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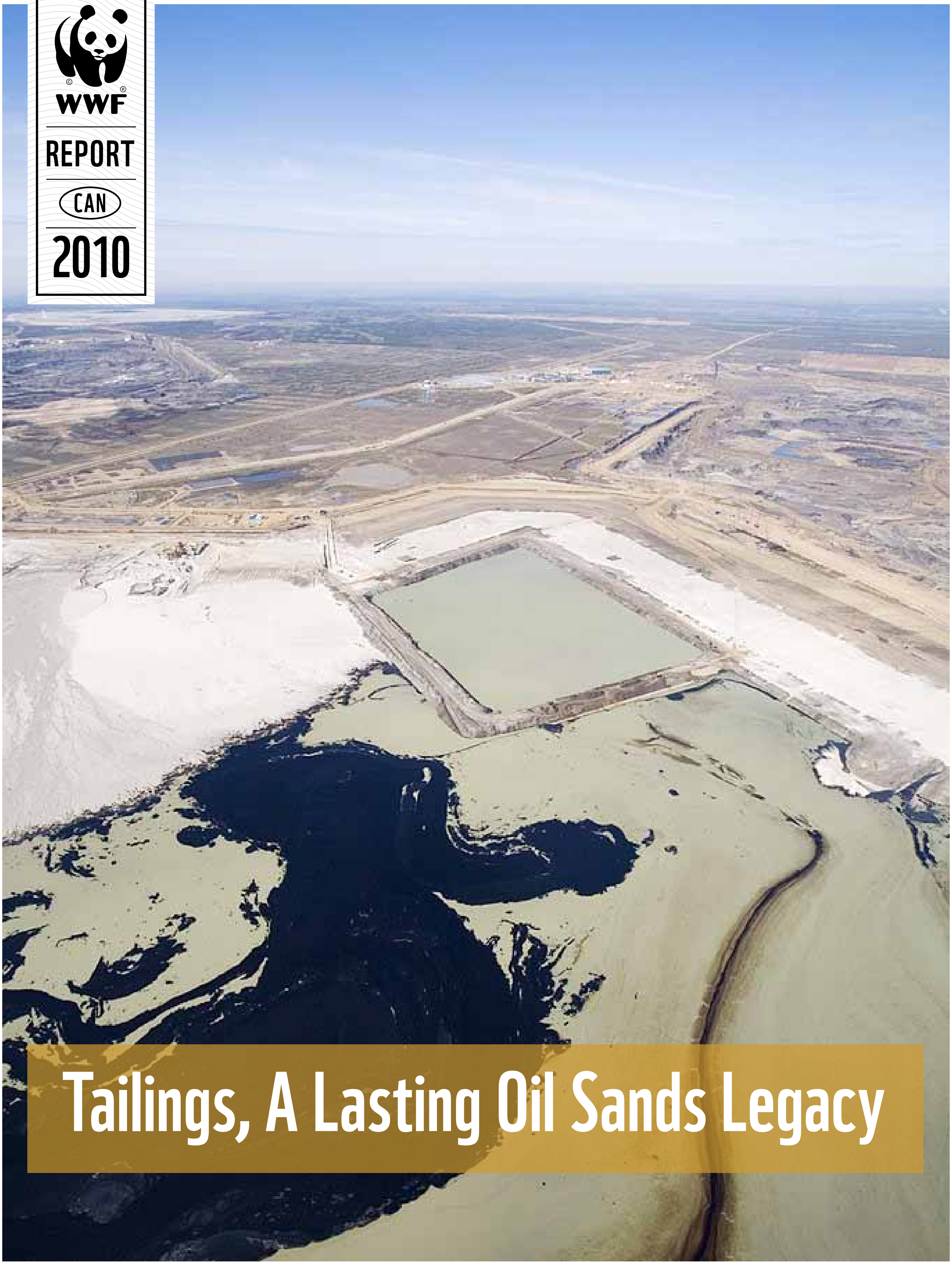

Tailings, A Lasting Oil Sands Legacy

Front cover: Aerial view of Syncrude Aurora mine and tailings lake north of Fort McMurray, Alberta, Canada. Oil sands mining over the past four decades has produced a vast and growing legacy of toxic liquid tailings. © Jiri Rezac / WWF-UK

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INTRODUCTION

Oil companies have been extracting bitumen from Alberta's oil sands for over four decades using a process that leaves behind vast lakes of toxic liquids and sludge. Tailings lakes (also known as tailings ponds[1]) are a threat to people and wildlife residing downstream from the oil sands mines and expose fresh water resources of the Athabasca Region to the risk of contamination.

Oil sands tailings are a serious, monumental and expanding environmental liability that grows more formidable with every year that passes. Clearly, the current growth in tailings cannot be sustained without doing long term or irreparable harm to the ecology of the Athabasca region and areas downstream of development. Effective and timely action is necessary if those currently benefitting from exploiting the resource are to be held accountable for remedying the damage that has accrued. Such action is necessary if we are to avoid passing a toxic legacy along to future generations of Canadians who will not have the benefit of revenue from the bitumen resource to mitigate the damage caused by its irresponsible exploitation.

This report:

- explores how toxic tailings lakes came into being and reports on their current status,
- describes regulatory attempts to remediate the tailings problem,
- investigates processes and technologies with the potential to eliminate the legacy inventory of tailings and reduce the volume of new tailings being generated,
- outlines the risks and liabilities resulting from the continued growth and the legacy volume of tailings and,
- proposes actions that government and the oil sands mining industry should undertake without delay to remedy the tailings problem.

TAILINGS DEFINED

Alberta's oil sands deposits have 170 billion barrels remaining of established reserves, 34 billion barrels of which are recoverable through mining (ERCB 2010d). The first commercial bitumen mine operated by Great Canadian Oil Sands Ltd. began operation in 1967 on the banks of the Athabasca River north of Fort McMurray.

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[1] The term tailings lake is used in this report to describe the tailings storage facilities. Although commonly referred to as tailings ponds, some facilities occupy up to 30 square kilometers which is far larger than what is commonly thought of as a pond.

Today four operators (Suncor, Syncrude, Shell and Canadian Natural Resources Ltd.) excavate and process bituminous sands, the technically correct name for the deposit, in a region in Northern Alberta that spans over 50 townships and encompasses about 4,800 square kilometers of boreal forest. The area of boreal forest disturbed by mining as of March 2009 was 602 square kilometers (Alberta Energy 2010); over one quarter of that area is occupied by tailings (Houlihan 2010). Combined, oil sands mines produced more than 825,000 barrels of bitumen per day in 2009 (ERCB 2010d) which was about 86% of total mining production capacity, see Table 1.

Table 1 - Operating Bitumen Mines (As of April 2010)			
Company	Proposed Mine	Startup	Production Capacity (bbl/d)
Suncor	Base Mine, Steepbank and Millenium	1967	320,000
Syncrude	Mildred Lake	1978	135,000
Syncrude	Aurora North	2001	215,000
Shell	Muskeg River Phase 1	2002	155,000
CNRL	Horizon Phase 1	2008	135,000
		Total:	960,000
From Oil Sands Developer Group website at http://www.oilsandsdevelopers.ca/index.php/test-project-table/?q=mining, retrieved April 2010.			

On average, two tonnes of ore are mined for every barrel of bitumen produced. The tar-like bitumen is extracted from the ore with hot water and chemicals. The Clark Hot Water Extraction (CHWE) process used to extract the bitumen was patented in 1929 and has been in commercial use since 1967. The process mixes water, heated to between 35 and 80 degrees Celsius (Gray 2008, Page B1-5), with crushed ore and sodium hydroxide to separate the ore into its constituent parts. Bitumen is liberated in the process, floats to the top of the mixture as froth and is skimmed off.

The process works because coarse Athabasca sands are hydrophilic (i.e., attracted to water). Grains of sand in the ore attract a thin film of water. In contrast, the bitumen in the ore is hydrophobic and repels wetted surfaces. It is these properties of both constituents that enable the CHWE process to separate bitumen from the ore.

The materials remaining after the bitumen has been separated from the ore are pumped into tailings lakes. Water, rendered toxic by the extraction process, forms the top layer of the tailings lake. Some water is recycled back into the process to extract more bitumen. Coarse sand grains in the tailings stream (larger than 44 microns) are relatively easy to reclaim; they settle out quickly and are used to form the beaches and dikes that contain the fluid tailings mix.

The “fines” (small clay particles under 44 microns in size) in the ore are suspended within the water that surrounds the grains of sand. These fine clays, also liberated from the ore in the CHWE process, are mixed in the waste slurry that is expelled into tailings lakes.

Table 2 – Mature Fine Tailings Inventory as of 2010 (From mine operator tailings plans submitted October 2009)	
Operator, Mine	**Cubic Metres**
Syncrude, Mildred Lake and Aurora North	511,300,000
Suncor, Base Mine and Millenium	212,000,000
Shell, Muskeg River and Jackpine	69,300,000
CNRL, Horizon	48,000,000
Total:	840,600,000

Mature Fine Tailings or MFT, is the term used to describe the mix of fine clay particles and water after the slurry has settled for several years. From that point on, further settling occurs only at a vastly reduced rate. With a consistency of thin yogurt, MFT is unable to support reclamation activities. Untreated, MFT is expected to persist in a fluid state for several hundred years. (Gray and Masliyah 2008, Page B1-32). MFT is too toxic to be released to the environment so it is stored on the landscape. Inventories of MFT continue to accumulate, creating what is essentially a growing and long-term liability.

MFT, comprised of 30-45% solids by weight (ERCB 2008), is created at the rate of roughly 1.5 barrels for every barrel of bitumen produced (Houlihan 2009b)[2]. In 2008, 264 million barrels of bitumen were produced by oil sands mines (ERCB 2009b) an amount that will eventually produce about 396 million barrels or 66 million m^3 of MFT. Bitumen production in 2009 will add another 72 million m^3 of MFT to the inventory[3]. As of 2010, 840 million m^3 of MFT were contained on the landscape behind dikes, see Table 2. That's enough MFT to cover the entire city of Fort McMurray to a depth of 24 metres[4]. Based upon mine operator submissions, the total volume of MFT stored on the landscape could reach 2.4 billion m^3 by 2040 (Houlihan 2009a).

The volume of mature fine tailings that has accumulated on the landscape in Northern Alberta since commercial mining began in 1967 has reached epic proportions. Mature fine tailings continue to grow at 1.5 times the rate of bitumen production and the volume stored in tailings lakes could almost triple by 2040 bringing increased liability and risk to the environment.

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[2] 0.25 m^3 of MFT is created for every barrel of bitumen produced. Calculation to equate units of measurement: 0.25 X 6.29 (barrels in a cubic metre) = 1.5725 barrels of MFT per barrel of bitumen.

[3] Based on 2009 bitumen production from operating mines of 47.9 million m^3 or 302 million barrels as per ERCB publication ST98-2010.

[4] Fort McMurray covers an area of 35 km^2 or 35 million m^2. 840 million m^3 of MFT divided by 35 million square metres = 24 metres of depth.

THE EVOLUTION OF TAILINGS LAKES

The full extent of the tailings problem became apparent in the 1970s when the Energy Resources Conservation Board (ERCB), the regulator responsible for overseeing oil sands mining activities, reviewed Syncrude's application for a mine expansion. The ERCB had concerns over the amount of bitumen that would not be recovered because it was beneath the proposed 25 square kilometer Mildred Lake tailings settling basin (ERCB 1994). Despite its concerns, the board approved the Syncrude application. Concerns over potential bitumen loss from future tailings lakes prompted the ERCB to commission a study[5] in 1978 on the feasibility of transporting and storing tailings outside the mineable region (Houlihan 2008b). The study provided estimates of the costs of relocating tailings by pipeline to two potential offsite locations, one near the Birch Mountains and another south of Kearl Lake. The recommendations from the study were never implemented.

Table 3 – Tailings and Mine Footprints in 2007 (square kilometers)

Mine	Mine Area	Tailings Area	Tailings Area as a Percentage of Mine Area
Syncrude Mildred Lake	178	60	33.7%
Syncrude Aurora North	47	11	23.4%
Suncor Base Mine	30	16	53.3%
Suncor Millenium	98	30	30.6%
Shell Muskeg River	44	10	22.7%

At Suncor, tailings from the first mine started by Great Canadian Oil Sands Ltd. grew rapidly, driving the need for increased storage capacity. The Tar Island dike on the west bank of the Athabasca River grew from its initial design height of 12 metres to 92 metres in 1984. In 1988, lateral movement in the clay foundation underlying the dike made it necessary to excavate part of the dike crest and use the material that was excavated to reinforce the toe of the dike. About the same time, Suncor stopped discharging tailings into the first of the oil sands tailings lakes and began building tailings containment lakes further back from the river (Hunter, 2001). Suncor expanded its tailings lakes on the west side of the Athabasca River to cover 16 square kilometers in six containment areas before the company moved its mining operations to the east side of the river where it has since added another 30 square kilometers of tailings lakes to the landscape.

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[5] Athabasca Oil Sands Tailings Disposal Beyond Surface Mineable Limits, a 1979 report by Hardy Associates and Moneco Consultants prepared for the management committee of the Off-site Tailings Disposal Study. The study was commissioned by Alberta Energy, Alberta Environment and the ERCB.

Syncrude meanwhile had leapfrogged north out of the area and in 2000 opened the Aurora North mine. The Aurora North tailings lake that evolved with the mine today covers 11 square kilometres. Shell brought its Muskeg River mine on stream in 2002 and created another tailings containment lake. Canadian Natural Resources Ltd. started producing tailings from its Horizon mine in 2008.

Today there are 17 tailings lakes scattered around the Athabasca mineable oil sands region that together have displaced almost 170 square kilometers of former boreal forest. (Houlihan 2008a, Houlihan 2010).

Current individual mine footprints are not available, however, Table 3 provides the tailings footprint in relation to mine disturbance as of 2007 to provide a sense of scale for the areas occupied by tailings.

The area occupied by oil sands tailings has been an issue of concern from the early days of bitumen mining. Oil sands tailings now occupy an inordinately large area in relation to total mine disturbance.

THE TAILINGS DILEMMA

The large and growing tailings lakes on the landscape are neither separate from the environment nor benign. They contain naphthenic acids, polycyclic aromatic hydrocarbons (PAHs), BTEX compounds (benzene, toluene, ethylbenzene and xylene), metals, salts and residual bitumen making the tailings toxic to living organisms. Many of these toxins are regulated under the Canadian Environmental Protection Act which prevents them from being released to the environment. Preliminary data from Environment Canada's National Pollutant Release Inventory (NPRI) show that oil sands tailings contain large amounts of such toxins, some that have shown significant annual growth (Environment Canada 2009). Table 4 illustrates the volumes and growth rates of some of the pollutants found in oil sands tailings between 2006 and 2009.

The tailings containment dikes are constructed from sand so they are prone to leak. As much as 65 litres/second flows from Suncor's Tar Island dike into the Athabasca River (Barker et al. 2007). Ditches installed around the perimeter of the lakes collect some of what leaks from the dikes, however, some leakage escapes the collection systems and finds its way into groundwater and from there into the Athabasca River (HOC 2009). The risk of groundwater contamination is higher for newer tailings lakes that are located nearer to sand aquifers (HOC 2009). Environmental Defence has estimated that the total leakage from oil sands tailings lakes could be as high as 11 million litres per day (Environmental Defence 2008). Such estimates are of necessity based upon a significant number of assumptions since actual leakage rates—while reported to the Alberta Government—are not publically accessible (Moorehouse 2008).

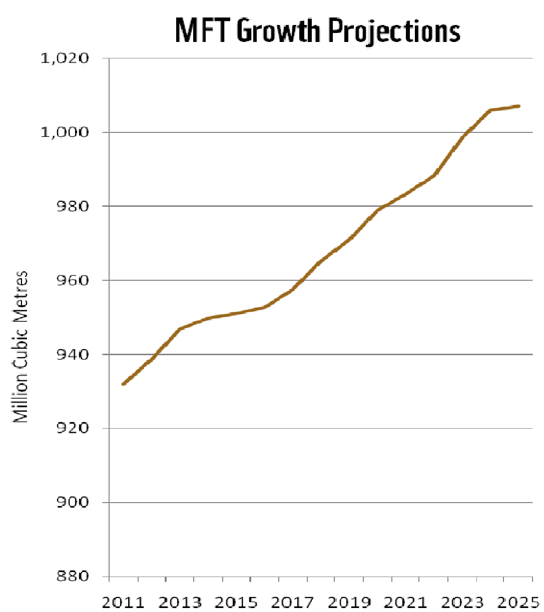
There is risk, however small, of a breach occurring in the dikes that contain the tailings on the surface of the land. Such a breach, releasing the large volume of effluent stored in a typical tailings lake, would almost surely harm ecosystems, water resources and communities downstream. Instances of slope and foundation instabilities have occurred in the past in Syncrude and Suncor tailings dikes (ICOLD-UNEP 2001). Concerns about a potential break in the dikes have led communities downstream (the City of Yellowknife and the Dene Nation) to pass resolutions calling for the Alberta government to halt expansion in the oil sands until contingency plans to deal with a catastrophic breach are publically available (Yellowknife 2009, Denendeh 2009).

Table 4 - NPRI Pollutants in Oil Sands Tailings, Disposal On Site

	2006	2009	Increase
	kilograms		
PAHs*	189,090	218,456	15.5%
BTEX**	2,690,000	3,488,000	29.7%
Lead	503,387	651,875	29.5%
Cadmium	2,454	3,336	35.9%
Mercury	459	747	62.7%
Arsenic	248,372	318,305	28.2%
Manganese	17,897,000	22,202,000	24.1%
Nickel	1,213,000	1,462,000	20.5%
Chromium	1,210,000	1,452,000	20.0%
Copper	386,000	499,600	29.4%

* Total of all polycyclic aromatic hydrocarbons reported

** Total of all benzene, toluene, ethylbenzene and xylene reported



Projections based on bitumen production growth forecast from CAPP Crude Oil Forecast, Markets & Pipelines dated June 2010 with MFT produced at the rate of 0.25 cubic metres per barrel of bitumen extracted.

Tailings lakes also emit methane, a potent greenhouse gas that contributes to Canada's increasing carbon emissions. One tailings lake alone, the Mildred Lake Settling Basin, has been estimated to release 12 grams of methane per square metre from its surface daily, as much methane from the lake as that produced by 500,000 cows (Holowenko 2000).

Because the lakes are fed with warm tailings effluent, they remain open when natural lakes in the area are frozen over, thus offering an invitation to migratory waterfowl to alight. Mine operators typically deploy cannons and scarecrows to dissuade birds from landing in the toxic lakes but such measures are not always sufficient to prevent mortality. In April 2008, more than 1,600 birds landed in Syncrude's tailings lake at the Aurora North mine, became trapped in residual bitumen and perished either from drowning, hypothermia or ingestion of toxic tailings material.

While oil sands mines operate under a regime that prohibits tailings release, Alberta regulations also stipulate that the mined land must eventually be reclaimed to a capability equivalent to what existed before mining began. This means that at some point in time, it will be necessary to eliminate the toxic liquid liability in order to reclaim the mined out land. Table 3 shows that the area covered in tailings as of 2007 ranged between 23% and 53% of the land disturbed depending upon the mine.

All of the above add up to significant liability and risk, both of which are growing unabated with the escalating growth in mature fine tailings.

We've seen that bitumen extraction produces 1.5 times more MFT than bitumen, an outcome of production that has deposited 840 million cubic metres of MFT waste on the land. Projections for bitumen production show that, unchecked, the inventory of MFT could grow to more than one billion cubic metres over the medium term.

Tailings lakes are toxic and they leak. The lakes pose a threat to communities downstream and to wildlife. The growing volume of MFT waste represents a significant environmental liability that continues to grow proportional to increases in bitumen production. Prompt, effective measures are needed to stop the growth of MFT and remove the accumulated waste from the landscape.

TAILINGS REGULATION

The continued growth in tailings has prompted the ERCB to direct mine operators to transform their fluid tailings into trafficable deposits[6] capable of supporting the equipment and traffic necessary to incorporate the tailings into a dry reclaimed landscape. The ERCB tailings directive issued in 2009 attempts to stem the continued increase in fluid tailings but stops short of addressing the legacy volume of MFT currently stored on the landscape behind dikes.

In issuing the directive, the ERCB was clear in stating that mine operators had failed to meet their targets, as promised in mine applications, for turning fluid tailings into solid deposits (ERCB 2009a). The tailings directive was meant to remedy the failures and set realistic targets for fluid tailings mitigation. It requires operators to:

- develop tailings management plans,

[6] The ERCB tailings directive defines trafficable deposit as having a minimum undrained shear strength of 5 kilopascals (kPa) one year after deposition and 10 kPa five years after deposition. With its final directive, the ERCB lowered the requirement for trafficability from that stated in the draft tailings directive dated June 26, 2008 which defined a trafficable deposit as having an undrained shear strength of between 10 kPa (capable of supporting foot traffic) and 100 kPa (capable of supporting a pick up truck or bulldozer).

- meet phased-in targets for capturing fine clay particles (smaller than 44 microns) in the ore feed (by June 2013, at least 50% of the fines must be captured and placed into trafficable deposits),
- define dedicated areas for disposing of solidified tailings,
- monitor compliance to the plans and report annually to the ERCB.

Mine operators submitted the first tailings management plans by the deadline of September 30, 2009, however, most of the plans did not comply with the directive. Syncrude's tailings plans for the Mildred Lake, Aurora North and Aurora South mines failed to meet the specified timelines for fines capture. Shell's Muskeg River mine has been producing tailings since 2002 yet the company indicated in its tailings plan that having tailings remediation facilities in place by 2010 would be a significant challenge. The company's Jackpine mine will begin producing tailings in 2010 yet the tailings plan for the mine does not meet the requirements of the ERCB directive until 2027. Although the Kearl mine will begin producing tailings in 2012, Imperial Oil's plan would not have tailings remediation facilities operational before 2018. CNRL will not meet the requirements of the tailings directive until 2025. Of all the plans submitted in 2009, only the plan submitted by Fort Hills Partnership (now owned by Suncor) complied fully with the directive. (Simieritsch et al. 2009 and ERCB 2010e)

Table 5 - Syncrude Fines Capture Non-Compliance With ERCB Directive 074

Year	Mine	As Required by the Directive	As Proposed by Syncrude and Approved by the ERCB
		% of fines in feed	
2010/2011	Mildred Lake	20	9.3
2011/2012	Mildred Lake	30	14.6
2012/2013	Mildred Lake	50	14.8
2012/2013	Aurora North	50	10.9
2013/2014	Mildred Lake	50	34.6

References: ERCB Approval 8573H dated April 23, 2010 (Mildred Lake) and ERCB Approval 10781B dated April 23, 2010 (Aurora North)

In late April 2010, seven months after the industry submitted its tailings plans, the ERCB provided its first response to the mine operators' submissions by approving the Syncrude and the Fort Hills tailings plans. In accepting the Fort Hills plan, the ERCB attached the condition that there be no residual MFT at the mine when it closes in 2055, a condition that the tailings plan had originally proposed (ERCB 2010c).

The ERCB approved Syncrude's tailings plans for Mildred Lake and Aurora North mines as submitted, even though the percentage of fines in the ore feed that Syncrude proposes to capture falls well short of directive requirements, see Table 5. (ERCB 2010a and 2010b)

In 1996 when Syncrude first applied to operate the Aurora North mine, the company promised it would have tailings remediation systems operational at the mine by 2009. That commitment is not kept with the approved 2009 tailings plan. Syncrude will not begin reclaiming tailings at Aurora North until 2013 (Syncrude 2010a, Question 10, Page 29).

In 2008, Syncrude applied to the ERCB for approval to convert a sand storage facility into another tailings lake. The 2010 tailings plan approval also approves that application authorizing Syncrude to expand its fluid tailings storage capacity at Mildred Lake. (ERCB 2010a).

The ERCB approved Suncor's tailings plan in late June 2010 despite noting that Suncor may not achieve the mandated 50% fines capture requirements in two years of operations (ERCB 2010e). As part of the approval, the regulator removed a restriction that had prevented Suncor from beginning to mine a new area until the company met previous tailings remediation targets. Just prior to approving the tailings plan, the ERCB (in April 2010) approved a separate application that lets Suncor increase its fluid tailings storage capacity by adding another 10 metres to the dikes around the company's largest tailings lake on the east side of the Athabasca River.

In August 2010, the ERCB approved Imperial Oil's tailings plan for the Kearl mine on condition that Imperial Oil resubmit an amended plan covering the full life of the mine by the end of September 2010. The ERCB approval allows Imperial Oil to delay meeting the directive requirement to capture 50% of the fines in the ore feed until 2018. However, the company must make up the difference in what should have been captured between mine startup and 2018 by the year 2023 (ERCB 2010e and 2010f and Imperial Oil 2010).

In late September 2010, the ERCB approved the Muskeg River tailings plan permitting Shell to delay construction of the company's proposed consolidated tailings plant until 2012. The approval means that Shell will not meet the fine tailings reduction criteria of Directive 074 until 2013. Similar to the Kearl approval, the ERCB has attached a condition to the Muskeg River mine approval that Shell exceed the directive requirements for fines capture from 2012 on to meet the directive's overall requirement for fines capture on a cumulative basis by 2017. The approval also requires Shell to conduct trials of alternative tailings treatment technologies. (ERCB 2010g)

The ERCB directive stipulates that updates to the tailings plans must be submitted by September of every year; however, Syncrude, Suncor, CNRL and Shell have all been granted deferrals by the ERCB for 2010 for the Aurora South, Fort Hills, Horizon and Jackpine mines respectively.

Tailings plan updates for the Aurora South and Fort Hills mines have not been submitted as there are applications for major updates to the mine plans under review. Any changes to tailings management will be reviewed by the ERCB under the mine applications. It should be noted that the Syncrude mine update submitted to the ERCB in December 2009 proposes a final MFT inventory of more than 3 billion cubic metres for the Aurora South mine which is more than 16 times what Syncrude had proposed as a final MFT inventory for Aurora South in 2006. (Syncrude, 2009d, Volume 1, Table 7-1, Page 7-15)

The ERCB continues to review the original tailings plans submitted by Shell and CNRL in September 2009 for the Jackpine and Horizon mines. Changes to the tailings plans for the two mines will be required before approval and the ERCB has indicated the changed plans will then be considered the 2010 update. (ERCB 2010h)

The tailings plan updates for the remaining mines were submitted in September 2010 but none had been approved by the ERCB as of October 2010 when this report was finalized. Because the information contained in the 2010 updates is unapproved and therefore subject to change and because updates are not currently available for all mines, information from the 2009 tailings plan submissions remains the basis for this report. Some highlights from the 2010 tailings plan updates that have been submitted are, however, included below.

With its 2010 plan updates, Syncrude has increased its projections for the amount of MFT that will accumulate at two of the company's three mines over the next six years. In 2011, the combined inventory of MFT at Mildred Lake and Aurora North will increase by 30.2 million cubic metres. (Syncrude 2010c and 2010d)

Syncrude's 2010 update contains apparent discrepancies however. The update for Mildred Lake shows only 137 million cubic metres of MFT remaining in the Base Mine EPL in 2046 even though 211 million cubic metres will have been deposited into the lake by the time it is commissioned in 2012. In addition, the 2010 update for Aurora North has an incorrect table inserted in place of the Tailings Production Summary making it impossible to determine the amount of MFT Syncrude plans to have remaining at mine closure for deposit into the Aurora North end pit lake. When asked for clarification on the discrepancies, Syncrude's designated contact person for the tailings update declined to respond, stating the company's policy was to correspond only with directly affected stakeholders and not with the public. For this reason and until we can obtain clarification on the 2010 discrepancies, we continue to use the information in this report from the ERCB-approved tailings plan that Syncrude submitted in September 2009.

Shell's 2010 update for the Muskeg River Mine shows the mine's fluid tailings inventory will increase by 2.1 million cubic metres in 2011 to 69.7 million cubic metres. (Shell 2010, Table 3.8, Page 18), Because no update for the Jackpine mine is available, Table 2 in this report contains the total for Shell mines as reported in the original 2009 tailings plan.

With its 2010 tailings plan update, Shell is projecting that the MFT inventory at the Muskeg River Mine will be 178 million cubic metres by 2054, roughly 2.5 times what it is now, despite plans to implement various tailings remediation technologies.

Suncor's 2010 tailings plan update is a bit more encouraging than the others submitted. In it, Suncor is projecting a decrease in MFT inventory for 2011 of almost 26 million cubic metres from the volume reported in 2010. However, it's unclear from the material balance and fluid inventory tables in Suncor's 2010 update how the 2011 reductions will be achieved in relation to the company's MFT inventory as reported in 2009. (Suncor 2009d and 2010f, Table 12)

Although industry projections of future tailings inventories are useful, a historical record of such projections in a form that would show how such projections change over time would add to their value in tracking tailings reclamation progress or the lack thereof. However, the only true measure of progress in tailings reclamation is whether current MFT inventories are increasing or declining.

The ERCB has said that its tailings directive is the first component of a larger initiative to regulate tailings. The directive could have marked a welcome departure from the Alberta government's overreliance on voluntary measures in the regulatory applications of the mining companies that the board notes the companies have failed to meet. The directive established reasonable targets and timelines for capturing fine particles in ore feeds, a necessary first step in curtailing the production of MFT. An obvious follow on step would be to expand the regulations to drive reductions in the legacy volume of tailings that has accrued over the past four decades.

Yet the industry is not being held to compliance. Non-compliance with directives should prompt enforcement but that option is not being exercised by the regulator. By approving non-compliant tailings plans, the ERCB has established precedents that could lead to future non-compliance on the part of mine operators. The ERCB's approval of increased fluid tailings storage capacity is the most telling signal to the oil sands industry that continued ineffective performance in remediating tailings will be tolerated.

Environmental groups (Pembina Institute, Water Matters and Ecojustice) have challenged the Syncrude approval saying the ERCB erred in law and does not have the legal authority to approve tailings plans that do not comply with the directive (Ecojustice 2010). Whether or not the challenge is successful, it's clear that the oil sands industry has obtained concessions from the Alberta regulator.

Alberta's premier has recently said the province will do away with oil sands tailings lakes (Fekete and Schmidt, 2010). This appears to be a sensible and welcome change from previous assertions that the oil sands mining industry and Alberta merely have an image problem based on public misunderstanding. If the government truly accepts the need to end the unsustainable practice of storing great quantities of MFT on the landscape, it can begin to address the environmental liability of tailings lakes and the bad publicity that goes with it.

In September 2010, Suncor announced that the surface of the company's first tailings lake constructed four decades ago on the shores of the Athabasca River, was finally reclaimed. The only way Suncor could accomplish this was to transfer the MFT out of the tailings lake (Suncor 2010e). While reclaiming the surface of the first tailings lake might have been a significant milestone, moving MFT in this manner from one location to another does nothing to reduce the accumulated and continually growing inventory of MFT.

A true commitment to a landscape without tailings would be reflected in strong regulations that are enforced. The government could re-establish the regulatory authority needed to demonstrate real progress in tailings reclamation by building on the ERCB's efforts to curtail the expansion of MFT with further requirements to treat and eliminate the legacy volumes of MFT. The effectiveness of any future initiatives undertaken will, however, depend upon a demonstrated political will to enforce the rules.

TAILINGS RECLAMATION

Over the first two decades of bitumen mining, little was done to address the problem of growing MFT inventories. Research conducted over the last two decades of mining has explored the fundamental properties of MFT and investigated potential technologies for remediating the substance.

In 1989, the federal and Alberta provincial governments, along with bitumen mine operators, established the Fine Tailings Fundamental Consortium (FTFC).[7] Over the five years of its existence, the consortium investigated and reported on options for reclaiming tailings in both dry and wet landscapes. Dry landscape reclamation removes sufficient fluid from MFT to make it trafficable in a terrestrial final landscape. Wet landscape reclamation disposes of MFT in a mined out pit and covers it with water. End pit lakes, the term given to the lakes that would form part of a wet reclamation landscape, are discussed later in this section.

Some dry reclamation technologies are more effective than others at turning MFT into a dry terrestrial landscape. Some are better suited to mitigating existing MFT volumes while others can slow or prevent the creation of fluid tailings coming out of the tailings pipe. The more commonly employed technologies are explored in the following paragraphs. Also covered are some technologies that have the potential to extract bitumen from ore without producing fluid tailings.

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[7] Membership in the Fine Tailings Fundamental Consortium included Alberta Energy, the Alberta Research Council, AOSTRA (Alberta Oil Sands Technology and Research Organization), Environment Canada, Canada Centre for Mineral and Energy Technology (CANMET), The National Research Council, OSLO (Other Six Lease Operators), Suncor and Syncrude Canada. AOSTRA operated the consortium directed by a management committee comprised of one representative from each member organization of the coalition. Funding came from Alberta Energy, AOSTRA, Environment Canada and CANMET each of which contributed an average of $450,000 per year over five years. Others in the coalition contributed in the form of laboratory and field testing and research.

CONSOLIDATED TAILINGS

Knowledge acquired by the FTFC led to the development of Consolidated Tailings (CT), a technology that was considered at the time of its inception to hold the greatest potential for turning fluid tailings into trafficable deposits in a dry reclamation landscape (FTFC 1995, Houlihan 2008b). Composite Tailings is another term used for the technology. The two longest running mine operators implemented CT as a strategy to reduce the growing volumes of MFT, Suncor with a commercial scale operation at the company's Pond 5 in 1995 (Suncor 2009d) and Syncrude at its the Mildred Lake Settling Basin in 2000 (Houlihan 2008b).

Although Shell has been extracting bitumen at its Muskeg River mine since 2002, the company has yet to produce any CT deposits. Shell's 2009 tailings plan indicated the company would have a commercial CT operation underway by 2009 or 2010 (Shell 2009a), however, the ERCB has given Shell permission to delay the beginning of CT operations until May 2012 (ERCB 2010g).

The CT process uses gypsum as a coagulant to change the chemical properties of the fine clay particles suspended in oil sands tailings thus enabling the fines to bind to heavier sand particles. The resultant tailings slurry is transported by pipeline and placed in a CT deposit. The bound particles create additional weight in the CT deposit to release process-affected water that is then collected and recycled back into the production process. At Syncrude's Mildred Lake facility, approximately two units of CT slurry by volume produce one unit of CT deposit after the fluid is released (Syncrude 2008s, Volume 1, Table 4.2-1).

One of the challenges to producing CT tailings is the sand-to-fines ratio (SFR) required by the process. CT is ideally produced at a SFR of four to one or greater, meaning four parts of sand are added to the mixture for each part of fines captured. The sand-to-fines ratio determines how long it will take to produce a trafficable surface on a CT deposit capable of being reclaimed. CT produced at a SFR of 4.5 requires seven years to produce a trafficable deposit. A SFR of 6 will produce a trafficable surface in less than five years but a SFR of 3.5 will require more than ten years before a trafficable surface is available for reclamation (Suncor 2007).

The large volumes of sand needed to build tailings containment dikes and beaches limit the amount of sand available to produce consolidated tailings. Syncrude has prioritized its sand allocations with the highest priority given to building dams and beaches to contain fluid tailings followed by capping CT deposits and finally using the sand to create CT. Only 17% of the total sand available will be allocated to CT production at Syncrude's Mildred Lake mine over the next four years (Syncrude 2010a, Response to Question 7, pp. 24-25).

Sand is separated from the tailings stream using cyclones. The overflow from the cyclones—thin fine tailings comprised of water, suspended fine clay particles, residual bitumen and chemical contaminants—is placed onto sand beaches that capture some of the fines. The majority of the fluid tailings, however, flow into the central part of the tailings lake where, over time, the fluids consolidate to the degree necessary to become MFT. CT operations combine sand with MFT with the aid of a coagulant, essentially putting the constituents of the ore back together to release the water that was added to extract the bitumen.

CT plant reliability at Syncrude has been less robust than expected; the company admits some components of the system could be improved upon. From the time CT production at Syncrude first began in 2000 until 2008, the process has captured just 24.2 million m^3 of MFT in a CT deposit with a volume of 50.3 million m^3 (Syncrude 2009e, Table 4.2-1 and Syncrude 2010a, Table SIR-8-1).

The rate of MFT capture at Syncrude has averaged 2.7 million m^3 per year over the nine years the company has been producing CT. The company currently has a legacy volume of 511.3 million m^3 of MFT on the landscape (Syncrude 2009a, b and c). If Syncrude's CT production rates were to continue as they have to date, it would take 189 years to turn the current volume of MFT into trafficable deposits capable of being reclaimed.

The company, however, appears to be ramping up CT production. Despite having produced just 50 million m^3 of CT at Mildred Lake over the last nine years, Syncrude has promised the ERCB it will create 912 million m^3 of consolidated tailings at the Aurora North mine between 2013 and 2038 (Syncrude 2010a, Table SIR-13-2, Page 37). That works out to more than 36 million m^3 per year over the 25 years which is about 6.5 times Syncrude's historical annual rate of CT production at Mildred Lake.

Suncor's experience with CT production over the past decade and a half has been similar to Syncrude's. Suncor has deposited consolidated tailings into Ponds 2/3, 5 and 6 which, as of 2008, together contained 68.2 million m^3 of CT (Houlihan 2009c).

Assuming Suncor's CT process has captured MFT at the same rate as Syncrude's process (roughly 2.1 m^3 of MFT consumed for every cubic metre of CT produced), about 32.5 million m^3 of MFT would have been consumed in CT deposits since Suncor began CT operations in 1995. That would be roughly 2.5 million m^3 of MFT captured per year over the 13 years the company's CT plant has been in operation, slightly less than Syncrude's annual rate of MFT remediation. Suncor's current legacy volume of MFT, at 212 million m^3, is considerably less than Syncrude's. Still, at past rates of CT production, it would take 85 years to turn Suncor's current accumulated volume of MFT into CT.

Not all the CT that has been produced over the years meets specifications. Over 60% of the surface area of Suncor's CT deposits in Ponds 5 and 6 are too soft to support reclamation activities and require remediation, primarily because the vast majority of deposits were produced with a SFR of less than 3. Suncor hopes to fix the non-conforming CT by capping the deposit with petroleum coke, a process the company has said is the only viable option for producing a trafficable surface for its CT deposits. (Suncor 2009e October TRO Application, Tailings Management Plan, pp. 7-11 and Suncor 2010b).

The ERCB, in response to Suncor's application for the North Steepbank mine expansion in 2006, expressed doubt that predicted CT production levels could be achieved and noted that the company had to date been able to achieve only 19% of its projections for CT production. The ERCB therefore placed a condition of approval on the North Steepbank mine extension (NSE), that Suncor have CT operations underway with a demonstrated 76% efficiency at the company's Millenium mine before mining could begin at the NSE mine (ERCB 2006). It is this condition that the ERCB removed with its approval of Suncor's tailings plan.

Given the weak performance of the CT process to date, Suncor plans to discard the technology in 2012 and implement a different technology for removing water from MFT. (Suncor 2010f).

Despite significant public and private investment in research and development, consolidated tailings, the technology employed over the last 15 years as the solution to mature fine tailings has failed to deliver expected results. While other solutions are now being explored, some operators are still using consolidated tailings to cope with growing inventories of mature fine tailings while others are discarding the technology.

MFT DRYING

Suncor is replacing its long-running CT operation with a relatively new process (MFT drying or MFTD) in what the company dubs "Tailings Reduction Operations" (TRO). The operations process existing volumes of MFT to release water and dry the fluid tailings and achieve the trafficability requirements for a dry reclamation landscape. The company maintains that the change from CT to MFTD will reduce the volume of MFT destined for end pit lakes at mine closure from a formerly-planned 108 million m^3 to 75 million m^3. The change to MFTD will also eliminate the need for an end pit lake that had been planned for the North Steepbank mine extension (Suncor 2009e).

Research into MFTD began at Suncor with a small-scale trial in 2003 which progressed to a larger pilot project at the company's Pond 1 in October 2004. The Pond 1 pilot project processed almost 90,000 m^3 of MFT over an area of 60,000 square meters. This created 42,000 tonnes of dried MFT in a trafficable deposit that exceeded the strength requirements stipulated by the ERCB tailings directive (Suncor January 2009a).

Suncor moved its MFT drying operations at Pond 1 to Pond 8A on the east side of the Athabasca River where operations began in March 2009. Results at Pond 8A were promising, prompting Suncor to apply to the ERCB in October 2009 to phase out and replace CT operations with the new MFTD process (Suncor October 2009e).

Suncor's new process mixes MFT with a polymer flocculant, an anionic polyacrylamide added at the rate of one part per hundred of fines in the MFT feed. The resultant mixture is then deposited in relatively thin (0.2-0.3 metre optimum) layers in batches onto slightly sloped beach areas (Suncor 2010c, response to Question 13). As the fines in the MFT consolidate due to the action of the flocculant, water in the mixture is released and runs off to be recycled in the production process. More water evaporates as the MFT deposit dries within the deposit.

Deposits are worked with a discer to increase the rate of drying (Suncor February 2010c, response to question 121). The process is intended to produce final deposits with 20 to 35% fluids content within 6 and 20 days of being deposited. No polymer is added during winter operations when Suncor expects seasonal freeze/thaw cycles alone will reduce water content in the MFTD deposits to 35% (Suncor, July 2009c).

Between 2010 and 2032, Suncor plans to dry 628 million m^3 of MFT with its tailings reduction operations at an average consumption rate of 27.3 million m^3 of MFT per year, almost 10 times the rate of MFT capture of the company's previous CT operations. The plans assume that four cubic metres of MFT per year can be dried for each square metre of drying area (Suncor 2009e). If achieved, the planned annual rate of MFT consumption would just keep pace with the amount of MFT Suncor would generate each year under full production of 320,000 barrels per day.

Other mine operators, including Imperial Oil and Shell are evaluating MFT drying as a tailings treatment option (Imperial Oil 2009, Shell 2009a and 2009b). Shell refers to the technology as Atmospheric Fines Drying (AFD) and began a test of the technology in June 2010. The Fort Hills mine, now majority owned by Suncor with the company's acquisition of PetroCanada, will use MFT drying as the primary means to reduce the MFT inventory to zero by the time the mine closes (Fort Hills 2009).

Suncor requested that its TRO test results and reports remain confidential and the ERCB has complied. The test data will be withheld from public purview until at least August 2012 and perhaps longer at the discretion of the board (ERCB 2009c). In contrast to Suncor, Shell has publicly offered to share its Atmospheric Fines Drying technology with other mine operators (VanderKlippe 2010).

Oil sands operators are highly competitive and tend to treat performance data as proprietary information. If an operator succeeds in resolving its MFT problem before other companies, this accomplishment could provide a competitive advantage. However, the tailings issue tarnishes the reputation of all mining industry participants as well as the Province of Alberta. Under these circumstances, cooperation rather than competition is warranted. If a solution to the tailings problem is ever to be found, the ERCB should oblige mine operators to make tailings information and performance data publicly accessible as soon as it becomes available.

MFT drying appears to be emerging as the new preferred technology for turning mature fine tailings into solid deposits, much as consolidated tailings emerged and was universally adopted by mine operators 15 years ago. At this point, however, it is too soon to determine if the fledgling drying technology will be robust enough to keep pace with the large volumes of MFT that continue to be generated.

MFT CENTRIFUGING

Centrifuging is an alternative technology that holds some promise for turning MFT into dry tailings. Centrifuged MFT has between 50% and 70% solids. (Syncrude November 2008). The process adds a polymer flocculant to a diluted MFT stream which is then fed into a mechanical centrifuge. While centrifuges are capable of processing the whole tailings stream, they are used only with MFT because of the large amount of flocculant that would be required to treat the entire tailings stream.

A successful pilot test with MFT centrifuging occurred at the Asphalt Ridge oil sands deposit in Utah in 1999/2000. The project used hot water to extract the Utah bitumen from the sand in a process derived from the Clark Hot Water Extraction process used in the Alberta oil sands. A shortage of water for extraction drove the need to release the water that was locked in the fine tailings to maximize water available for recycling. Dry tailings were a side benefit of the water conservation initiative. Laboratory scale centrifugation tests subsequently carried out at NRCAN's CANMET facility using Athabasca oil sands tailings found that dry tailings could be produced through centrifuging while reducing by half the amount of water normally needed to produce a barrel of bitumen. (Mikula et al., 2008)

Both Suncor and Syncrude have evaluated MFT centrifuging. Suncor's application for a TRO experimental facility in March 2009 had included a proposal to operate four centrifuges in parallel. This would have processed 166 cubic metres of MFT per hour to produce 60 tonnes of centrifuge cake per hour with a solids content of 60% (Suncor March 2009). Suncor subsequently withdrew its centrifuging proposal citing unfavorable economics compared to MFT drying (Suncor 2009e).

Syncrude on the other hand, plans to augment its CT processes at Mildred Lake with a modular centrifuging implementation that the company claims will treat 1.5 million m^3 of MFT per year by 2012. By scaling up operations with additional centrifuges, Syncrude contends it will treat 5 million m^3 of MFT per year by 2015 and 10 million m^3 per year by 2018 (Syncrude November 2008, Table 4.4-3, Page 4-20). A production rate that achieves the Mildred Lake mine capacity (135,000 barrels per day) would produce approximately 11.7 million cubic metres of MFT annually.

Syncrude is also proposing to centrifuge fine tailings at its future Aurora South mine where centrifuging operations are scheduled to begin in 2018, two years after mine startup, when a sufficient inventory of fluid tailings will be available to support the operations. The Aurora South centrifuging process would transform fluid tailings at 26% fines content into a cake-like substance with 55% solids without the addition of sand. The cake would then be placed, in one- to two-metre thick lifts, into disposal areas where it would consolidate further under its own weight to 80% solids within two years. Syncrude expects to produce centrifuge cake at Aurora South at an average rate of roughly 20 million m^3 per year. The total volume of centrifuge cake produced out of the 1,749 million m^3 of fluid tailings (at 23% fine solids content) that will be generated at Aurora South over the 27 years of operations between 2016 and 2044 is projected to be 546 million m^3 (Syncrude 2009d, Table 7-4 and 7-10).

The absence of sand in the centrifuged tailings output provides a significant advantage over the CT process where sand needed to produce a trafficable product is often diverted to build dikes and beaches for tailings containment, a diversion that has, as we have seen above, reduced the effectiveness of CT operations. While a dry tailings product is desirable, centrifuging incurs a cost disadvantage since it is less expensive to move the wet slurry produced with other tailings technologies through a pipeline. Centrifuged cake must be removed from the centrifuge outlets by conveyor belts and trucked to disposal areas. These transfers incur greater costs than transport by pipeline (Mikula et al., 2008).

In determining the technology that would be used for tailings management at Aurora South, Syncrude evaluated consolidated, as well as thickened tailings (see the following section), before deciding on centrifuged tailings. The evaluation determined that centrifuged tailings would produce a smaller footprint than the other two technologies and that less MFT would be put into the end pit lake at mine closure with centrifuged tailings. Syncrude also determined that the company could not meet the fines capture requirements of the ERCB tailings directive with consolidated or thickened tailings technologies alone. Economically, Syncrude determined that centrifuged tailings was the better solution overall, even though some costs were higher than the other two options evaluated. (Syncrude 2009d).

Given the vast amount of fluid fine tailings stored on the landscape, operating and capital investment costs are an important factor in managing tailings. While operating and capital costs for centrifuging are higher than other technologies, savings are expected from the reduced need to construct dikes for fluid tailings containment. The technology could ultimately have a lower full life cycle cost than other tailings technologies (Devenny 2009).

Centrifuged MFT is yet to be implemented on a commercial scale for any oil sands mine. Should Syncrude's MFT centrifuging operations perform as projected, the technology would be an improvement over consolidated tailings in producing a dry final reclamation landscape. Like MFT drying, however, only a large scale commercial implementation over an expanded timeframe will determine whether or not centrifuges will perform to the extent necessary to stop or even slow the growth in MFT inventories.

THICKENED AND NON-SEGREGATING TAILINGS

To comply with the ERCB directive, new mines without an inventory of MFT can produce thickened tailings that can be used in place of MFT to form trafficable deposits. Thickened tailings (TT) are produced by separating the tailings stream with cyclones (cyclones are similar to centrifuges but they apply less centrifugal force) into a coarse sand underflow and a fluid fine tailings overflow. The overflow, comprised primarily of water and fine particles, is then combined with a polymer in a thickener vessel to produce tailings that have about the same solids content as MFT. By thickening the overflow tailings stream to the approximate consistency of MFT as tailings are produced, rather than waiting for time and gravity to do the job, water is released immediately for recycling. The process also enables heat energy to be recovered from the tailings stream which reduces energy use and associated greenhouse gas emissions. The area occupied by tailings ponds is also reduced along with the costs associated with tailings pond construction and maintenance. (AERI 2009, Matthews 2004, Nelson and Devenny 2009).

Non-segregating tailings (NST), are then produced in a process similar to that used to produce consolidated tailings, the difference being that thickened tailings in place of MFT are combined with sand and a coagulant or flocculant to produce the NST deposit.

Shell first experimented with NST with a pilot scale project in 2007 and intends to implement the NST process on a commercial scale after further testing, analysis and design (Shell 2009b).

Thickened tailings will be produced at Shell's Jackpine mine but NST production at Jackpine is not slated to begin until 2027. Shell recognizes that TT alone will not, over the long term, meet the requirements for fines capture stipulated in the ERCB tailings directive (Shell 2009b).

Canadian Natural Resources Ltd. (CNRL) plans to produce TT at its Horizon mine, which began mining bitumen in 2008, but NST production will not begin until 2015 (CNRL 2009).

While thickened and non-segregating tailings may have the potential to reduce emissions and provide economic advantages for bitumen extraction, the full process has not yet been implemented at commercial scale. The effectiveness of the technology in producing a dry reclamation landscape has not been demonstrated.

DRY TAILINGS EXTRACTION TECHNOLOGIES

Much work has gone into developing alternative extraction technologies that might reduce or eliminate the fluid tailings produced when bitumen is extracted from ore. Continued investment in such research and development would seem to be justified both to resolve the large and rapidly growing fluid tailings legacy and to enable continued exploitation of the resource in the face of mounting public and regulatory concerns over fluid tailings. Nevertheless, some of the more promising technologies for bitumen extraction have yet to be tested at scale or implemented commercially in the Athabasca oil sands.

In the mid 1980s, the ERCB commissioned an investigation into alternatives to the Clark Hot Water Extraction (CHWE) process with the objectives of improving the bitumen recovery rate for lower grade ore and reducing the rate of fluid tailings accumulation. The evaluation identified 33 potential extraction processes and studied seven, three of which were selected for detailed evaluation against the existing CHWE process. Of the technologies studied in detail, the Taciuk direct retorting process was determined to have the greatest long-term potential for reducing fluid tailings (ERCB 1984, FTFC 1995). The process (designated ATP for "Alberta

Taciuk Process") derives its name from inventor William Taciuk. Ore is fed into a rotating drum and heated to 750° Celsius in a retorting process that distills out the hydrocarbons. Outputs are a partially upgraded crude oil and dry tailings. Tests carried out with oil sands feeds in the early 1990s determined that tailings from the process could produce a dry reclaimed landscape even if water was added so that wet tailings could be transported from the production vessel to disposal areas by pipeline to save costs.

Since the 1992 tests, the technology has been employed in extracting oil from shale in Australia and to clean up PCB contaminated soil in the United States. An ATP plant for processing oil shale is currently under construction in Fushun China. The Al Lajjun oil shale project in Jordan is using two 500 tonnes-per-hour ATP retorts to produce synthetic crude oil from oil shale. Despite its growing use elsewhere in the world, ATP technology is not being used to extract bitumen from sand in Alberta's oil sands.

In 1992, Bitmin Resources began development of a water-based process for bitumen extraction that uses less energy than the CHWE process while producing trafficable dry tailings and relatively non-toxic water as outputs. The process accomplishes this by minimizing the breakdown of clay constituents in the ore in a more gentle digestive system that omits caustic soda as an additive and by thickening and filtering the tailings output. Bitmin tested the process at Suncor in 1993 with a 20 tonnes-per-hour demonstration plant and progressed from a 25 tph demonstration in 1994 to a 300 tph demonstration at the Fort Hills mine in 2005. The later demonstration achieved only 60% of the projected production rate, which, according to Bitmin, was because incorrect water chemistry was used throughout the duration of the test. The demonstration did, however, achieve very good bitumen recovery and froth quality while using 1/3 less water and less than half the energy of conventional processes. Consuming less energy means lower greenhouse gas emissions and costs. The demonstration also produced trafficable tailings that were suitable for immediate dry reclamation. Because the full continuous production rate was not achieved, the mine operator at the time (Fort Hills Partnership consisting of PetroCanada, UTS and Teck Cominco) decided not to use the Bitmin process for the Fort Hills mine (FTFC Vol 4, Chapter 7, Roa 2009, UTS 2007).

Dr. Selma Guigard, associate professor with the Environmental Engineering Group at the University of Alberta, has been working for 15 years on supercritical fluid technology. She is applying that technology towards refining a process that laboratory modeling has shown uses virtually no water and only 1/3 the energy currently used to extract bitumen from oil sands. The process heats solvents under pressure to where they are neither a liquid nor a gas in a closed loop system that recycles the solvents. The technology, proven and in use by other industries in Europe, competes economically with the current water-based bitumen extraction process and has the potential to eliminate tailings lakes. Dr. Guigard has been unsuccessful in her quest for funding from the oil sands industry to take her research from the laboratory to a pilot project. (Globe and Mail 2009)

A great deal of research has gone into developing technologies that could one day reduce the production of toxic tailings sludge and treat the large volumes of MFT that make reclamation of tailings lakes so difficult. The value of many promising technologies has never been demonstrated at production scale. Not only do existing mines still use the old Clark Hot Water Extraction process, new mines coming on stream continue to employ the same water intensive method to extract bitumen. Lost with this risk-averse approach are opportunities to produce fewer fluid tailings and reduce water use.

Technological innovation can reduce costs and provides opportunity for improving both the environmental performance and the reputation of the industry. Despite such potential, the companies operating in Alberta's oil sands have, over more than four decades of mining for bitumen, failed to make the capital investment in infrastructure necessary to implement new and innovative technologies on a scale that would significantly reduce or eliminate tailings.

END PIT LAKES

The oil sands mining industry is espousing a wet landscape as an alternative to a dry reclamation landscape to deal with the tailings liability. With the proposed wet landscape model, mature fine tailings are pumped into mined out pits and covered with water to form a lake. These "end pit lakes" are the least expensive means of disposing of decades of accumulated MFT. The problem is, neither the industry nor regulators know if the proposal will work.

Pit lakes have been used elsewhere by the mining industry to reclaim land after mines have ceased operating. The objective is to have the lake gather runoff from land that has been disturbed by mining activities and contain the runoff over a sufficient period of time to cleanse the water through bioremediation after which it can be released to the surrounding watershed. While pit lakes are a relatively common feature of mine reclamations throughout the world, the aspect of disposing of MFT in the bottom of the lakes is unique to Alberta's oil sands mines. There are concerns about potential toxicity arising from the tailings below the water cap and the ability of EPLs to eventually evolve into self-sustaining, viable ecosystems.

The first proposal to dispose of mature fine tailings in end pit lakes cap came with Syncrude's 1992 application to the ERCB to expand production at the Mildred Lake mine. The ERCB approved the proposal even though the regulator had concerns about the risks that came with water-capped tailings and despite Syncrude's admission that research on geotechnical stability, hydrology and toxicity remained to be done. Attached to the approval was a requirement for Syncrude to reclaim the lake and implement a suitable alternative reclamation technique for the remaining tailings inventory should the demonstration lake fail to produce desired results (ERCB 1994). How the lake might be reclaimed if the demonstration failed was not specified in the ERCB's decision.

The Syncrude end pit lake (EPL) is intended to demonstrate the viability of water-capped MFT as a final reclamation option. Base Mine Lake, the name given to this first EPL, is being created by pumping 211 million m^3 of MFT into Syncrude's West In-Pit (WIP) mine pit and capping it with 40 million m^3 of water to a depth of five metres (SWSS 2008, Volume 4, May 2009 response to Question 90). Inlets and outlets to BML will not be constructed until monitoring has determined that lake water will meet water quality standards and will have no adverse environmental effects if released. If and when water quality standards are met, runoff from the surrounding lease will be diverted into the lake and an outlet will be established to drain water from the lake into the surrounding watershed (ERCB 1994).

Syncrude conducted conceptual and laboratory research into water-capped MFT beginning in the early 1980s which led to the construction of seven small and two large experimental pits followed by a larger water-capped MFT demonstration pond built in 1993. Studies to determine whether EPLs would support aquatic life were undertaken with the University of Waterloo. The studies compared aquatic organisms in the experimental ponds with those found in natural lakes in the region. Various components of the food chain were studied including microscopic floating/suspended plants (phytoplankton) and animals (zooplankton), larger aquatic plants (macrophytes), bottom dwelling organisms (benthic invertebrates) and fish.

The studies found that phytoplankton did not become established in water-capped MFT ponds for four years and, when they did, the composition of species differed from that found in regional lakes. The differences were ascribed to elevated concentrations of naphthenic acids and salts emitted from the water-capped MFT. Communities of zooplankton from the experimental ponds were less abundant than those found in regional lakes. Benthic invertebrates took longer to become established in the experimental ponds, were less plentiful and were different than communities found in lakes within the region (Westcott 2007a).

Later research provided evidence that higher life forms might not survive in water bodies containing tailings-affected water. Yellow perch introduced into Syncrude's water-capped MFT demonstration pond and studied between 1995 and 1997 developed lesions that resembled tumors, had gill abnormalities and experienced fin disintegration. Fish introduced into other water bodies that had elevated naphthenates (salts from naphthenic acids) fared as badly while those introduced into reference water bodies that did not contain oil sands effluent remained relatively unscathed (van den Heuvel et al. 2000). A study carried out later on Suncor wetlands and ponds found that fish indigenous to the area would not survive in water containing oil sands effluent (Bendell-Young et al. 2000).

A study carried out in 2000 of boreal toad and wood frog tadpoles exposed to tailings-affected water in Suncor ponds concluded that "wetlands formed from oil sands effluent would not support viable amphibian populations" (Pollet and Bendell-Young 2000). In another study, mallard ducklings held for 33 days in pens on wetlands that were formed with tailings water had reduced body mass and skeletal size compared to ducklings held on wetlands that were not impacted by tailings (Gurney et al. 2005).

Such studies indicate a viable food web may not become established in end pit lakes even though EPLs are expected to be biologically active, self-sustaining, functional ecosystems that support diverse and natural life forms. (Westcott and Watson 2007a) The Alberta Government has clearly indicated it expects EPLs to be fully functional, self sustaining lakes with water quality and habitat capable of supporting aquatic life including fish (Westcott and Watson 2007a, Appendix A letter from ASRD). The studies raise doubt that EPLs will be a viable tailings solution given expectations for the final reclamation landscape.

Since the Energy Resources Conservation Board first granted permission for Syncrude to build its EPL demonstration lake, other operators have, in their applications for new mines and mine expansions, proposed to incorporate water-capped MFT as a means to dispose of tailings. Regulators have raised many concerns about EPLs in the course of the hearings associated with these applications.

The ERCB acknowledges that the EPL concept is complex and unproven (EUB 2006b). The board is concerned with the increased liability that comes with water-capped MFT at mine closure (EUB 2006a). Approvals granted by the ERCB have included clauses that make the adoption of EPLs conditional upon the success of the Syncrude demonstration lake. The ERCB would prefer to see operational plans that eliminate long-term storage of fluid tailings from the reclaimed landscape (ERCB 2009).

Environment Canada has expressed concern over aspects of the contaminants found in water-capped MFT, including the longevity of polycyclic aromatic hydrocarbons and naphthenic acids and the effects that sediment-based contaminants might have on aquatic life. The federal department of Fisheries and Oceans has voiced concern that there may be a lack of options for reclamation at mine closure if EPLs do not prove viable (Westcott and Watson 2007a, Page 8).

Alberta Environment has expressed reservations that the Syncrude Base Mine Lake demonstration will validate predictions for EPLs citing uncertainties with respect to design, functionality and water quality. The department has also stated that the viability of EPLs has not been substantiated (EUB 2004).

Alberta Sustainable Resources Development (ASRD) would like to see a stated end use for each EPL, with a design specific to that use. ASRD has concerns around safety and public use, water quality and the ability of EPL habitat to support fish as part of a self-sustaining, functioning ecosystem. The regulator recognizes there remains a need to address contaminants, bioaccumulation and impacts on vegetation and migratory birds (Westcott and Watson 2007a, Appendix A).

First Nations have also expressed concern about the ability of EPLs to become viable, functioning ecosystems and are concerned about the potential for tailings deposits in the bottom of EPLs to contaminate fish and render them unsuitable for human consumption. First Nations stakeholders would like to see designated end uses for EPLs that prioritize traditional land use activities over recreational use (EUB 2006b).

An issue related to the design of EPLs is the question of whether or not the lakes will permanently stratify in layers in a process known as meromixis. If permanent stratification should occur, the interface between MFT and the water cap could become oxygen deprived and thus incapable of supporting the benthic populations necessary to produce a functional food web that would include higher life forms such as fish. Lack of oxygen is likely to also hinder development of a detrital layer at the MFT/water interface. The salinity levels in the lakes, influenced by process water and releases from tailings deposits, will likely be the deciding factor in determining if meromixis will occur or be maintained (Westcott and Watson 2007a).

Modeling has suggested that prolonged stratification will not occur in EPLs that are less than 5-metres deep. However, the probability of stratification increases with depth and water salinity (Golder 2007). While Syncrude's demonstration EPL will have an optimum 5-metre depth of capping water, other EPLs with tailings deposits planned for the region will have depths up to 50+ metres (CEMA 2007).

The more MFT there is at the bottom of an EPL, the less space is available in the lake for capping water. Reduced water volume and depth means there will be less time for bioremediation to clean the water before release. If the lakes do not turn over regularly, anoxic conditions could develop at the bottom of the lake which could reduce the potential for bioremediation. Should a lake with oxygen deprivation at depth suddenly turn over after a prolonged period of meromixis, it could negatively affect the quality of surface water and its ability to support life. (Golder 2007).

Table 6 – Planned End Pit Lakes With MFT Deposits (Operating and Approved Mines)

Operator and Mine	Date of Mine Closure	EPL	MFT (Mm^3)
Syncrude Mildred Lake	2046	Base Mine Lake	211.3
		North Mine Lake	129.1
Syncrude Aurora North	2046	Aurora West Pit Lake	218.2
Syncrude Aurora South	2044	Not named	47.6
		Syncrude Total:	606.2
Shell Muskeg River	2059	Settling Basin 2a	188.1
Shell Jackpine	2059	Not named	79.9
		Shell Total:	268.0
Suncor Millenium	2032	End of Mine Pit Lake	74.9
CNRL Horizon	2054	Not named	140
Imperial Oil Kearl	2060	Central Pit Lake	30
		Total MFT:	**1,119**

Source: Annual Tailings Plans Submitted to the ERCB in September 2009.

Source for Syncrude Base Mine Lake: Southwest Sand Storage Application Supplementary Information Request, May 2009

Until water quality that is acceptable for release has been achieved, human intervention will be needed to maintain the water balance of EPLs and compensate for the effects of precipitation, runoff and evaporation. Factors that will determine how long it will take before water quality is acceptable include the depth and surface area of the lake, the length of time taken to fill the lake and the length of time the water stays in the lake once filled. The initial chemistry of the large volume of water needed to cap most lakes will also have a bearing on how long it will take before water can be released (Golder 2007, Summary Page iii). Syncrude's demonstration lake will be capped with 50% process affected water and 50% fresh water taken from the watershed (SWSS 2008, Volume 4, May 2009 SIR response to Questions 29). Syncrude recognizes that both the water and the sediments in BML may need to be treated depending upon water chemistry after the lake is capped (Syncrude 2006, Section 7.7, Page 39).

The methane that has been bubbling up from Syncrude's Mildred Lake Settling Basin since the early 1990s could also affect the viability of end pit lakes. As the methane rises from the depths there is a possibility it could transport toxic materials, naphthenic acids in particular, from the MFT into capping waters (Holowenko et al. 2000). Methane released from MFT in EPLs could destabilize the MFT/water cap interface by re-suspending fine tailings or detrital material into the capping water (Fedorak 2002). Bacteria that use methane could also deplete oxygen from the water necessary for higher aquatic life forms to become established (Holowenko et al. 2000 and Fedorak 2002).

Syncrude's Base Mine Lake demonstration has been under development for a long time. More than a decade and a half have passed since the ERCB approved the demonstration yet BML will not contain its full allotment of MFT—and hence not be ready for biological monitoring and evaluation to begin—until 2012 (SWSS 2008). According to Syncrude, monitoring and evaluation of the lake will be conducted over 10 years, after which there will be a period of time when, as Syncrude has stated "…the lake would continue to develop towards a final reclamation outcome." (Syncrude May 2009)

Should Base Mine Lake not prove viable, the cost to remove contaminated water and reclaim the MFT that has been deposited in the pit could be significant. The only option Syncrude has offered as possible mitigation if bioremediation fails, is to actively treat the process-affected water in the lake to remove contaminants such as naphthenic acids.

Recall that 40 million cubic metres of process affected and fresh water will cap the MFT and more process affected water will be released as the MFT matures. The estimated cost to actively treat the process-affected water has not been made public. Neither have any alternative plans or associated costs for dealing with the water-capped MFT should active water treatment not work or prove too expensive (Syncrude 2010b).

Studies and the EPL modeling carried out to date have provided some insight into the viability of EPLs. Uncertainties remain, particularly with respect to water quality and toxicity as the EPLs are commissioned and evolve over time. Questions remain over the length of time it will take for capping water to detoxify through natural processes, what levels of toxins will remain and whether or not EPLs might eventually be capable of supporting higher trophic levels (Westcott 2007b).

Criteria have not been established for the conditions under which the mining industry might be allowed to transfer liability for EPLs nor for the release of water from EPLs into the environment. Existing water quality guidelines, such as the Canadian Council of Ministers of the Environment for the Protection of Aquatic Life, could be used to set water release criteria, but there are currently no standards for determining acceptable levels of some contaminants found in EPLs, e.g. naphthenic acids (Westcott 2007b).

There are other uncertainties around EPLs:

- It is uncertain how MFT will interact with natural sediments that form on the lake bed as the lakes mature and natural biological processes become established,
- Information is lacking on how water released from MFT as it consolidates over centuries might affect toxicity in the lake,
- Questions remain over how safe the lakes might be for human use and whether residual contaminants, or those released from consolidating MFT, will render fish in the lake unfit for human consumption,
- Uncertainty exists over the long-term geotechnical stability of pits that contain the lakes, the degree to which shoreline erosion will take place and the roles groundwater and seepage might play over time (Westcott 2007b, Page 34).

These uncertainties constitute considerable risk and potential liability. Currently, industry and regulators are struggling with the uncertainties but eventually an answer will need to be found to the outstanding question of whether or not end pit lakes will become self-sustaining, fully functional ecosystems.

Every operator now includes EPLs in mine reclamation plans. Nine end pit lakes that would eventually contain over one billion cubic metres of MFT are planned for mines that are currently operating or have been approved, see Table 6. New mine applications such as Suncor's Voyageur South continue to propose water capped MFT as a solution to the tailings problem, even though the viability of the first EPL as a functional self-sustaining ecosystem will not be determined for at least another decade or longer.

Although research into end pit lakes as a means of disposing of MFT has been underway for considerable time, serious doubts remain over whether the concept will prove viable. Even though many questions remain unanswered, viable, detailed and fully costed alternative plans for disposing of the MFT destined for end pit lakes have not been produced.

By the time the success or failure of the first EPL is determined, the volume of MFT on the landscape will be far greater than it is today. If mine operators eventually discover that the volumes of MFT they hoped to store in pits must be retrieved and treated, the result would have an industry-wide adverse impact.

The oil sands industry and regulators continue to predict that technology will ultimately provide a solution to the decades-long problem of fluid tailings. So far it hasn't. Consolidated Tailings, implemented 15 years ago as the primary technology for remediating MFT, has not lived up to expectations. Other innovative technology that has shown promise over the years has not been adopted. Newer technology under development within the last five years remains unproven and has not been implemented at the scale necessary to effectively reduce the long-standing and still-growing inventory of MFT. The oil sands industry still relies on aged technology developed in the early part of the last century to extract bitumen, technology that continues to generate an ever increasing liability.

TAILINGS LIABILITIES AND COSTS

Of all the mine operators, Syncrude plans to dispose of the largest inventory of MFT—more than 600 million cubic metres—in end pit lakes when it comes time to reclaim the company's mines. Given the uncertainties over whether EPLs will be a viable reclamation mechanism, such large inventories translate into significant risk and potential financial liability.

With more than 500 million m^3 of MFT—roughly 60% of the total inventory currently on the landscape—Syncrude is the most exposed of all mine operators to financial liability if the EPL concept is discredited. All operators will be exposed to increased liability and costs if Alberta's regulators eventually require all liquid tailings inventories to be turned into trafficable deposits.

Mine operators do not normally divulge their costs for remediating MFT. Syncrude, however, in a recent application, revealed that costs could range between $1.50 and $4.90 per cubic metre depending upon the technology used. Syncrude's cost of remediating MFT using centrifuging technology has been estimated at between $2.10 and $2.75 per cubic metre (SWSS 2008, Volume 1, Table 4.3-2). At that rate, the cost of centrifuging Syncrude's existing inventory of MFT would be $1–$1.4 billion. The costs to centrifuge Syncrude's inventory of MFT that is destined for disposal in end pit lakes (should EPLs prove to be a non-viable reclamation option) would be a further $1.3 to $1.7 billion. MFT remediation costs would be in addition to other costs of land reclamation such as moving overburden to fill pits and restoring wetlands and forests.

The potential risks and liabilities from fluid tailings extend beyond the industry that extracts the bitumen. Alberta taxpayers may be at risk as well. The Alberta Government maintains security in its Environmental Protection and Security Fund that, according to the province's Conservation and Reclamation Regulation must be sufficient to ensure reclamation is completed on disturbed land. Indications are that the security held for oil sands mine reclamation is insufficient to ensure that full reclamation, including tailings remediation, is carried out.

The amount of security held in the fund for each mine is determined by the mine operators who estimate what it would cost to reclaim land disturbed to date and then remit the corresponding security. The Alberta Government has the option to review the estimates and ask for more security, however, there is no public transparency as to the adequacy of the security held since mine operators' reclamation estimates are considered proprietary and as such are withheld from public scrutiny.

Since 1999, Alberta's Auditor General has consistently commented on the oil sands mine security deficiency. In his October 2009 annual report, he summarized "With the passage of time, the Department continues to be exposed to the risk of obtaining inadequate security for conservation and reclamation activity which may result in additional costs to the province" (Auditor General of Alberta 2009, pp. 207-209).

The provincial government has been trying to develop a risk based Mine Liability Management program that might ensure adequate security for reclamation since 2004[8]. The Auditor General noted in his 2009 report that a draft program report had been prepared for approval by cabinet and the government had consulted with industry but no solution to the problem of inadequate security appeared imminent. Six years after the Alberta government decided it would look into the problem, the province remains saddled with the risk of having insufficient security to ensure oil sands mines are reclaimed.

As of March 31, 2009, the reclamation security fund held just under $183.4 million to ensure that the land Syncrude has mined (225 square kilometers) and the MFT the company has accumulated to date (511 million m^3) is reclaimed. Applying the full amount of security held to Syncrude's tailings liability would provide only 36 cents to reclaim each cubic metre of MFT that the company currently has stored in its tailings lakes, a number substantially less than Syncrude's range of estimates for treating MFT.

The total held in the government fund to reclaim all oil sands mines was $820.5 million as of March 2009. That amount must ensure 840 million cubic metres of MFT are reclaimed. An expenditure of less than one dollar per cubic metre to reclaim the existing inventory of MFT would exhaust the entire security fund with nothing left over to pay for other required reclamation activities. Numbers such as these make it clear that the government of Alberta does not hold enough security to ensure oil sands mine reclamation obligations are fulfilled.

Investors too are at risk from the continued growth and accumulation of fluid tailings. Northwest & Ethical Investments has observed that not all mine operators report tailings pond retirement obligations and there is "...little clarity about financial provision for their reclamation." When surveyed by the investment group, no oil sands mine operator would disclose the reclamation cost estimates related to tailings in their asset retirement obligations (Northwest & Ethical Investments 2009).

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[8] The Joint Panel Review Decision on the Shell Muskeg River mine expansion dated December 2006 states on Page 66: "Alberta advised that the Mining Liability Management Program was a draft document under development for about two years."

The Ethical Funds Company has observed that weak reclamation requirements do not absolve oil sands mine operators from the obligation to reclaim tailings. Ethical Funds also notes that tailings reclamation experts are concerned that funds set aside to reclaim land disturbed to date are inadequate (Ethical Funds 2008, Page 9).

A recent report commissioned by the Alberta Energy Research Institute (AERI) offers a solution to the problem of inadequate security. The report's author suggests that more appropriate tailings technology would be employed and better tailings performance would result if tailings liabilities were acknowledged as they are created. This could be done by depositing sufficient funds into an environmental trust in advance to pay for future reclamation of fluid tailings. Funds deposited to a qualifying environmental trust would be recognized as operating expenses in the year they were deposited while interest earned on funds in the trust would be deemed as income. These features of the environmental trust would provide tax advantages as well as incentives to expedite tailings reclamation (Devenney 2009, Page 56).

Some mine operators are more exposed to risk than others should end pit lakes prove unworkable. The costs of alternative remediation will be substantial should EPLs fail to deliver the hoped for inexpensive solution for MFT disposal. There is strong evidence to support the contention that the Alberta government holds insufficient security to cover the full cost of tailings reclamation.

The uncertainties inherent in the proposed end pit lake solution should dictate that operators provide alternative plans for reclaiming proposed residual MFT as trafficable deposits at mine closure. Alternative plans are very likely to accrue costs for reclamation that are greater than those associated with disposal in end pit lakes.

Timelines for tailings reclamation are currently measured in decades. The requirement for the industry to reclaim MFT in a timely and responsible manner becomes more critical as the bitumen resource is depleted. If mine operators walk away from their reclamation obligations, future generations of Canadians could be forced to shoulder the cost of cleaning up the MFT that has been left behind.

The public should be entitled to a transparent accounting of reclamation costs in relation to the security the government has obtained on their behalf. This includes full access to independent reclamation cost estimates. In the end, security held by the Alberta government must cover the full costs of mine reclamation if we are to avoid passing along the costs of failed tailings remediation schemes to future generations.

RISKS TO MIGRATORY WATERFOWL

Canadians weighed in on both sides of the issue in April 2008 when 1,600 ducks perished in Syncrude's Aurora North tailings lake. The federal and Alberta governments responded with charges under the Migratory Birds Convention Act (MBCA) and the Alberta Environmental

Protection and Enhancement Act. The court found Syncrude guilty and convicted the company on both charges.

The Syncrude incident was serious and regrettable but it would be far more devastating if any of North America's largest migratory bird, the endangered whooping crane, were to alight on a tailings pond.

Such a scenario is not outside the realm of possibility. Twice every year, the 260 or so birds that comprise the last remaining wild population of whooping cranes in the world fly near oil sands tailings lakes as they migrate between wintering grounds at Aransas National Wildlife Refuge in Texas and nesting habitat in Canada's Wood Buffalo National Park. An unfortunate stop in a tailings lake could negate efforts to conserve the species that have been underway since the whooping crane was declared endangered in 1967. Any convictions under the MBCA that might result would fail to compensate for the loss.

If a Syncrude tailings lake can destroy 1,600 migratory birds in one day, it or another of the 17 other tailings lakes scattered over the landscape in Northern Alberta could do so again. In fact, as this report is being finalized, there are reports in the news that more migratory waterfowl have landed and perished in oil sands tailings lakes.

The risk of ongoing bird mortality exists as long as tailings lakes exist. This risk will extend well into the future with potentially toxic end pit lakes—by design far more enticing to migratory birds than barren tailings lakes—situated near the flyway. As long as they remain toxic, deterrent measures for EPLs similar to those currently used on tailings lakes would need to be deployed to prevent ongoing deaths.

Every year migratory birds die in oil sands tailings lakes. Some mine operators have better records than others at preventing the deaths. Environmental tragedies such as the Syncrude duck incident are only prevented through annual deployment of expensive resources and technology and it is only through adequate performance in bird deterrence that mine operators are able to mount a due diligence defense to avoid prosecution for the numbers of migratory waterfowl that every year alight in tailings lakes and die. The risks to endangered species and the costs of bird deterrence add to the reasons for eliminating MFT from the landscape.

THE FUTURE OF OIL SANDS TAILINGS

Tailings have grown unabated over the first four decades that bitumen has been mined in the Athabasca oil sands and during that time minimal progress has been made in curtailing the burgeoning inventory of MFT. At this point in developing the resource it is apparent that significant change must occur if MFT inventories are to be reduced to a manageable size and further growth in MFT inventories is to be avoided.

This report has so far only looked at tailings associated with oil sands mines that are currently producing or are approved for construction. The current production capacity for operating mines is 960,000 barrels per day (Table 1).

Over the next decade, Total, Imperial Oil and Sinopec plan to commission and operate new bitumen mines in the Athabasca region. Long-established mine operators Syncrude and Suncor have plans to expand their operations as do relative newcomers Shell and CNRL. Production capacity for new mines and mine expansions could increase by 2.5 million barrels per day over the next decade or so, see Table 7. Should existing and proposed mines manage to reach full production capacity of 3.4 million barrels per day, they could add an unimaginable (and unmanageable) 310 million cubic metres of MFT to the landscape every year.[9]

Table 7 - Proposed Bitumen Mines

Company	Mine	Startup Date	Production Capacity (bbl/d)
Suncor	Fort Hills	Not established	190,000
Suncor	North Steepbank Expansion	Not established	180,000
Suncor	Voyageur South	Not established	120,000
Syncrude	Aurora South	2016	215,000
Total/Sinopec	Joslyn North	2014	100,000
Total/Sinopec	Joslyn South	Not established	100,000
Total/Sinopec	Northern Lights	Not established	100,000
UTS/Tech Cominco	Equinox	2017	50,000
UTS/Tech Cominco	Frontier	2018	160,000
CNRL	Horizon Phases 2 and 3	Not established	135,000
CNRL	Horizon Phases 4 and 5	Not established	300,000
Shell	Jackpine Phase 1, Train 1	2010	100,000
Shell	Jackpine Phase 1, Train 2	2010	100,000
Shell	Jackpine Mine Expansion	2015	100,000
Shell	Pierre River Phases 1 and 2	2018	200,000
Imperial Oil	Kearl Phase 1	2012	100,000
Imperial Oil	Kearl Phase 2	2015	100,000
Imperial Oil	Kearl Phase 3	2021	100,000
Source: Oil Sands Developer Group website, April 21, 2010		Total:	2,450,000

[9] Calculation: 0.25 cubic metres of MFT per barrel X 3.4 million barrels per day X 365 days = 310 million cubic metres per year

SUMMARY

Since bitumen mining first began in Alberta, the resources that mine operators have applied to address the tailings problem have proven insufficient to curb MFT growth or to reduce to any significant degree the large volume of MFT that has accumulated on the landscape.

The tailings remediation technology available today might offer solutions that could achieve the reductions in MFT production and inventories necessary to resolve the long standing tailings problem. However, it is important to note that once-promising technology has failed in the past to accomplish this goal. To date, the oil sands mining industry has not invested sufficient funds to curb the continued growth in tailings inventories and the Alberta government has failed to hold mine operators accountable for the liability they have created and continue to grow.

Even former industry representatives recognize that tailings remediation performance has been inadequate. In a recent *Edmonton Journal* news article, retired Shell Canada CEO Clive Mather said it is time the industry provided a clear plan and a timeline to eliminate tailings ponds. Mr. Mather maintains there is no reason for tailings ponds to exist any longer and that the industry has the tools available to clean up tailings—all it needs is the direction to do so (Lamphier 2010).

Bruce Friesen, former land and environment manager for Syncrude also spoke to the issue in an interview just prior to his retirement in 2007 when he said "Land reclamation is serious business involving serious money. It's not trivial—it is vital to the industry. We know that we can reclaim the mine sites we are developing. If we don't know how to do that, then we have no right to disturb the land." (Air Water Land 2007). Many Canadians would agree with Mr. Friesen.

RECOMMENDATIONS

The oil sands industry has created a monumental environmental liability in Northern Alberta by allowing the volume of MFT to continuously grow over four decades of mining. Efforts by the Alberta Government to hold the industry responsible for mitigating its waste have failed to achieve the necessary results. There are, however, steps that both industry and government can take to remedy the situation. The following actions could begin to bring about the change necessary to see responsible tailings management in the Alberta oil sands:

- Mine operators should invest in dry tailings technology and infrastructure to the extent necessary to be able to demonstrate an immediate and significant reduction in MFT inventories.
- Mine operators should provide full disclosure of tailings remediation costs in their asset retirement obligation reporting.
- The Alberta government should maintain and enforce the original targets for fines capture set by the tailings directive. Appropriate penalties should be applied to companies that fail to meet the targets.

- The ERCB should expand its tailings directive to cap legacy MFT inventories at the current volume and require mine operators to turn legacy volumes of MFT, under an aggressive schedule, into dry deposits.
- The Alberta Government should impose limits on the amount of bitumen each mine is allowed to produce annually. Production limits should be based upon tailings performance with the objective that no more MFT is produced in any given year than is reclaimed as solid deposits in the previous year. Bitumen production restrictions should be eased only after mine operators have met aggressive MFT inventory reduction milestones.
- The ERCB and Joint Review Panels should not approve any further mine applications that include end pit lakes as part of the mine reclamation strategy.
- In light of the considerable uncertainty over the environmental performance of EPLs, the Alberta government should require mine operators to provide detailed and viable alternative plans to treat and dispose of MFT destined for EPLs in the event the concept proves unviable. Such plans should be backed by security sufficient to see them implemented.
- The Alberta government should require that industry fully disclose to the public the estimates upon which the security that is held for oil sands mine reclamation is based.
- The Alberta government should commission an independent inquiry into the province's Environmental Protection Security Fund to determine if the security held in the fund is adequate to ensure full reclamation of oil sands mines, including tailings, and should make the results of the inquiry public.

If the companies operating in Alberta's oil sands are unable or unwilling to responsibly reclaim their mine tailings, the companies should forfeit both the social and the regulatory licenses they need to continue operating.

ACRONYMS

AERI	Alberta Energy Resources Institute (Now known as Alberta Innovates)
ATP	Alberta (or AOSTRA) Taciuk Process
AOSTRA	Alberta Oil Sands Research and Technology Authority
CHWE	Clark Hot Water Extraction
CT	Consolidated Tailings
BML	Base Mine Lake
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
EPL	End Pit Lake
ERCB	Energy Resources Conservation Board
EUB	Energy and Utilities Board, precursor to the ERCB
MFT	Mature Fine Tailings
NRCAN	Natural Resources Canada
PAHs	Polycyclic Aromatic Hydrocarbons

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