil sands reclamation than is being delivered in the Athabasca Boreal region. In a professional telephone opinion survey of 500 Albertans, conducted by Probe Research in April 2007, 88% of Albertans felt that new oil sands mines should only be approved if companies can demonstrate that they can return mined areas to the way they were before mining began. In January 2008, a survey of 1,303 Albertans rated the pace of reclamation as one of the top three value drivers important to Albertans’ outlook on oil sands development.[66]

Although Albertans’ expectations for reclamation may be more akin to restoration, the perspectives of regulators and industry people appear to be far less hopeful. In a recent report commissioned by the Canadian Boreal Initiative, qualitative interviews with 33 representatives from industry, government, academic, First Nations and non-governmental sectors were conducted to get input on terrestrial mitigation options in northeastern Alberta.[67] Over 90% of all respondents (11 out of the 33 were industry representatives) considered the current requirements for reclamation in northeastern Alberta inadequate. Their concerns regarding the existing regulatory framework included the following: inadequate techniques to restore ecological viability; rapid development that outpaces reclamation abilities and activities; and the inability to deal with cumulative effects and long reclamation lag times.

2. Government Policy and Process

2.1 Shortcomings of Environmental Assessment and Approvals

Environmental impact assessments (EIAs) are required by Alberta Environment and the Energy Resources Conservation Board (ERCB)[68] for large, complex projects that have significant environmental impacts.[69,70] All oil sands mining projects require an EIA.[71] Environmental approvals generally set project-specific operational limits for air, water and land for 10-year terms.[72] Proponents are expected, but not required, to use the best available technology, as well as to meet all of the regulatory criteria and guidelines for landscape reclamation and cleanup of contamination. The current EIA process assumes reclamation success: "Mitigation paired with reclamation assumes a post-project success rate of 100%. Residual effects are considered on this basis. Uncertainty with reclamation methods are assumed to be resolved with ongoing reclamation monitoring and research."[73] EIAs are intended to be a conservative assessment of impacts and thought to err on the side of caution. And yet here, prior to any certified reclamation, operators and regulators were assuming 100% reclamation success.

In the haste of regulators to promote oil sands growth in Alberta, project after project has been approved on the basis of vague and unclear assumptions that reclamation will work. Furthermore, the gap between what is disturbed from mining activities to what will be reclaimed is growing.

A Development and Reclamation Approval, along with all other necessary permits and licenses related to environmental matters, is only required *after* a project is approved, but it must be acquired prior to any surface disturbance.[74] These approvals, and the Alberta Environmental Protection and Enhancement Act (EPEA) and its Conservation and Reclamation Regulation, guide oil sands reclamation. Under Alberta's EPEA, reclamation means any or all of the following:

i) the removal of equipment or buildings or other structures or appurtenances;
ii) the decontamination of buildings or other structures or other appurtenances, or land or water;
iii) the stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land; and
iv) any other procedure, operation or requirement specified in the regulations.[75]

Under EPEA, it is legally required for an operator to conserve and reclaim their specified land under development in accordance with the following:

a) the terms and conditions in any applicable approval or code of practice,
b) the terms and conditions of any environmental protection order regarding conservation and reclamation that is issued under this Part,

c) the directions of an inspector or the Director, and

d) the Act itself.[76]

Companies must annually report on development and reclamation activities. These reports require companies to provide a status and record of surface disturbance and reclamation, demonstrate compliance with their EPEA approval and identify problem areas and their resolution.

The regulatory process is supposed to ensure that projects are approved or declined based on informed decisions and that projects are in the public interest.[77] Despite these criteria, the application for a Development and Reclamation Approval occurs after the formal regulatory process and after a project is approved.[78] The current EIA process that regulates major oil sands projects fails to adequately address reclamation prior to project approval. This order of events “expedites the review of the application so that an approval can be issued shortly after the ERCB [EUB] Approval is granted.”[79] The current approval process favours development of the resource and the interests of the proponent over the assurance that reclamation will happen in an effective and timely manner after the land is disturbed.

2.2 Benefits of Reclaiming as You Go

In principle the Government of Alberta supports progressive reclamation[80] — reclaiming as you go. The benefits of progressive reclamation are manifold because it sets the stage for a self-sustaining ecosystem early on. It allows operators and regulators to acquire a longer performance record of the reclaimed lands. Companies can discover problems while the mine is still in operation instead of after closure when the problems are public liabilities. Progressive reclamation also makes good business sense: “Remedying long-term liabilities by physical rehabilitation of mine closure facilities after the end of mine operation can be more expensive than conducting such work during mine operation.”[81]

Despite the benefits of progressive reclamation, the Government of Alberta has only required it through conditions under an EPEA approval once. A rare example of a binding progressive reclamation goal is the Fort Hills Project, which was originally proposed by TrueNorth Energy in 2002. TrueNorth Energy voluntarily committed to a progressive reclamation target that would cap disturbance at 4,000 ha. In the decision report approving the project, the Alberta Energy and Utilities Board (AEUB) directed TrueNorth to limit its land disturbance to 5,000 ha at any one time. The Board stated “[It] is concerned about the pace of reclamation in the oil sands area and therefore believes that it is appropriate to recognize TrueNorth’s commitments in this regard as a condition of its approval.”[82]

Despite the TrueNorth precedent, other proponents have not voluntarily made this type of commitment, nor has the ERCB or Alberta Environment included it as a condition in subsequent approvals. Similarly, binding reclamation timelines are also absent from EPEA approvals.[83] As such, few requirements or incentives exist for new and existing companies to undertake timely progressive reclamation or even achieve reclamation certification as quickly as is feasible. Further, companies are not legally required to meet the reclamation timelines and milestones identified in Conservation and Reclamation

Plans. Given this lack of accountability, it is unsurprising that reclamation performance has been poor to date.

Reclamation lag times contribute to the decline of woodland caribou. Several studies predict grim consequences for the species if the current industrial management practices remain unchanged.[84,85,86]

2.3 What Is Equivalent Land Capability?

Returning the specified land to an equivalent land capability is the central objective of the Development and Reclamation Approval for an oil sands project. Equivalent land capability is noted as a key objective of the conservation and reclamation of specified land, however, it is not a legislated requirement.[87]

> **Equivalent land capability** = "The ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical."[88]

Equivalent land capability is currently measured largely by the Land Capability Classification for Forest Ecosystems in the Oil Sands (LCCS). The LCCS was created to facilitate the evaluation of land capabilities for forest ecosystems on natural and reclaimed lands in the Athabasca Boreal region. With a focus on commercial forestry,[89] the LCCS strives to achieve commercial forestry targets, particularly for soil, erosion and tree growth aspects.[90]

Figure 11: Reclaimed oil sands areas will result in a greater proportion of upland landscapes that do not resemble the natural boreal mosaic of forests and wetlands

Photo: David Dodge, The Pembina Institute

The LCCS indirectly implies that economic or productivity factors dictate the reclaimed target landscape — a forested ecosystem. For instance, a Class 1 on the LCCS scale is considered a High Capability Land, which has "no significant limitations to supporting productive forestry," whereas Class 5 on the LCCS scale is considered Non-Productive Land that has "limitations which appear so severe as to preclude any possibility of successful forest production."[91] From the LCCS scale, regulators and operators alike claim to be able to create self-sustaining ecosystems with capabilities equivalent to or *better* than pre-disturbance conditions.[92] Class 4 and 5 lands represent peat and non-peat wetlands. The loss of wetlands and increase in forest capability are broadly considered an improvement. Using the LCCS land and soil categories diminishes the value of wetlands and leads to a perverse situation where oil sands proponents claim there will be an improvement in land capability after reclamation.

Figure 12: This open bog is one of the fives types of Alberta wetlands, which all occur in the oil sands region

Photo: Ducks Unlimited

2.4 Reclamation Certification: Still an Evolving Practice

A reclamation certificate is considered the terminal end point of an oil sands mine and indicates successful reclamation. Under the EPEA, operators are required to obtain a reclamation certificate from Alberta Environment. The ultimate decision to certify or not certify a site is based on the conservation and reclamation requirements of the EPEA,[93] and when a reclaimed site has met all applicable criteria. Once a site is certified, any future reclamation problems are the provincial government's responsibility and the operator is freed of its reclamation duties according to the Conservation and Reclamation Regulation and the Activities and Designation Regulation. In some cases, a reclamation certificate does not operate as a final release of environmental liabilities. An operator can be issued an environmental protection order (EPO) for reclamation-related problems on an oil sands processing plant for up to 25 years after a reclamation certificate. The ability to issue an EPO in respect of an oil sands mine itself is much more limited.[94] No EPO may be issued in respect of a mine (for which an approval was held) after the date that the reclamation certificate for the mine is issued. Plant sites represent only a fraction of an overall oil sands mine. The government's ability to issue an EPO for plant sites and not the remaining mine illustrates the potential for problems. There are reclamation uncertainties pertaining to tailings ponds, end pit lakes, CT strategies and wetland reconstruction.

There is a significant lack of transparency surrounding reclamation certificates. Alberta Environment's routine disclosure initiative, through which information is supposed to be more readily available under section 35 of EPEA, does not apply to information related to reclamation certificates. In fact, information relating to reclamation certificates is expressly excluded.[95]

3. Uncertainties: A Large-Scale Experiment

3.1 Will the Boreal Forest Ever Recover?

In simple terms the generalized steps to reclaim the landscape after oil sands mining are the following: the leveling of overburden, soil replacement, revegetation and land management. Soil reconstruction is a critical component of reclamation success; the quality of reconstructed soil is a principal determinant for the sustainability and biodiversity of vegetation and wildlife.[96] To generate soils and vegetation to cover the landscape a reclamation plan must consider climate, topography, parent material, drainage and time.[97] The surface of the reconstructed landforms are covered with a layer of soil that is a peat-mineral mix that has been salvaged from areas to be mined. Salvaged soil is either stored in a stockpile for use at a later date or directly placed onto areas to be reclaimed. Soil stockpiling is required during the early stages of a mine development, when surface disturbance has just begun on a site and there are no areas available for reclamation.[98]

Figure 13: The three oil sands mines currently operating in the Athabasca Boreal reigon will disturb 615 km^2 of boreal forest

Photo: David Dodge, CPAWS

> Effectively, a complete loss of soil and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and biodiversity happens for this area for the period of operations. Therefore, during operations the environmental consequence to all components is considered to be high. However, a successful reclamation reduces this high environmental consequence.
>
> — Albian Sands Energy, Muskeg River Mine Expansion[99]

If no peat-mineral mix is available as a cover soil amendment, 50–70 centimetres (cm) of sandy or clayey soil material may be placed over tailings sand or suitable overburden. Even more cover soil (about 1 m) is required for landforms such as overburden dumps because of their high salt content.[100] Soils are constructed to meet various criteria as identified by the Land Capability Classification System for Forest Ecosystems manual. The LCCS is based on an integration of numeric values assigned to soil and landscape parameters (e.g., soil moisture regime) that are known to be instrumental to ecosystem productivity. Currently the link between LCCS rating and forest productivity is undemonstrated.[101] One study states "Results suggest that current reclamation is successful. Soil physical and chemical properties are within similar ranges in natural and reclaimed soils and this implies that equivalent land capability is being attained in the reclaimed soil profiles."[102] The same study goes on to report that "The comparison of species composition and abundance between the natural and reclaimed plots indicate there is relatively little similarity in the early years of reclamation" and that "only a few of the reclaimed plots established on these soil series prescriptions had any appreciable similarities in species and per cent vegetative cover with natural area plots."[103] Two years later, results of the same study reported that reclaimed plots had consistently fewer shrub species and greater numbers of grasses and grass-like plants than that observed in natural areas with similar combinations of soil moisture and nutrient regimes.[104]

This finding suggests that even though reclaimed soil's physical and chemical properties may meet the regulatory objective of equivalent land capability (as directed by the LCCS), it does not equate the original soil's ability to propagate native vegetation. It is unknown why reclaimed soil, equivalent in physical and chemical properties to the pre-disturbance soil, fails to produce vegetation that is similar to the landscape prior to disturbance. It is also unknown if the objective of equivalent land capability — as the oil sands reclamation cornerstone — will adequately ensure reclamation success.

Many oil sands operators rely on plant succession models to generate the establishment of climax communities, which are communities of plants that are stable and capable of perpetuating themselves.[105] There is little evidence, however, that natural plant succession — where an assemblage of species is naturally replaced with new species and associations better suited to the prevailing site conditions — is likely to occur. The following points represent evidence that reliance on succession is failing and that oil sands revegetation is not proceeding as hoped:

- In 2006, after four years of monitoring reclaimed plots, "Plant communities of reclaimed and natural plots show relatively little similarity in terms of their species richness, vegetation cover or community composition."[106]
- In 1990, after 15 years of monitoring, "Natural invasion into sites seeded to agronomic grasses and legumes was minimal even after 15 years."[107]

- In 1995, after 20 years of monitoring, "In general, the results indicate there was little similarity in terms of species composition between any of the reclaimed areas with the natural stands"[108] and "Natural invasion is occurring very slowly."[109]
- In 2000, after 30 years of monitoring, "Although herbaceous species can quickly invade areas not seeded to grasses and shrubs, natural invasion of shrubs and trees appears to be very slow."[110]

Figure 14: Wild strawberry seedlings are among the most susceptible plants to water containing consolidated tailings salts

Photo: David Dodge, CPAWS

These statements indicate that the plant succession model is unproven and inappropriate for oil sands revegetation. The application of non-native species, such as barley, is effective for erosion control, but such species inhibit the establishment of shrubs and trees that are required to meet the end land use objectives.[111] In addition, the permanent establishment of non-native species is a grave concern in the revegetation process. For example, non-native species, such as perennial sow thistle, fireweed, sweet clover and hawksbeard, are recorded to dominate some sites and "provide close to 100% total area cover within a few years after reclamation."[112] The negative effects of non-native species are well documented. Non-native species out-compete native biodiversity, hinder ecosystem processes and human economies, and permanently change community composition, which results in new succession trajectories and altered ecosystem processes.[113] Despite some companies' assurances that "developed lands shall be reclaimed to viable ecosystems compatible with pre-development, including forested areas, wetlands and streams,"[114] 35 years of reclamation efforts indicate otherwise.

The majority of native shrubs are not able to establish a foothold on most sites, which could potentially be related to the increased competitive pressures from well-established non-native species.[115]

3.2 Wetlands Reclamation — Unattainable?

Wetlands are integral components of the boreal forest ecosystem. They increase landscape diversity, protect, improve and maintain the quality of surface water and groundwater, and control soil erosion.[116] Wetlands are natural filters that purify the water passing through them; water is absorbed from spring snowmelt and summer storms, which reduces flooding, erosion and sedimentation, and recharges the water table in times of drought.[117] Wetlands are formed in low-lying areas or depressions where water accumulates for long enough periods to support wet-adapted processes and plants. In Alberta, there are five types of wetlands: bogs, fens, swamps, marshes and ponds, all of which occur in the Athabasca Boreal region.[118]

Figure 15: Wetlands, such as this treed fen, are biologically, culturally and socially valuable components of a functioning ecosystem

Photo: Ducks Unlimited

Wetlands provide habitat for a wide variety of plants and wildlife, including rare and endangered species. It is estimated that Alberta's original wetland area was reduced province-wide by 50% by 1960 and by 60% by 1996.[119] The term wetland encompasses both peat and non-peat wetlands. Peat forms in wet anaerobic conditions and covers large areas of northern Alberta. Non-peat wetlands, often simply described as wetlands, include sloughs, marshes and areas of shallow water, which may be permanent or non-permanent, and are more commonly found in the southern part of the province.[120] In northeastern Alberta, about 40% of the landscape is wetland with bog and fen peatlands as the dominant wetland type (Figure 16).[121,122] Bogs in northeastern Alberta commonly contain lichens, which are critical forage for woodland caribou.[123]

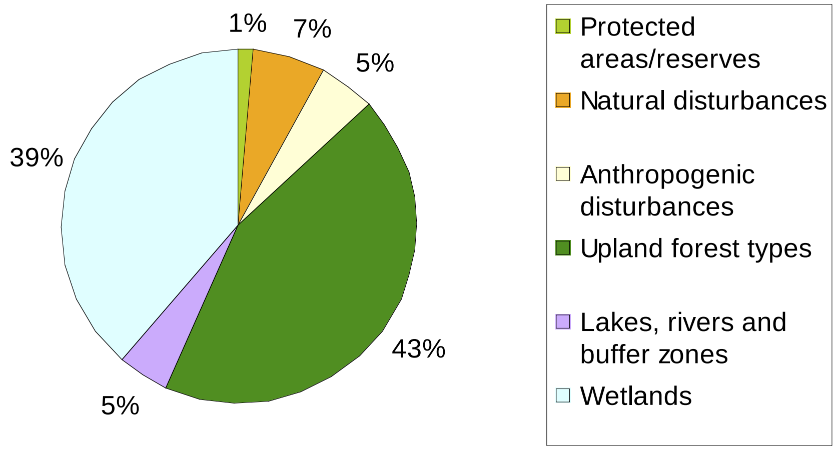

Figure 16: Relative area of land base types in the mineable oil sands

Data Source: This chart was generated with data from Alberta-Pacific Forest Industries, *Harvest Net-Down Analysis for Forest Management Unit A15 and the Mineable Oil Sands Area (MOSA).*

Surface mining leaves no remnants of wetlands to recover, and there is currently no demonstrated success in reclaiming peat-forming wetlands. The reclamation of peatlands (fens or bogs) in the Athabasca Boreal region has not yet been demonstrated; bog reclamation may prove very difficult to achieve.[124] The surface mining process will require the complete construction of wetland ecosystems. Yet Alberta Environment's 2005 Provincial Wetland Restoration/Compensation Guide states that it almost impossible to fully replicate the complexity of a natural wetland ecosystem.[125]

3.3 Managing Toxic Tailings Material in the Long-term

So far there are two primary initiatives to remediate and manage mature fine tailings that have been deemed acceptable by regulatory authorities:

- consolidated tailings (CT)
- end pit lakes

Currently, end pit lakes are the lowest cost[126] and the most relied upon practice to date. Neither option has adequately demonstrated that it can meet expectations for long-term reclamation.

3.3.1 Integrating Consolidated Tailings into the Landscape

Consolidated tailings (CT), also referred to as composite or non-segregating tailings, are an engineered tailings product with improved dewatering characteristics.[127] The production of CT helps consume the existing MFT. CT mixes can be created through the addition of a variety of chemical agents (e.g., gypsum, lime, acids, polymers, carbon dioxide). These chemicals provide some strength to the silts and clays, allowing them to support a fraction of sand, which initiates and accelerates the consolidation or dewatering process. When considered together, MFT and coarse tailings represent a significant consumption of water that cannot be recycled in oil sands mine operations. Consolidated tailings help free up a fraction of this water to be recycled back for plant use and reduce the overall MFT volume. In theory, CT is non-segregating during transport, discharge and deposition. However, at the 2006 hearing for Suncor's Steepbank Mine extension and Voyageur bitumen upgrading facility "Suncor noted that although it had not achieved the level of performance it desired on a daily basis with respect to CT performance …"[128] Government and regulatory acknowledgement of the uncertainties with CT is becoming more apparent, and the regulators are beginning to put performance stipulations on further mine expansions.[129]

Figure 17: Toxic tailings waste grows by 1.8 billion litres a day

Photo: David Dodge, CPAWS

Reclaimed CT deposits are proposed by industry to comprise a significant part of the reclaimed oil sands landscape. It is anticipated that approximately two thirds of the CT deposits will be capped with tailings sand and will be reclaimed by using established reclamation practices. The remaining one third of the deposits will not be capped with sand but will be amended with peat or capped with reclamation materials and vegetated. Most of this uncapped landscape is proposed to support wetland communities, however, this proposal remains unproven. Despite the proposed significant presence of CT on the final landscape, there is a high degree of uncertainty as to how the composition of CT and its release water will affect vegetation.

3.3.2 End Pit Lakes as Waste Dumps — An Unproven Concept

At the end of a mine's life cycle and once all economically recoverable oil sands are removed, companies propose that the final mine pit becomes an end pit lake (EPL).[130] EPLs serve as reclamation tools to help operators dispose of tailings waste in order for the company to meet water quality guidelines before discharging the waste into the environment.[131] Pit lakes are used in other mining sectors to control water drainage before discharging the water into the environment; oil sands operators use end pit lakes, which is unique in that the EPLs are used as disposal sites for toxic tailings waste. Depending on the materials remaining after mine operations, all of the following will be disposed of in the bottom of an EPL:[132] consolidated tailings, mature fine tailings (MFT), overburden, lean oil sands and operational release waters in varying quantities.

> "The development of EPLs as a natural reclamation tool for process-affected waters raises issues of concerns for regulators and stakeholders. Much of this concern results from the fact that historical data are insufficient to determine a realistic outcome of the final features of EPLs. Modelling and relevant background studies have been the basis of research, but a fully realized EPL has yet to be constructed."[133]

EPLs will be a permanent feature of the reclaimed landscape, but it is not yet known if they will support a sustainable aquatic ecosystem. Based on Table 1 and Figure 18, at least 25 EPLs are planned for the Athabasca Boreal region within the next 60 years.[134] This number includes the planned EPLs for existing and proposed mines up to 2007. It will likely increase if the current rate of oil sands development continues. These EPLs have been approved in the absence of a single demonstrated EPL by any oil sands operator.

Table 1: End pit lakes for existing and planned mines in the Athabasca Boreal region

(All information is taken from project EIAs. General EIA references are provided; detailed references are available upon request. Data in italics — Syncrude EPLs and Sharkbite pit lake — is unconfirmed.)

Mine Project	End Pit Lakes	EPL Area (ha)	EPL Volume (million m^3)	EPL Beginning of Release	EPL Water Depth (m)	EPL MFT Depth (m)
Suncor Voyageur South[135]	North lake (VSP11)	1,175	332[136]	2056	15	55
	South lake (VSP12)	398	137[137]	2056	9	66
Suncor Millennium Mine	North and south pit lakes	Unknown	485	2043	Unknown	Unknown
Petro-Canada Fort Hills[138]	South pit lake	5,100	4.7–13[139]	2022	Unknown	Unknown
	East pit lake		8.6–15	2040	Unknown	Unknown
	North pit lake		10.2–33	2044	Unknown	Unknown
Syncrude Mildred Lake Mine	Base Mine lake	Unknown	*40*	*2030*	Unknown	Unknown
	MacKay lake	Unknown	*313*	*2055*	Unknown	Unknown
Syncrude Aurora North Mine	West pit lake	Unknown	*315*	*2049*	Unknown	Unknown
Syncrude	South pit lake	Unknown	*750*	*2050*	Unknown	Unknown

Mine Project	End Pit Lakes	EPL Area (ha)	EPL Volume (million m^3)	EPL Beginning of Release	EPL Water Depth (m)	EPL MFT Depth (m)
Aurora South Mine						
Albian Sands Muskeg River Mine[140]	West end pit lake	343	130	2031	20	Unknown
	Sharkbite pit lake	Unknown	*100*	*2061*	Unknown	Unknown
Shell Jackpine Mine Phase 1[141]	East end pit lake	1,615	186.5	2040	11	Unknown
	West end pit lake		186.5	2040	50	0
Shell Jackpine Mine Phase 2[142]	North Central, North Upstream and Down-stream Cell	3,924	477	2044	Unknown	Unknown
Shell Pierre River Mine[143]	North, South and Raw Water Storage Facility	5,739	144	2049	3	Unknown
Imperial Oil Kearl[144]	PL6	1,320	425[145]	2060[146]	41	19
CNRL Horizon Mine[147]	EPL1 (East lake)	70	4.3	2057	6	Unknown
	EPL2 (West lake)	910	427	2057	55	Unknown
Synenco Northern Lights Mine[148]	End pit lake 1	490	68[149]	2044	13	Unknown
	End pit lake 2	520	78	2048	19	Unknown
	End pit lake 3	560	78	2052	21	Unknown
Total Joslyn North Mine Project[150]	End pit lake 1	510	98.3	2034[151]	55	0[152]
Albian Sands Muskeg River Mine Expansion[153]	Cell 7	273.7	158[154]	2046	6.5[155]	Unknown
	Cell 12A	273.7	95[156]	2046	6.5	Unknown
	Cell 16	273.7	95[157]	2046	6.5	Unknown

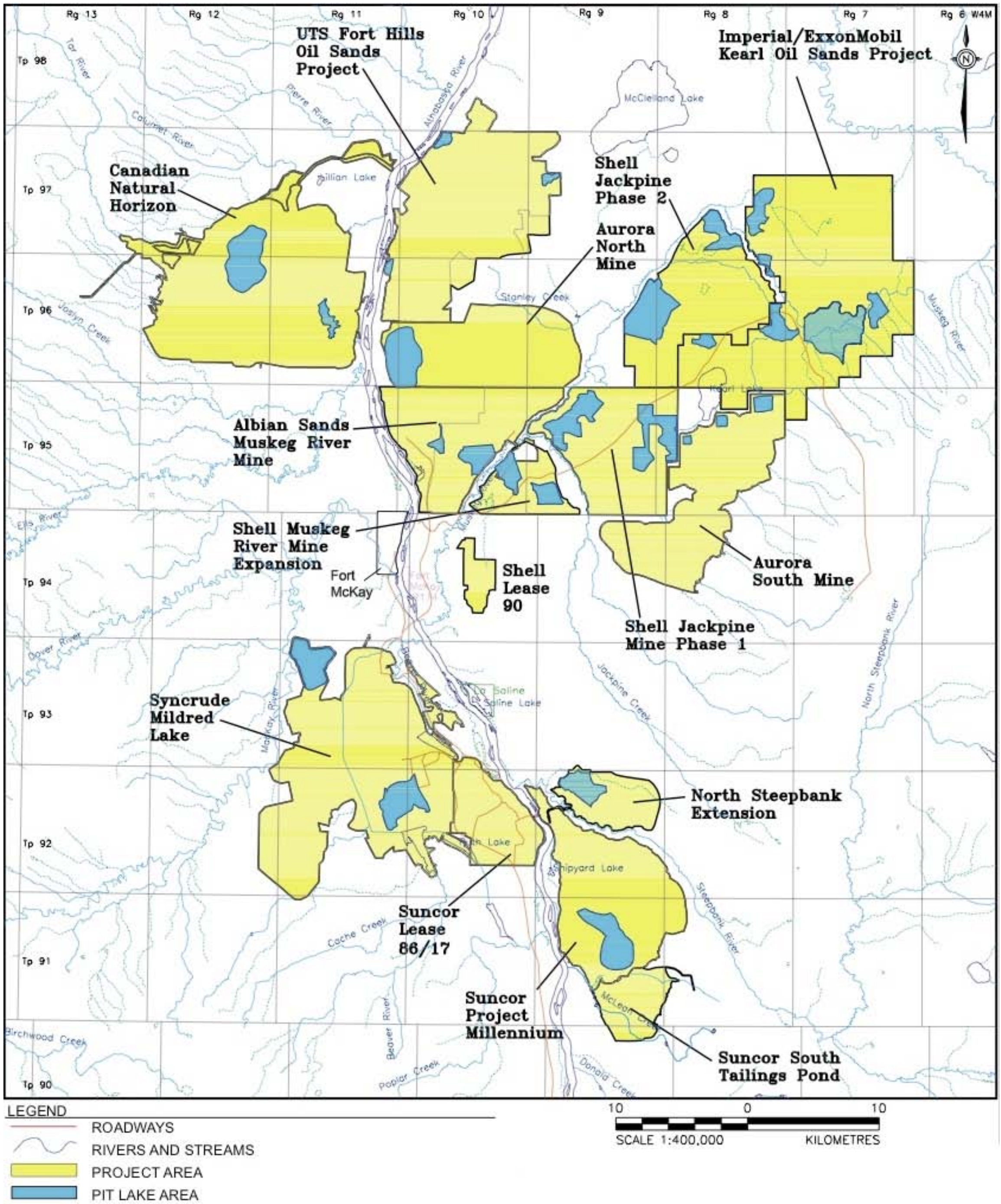

Figure 18: Location of planned end pit lakes in the Athabasca Boreal region

Image Source: Fay Westcott, "Oil Sands End Pit Lakes: A Review to 2007," in *The Cumulative Environmental Management Association End Pit Lakes Subgroup, Project 2006-32* (Clearwater Environmental Consultants Inc., 2007), 2.

In theory, EPLs are hoped to become viable aquatic ecosystems with active littoral zones, shallow wetlands and shoreline habitat. A viable ecosystem will support biological activity and help biodegrade organic chemicals that accumulate from runoff through the reclaimed landscape. Unlike the tailings ponds, which only have approximately 5 m of water overlying the MFT, EPLs will be considerably deeper with 65–100 m of water overlying the tailings deposit.[158] This primary source of this water will be drawn from the Athabasca River; there may be even more significant demands on the Athabasca River in the future from cumulative withdrawal of water to fill EPLs for multiple oil sands mines.

In the far-future, the EPL will be a biologically active, self-sustaining and functional ecosystem.[159]

A key area of EPL uncertainty, and an area of ongoing research, is the state of meromixis, which is the condition whereby upper water layers do not mix with the lower portions. Meromixis is achieved by increased salinity, which increases water density. It is intended to prevent the mixing of upper lake layers with lower lake layers.[160] The reclaimed landscape will be contoured to drain into the EPL, which in turn will discharge into the Athabasca River watershed. During this process, organic chemicals and salts will accumulate in surface runoff that passes over and through the tailings material and incorporated into the reclaimed landscape. These chemicals and salts will accumulate in the EPL where they are expected to be diluted and biologically degraded over time. The size and volume of an EPL depends upon the pit size and the amount of tailings material that it will contain.

The planned EPL for Suncor's Steepbank Mine will have a volume of approximately 285 million m^3 and will cover an area of 883 ha (whereas the proposed Albian Sands EPL for the Muskeg River Mine will have a volume of 130 million m^3 and cover an area of 442 ha.[161]

An EPL study released in 2004 revealed the following: meromixis is at best a temporary condition in all of the EPL scenarios modelled in the study because of a lack of a constant salt input. The progression towards non-meromictic lakes for all scenarios modelled in the study was likely due to the declining salt input over time.[162] EPLs are complex systems in terms of hydrology, chemistry and biology, and their design requirements need to be more fully developed.

Uncertainties regarding the construction, maintenance and final success of EPLs remain. An EPL will need to be controlled, managed and monitored throughout much of its initial filling and during discharge to downstream aquatic environments. Alberta Chamber of Resources has noted that "Current practices for long-term storage of 'fluid' fine tailings pose a risk to the oil sands industry." It suggested that the industry "is likely to come under increasing scrutiny from all stakeholders, including regulators, operators, owners, local groups and the regional municipality of Wood Buffalo."[163] Given that tailings materials are proposed to be integrated into the reclaimed landscape (in the case of CT) or disposed of in EPLs, both surface water and groundwater will pass over and through these materials. This situation will potentially affect water quality, which in turn will affect the regional ecosystem and those species that depend on it.

4. Risks: Loss and Liability

Once an area has been mined, operators and regulators are charged with the task of not only getting back what was lost — soil, wetlands, forests, wildlife, traditional uses — but also the task of reclaiming what was created — stockpiles of overburden, industrial landfills and most notably, massive lagoons of liquid tailings waste. Overall, Canada's mining industry has a very poor record of being accountable for reclaiming the areas they have disturbed; there are over 10,000 abandoned, unreclaimed mines in the country.[164] This unaccountability places a significant economic and environmental liability on the public.

4.1 Permanent Loss of Wetlands?

In addition to the uncertainty of the success of peat wetland reclamation, there will also be a significant degree of wetland loss through its conversion to upland[165] habitat after oil sands development. For example, development and reclamation of Suncor's North Steepbank Mine is predicted to shift the area from substantial wetlands (48%) at pre-development to a predominantly upland ecosystem (65%) at mine closure.[166]

Figure 19: Woodland caribou depend on forested and wetland habitats, such as this treed bog, in the boreal forest

Photo: Ducks Unlimited

> Peatlands sequester about 0.273 tonnes carbon/hectare/year. More carbon is embodied in Canada's peatlands than in our forests.[167] The 1996 Peatland Inventory of Alberta reported the approximate area of peatlands to be 10.32-million ha.[168]Based on this area, the peatlands of Alberta contained an estimated 13.74-billion tonnes of carbon in 1996.[169]

Currently, there is a potential loss of 1300 km^2 of wetlands due to oil sands mining projects.[170] Many applications boldly assert that this conversion from wetlands to uplands is a net benefit of mining once a mine is shut down — they state that the upland habitat is better suited for forestry and would result in more obvious economic gains than a wetland. The end land use goals toward which Suncor's closure plan is directed include "forest productivity of reclaimed landscape to be equal to or greater than pre-development conditions."[171]

With no known means to re-establish peatlands, their loss may be irreversible. This serious side effect of oil sands mining is well documented, but it has had no effect on the current pace and scale of oil sands development, nor on mitigation strategies required by Government of Alberta. Developers in the province's settled portion are required to adhere to a policy of no net loss of wetlands through conservation and restoration of other wetlands to offset their impacts. Remarkably, oil sands developers are not required to follow similar rules.

> "The reclamation of fens and possibly bogs in the oil sands region is a major challenge... there is still a poor understanding of nutrient and chemical loadings to wetlands from uplands composed of varying reclamation materials. The issue of nitrogen and phosphorus limitations to vegetation establishment in reclaimed wetlands are not well known, and thus there is no clear understanding of the role for fertilization as a strategy for improving initial establishment rates."[172]

4.2 Long-term Fate of Tailings Toxins

Tailings ponds not only house sand, fines (silts and clays) and water but a host of additional toxins that include naphthenic acids, phenolic compounds, ammonia-ammonium and trace metals such as copper, zinc and iron. These trace metals can exist at concentrations that exceed the Canadian water quality guideline for freshwater aquatic life.[173] The migration of pollutants (such as naphthenic acids) through the groundwater system and potential leaks to the surrounding soil and surface water present serious risks to the boreal landscape.[174] Tailings have also been found to contain residual bitumen (e.g., Suncor's tailings pond contained 9% residual bitumen)[175] and diluent[176] (e.g., naphtha).

> "Current practices for long-term storage of 'fluid' fine tailings pose a risk to the oil sands industry …. (the industry) is likely to come under increasing scrutiny from all stakeholders, including regulators, operators, owners, local groups and the regional municipality of Wood Buffalo."[177]

Naphthenic acids (NAs) are considered the most significant environmental contaminant resulting from oil sands development.[178] NAs are naturally occurring, soluble constituents of bitumen that become concentrated in tailings as a result of the bitumen extraction process. The presence of NAs in local water bodies and their potential effects on water quality and fish reproduction and tainting has brought significant attention to their persistence in the environment and to their aquatic toxicity at the levels found in tailings ponds.[179] Concentrations of NAs in rivers within the Athabasca Boreal region are generally below 1 mg/L, but they range between 60 and 120 mg/L in process-affected waters in active tailings containment.[180] NAs cause tailings to be acutely toxic to aquatic organisms[181] and mammals.[182] Mammalian toxicological results indicate that while acute toxicity in wild mammals is unlikely under worst-case exposure conditions, repeated exposure may have adverse health effects.[183]

Figure 20: About 40% of the landscape in the oil sands region is wetlands, with bog and fen peatlands as the dominant wetland type

Photo: David Dodge, CPAWS

The effects of NAs are further exacerbated by methane-producing bacteria. Tailings lakes are full of bacteria that break down the different hydrocarbons at different rates. Some bacteria produce methane, a serious greenhouse gas. It was determined that methane formation by bacteria in the Mildred Lake Settling Basin (MLSB) — the primary tailings pond for Syncrude Canada Ltd. — poses potential problems for reclamation, particularly with the wet landscape approach where end pit lakes are a permanent part of the final landscape. Methane seeping into the overlying water cap from the fine tailings will provide a faster transport of toxic compounds (primarily naphthenic acids) into the capping water layers.[184] As well, methane in the water could reduce the oxygen in the water cap, particularly during periods of ice cover, and prevent the establishment of a lake ecosystem with higher pelagic forms of life (e.g., fish), which may hinder remediation by the wet landscape approach.[185] It is critical that the reclamation of tailings into terrestrial and aquatic landscapes at the end of an oil sands mine operation "address residual levels of naphthenic acids and their rate, fate and transport in the environment."[186] Regional First Nations' and Métis have significant concerns about their consumption of fish and wildlife that may have absorbed toxins, and the unknown effects that naphthenic acids have on human health.

Another toxin associated with tailings lakes and end pit lakes is mercury. The flooding of the vegetation that underlies tailings lakes releases mercury into the water. The release of mercury into surface water bodies is a concern particularly when it bioaccumulates[187] up the food chain.[188]

In the Mikisew Cree First Nations' (MCFN) submission to the Joint Review Panel for CNRL's Horizon project, an analysis was presented that predicted mercury levels in Calumet Lake and the proposed compensation lake would become elevated. These predicted elevated levels would be a result of flooding the vegetation — not unlike the effects observed when reservoirs are created.[189] In addition, the MCFN noted that the stripping of wetlands that contain naturally high levels of mercury might result in higher mercury concentrations in receiving waters.[190]

Mitigating Impacts of Tailing Ponds on Birds: Propane Cannons

Waterfowl and shorebirds depend on freshwater ponds for nesting, foraging and roosting, and as stop-over sites during migration. Spring migration is becoming increasingly problematic in northeastern Alberta. While natural water bodies are still frozen, the warm-water waste runoff to tailings ponds from oil sands mines creates limited open water ponds.[191]

The tailings produced from oil sands mining is dangerous to waterfowl. The birds may ingest the oil and their plumage may become oiled with waste bitumen. Oil-covered birds may be unable to fly, and their feathers may lose their insulating properties, which can result in the bird's death from hypothermia.[192] Shorebirds are also at risk because they may misconstrue the thick oily shorelines of tailings ponds as mudflats. It is estimated that several 100 birds are oiled in a typical year at individual ponds.[193]

There are more than 10 tailings ponds operating in the northeastern Alberta region.[194] This problem will magnify because Alberta's oil sands are situated along a major migratory flyway for waterfowl travelling to the Peace-Athabasca Delta, an internationally significant staging area,[195] and because oil sands development is predicted to double in less than a decade.[196] Because existing tailings ponds already provide the largest water body in this part of the migratory flyway (tailings ponds range in size from approximately 150–3,000 ha),[197] operators are increasingly dependent on ways to deter birds from tailings ponds. Research of this topic revealed that on-demand cannon deterrent systems can reduce avian mortality, but it is not recommended as a long-term solution.[198]

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In April 2008, hundreds of migrating ducks died after landing on a tailings pond in northern Alberta owned by Syncrude Canada Ltd. Early estimates indicated that about 500 ducks were trapped in the large pond filled with toxic wastes from the oil sands operation. An Alberta government release says some of the birds were "clearly heavily oiled." Syncrude claimed they had not been able to put any deterrent systems out on the pond due to a late spring storm. Migrating waterfowl annually pass through the oil sands region on their way to the Peace-Athabasca Delta.[199]

The current practice of storing fluid fine tailings in ponds presents a major environmental challenge. The sedimentation and consolidation of the fine tailings could take 125–150 years.[200] The volume of fine tailings ponds produced by Suncor and Syncrude alone will exceed 1 billion m^3 by the year 2020.[201] The total volume of tailings for approved projects is outlined in Table 2.

Table 2: Total volume of tailings for existing and planned mines in the Athabasca Boreal region

(Data for this table were taken from the relevant Environmental Impact Assessments. Unfortunately, the volumes of tailings for some of the mines in Table 1 were not found and could not be included. General EIA reference is provided.)

Mine Project	Number of Ponds	Total Tailings Pond Volume (million m^3)	Total Tailings Pond Area (ha)
Suncor Voyageur South[202]	10	1,547	4,430
Suncor Millennium Mine	Unknown	Unknown	Unknown
Petro-Canada Fort Hills[203]	3	4,172	1,600
Syncrude Mildred Lake Mine	Unknown	Unknown	Unknown
Syncrude Aurora North Mine	Unknown	Unknown	Unknown
Syncrude Aurora South Mine	Unknown	Unknown	Unknown
Albian Sands Muskeg River Mine[204]	5	659	1,039
Albian Sands Muskeg River Mine Expansion[205]	1	520	1,316
Shell Jackpine Mine Phase 1[206]	2	516	1,600
Shell Jackpine Mine Phase 2[207]	2	1,010	2,520
Shell Pierre River Mine[208]	5	620	1,585
Imperial Oil Kearl Lake Mine[209]	1	950	2,200
CNRL Horizon Mine[210]	1	1,186	3,580
Synenco Northern Lights Mine[211]	1	173	1,180
Total Joslyn Mine[212]	3	295	1,040
Total for All Mines	**27**	**11,648**	**22,090**

Even with some data being absent in Table 2, the volume of expected tailings ponds is 11,648 million m^3. Over the course of these mine cycles, tailings ponds will occupy over 220 km^2. This area will be five times greater than Sylvan Lake, which is in central Alberta.[213] The average lifespan of an oil sands mine is 30 years. Taking into account the staggered timelines for each operating mine, approved mine or mine under application, the Athabasca Boreal region will, at a minimum, contain tailings ponds for the next 53 years.[214] Reclamation of ponds will occur and therefore the listed tailings ponds will not be on the landscape simultaneously. However, reclamation does not mitigate the vast area occupied by tailings ponds; in 2005, when only two mines were fully operational, tailings ponds occupied 50 km^2.[215]

The largest tailings pond at Syncrude Canada Ltd. is the Mildred Lake Settling Basin, which has a water surface of 13 km^2 and contains over 400 million m^3 of fine tailings — equivalent to 160,000 Olympic-sized swimming pools.[216]

Figure 21: Tailings lakes cover more than 50 km^2 and are among the largest human-made structures in the world. Factoring in new approvals and planned projects, tailings lakes will eventually occupy more than 220 km^2 — five times bigger than Sylvan Lake.
Photo: David Dodge, CPAWS

4.3 What If Tailings Reclamation Doesn't Work?

It is not certain whether reclaimed land that includes consolidated tailings (CT) can support native boreal forest vegetation. For example, the coagulant aids added to create CT affect the composition of released water.[217] Consolidated tailings materials are characterized by a relatively high salinity (dominated by sodium, sulphate and chloride) and a high pH (8–9).[218] Similarly, the CT release water can contain elevated levels of sodium, sulfate, bicarbonate and chloride, which can affect terrestrial reclamation abilities.[219] Furthermore, boron is present at concentrations that could cause plant toxicity.[220] The effects of CT water on plant growth, survival and propagation are still unknown. The Joint Review Panel for the Imperial's Kearl Lake Mine expressed concern regarding CT technology:

> The Joint Panel accepts that Imperial Oil's proposed tailing (sic) plan is reasonable based on currently available technology. The Joint Panel is concerned, however, that the use of thickeners to produce CT [consolidated tailings] has not been commercially demonstrated by the industry at this time. The Joint Panel encourages Imperial Oil to demonstrate this technology in a pilot-scale project, either in cooperation with other operators or on the [Kearl] Project site itself, prior to start-up of CT production.[221]

Saline consolidated/composite tailings are intended to be used as a predominant substrate for reclamation and revegetation. Evidence to suggest that the presence of saline water will negatively influence plant physiological function include the following:

- Jack pine seedlings treated with CT water treatments for four weeks demonstrated reduced survival rates of jack pine seedlings and showed leaf tip necrosis, a typical sodium toxicity symptom.[222]
- One study suggested that alum- and gypsum-CT substrates are not suitable growth media for slender wheatgrass and wild rye and caused a severe reduction in seed germination. "Plants that did germinate had reduced growth, so it is unlikely they could play a major role in improving substrate properties, or allowing the establishment of a self-sustaining forest ecosystem."[223] We can expect even higher levels of salinity than used in the study due to the recycling of CT water in the extraction process.
- Bioaccumulation of toxic elements is likely. Where tailings seepage water is present in plant root zones, plants bioaccumulate elements from the water (e.g., sodium, boron) in their above ground tissues. While the implications of this accumulation are under study,[224] it is known that micronutrients such as boron reduce growth at relatively low concentrations.[225]

Despite the potential for CT water to negatively affect revegetation success, it is estimated that over 50% of the extraction tailings will be handled in the CT process.[226] Furthermore, there remains no demonstrated means to reclaim the remaining mature fine tailings. In considering Shell's Jackpine Mine–Phase 1 project, the Joint Review Panel concluded that "Tailings management is one of the main challenges for the oil sands mining industry."[227] In 2004, the panel directed the EUB (now the ERCB) to "work with the mineable oil sands industry, Alberta Environment and Alberta Sustainable Resource Development to develop performance criteria for tailings management"[228] for June 2005. In April 2005, the EUB (ERCB) acknowledged that the recommendations would not be complete at this time.[229] In 2007, little progress had been made on the creation of performance criteria for tailings management:

> "The Joint Panel continues to be concerned about the overall tailings performance of the oil sands industry in general; therefore, the Joint Panel believes that it would be appropriate for the EUB to revisit the tailings criteria initiative, as initially discussed in the 2004 Jackpine Mine decision (Joint EUB/Agency *Decision 2004-009*) and further discussed the 2006 Albian Sands decision (Joint EUB/Agency *Decision 2006-128*). The Joint Panel believes that the tailings criteria initiative should attempt to establish tailings performance criteria in a timely fashion and should also recommend consequences for not meeting performance requirements. The Joint Panel recommends that the full Board establish a formal mechanism or taskforce to establish tailings performance criteria and specific enforcement actions on an industry-wide basis."[230]

Similarly, end pit lakes (EPLs) are fraught with significant uncertainties that ultimately translate into public risk. In spite of both the uncertainties and the risks, large oil sands mines that rely on end pit lakes as reclamation tools are being approved by regulators:

> "The Joint Panel notes that the EPL reclamation strategy remains an unproven and unapproved reclamation option. The Joint Panel also notes that the CEMA EPLSG, CONRAD and others are conducting research that will address many of the concerns expressed by MCFN regarding the viability of EPLs and their ability to support higher trophic levels, including fish. The Joint Panel notes MCFN's concerns and agrees that there are many uncertainties regarding the efficacy of EPLs. …The Joint Panel agrees with MCFN and AENV that due to the complexity and uncertainty about EPLs, it is a priority that ongoing, comprehensive research occur now."[231]

In addition to the uncertainty of meromixis, end pit lakes are a great source of concern given their potential to hold and discharge acutely toxic substances, such as naphthenic acids. Most EPLs will contain mature fine tailings. EPLs without tailings will be exposed to oil sands along the substrate or from process-affected runoff or seepage, with the potential for toxic substances to enter the lake.[232]

> "This so-called wet landscape reclamation has several unknown long-term monitoring liabilities, aside from the difficulties inherent in the creation of an artificial lake above the mature fine tailing."[233]

In addition to naphthenic acids, other substances of concern for the water quality within an EPL and that discharge to surface waters are the following:[234]

- salts
  - elevated sodium, chloride, sulphate
  - elevated total dissolved solids, pH, conductivity and alkalinity
  - lower calcium and magnesium (soft water)
  - variable levels of trace metals, including boron, arsenic and strontium
- elevated ammonia
- decreased dissolved oxygen (owing to high oxygen demand)
- elevated dissolved organics, including naphthenic acids, phenols, hydrocarbons and polycyclic aromatic hydrocarbons
- other acute and chronic toxicants

The persistence of these toxins and their effects on aquatic life is unknown, however, fish stocked in Syncrude's experimental ponds have shown signs of chronic stress, such as disease and morphological deformities.[235] The densification of tailings in an end pit lake could take many centuries, and the long-term integrity of containment structures during such periods is unknown.[236] There may be long-term risks and environmental liabilities associated with the containment of the aforementioned tailings toxins.

The concerns regarding end pit lake viability will not be resolved in the near future; Syncrude recently stated that their EPL pilot project, the first of its kind, will not occur until 2012.[237] The ability to plan for and predict EPL success is further complicated by the influences of natural phenomena such as climate change, extreme weather, flooding and ice formation.

The long-term intent of an EPL is that it will be a lake containing tailings waste materials that discharges and recharges from the surrounding landscape. End pit lakes will therefore be reconnected to the Athabasca River, which flows north into the Slave River and finally onto the MacKenzie River system. Water from the Mackenzie River system flows out into the Beaufort Sea. Surface mine operators have committed to only discharging water from these end pit lakes that meets Alberta's Surface Water Quality Guidelines[238] or the guidelines in force at the time of release. However, in the absence of any established end pit lakes, the feasibility of this commitment is questionable. There is no Plan B should it prove impossible. Further, existing standards which include Alberta's Surface Water Quality Guidelines, do not include water quality limits for some of the chemicals, such as naphthenic acids, found in the fluid fine tailings that will be placed in the end pit lakes. Despite concern about the persistence and aquatic toxicity of naphthenic acids, Alberta Environment does not have any regulations for this toxin.[239]

4.4 Financial Liabilities for the Public

4.4.1 Inadequate Reclamation Securities to Protect the Public

The Government of Alberta requires that all oil sands operators — all of whom are holders of the Development and Reclamation Approval — post a security deposit with the Government of Alberta[240] to act as a financial mechanism to fund any unforeseen events that may arise during the life cycle of an oil sands mine (construction, operation, reclamation and decommissioning). The funds, held in the Environmental Protection and Security Fund, are considered a surety to prevent the public from bearing the reclamation costs if, for example, a company goes bankrupt. This security deposit is particularly important when operators possess limited funds at the time of the application.[241] For a new approval, the security deposit must be provided before the approval is issued. For an approval amendment or a change to the amount of security required, the security must be provided within 30 days of a request by the Director of Regulatory Approvals. In addition to the security funds, Alberta Environment conducts inspections of conservation and reclamation activities. Annual conservation and reclamation reports have to be submitted to both Alberta Environment and to Alberta Sustainable Resource Development. Both departments have the power to issue enforcement orders if needed.[242]

The current oil sands mine reclamation security program lacks transparency. Information about reclamation costs, the calculation of liability bonds and the frequency (if any) of third party validation of reclamation plans are not publicly available or readily accessible.

4.4.2 How Much Is Enough?

Security deposits are supposed to be based on the total cost of reclamation. The Minister of Environment enters into an agreement with the holder of an approval relating to the required amount of funds. These agreements are created on a mine-specific basis that sets the security deposit from actual reclamation costs at the mine. The amount is based on

- the estimated costs of conservation and reclamation submitted by the operator
- the nature, complexity and extent of the activity
- the probable difficulty of conservation and reclamation, giving consideration to such factors as topography, soils, geology, hydrology and revegetation
- any other factors the director considers relevant.[243]

The estimated costs of conservation and reclamation include filling in pits, recontouring, grading, subsoil and surface soil storage, revegetation, post-closure monitoring, remediation, establishing drainage patterns, such as creeks, ponds, lakes and wetlands, and an overall fee to manage the reclamation work.[244]

The operator submits the security deposit estimate based on the costs for a third party to do the work.[245] There are no specific written guidelines for companies to follow, nor are clear requirements outlined in legislation or policy. None of the details of what process was followed or what activities and costs are included is ever made publicly available. Annual reports of reclamation activities are submitted by operators and must indicate compliance with the Development and Reclamation Approval. The cost of reclamation may be subject to an audit where reclamation activities will be verified by the government. Alberta Environment can adjust the costs in cases where, for example, the cost of future conservation and reclamation changes, development activities increase or decrease, or if a portion of the land is reclaimed.[246] When a company has initiated reclamation on its site, security adjustments are made based on the following:

$$\textbf{Security required} = \textbf{Total Cost of Reclamation} + \textbf{Disturbance cost for current year} - \textbf{Reclamation cost for current year}$$

It is important to note that the security deposit only covers the costs of mining activities and does *not* consider the reclamation costs of the processing plants.[247] Security can be submitted in a variety of forms (e.g., cash, cheques, bonds, letters of credit) and is placed in the Alberta's Environmental Protection Security Fund. Security is returned to the operator when the site is reclaimed and a reclamation certificate is issued. Part of the security deposit can be returned when part of the site is reclaimed, even if this land has not been formally certified as reclaimed. In theory, if an operator fails to meet a project's reclamation obligations, then the government will use the security funds to close the project.[248] Total oil sands security in the fund is $468 million,[249] on a current disturbance footprint of around 42,000 ha.[250] This represents $11,142 per hectare. Appendix A indicates the 2007 annual summary of account balances for oil sands mine operators.

Because reclamation costs and plans are not publicly available, this report is unable to ascertain whether or not current security deposits are adequate. There is, however, anecdotal evidence to suggest otherwise. Regulators and operators justify the lack of transparency by saying the cost calculation information is proprietary and has competitive value. It has been suggested that for revegetation to be successful the planting of 10 plants per square metre is required. The cost of reclamation for revegetation alone is therefore $200,000 per hectare.[251]

The estimate given by Syncrude about the reclamation certification costs of Gateway Hill is another example of true costs of reclamation. Syncrude did not have a breakdown for the cost of Gateway Hill, which was the first reclaimed site to receive a reclamation certificate. However, in 2006 Syncrude spent a total of $30.5 million on reclamation activities on 267 ha. That breaks down to about $114,000 per hectare.[252]

A final comparison can be made — a single diamond mine in the Northwest Territories has a 900 ha disturbance footprint.[253] This mine is required to post a security bond in excess of $100 million during maximum disturbance,[254] or approximately $110,000 per hectare.

Figure 22: The long-term viability of tailings dykes will remain an ongoing concern long after operations cease. Dyke failures could release unstable materials into the Athabasca River, with catastrophic effects on the aquatic ecosystem.

Photo: David Dodge, The Pembina Institute

Currently, the Government of Alberta is producing a Mine Liability Management Program (MLMP).[255] This program is redesigning the bonding process for oil sand operators, but it been under review for several years, does not allow for public input and has missed its proposed due date on at least one occasion. The program is being developed by industry and government personnel without input from stakeholders and the public. The need for increased transparency was voiced in the consensus recommendation made by the Oil Sands Multistakeholder Committee in 2007. The Committee recommended that the Government of Alberta "develop formal and transparent processes and policies for financial management of reclamation liabilities." Therefore, the province needs to ensure appropriate regulatory processes are in place to manage the potential risks.[256]

> The many uncertainties associated with oil sands development (consolidated tailings, end pit lakes, revegetation success) may be future environmental liabilities for Canadians. In the United States, regulations requiring the quantification and disclosure of any potential environmental liabilities exist. For example, the Sarbanes-Oxley Act was introduced in 2002 following a series of corporate scandals that included Enron and WorldCom, and resulted in the loss of hundreds of billions of dollars in corporate and investor dollars. The Act was created in attempt to restore investor confidence and decrease further occurrences of fraud through provisions that included enhanced accountability of corporate officers, improved corporate disclosure and new audit committee standards.[257]

4.4.3 Are Canadians Adequately Protected?

The 2005 Alberta Auditor General report expressed concerns about inconsistencies in the application of the oil sands mine reclamation security program and the failure of oil sands operators to properly estimate reclamation costs.[258] If the current deposits prove inadequate, Canadians are at risk of footing the reclamation bill through their tax dollars. In addition, no opportunities exist for public input or review of the cost of the security deposits — companies calculate the cost of their own security deposits. The fact that virtually no reclaimed sites, apart from the small 104 ha parcel of upland habitat, have been certified suggests not only that the true costs have *not* been identified, but that they *cannot* be identified. This is particularly true for the reclamation of MFT by end pit lakes and for wetland reclamation — both of which are undemonstrated in the Athabasca Boreal region. In this situation, it is essential that liability bonds are conservative to ensure that Canadians are protected. Industry has been reticent and ambiguous about providing information about realistic estimates of actual reclamation costs. For instance, during the Joint Panel Hearing to review the Kearl Oil Sands Mine Project, Imperial Oil indicated it did not know whether reclamation is economically feasible. This indication is noted in the following exchange between Imperial's witness Mr. Mark Little and a lawyer acting for the Alberta Energy and Utilities Board:[259]

> Q. Panel, I'm looking in this next question for a dollar figure on a per hectare basis. And I don't know if you can provide a response, but I'll try you. What would Imperial be required to commit on a dollar per hectare basis to the implementation of a landform design that captures the end land use requirements for stability, watershed design and natural appearance? We're talking about overburden dumps here.
>
> A. MR. LITTLE: Sir, we don't have that information with us.
>
> Q. Is it readily available, Mr. Little, or does it not exist?
>
> A. No, it does not exist.

Sydney's Tar Ponds — Costly environmental liabilities in Canada are not unheard of. One hundred years of steel and coke production left more than a million tonnes of contaminated soil and sediment in Sydney on the eastern coast of Cape Breton Island, Nova Scotia.[260] This prompted the Government of Canada to "undertake a 10-year, $3.5 billion program to clean up contaminated sites for which the Government is responsible. And the Government of Canada will augment this with a $500 million program of similar duration to do its part in the remediation of certain other sites, notably the Sydney tar ponds,"[261] as announced in the 2004 Speech from the Throne. For comparison, the Sydney tar ponds cover an area of 31 ha. Alberta's oil sands cover an area of 47,000 ha, 1,500 times larger.

5. Conclusions and Recommendations

In the past decade, oil sands development has proceeded at an irresponsible pace. While the scope and scale of oil sands projects have expanded rapidly, government policies and planning have fallen behind, which puts Alberta's environment and Canadians at risk. The government still lacks environmental management systems to ensure development occurs within environmental limits, yet it continues to approve new development. Oil sands reclamation, particularly of tailings material, remains unproven. Without proof, the government is approving reclamation plans based upon good faith rather than hard fact. Government policies and management actions regarding reclamation must be urgently developed and implemented to avoid placing Canadians at further risk of costly environmental consequences and liabilities.

The government has rushed to approve new oil sands mine operations based on a risky and uncertain assumption that reclamation can and will occur despite the lack of on-the-ground evidence that it can be successful. With only one reclamation certificate in 40 years of oil sands mining, this confidence is ill-advised. It is the Government of Alberta's duty, through the ERCB and Alberta Environment, to approve only those projects that are in the public interest. The fact that oil sands mines continue to be approved in the absence of certainty regarding the risks and feasibility of reclamation calls into question the legitimacy of the current process. As an overarching recommendation, the Governments of Alberta and Canada should suspend new approvals for oil sands mines until sound reclamation policies and practices are implemented and until the most significant risks and uncertainties are addressed.[262]

To address the challenges, uncertainties and risks regarding oil sands mine reclamation, the Government of Alberta should adopt and implement the following seven recommendations:

5.1 Require Restoration of Oil Sands Mines to Self-Sustaining Boreal Forest

Equivalent land capability is a key objective of the conservation and reclamation of developed land in the oil sands region. The definition of equivalent land capability is "The ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical."[263] As discussed earlier, this definition is problematic:

1) It misleads stakeholders to expect that the original landscape will be returned.
2) It emphasizes forestry production values as opposed to the full array of values that existed on the landscape pre-disturbance.
3) It is vague in concept and is therefore subject to the discretion of both the operator and regulator.

For instance, Syncrude's recently certified Gateway Hill site is a forested hill with public walking trails. Pre-disturbance, this area was a low-lying wetland. Clearly, equivalent land capability is a subjective term that needs some boundaries and parameters.

To fulfill the expectations of Albertans, the government should require that oil sands operators return self-sustaining ecosystems and re-establish ecosites in the approximate same proportion that existed prior to disturbance. Further, they should be required to provide the ecological conditions for restoration of the diverse boreal ecosystem in the future. This definition is compatible with the consensus recommendation made to the Government of Alberta by the Oil Sands Multistakeholder Committee: "Define a reclamation standard that describes final certification requirement where site conditions are clearly self sustaining, and where natural succession to a typical boreal ecosystem would occur."[264]

5.2 Establish a Set of Transparent Reclamation Standards

Currently, there are a total of 11 (not including expansions) mines that are either operating, approved or planned in the Athabasca Boreal region. One would expect that in the past 40 plus years of mining a common set of reclamation standards would exist for these companies. Unfortunately, reclamation is only guided by the objective of equivalent land capability and the Land Capability Classification for Forest Ecosystems. As a result, it is highly unlikely that reclamation efforts will yield outcomes that meet Albertans' expectations for restoration. These tools are inadequate and should be bolstered by a full set of detailed standards. Standards for reclamation should in part be based on the current reclamation research to date, the historic environmental baseline and traditional ecological knowledge. In addition, significant research and the demonstration of new technologies and practices need to occur and be integrated with existing information to reduce uncertainty and minimize risk. Reclamation standards that consider aboriginal, aquatic and wildlife values need to be established and integrated into EPEA approvals and reclamation guidelines.

5.3 Prohibit the Creation of Liquid Tailings

There are numerous steps required to extract bitumen from the oil sands. The step that results in the largest challenges for reclamation is the extraction process, for it is the extraction process that produces large volumes of tailings. The long-term plan to reclaim mature fine tailings is to place them in large dug out pits and cap them with water to yield an end pit lake. As discussed, there is no evidence that end pit lakes will result in lakes that are capable of supporting aquatic life. Responsible oil sands development should prevent the creation of toxic tailings, thereby eliminating the need for managing these wastes through end pit lakes. While end pit lakes are common practice in the overall mining industry, it is not common practice to deposit toxic waste at the bottom of them. Total tailings treatment options exist today,[265] and new technologies are being investigated increasingly. The Government of Alberta should clearly communicate to the industry that it will not approve any new oil sands mining projects that result in end pit lakes for mitigating and managing toxic waste; doing so would drive the industry to develop new processes that prevent the creation of tailings.

Figure 23: Tailings contain acutely fatal toxins, such as naphthenic acids
Photo: David Dodge, CPAWS

5.4 Reform the Reclamation Security Policy to Protect Canadians

The current oil sands mine reclamation security program lacks transparency. Information about reclamation costs, the calculation of liability bonds and the frequency (if any) of third party validation of reclamation plans are not publicly available or readily accessible. The lack of transparency associated with this information forces the public to entrust the government and oil sands operators to ensure that the current bonding policy is adequate.

An independent third party review should be undertaken to establish the true costs of oil sands reclamation and to recommend clear guidelines for how companies calculate their reclamation liability, including consideration of reclamation uncertainty. This review will ensure clarity for Canadians and oil sands operators alike and will ensure that sufficient money is collected to protect Canadians from potential liabilities. This third party review should be completed by a team of independent scientists and Traditional Ecological Knowledge (TEK) specialists.

In addition, Alberta Environment should amend its current practice of deducting liability from operators' security deposits when a company claims that reclamation work is complete. While it is logical that the security deposit be reduced as reclamation work is completed, doing so must be based upon receipt of a reclamation certificate from Alberta Environment.

These recommendations are consistent with a consensus recommendation made by the Oil Sands Multistakeholder Committee that the Governement of Alberrta "develop formal and transparent processes and policies for financial management of reclamation liabilities." Therefore, the province needs to ensure appropriate regulatory processes are in place to manage the potential risks.[266]

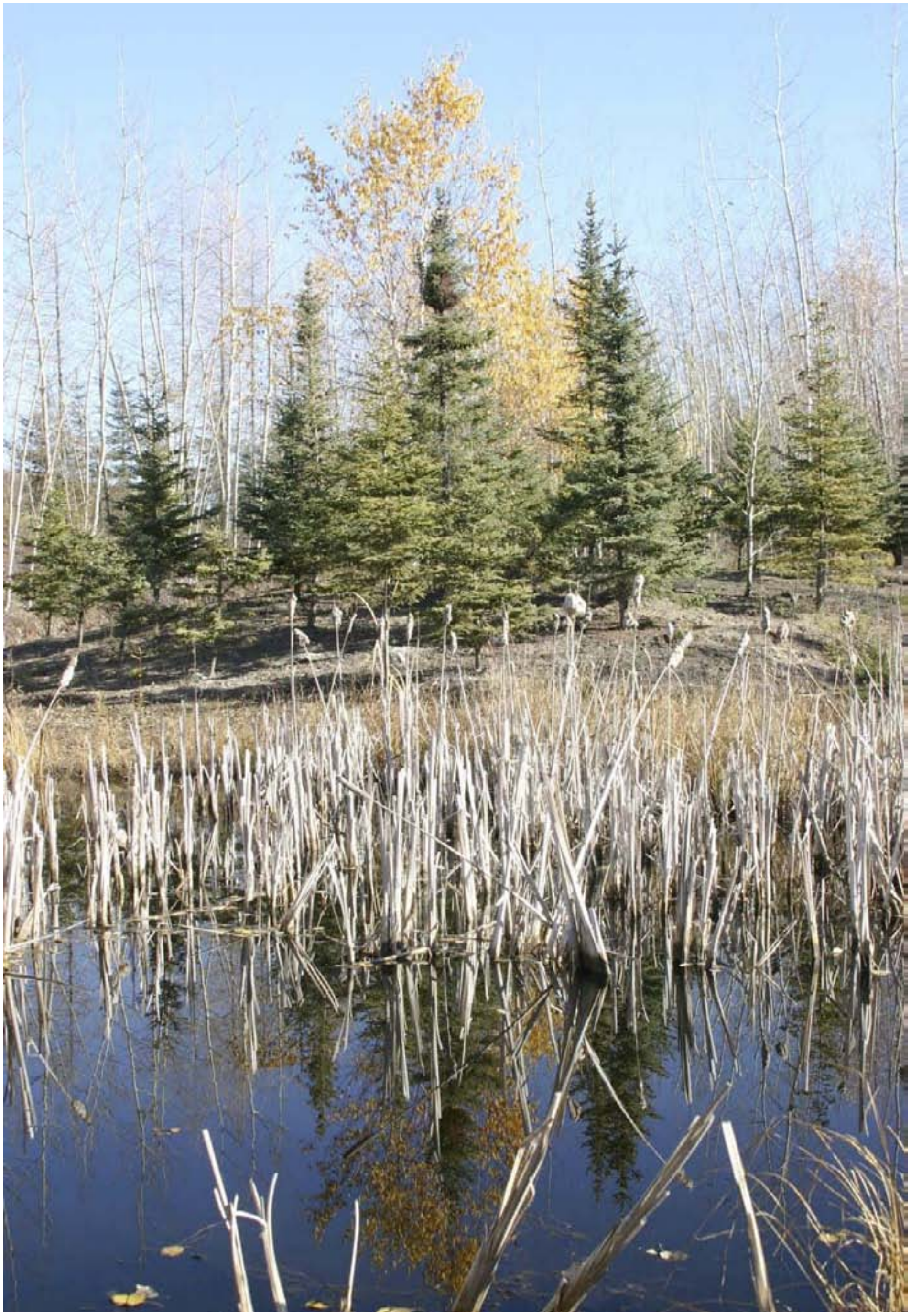

Figure 24: The Athabasca region's lakes and wetlands purify water, produce oxygen and moderate our climate

Photo: David Dodge, The Pembina Institute

5.5 Institute a Total Disturbance Area Cap for Each Project to Ensure Progressive Reclamation

Despite the clear benefits offered by the progressive reclamation precedent in the TrueNorth approval, proponents have not voluntarily made a progressive reclamation commitment, nor has the ERCB or Alberta Environment included it as a condition in subsequent approvals. There are few requirements or incentives for new and existing companies to undertake timely progressive reclamation or even achieve reclamation certification as quickly as is feasible.

To ensure industry accountability for progressive reclamation, Alberta Environment should develop and implement a consistent approach to including quantitative reclamation targets and timelines in EPEA approvals for oil sands mine operations. Alberta Environment should apply this approach to both existing EPEA approvals, by re-visiting and revising these approvals, and to any future EPEA approvals for oil sands mining.

5.6 Increase Public Transparency of Corporate Reclamation Performance

Annual Conservation and Reclamation reports that allow companies to report on development and reclamation activities are supposed to be publicly available. However, acquiring copies of these reports for operating mines is extremely difficult. In writing this report, both the Government of Alberta and the companies themselves referred to one another as providers for the reports, and in most instances neither could deliver until months had passed after the initial request. The Pembina Institute was invited to Edmonton to view the reports at the government library, as the reports were not electronically available. Similarly, a high level of secrecy surrounds the upcoming Mine Liability Management Program (MLMP).[267] The program is being developed by industry and government personnel without input from stakeholders and the public. The recently certified Gateway Hill site is a final example of the disappointing lack of transparency about reclamation performance. Both government and Syncrude press releases failed to disclose specifics of the pre- and post-disturbance site, as well as the costs for the work done.

C&R reports must be made readily available to the public by posting them on Alberta Environment's website. Further, when the Government of Alberta certifies reclamation it should publish its analysis of the reclaimed land and the rationale for issuing the certificate and assuming liability for the land. Finally, the government could increase Albertans' confidence in oil sands reclamation by providing a report every two to five years that provides a full account of the land that has been disturbed versus reclaimed.

5.7 Require Environmental Compensation to Offset Mining Impacts

Projections of long-term forest loss associated with mining and in situ oil sands development forewarn of major negative consequences for Alberta's boreal forest. Reclamation lag times and uncertain reclamation success challenge the adequacy of reclamation alone as the primary form of terrestrial mitigation. Mitigation or conservation offsets are intended to compensate for unavoidable impacts that remain after companies have implemented conventional reclamation strategies. These offsets involve the restoration, creation, enhancement or preservation of additional ecological resources.[268]

Alberta Environment should rapidly implement a compensatory mitigation policy, for both wetlands and terrestrial habitats, to help mitigate terrestrial disturbance in northeastern Alberta. In the absence of a formal policy, regulatory panels could also immediately require compensatory offset mitigation, which would be simply based on requirements for adequate mitigation under the Canadian Environmental Assessment Act. It is unacceptable that oil sands operators do not have to meet requirements for no net loss of wetlands, as is required of developers operating in the settled portions of Alberta.

A compensatory mitigation program would help alleviate the current risks and uncertainties associated with oil sands reclamation. It should be noted that compensatory mitigation is a complement to reclamation and does not replace the need for timely and effective reclamation.

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Appendix

Table 3: 2007 Oil Sands Securities

(Adapted from Alberta Environment's 2007 *Environmental Protection and Security Fund Annual Report*.)

Company Name	Project	Value of Security
CNRL	Horizon Oil Sands Project	$27,552,040.00
Canadian Oil Sands L.P.	Aurora Mine	$4,510,000.00
Canadian Oil Sands Ltd.	Aurora Mine	$28,629,480.00
Canadian Oil Sands Ltd.	Mildred Lake	$16,186,762.50
Chevron Canada Limited	Jackpine Oilsands Mine	$4,467,123.80
Chevron Canada Resources	Muskeg River Mine	$10,257,000.00
Conocophillips OS Partner II	Aurora Mine	$8,145,060.00
Conocophillips OS Partner II	Mildred Lake	$3,978,401.34
Imperial Oil Limited	Aurora Mine	$22,550,000.00
Imperial Oil Limited	Mildred Lake	$11,014,400.18
Mocal Energy Ltd.	Aurora Mine	$4,510,000.00
Mocal Energy Ltd.	Mildred Lake	$2,202,880.04
Murphy Oil Company Ltd.	Aurora Mine	$4,510,000.00
Murphy Oil Company Ltd.	Mildred Lake	$2,202,880.04
Nexen Inc.	Aurora Mine	$6,521,460.00
Nexen Inc.	Mildred Lake	$3,185,364.53
Petro-Canada	Fort Hills Oil Sands	$1,741,437.00
Petro-Canada	Aurora Mine	$10,824,000.00
Petro-Canada	Mildred Lake	$5,286,912.08
Shell Canada Ltd.	Jackpine Oilsands Mine	$13,401,371.40
Shell Canada Ltd.	Muskeg River Mine (1999 site)	$30,771,000.00
Suncor Energy Inc.	Steepbank/Millenium	$231,390,420.00
Western Oil Sands Inc.	Jackpine Oilsands Mine	$4,467,123.80
Western Oil Sands Inc.	Muskeg River Mine (1999 site)	$10,257,000.00
	TOTAL	**$468,562,116.71**

Endnotes

[1] This number indicates the remaining established reserves for crude bitumen as of 2007. More information is available in Alberta Energy and Utilities Board, *ST98-2007: Alberta's Energy Reserves 2006 and Supply/Demand Outlook 2007–2016* (Calgary, AB: Alberta Energy and Utilities Board, 2007).

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[133] Ibid., 4.

[134] Since EPLs are a permanent feature on the landscape, the total number of EPLs (25) will be present when the last EPL is constructed (Imperial Kearl Lake in 2060), as indicated in column 5 in table 4.3.

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[137] Water volume 37 million m^3; MFT volume 100 million m^3.

[138] Fort Hills Energy Corporation, *Fort Hills Oil Sands Project Application and Environmental Impact Assessment — Supplemental Information* (2002), *Project Amendment Application Environmental Effects Update* (2007), and *Project Application and Environmental Impact Assessment* (2007).

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[140] Shell Canada Ltd., *Application for the Approval of the Muskeg River Mine Project — Environmental Setting Reports* (1997).

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[147] Canadian Natural Resources Ltd., *Horizon Oil Sands Project Application for Approval — Supplemental Information* (2003).

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[149] EPL volumes for each lake (68 Mm^3, 78 Mm^3 and 78 Mm^3) are water cap only. EPL 1 also contains 11 million m^3 thickened tailings. EPLs 2 and 3 are filled with overburnden, interburden and coarse sand tailings material.

[150] Deer Creek Energy Ltd., *Joslyn North Mine Project Integrated Application and Supplemental Information* (2007). Should Deer Creek's optimal tailings management scenario proceed, the Joslyn end pit lake will not have any MFT. The end pit lake is required to capture all the site drainage at end of mine life and eventually release the water into the Ells River once it meets water quality parameters. The end-pit lake will be initially filled to some level using Athabasca River water. According to the company: "Past applications have shown transference of MFT from the final in-pit tailings cell into the end-pit lake to allow reclamation of the last in-pit cell. The idea is that the MFT is at the bottom of many metres of quality water and should stay there, thus will not impact fish. Our Project Update states that we do not plan on placing MFT into the end-pit lake and will manage it in the end-pit cell to effect reclamation within approximately seven or eight years." Personal communication from Karim Zariffa of Total Canada to Jennifer Grant, February 28, 2008.

[151] End of mining.

[152] There will be no tailings in the end pit lake. Total will use a dry tailings technology.

[153] Shell Canada Inc., *Application for the Approval of Muskeg River Mine Expansion Project* (2005).

[154] Includes 50 million m^3 water cap.

[155] Taken from cross-section drawing of a typical sedimentation pond. *Volume 1 Section 10.2, figure 10.2, page 10–11.*

[156] Includes 35 million m^3 water cap.

[157] Includes 25 million m^3 water cap.

[158] Mary Griffiths, Dan Woynillowicz and Amy Taylor, *Troubled Waters, Troubling Trends: Technology and Policy Options to Reduce Water Use in Oil and Oil Sands Development in Alberta* (Drayton Valley, AB: The Pembina Institute, 2006).

[159] Westcott and Watson, "End Pit Lakes Technical Guidance Document," 1.

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[166] Suncor Energy Inc., *Voyageur Project- North Steepbank Extension Project Application, Volume 1a*, 11-4.

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[261] Privy Council Office, "Speech from the Throne," www.pco-bcp.gc.ca/default.asp?Language=E &Page=archivemartin&Sub=speechesdiscours&Doc=speech_20040202_278_e.htm.

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[268] In the context of oil sands development, compensatory mitigation can involve the purchase and protection of private forestlands and wetlands; the restoration of existing disturbances, such as historic abandoned well sites or seismic lines, and other habitat enhancement methods; or the conservation of public lands.