



2012 Tailings Management Assessment Report

Oil Sands Mining Industry

June 2013

ENERGY RESOURCES CONSERVATION BOARD

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Suite 1000, 250 – 5 Street SW

Calgary, Alberta

T2P 0R4

Telephone: 403-297-8311

Toll free: 1-855-297-8311

E-mail: Inquiries@ercb.ca

Website: www.ercb.ca

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1 Purpose

This document contains the Energy Resources Conservation Board's (ERCB) assessment of the oil sands mining industry's tailings management performance for the reporting period of July 1, 2010, to June 30, 2011, and for the reporting period of July 1, 2011, to June 30, 2012.

2 Regulatory Context

Large volumes of tailings are produced when bitumen is extracted from mined oil sands. These tailings consist of water, sand, silt, clay, and small amounts of residual bitumen. They are deposited either in man-made tailings ponds or in mined-out areas once mining has sufficiently advanced.

Tailings ponds are essential to the oil sands mining industry. They act both as settling basins to separate solids from the tailings streams and as holding areas from which water can be recycled back to the bitumen extraction process.

When tailings are discharged into a tailings pond, the sand tends to settle quickly; the sand forms beaches or it can be used to construct dikes to contain the fluid tailings. Some of the smaller particles in the tailings (silts and clays equal to or less than 44 micrometres in size) are captured in the dikes and beaches; any remaining smaller particles flow with the water into the pond to form fluid tailings. These smaller particles of silt and clay tend to remain in suspension and take decades to slowly settle, and even then only to a consistency of soft mud.

In their project applications, operators had proposed to convert their tailings ponds into deposits suitable for reclamation. However, operators failed to meet their performance commitments. The volume of fluid tailings, and the area required to hold fluid tailings, continued to grow, and the reclamation of tailings ponds was further delayed.

In 2009, the ERCB introduced *Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes*. The directive was introduced to slow the growing volumes of fluid tailings and the proliferation of tailings ponds. The directive requires a fundamental shift in operators' approach to tailings management: operators must commit resources to research, develop, and implement fluid tailings reduction technologies, and tailings management and progressive reclamation must become operational priorities that are integrated with mine planning and bitumen production activities.

Directive 074 is the ERCB's regulatory approach to tailings management, which will in the future be complemented by a broader Government of Alberta Tailings Management Framework that will provide policy to ensure that fluid fine tailings are reclaimed as quickly as possible and that current inventories are reduced. *Directive 074's* long-term objectives are to

- minimize and eventually eliminate the long-term storage of fluid tailings in the reclamation landscape,
- create a trafficable landscape at the earliest opportunity to facilitate progressive reclamation,
- eliminate or reduce the containment of fluid tailings in an external tailings disposal area during operations,
- reduce stored process-affected waste water volumes on site,
- maximize intermediate process water recycling to increase energy efficiency and reduce fresh water import,
- minimize resource sterilization associated with tailings ponds, and
- ensure that the liability for tailings is managed through the reclamation of tailings ponds.

3 Regulatory Requirements

Under *Directive 074*, each project must reduce its fluid tailings. Reduction is achieved by capturing fines from fluid tailings and depositing them in a dedicated disposal area (DDA) in a manner that facilitates subsequent reclamation of the DDA into a trafficable deposit.

The deposit must achieve a minimum undrained shear strength of 5 kilopascals (kPa) within one year of deposition and be ready for reclamation within five years after active deposition has ceased.

The fines that each project must capture are a percentage of the fines in its oil sands feed. The fines capture is in addition to the fines that are captured in dikes and beaches. With the release of *Directive 074*, fines capture requirements were to be phased in over a three-year period as shown in table 1.

Table 1 *Directive 074* annual fines capture requirements

Fines capture requirements (% of fines in oil sands feed)	Timing
20.0	July 1, 2010, to June 30, 2011
30.0	July 1, 2011, to June 30, 2012
50.0	July 1, 2012, to June 30, 2013, and annually thereafter

Some operators requested, and were granted, flexibility in meeting the annual fines capture requirements with the understanding that on a cumulative basis, and within a given time period, a project had to make up any shortfall in its annual fines capture requirements relative to the requirements of *Directive 074*.

4 Oil Sands Mining Industry

There are nine approved oil sands mining projects in the Athabasca oil sands deposit:

- Suncor Energy Inc. (Suncor)
- Syncrude Canada Limited (Syncrude)
 - Mildred Lake
 - Aurora North
- Shell Canada Limited (Shell)
 - Muskeg River
 - Jackpine
- Canadian Natural Resources Limited (CNRL) Horizon
- Imperial Oil Resources Ventures Limited (Imperial) Kearl Oil Sands Project (KOSP)
- Total E&P Canada Ltd. Joslyn North Mine
- Fort Hills Energy Corporation (FHEC)

Suncor, Syncrude, Shell, and CNRL are operating projects. In 2011 these projects mined over 520 million tonnes of oil sands and produced over 52 million cubic metres of bitumen.

The KOSP has been approved and production is expected to start in 2013. The Joslyn North Mine and FHEC projects have been approved, and construction of these projects is in its initial phases.

Under *Directive 074*, each project must develop a tailings management plan. The tailings management plan must include the research, development, and implementation of technologies for fines capture. While each project employs different fines capture technologies, most technologies are based on the principle of mixing fluid tailings with chemicals, additives, or flocculants to promote dewatering and depositing the mixture in a manner that allows it to consolidate and form a solid deposit. Dewatering can occur by a combination of mechanical, physical, or natural means.

5 Industry Performance

Table 2 shows the fines capture performance of the Suncor, Syncrude Mildred Lake, Shell Muskeg River, and Shell Jackpine projects for the reporting period of July 1, 2010, to June 30, 2011. As noted previously, the deposit must achieve a minimum undrained shear strength of 5 kPa within one year of deposition; therefore, table 2 also shows the fines capture performance after accounting for the strength of the deposit.

Table 2 Fines capture performance from July 1, 2010, to June 30, 2011

Project	Fines capture requirements ¹ (% of fines in oil sands feed)	Fines captured ² (% of fines in oil sands feed)	Fines captured—adjusted for strength (% of fines in oil sands feed)
Suncor	20.0	10.7	10.7
Syncrude Mildred Lake	9.2	17.7	17.7
Shell Muskeg River	8.5	1.9	1.9
Shell Jackpine	9.5	0.0	0.0

1. Fines capture requirements are based on the commitments that operators made as part of their tailings management plans.

2. Fines captured is the fines capture performance that the ERCB is prepared to accept based on the ERCB's assessment of an operator's reported performance.

Table 3 shows the fines capture performance of the Suncor, Syncrude Mildred Lake, Shell Muskeg River, and Shell Jackpine projects for the reporting period of July 1, 2011, to June 30, 2012. The strength of the deposit during this reporting period will not be assessed until the next tailings management assessment report.

Table 3 Fines capture performance from July 1, 2011, to June 30, 2012

Project	Fines capture requirements (% of fines in oil sands feed)	Accepted fines captured (% of fines in oil sands feed)	Fines captured – adjusted for strength (% of fines in oil sands feed) ¹
Suncor	30.0	8.5	n/a
Syncrude Mildred Lake	12.0	8.8	n/a
Shell Muskeg River	23.5	8.8	n/a
Shell Jackpine	15.5	0.0	n/a

1. The strength of the deposit will not be assessed until the next tailings management assessment report in 2015.

For the two reporting periods, the Syncrude Aurora North and CNRL Horizon projects were not required to capture fines.

Under *Directive 074*, each project is required to develop a measurement plan as part of its tailings management plan. The measurement plan must describe

- how oil sands feed, tailings streams, tailings ponds, and deposits will be sampled;
- how particle sizes equal to or less than 44 micrometres will be determined; and
- how fines capture will be determined.

Operators use different methods to sample, analyze, and determine their fines capture performance. As a result, a meaningful comparison of fines capture between projects is not possible at this time. However, to ensure a fair and appropriate regulatory response to an operator's fines capture performance, credible, accurate, and standardized methodologies for sampling, analyzing, and determining fines capture are necessary. As a result, the ERCB expects industry to investigate differences in methodologies and to develop a consistent industry-wide approach for sampling, analyzing, and determining fines capture. If the industry is unable to develop a consistent industry-wide approach, the ERCB will mandate specific standards.

5.1 Suncor

Suncor captures fines by combining its fluid tailings with flocculants and depositing the mixture in thin lifts (or layers) to allow the deposit to dewater and dry under ambient conditions. (Suncor refers to this process as mature fines tailings drying.) Following drying, additional lifts are added.

For the 2010/2011 reporting period, Suncor had a lower-than-expected fines capture performance, which it attributed to the following:

- Disruptions in the fluid tailings supply system—The dredge and pipeline system used to recover fluid tailings from Suncor's tailings ponds and to transport them for processing had operational issues.
- A shorter drying season and a lower drying rate—Treated fluid tailings are deposited in thin lifts to allow the material to dewater and dry, and to achieve the necessary strength requirements. Colder-than-expected temperatures, and drying rates reduced by problems with flocculent dosages and cell design, limited the quantity of the fluid tailings that could be processed.
- A higher strength requirement—Suncor's treated fluid tailings meet the strength requirements of *Directive 074*; however, for mine planning purposes, Suncor requires a higher deposit strength. The combined effect of a shorter drying season with a lower-than-expected drying rate limited the treated fluid tailings that could meet Suncor's strength objectives.
- Oil sands feed with a higher-than-expected fines content and higher bitumen production—Suncor's fluid tailings treatment system was unable to cope with the combination of an oil sands feed that had a higher-than-expected fines content and the higher bitumen production rate that Suncor was able to achieve during the reporting period.
- Size of DDAs—There was a lack of space for depositing treated fluid tailings due to delays in the construction of new and expanded DDAs.

In 2011, Suncor requested that the fines captured in its Pond 7 be included in its annual fines capture performance, which would increase its fines capture to 25.2 per cent. Pond 7 was operational in 2007 and consolidated tailings were deposited in 2009. Deposition of consolidated tailings has ceased and infilling of Pond 7 is expected to begin in 2022, with final reclamation planned for 2029. Only fines captured in DDAs are assessed when determining a project's fines capture performance. Suncor's request to have Pond 7 regulated as a DDA was denied, and the fines captured in Pond 7 were not considered as part of Suncor's 2010/2011 fines capture performance.

For the 2011/2012 reporting period, Suncor again had a lower-than-expected fines capture performance due to many of the same operational issues it encountered in the 2010/2011 reporting period; in particular, a lower-than-expected drying rate, the need for a higher deposit strength, and a lack of drying area. Suncor's lower-than-expected performance was also affected by its decision to process low-fines fluid tailings that were not part of its approved tailings management plan.

While Suncor's fluid tailings treatment technology shows promise, if Suncor is to meet its fines capture requirements, it will need to

- reduce drying times, which may include mechanical systems to enhance drying,
- increase fluid tailings treatment capacity to handle higher bitumen feed rates, and
- coordinate the mining and bitumen operations so that neither operation exceeds the capacity of the fluid tailings treatment system to meet Suncor's approved fines capture requirements.

The ERCB notes that Suncor has undertaken the following activities to further develop its fines capture technology:

- Reliability and availability of the fluid tailings dredge and pipeline has been improved.
- Work is underway to optimize the flocculent dosage to ensure maximum dewatering and to optimize the cell design and material deposition to ensure maximum drainage.
- Deposition studies have been undertaken to improve the utilization of available drying areas, including using pre-stripped areas as DDAs.
- Drying rate studies have been undertaken, including the use of mud farming to enhance drying and dewatering.
- A small pilot was operated to test centrifuging of froth treatment tailings.

5.2 Syncrude Mildred Lake

At its Mildred Lake project, Syncrude uses composite tailings (CT) technology to capture fines. CT is a mixture of coarse tailings sand, fluid tailings, and a small amount of gypsum. At Mildred Lake, the mixture is deposited beneath a cap of recycle water and fluid tailings.

For the 2010/2011 reporting period, Syncrude's fines capture at its Mildred Lake project was almost double its expected fines capture.

The captured fines deposited in a DDA must achieve a minimum undrained shear strength of 5 kPa within one year of deposition and be ready for reclamation within five years after active deposition has ceased. Syncrude's fines capture was based on the assumption that all the fines deposited in its DDA were captured and that the deposited fines would meet the 5 kPa requirement after one year.

Surveys of the fines deposited have indicated that about 80 per cent of the deposit has achieved a strength greater than 5 kPa. It is expected that with continued loading of the deposit, strength performance will improve. As a result, for the 2010/2011 reporting period, Syncrude's fines capture of 17.7 per cent is accepted without a reduction for a shortfall in the deposit's strength characteristics.

Syncrude has put forth arguments that its measurement techniques for fines capture identified more fines in oil sands than did the measurement techniques used by the other projects. As a result, Syncrude claims its fines capture should be increased to 22 per cent by using a fines-in-feed adjustment factor of 0.81. While Syncrude's claim may have merit, Syncrude has yet to provide adequate data to support its arguments. Syncrude's fines capture performance for the 2010/2011 reporting period does not include a fines-in-feed adjustment factor.

For the 2011/2012 reporting period, Syncrude had a lower-than-expected fines capture performance at its Mildred Lake project. The ERCB understands that the lower-than-expected recovery was attributed to a lack of coarse tailings sand to make CT and the poor reliability of the CT plant.

While CT has proven to be an effective fines capture technology, if Syncrude is to meet its fines capture requirements, it will need to

- improve the reliability of the CT plant;
- ensure that adequate coarse tailings sand is available at all times or that contingencies are in place when coarse tailings sand is unavailable; and
- accelerate the development of supplemental fines capture technologies, such as fluid tailings centrifugation, to offset any problems in CT production.

Despite the lower-than-expected fines capture performance of the 2011/2012 reporting period, the ERCB notes that Syncrude's cumulative fines capture performance over the two reporting periods has exceeded expectations. The ERCB also notes that Syncrude

- is testing deposition technology to improve its CT performance, and
- has initiated field tests of overburden mixing with fluid tailings and thin lift drying of fluid tailings.

At its Mildred Lake project, Syncrude is also developing fluid tailings centrifugation as a supplemental technology to capture fines. Fluid tailings centrifugation involves placing fluid tailings in a centrifuge where the water is spun out and a dewatered tailings is produced. The centrifuge product is then deposited in a DDA. A commercial demonstration of fluid tailings centrifugation began in 2012, and a full-scale commercial operation is expected to begin in 2015.

5.3 Shell Muskeg River

At its Muskeg River project, Shell uses atmospheric fines drying (AFD) technology to capture fines. AFD combines fluid tailings and flocculants and deposits the mixture in a sloped area to allow the water to drain and the deposit to dry.

For the 2010/2011 reporting period, Shell had a lower-than-expected fines capture performance, which it attributed to the following:

- Process and operational issues—The dredging equipment used to recover fluid tailings was subject to reliability and efficiency problems. The fluid tailings density could not be properly controlled, the treated fluid tailings could not be deposited in uniform lifts, and foaming process water lead to plant upsets.
- A shorter drying season—The AFD facility started operation later than planned and above-average rainfall hampered the atmospheric drying (evaporation) potential.
- Drying area—Operations were hampered by a lack of drying area.

At its Muskeg River project, Shell operates a tailings thickener to treat its flotation tails. The underflow from the thickener is deposited in an external tailings area along with the tailings from Shell's tailings solvent recovery unit. Shell requested that the fines captured in this deposit be included in its annual fines capture performance, which would increase its 2010/2011 fines capture to 11.7 per cent.

For the 2011/2012 reporting period, Shell had a lower-than-expected fines capture performance, though Shell continued to argue that it should be credited with the fines captured in its external tailings deposit, which would have yielded a higher-than-expected fines capture performance.

Shell's management of its thickened flotation tails and tailings from its tailings solvent recovery unit were not approved as part of Shell's tailings management plan, and the deposited tailings were not part of an approved DDA. Only fines captured in a DDA are assessed when determining a project's fines capture performance. The fines captured in Shell's thickened flotation tails and tailings from its tailings solvent recovery unit are not included in assessing Shell's 2010/2011 fines capture performance or its 2011/2012 fines capture performance.

While AFD technology shows promise, if Shell is to meet its fines capture requirements, it will need to

- add process flexibility to maintain operating schedules,
- mitigate the impacts of adverse weather conditions by modifying the DDA design to accommodate higher-than-expected rain volumes or by implementing mechanical dewatering and supplemental drying, and
- optimize the project's footprint to take advantage of existing disturbed areas for deposition, and make application for DDAs in time to accommodate tailings deposition needs.

Despite the lower-than-expected fines capture performance, the ERCB notes that Shell has addressed some of its operating problems:

- Equipment has been added to improve the reliability and availability of the fluid tailings dredge.
- The AFD process design was modified to improve density control, uniform lift deposition, and to prevent process-water foaming.

Shell has also tested mechanical mixing of the AFD deposit to reduce drying time, and it has tested the placement of untreated fluid tailings in a prestrip area to dry and be codisposed with the overburden.

5.4 Shell Jackpine

At its Jackpine project, Shell uses thickened tailings (TT) technology to capture fines. TT involves the use of a thickener with flocculents to produce a thickened tailings stream. The thickened tailings are deposited in a DDA.

For the 2010/2011 reporting period, Shell reported a higher-than-expected fines capture performance.

While Shell claims to have met its fines capture requirements, the performance of the thickener, the mixing of extraction tailings with the TT deposit, and measurement uncertainties raise questions concerning the reliability of Shell's TT technology and the validity of Shell's fines capture claims:

- The thickener did not perform as expected due to start-up problems and a design that could not accommodate a range of oil sands feed fines or varying process conditions. The quality of the TT was compromised and stable, long-term operation of the thickener could not be maintained.
- Extraction tailings and TT were discharged into Shell's DDA. This has led to a complex deposit of interlayered TT and extraction tailings in which it was difficult to confirm the fines captured by TT. Combining extraction tailings with TT was not part of Shell's approved tailings management plan for the Jackpine project.
- Limited sampling of the deposit and random measurement locations yield a high level of uncertainty concerning fines content, the fines capture within the entire deposit, and the strength of the deposit.

For the 2011/2012 reporting period, Shell had a lower-than-expected fines capture performance, which Shell attributed to the poor performance of its thickener.

Shell's TT technology has not proven effective at capturing fines, and Shell's management of its TT DDA deposit was not in accordance with the requirements of *Directive 074*. As a result, the ERCB cannot verify Shell's fines capture claims, and Shell is not credited with any fines capture over the 2010/2011 and 2011/2012 reporting periods. Provided Shell can resolve its operational, management, and measurement problems, Shell may be credited with fines capture in the future. Shell is expected to take measures to address the shortcomings of its thickener operation, ensure that the operation of its DDA is not compromised by the addition of extraction tailings, and conduct a credible measurement program to properly delineate the DDA deposit and determine both the deposit's fines content and strength characteristics.

6 Conclusions

Industry performance over the 2010/2012 reporting period has not met the original expectations of *Directive 074*. However, the ERCB notes that all operators have

- committed significant resources towards managing their tailings in accordance with the objectives of *Directive 074*,
- made material progress in developing and implementing fines capture technologies as part of their tailings management plans, and
- integrated tailings management with mine planning and bitumen production activities.

The fines capture performance indicates that the expectations of the ERCB and industry were optimistic. The commercial implementation of tailings management technologies will take longer than expected and performance will be lower than expected until operational problems are resolved.

Given the issues that industry has encountered, the ERCB does not believe that it would be appropriate to enforce compliance measures at this time. The ERCB has noted its concerns with operators' performance in this report and expects operators to take appropriate measures, as some have begun to do. If operators do not meet their tailings management performance expectations the ERCB will assess enforcement options at that time.

7 Regulatory Process

The ERCB will issue its next tailings management assessment report in 2015. The assessment report will be based on each project's approved tailings management plan and associated approval conditions. At this time, if operators do not meet their tailings management performance expectations the ERCB will assess enforcement options.

In the interim, the ERCB will continue to monitor industry performance, supported by annual industry reporting and ongoing dialogue, and it will assess enforcement options if critical milestones in an operator's tailings management plans are missed or if unacceptable management plans are submitted.

Directive 074 sets out the first industry-wide requirements for tailings management. *Directive 074* requires operators to commit resources to research, develop, and implement fluid tailings reduction technologies and to commit to tailings management and progressive reclamation as operational priorities that are integrated with mine planning and bitumen production activities.

The ERCB remains committed to the objectives and requirements of *Directive 074*, which will in the future be complemented by a broader Government of Alberta Tailings Management Framework that will provide policy to ensure that fluid fine tailings are reclaimed as quickly as possible and that current inventories are reduced.