Alberta Energy Regulator

State of Fluid Tailings Management for Mineable Oil Sands, 2022

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Suite 1000, 250 – 5 Street SW
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Telephone: 403-297-8311
Inquiries (toll free): 1-855-297-8311
Email: inquiries@aer.ca
Website: www.aer.ca

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Abbreviations

AEPN-E	Aurora east pit north-east
AEPN-W	Aurora east pit north-west
AEPS	Aurora east pit south
AER	Alberta Energy Regulator
AFD	atmospheric fines drying
ASB	Aurora settling basin
BML	base mine lake (used interchangeably with west in-pit)
CFFT	centrifuge fluid fine tailings
CNRL	Canadian Natural Resources Limited
CNUL	Canadian Natural Upgrading Limited
COSIA	Canada's Oil Sand Innovation Alliance
CST	coarse sand tailings
CT	composite tailings
DDA	dedicated disposal area
EETA	east external tailings area
EIP	east in-pit
EPEA	*Environmental Protection and Enhancement Act*
EPO	environmental protection order
eNST	enhanced nonsegregating tailings
esNST	enhanced spiked nonsegregating tailings
ETA	external tailings area
ETF	external tailings facility
FC	fluid cell
FFT	fluid fine tailings

ILF	in-line flocculation
IPA	integrated project amendment
IPC	in-pit cell
KFTT	Kearl fine tailings treatment
MAFD	modified atmospheric fines drying
MD9	mine dump 9
MD9S	mine dump 9 south
MLSB	Mildred Lake settling basin
Mm^3	million cubic metres
MSP	measurement system plan
NMSP	north mine south pond
NMSPE	north mine south pond east
NPD	north pool deposit
NRU	naphtha recovery unit
NST	nonsegregating tailings
OPTA	out-of-pit tailings area
OSCA	*Oil Sands Conservation Act*
PASS	permanent aquatic storage structure
RTR	ready to reclaim
SC	sand cell
SD	sand dump
SIR	supplemental information request
STP	south tailings pond
SWIP	south west in-pit
SWSS	south west sand storage

TMF	*Tailings Management Framework*
TMP	tailings management plan
TMR	tailings management report
TSRU	tailings solvent recovery unit
TSS	total suspended solids
TT	thickened tailings
TZ	transition zone
WETA	west external tailings area
WT	whole tailings

Executive Summary

Alberta has eight operating oil sands mines, and each site has an approved tailings management plan (TMP). Under *Directive 085: Fluid Tailings Management for Oil Sands Mining Projects*, mine operators must annually submit tailings management reports (TMR) that show how they are implementing their TMPs.

This report summarizes the information for the 2022 reporting year and assesses the operators' progress in managing fluid tailings. Operators continue to report improvements in their tailings treatment technologies and the piloting and development of new technologies.

Directive 085 requires TMPs to be updated to build on existing approval conditions and provide assurance that the *Lower Athabasca Region: Tailings Management Framework for Mineable Oil Sands* (*TMF*) outcomes can be achieved. Seven of the eight operating oil sands mines submitted TMP amendments in 2022 and 2023. These amendments are currently under review by the Alberta Energy Regulator (AER). The AER reviews TMPs to ensure tailings profiles align with projections and reflect current technology, new knowledge, and continuous improvement.

For management purposes, fluid tailings are categorized as legacy fluid tailings (fluid tailings stored before January 1, 2015) and new fluid tailings. The total volume of fluid tailings (new and legacy tailings combined) on oil sands mine sites in the Athabasca oil sands region increased between 2014 and 2022, apart from a slight decrease in 2021. The increase in the total regional volume of fluid tailings is expected based on approved tailings profiles. Despite this trend, the total regional volume for all operators of fluid tailings remains below their combined profiles of new and legacy fluid tailings.

The total volume of water in fluid tailings ponds in the Athabasca oil sands region varied from 2014 to 2022. From 2014 to 2017, the total volume of water in the tailings ponds decreased, then increased between 2018 and 2020. The total volume of water in tailings ponds in the region decreased from 2020 to 2022.

From 2014 to 2019, bitumen production increased, as did the number of operating mines. This was followed by a decrease in production in 2020 during the COVID-19 pandemic and the associated drop in global oil demand. Bitumen production increased from 2020 to 2022.

TMPs include volume profiles for both legacy and new fluid tailings. All operators were below their approved new fluid tailings profiles, total volume triggers, and total volume limits. All operators were also below their 20% deviation triggers for new and legacy fluid tailings. Syncrude Mildred Lake exceeded its legacy fluid tailings profile from 2017 to 2022.

There has been no change in management level, as described in *Directive 085*, required for Syncrude Mildred Lake because their volume is within the total allowable volume trigger and limit. The AER is

closely monitoring Syncrude Mildred Lake to ensure the reduction in its legacy fluid tailings inventory accelerates to meet the profile target.

In September 2022, the AER issued a notice of noncompliance to Imperial Oil Resources Limited (Imperial) under its *Environmental Protection and Enhancement Act* approval for Kearl for releasing industrial wastewater from its site and failing to manage and contain it. In 2023, the AER issued an environmental protection order to Imperial for the 2022 seepage event and a second event in 2023 of industrial wastewater overflow from a storage pond. The AER has initiated formal investigations for each of these incidents. The two investigations are ongoing, and the AER continues to review information gathered from the investigations to determine if treated tailings deposits are achieving subobjective 2 performance criteria. If the reviews indicate Imperial has not met and maintained its approved ready-to-reclaim (RTR) criteria, the AER will determine the appropriate management level to apply to Imperial and the management responses.

The tailings volumes presented in this report are as reported by the operators. The AER requested clarification or additional data from all operators relating to their 2022 TMRs. The AER has not received or completed reviews of all responses before finalizing this report. Requests for clarification or additional data are part of an ongoing iterative process between the AER and operators. Operators require time to collect data, complete analyses, or review calculations before submitting responses to the AER. This report only includes information that was available at the time of writing. Further review of those responses and the fluid tailings volumes, including assessing if they meet RTR criteria, may lead to changes in the reported data or analyses from previous years and will be reflected in the 2023 report.

Operators are required to submit measurement system plans (MSPs) showing how they measure and report fluid tailings volumes and the performance of their tailings deposits. The AER completed assessments of the MSPs submitted by the operators related to determining whether the physical properties of the tailings deposits are on a trajectory to support future stages of activity (subobjective 1 in *Directive 085*, fluid tailings volumetric calculations, laboratory testing).

The AER continues to assess MSPs to address the need to minimize the effect the tailings deposit has on the surrounding environment and ensure the deposit will not compromise the ability to reclaim the area to a locally common, diverse, and self-sustaining ecosystem (subobjective 2). The AER has assessed the groundwater monitoring portion of subobjective 2 in *Directive 085* as it relates to water quality characterization and the measurement of chemicals of potential concern.

In 2022, the AER issued a notice to oil sands mining operators clarifying the *Directive 085* water quality characterization and reporting requirements for tailings surface water. Because of this guidance on reporting requirements, operators were required to submit updated MSPs. The AER is currently reviewing these updated MSPs.

The water quality parameters specified in the notice apply to water overlying treated tailings deposits and fluid tailings ponds. The sampling and characterization are included in the 2022 TMRs.

The AER may issue additional supplemental information requests in the future. The tailings MSPs are live documents that must be regularly updated with changes to reflect current best practices and operations. Operators must notify the AER of all MSP changes.

1 Introduction

The Alberta Energy Regulator (AER) regulates oil sands mines and the associated management of fluid tailings as part of its mandate to ensure the safe, efficient, orderly, and environmentally responsible development of energy resources over the entire development life cycle.

This report summarizes information submitted by oil sands mine operators in their annual tailings management reports (TMRs).

An approved tailings management plan (TMP) and a measurement system plan (MSP) are required for the AER to assess the data in an operator's annual TMR. Both are required for the AER to assess fluid tailings inventory data as they allow for the determination of what volumes are considered ready to reclaim (RTR) and can be removed from the operator's fluid tailings inventory. Operator reports for 2022 must adhere to all reporting requirements in *Directive 085*: *Fluid Tailings Management for Oil Sands Mining Projects* and to conditions in each operator's tailings approvals.

The AER completed assessments of the MSPs submitted by the operators related to determining whether the physical properties of the tailings deposits are on a trajectory to support future stages of activity (subobjective 1 in *Directive 085*, fluid tailings volumetric calculations, laboratory testing). In addition, the AER assessed the groundwater monitoring portion of subobjective 2 in *Directive 085*—the need to minimize the effect the tailings deposit has on the surrounding environment to ensure it will not compromise the ability to reclaim the area to a locally common, diverse, and self-sustaining ecosystem. The AER continues to assess MSPs to address water quality characterization and measurement of chemicals of potential concern, which are part of subobjective 2.

The tailings MSPs are live documents that must be regularly updated with changes to reflect current best practices and operations. Operators must notify the AER of all plan changes. All operator MSPs are posted on the AER's website under By Topic, Tailings. The AER may issue additional supplemental information requests (SIRs) in the future.

The fluid tailings volumes described in this report are presented as reported by operators and are subject to change upon further review of fluid tailings volumes, including assessment of whether they meet RTR criteria.

Annual TMRs submitted by operators are reviewed by the AER. This review may lead the AER to request further clarification or additional information from an operator. In addition, potential compliance issues are referred to the AER's Compliance and Liability Management team.

Information provided by the operators for 2022, upon further review by the AER after the publication of this report, may lead to changes in the data. Any changes will be incorporated into the 2023 edition of this report, which will be issued by October 30, 2024.

2 Purpose

The purpose of this report is to summarize information from individual operators based on *Directive 085* requirements, including

- fluid tailings volumes for each operator and the region;
- water volumes stored in tailings facilities for each operator and the region;
- tailings volumes claimed as having reached RTR status;
- whether operators are within their approved fluid tailings profiles;
- site-wide fluid tailings management activities for each mine site;
- tailings treatment and developing treatment technologies;
- project-specific performance;
- progress made in managing fluid tailings; and
- alignment with the approved TMPs.

This report also includes a summary of the AER's regulatory and management actions taken in 2022 relating to fluid tailings.

This report does not address mine financial security, waterfowl protection, dam safety, or air emissions from tailings ponds. Information on these issues can be found on the AER website (www.aer.ca) or the Alberta Environment and Protected Areas oil sands information portal (http://osip.alberta.ca/). This report does not include information on audits or inspections conducted by the Compliance and Liability Management team or information reported on the AER Compliance Dashboard. However, it does include a summary of the 2022 tailings-related regulatory site inspections (see appendix 2).

3 Regulatory and Operational Context

3.1 Regulatory Context

On March 13, 2015, the Government of Alberta released the *Lower Athabasca Region: Tailings Management Framework for Mineable Oil Sands* (*TMF*) to manage and decrease liability and environmental risk from the accumulation of fluid tailings on the landscape. The *TMF*'s goal is to "increase the rate of reclamation and enhance the reduction of tailings ponds" and establishes the following policy outcomes:

- land use must be returned to Albertans
- sustainable ecosystem (after reclamation)
- liability is minimized to Albertans
- environmental effects are managed

In support of the *Lower Athabasca Regional Plan*'s strategic direction of "encouraging timely and progressive reclamation," the *TMF* provides guidance and an objective for managing fluid tailings so that both new and legacy tailings can be reclaimed in a timely manner. The *TMF* objective states that fluid tailings accumulation be minimized by ensuring fluid tailings are progressively treated and reclaimed during the life of an oil sands mining project and by ensuring that all a project's fluid tailings are RTR within ten years of the project's end-of-mine life.

On July 14, 2016, the AER released *Directive 085* under the *Oil Sands Conservation Act (OSCA)*, replacing *Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes*. *Directive 085* enables implementation of the *TMF* and aligns with the *Lower Athabasca Regional Plan*. It also sets out new application and performance reporting requirements for fluid tailings management. On October 12, 2017, the AER updated *Directive 085* to clarify compliance and enforcement, public education and awareness, and the review cycle. The AER updated *Directive 085* on May 19, 2022, to address the publication date for the annual performance report on the state of fluid tailings management.

3.2 Operational Context

Eight oil sands mining projects were operating in 2022:

- Suncor Energy Incorporated (Suncor) Base Plant, which includes the Millennium and North Steepbank mines
- Syncrude Canada Limited (Syncrude) Mildred Lake
- Syncrude Aurora North
- Canadian Natural Upgrading Limited (CNUL) Muskeg River mine
- CNUL Jackpine mine
- Canadian Natural Resources Limited (CNRL) Horizon
- Imperial Oil Resources Limited (Imperial) Kearl
- Suncor Fort Hills

The locations of operating and approved oil sands mining projects and their tailings ponds are shown in figure 1. The approvals for the Teck Resources Ltd. Frontier oil sands mine were cancelled in April 2023.

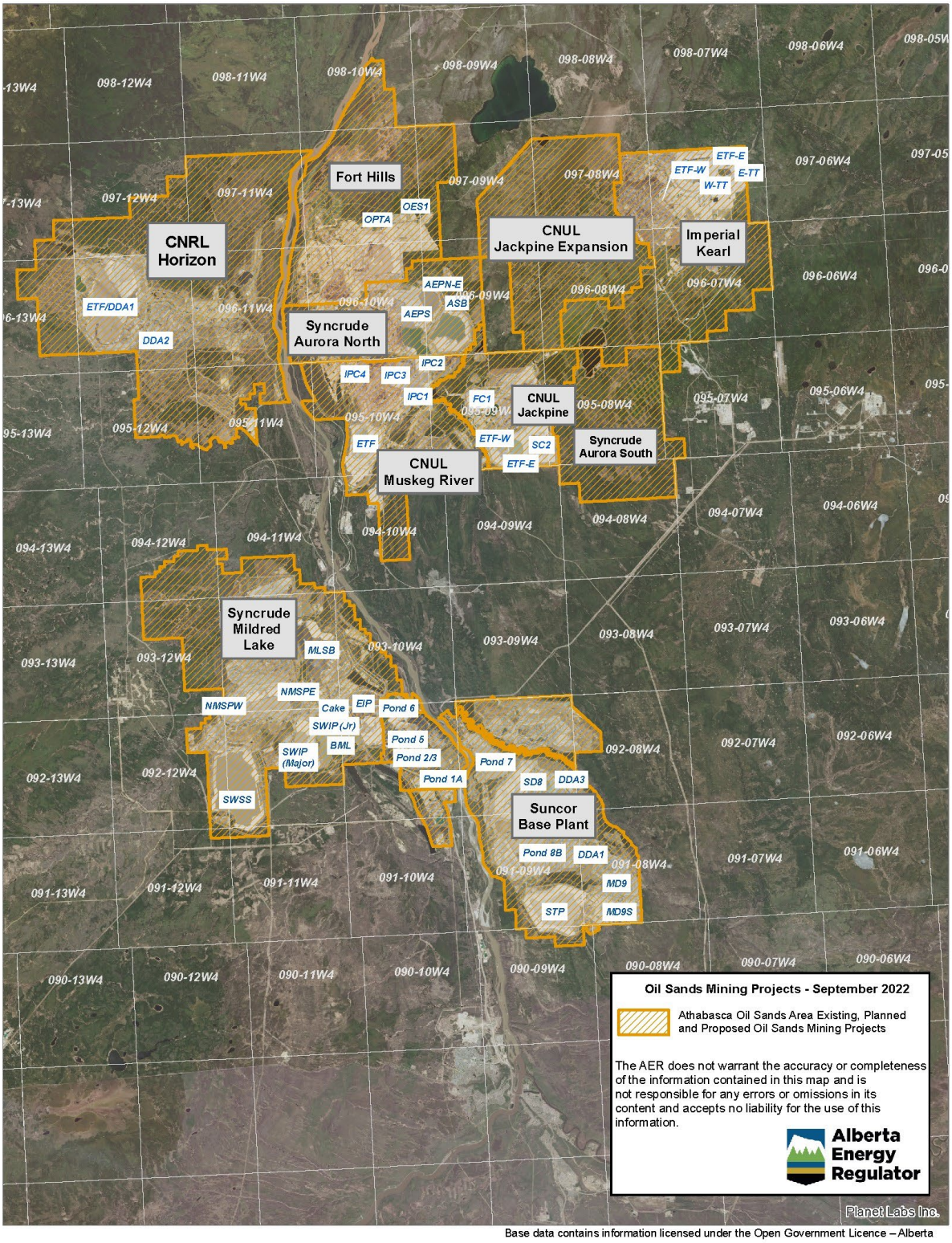


Figure 1. Operating and approved oil sands mining projects and tailings ponds/deposits in 2022

4 2022 Reporting

The AER requires operators to report on the status of fluid tailings management at their sites by April 30 of each year in accordance with *Directive 085*. For most operators, 2022 marked the sixth year for submitting annual TMRs. It was also the fourth year where all operators were required to meet full reporting requirements under *Directive 085* and their conditions of approval. Operator submissions for 2022 were made available on the AER website on May 30, 2023, under By Topic, Tailings.

In 2020, the AER directed the operators to provide the previous year's measured tailings and fluid volumes in the format specified by the AER. Operators were allowed to select the year-end date of their choosing for the measured volumes they report. Operators must notify the AER before the end of the reporting year to change the year-end reporting date. Tailings and fluid volumes in this report are as-measured volumes beginning in 2019 unless otherwise stated.

4.1 2022 Report Review

As part of its review of annual tailings reports submitted by operators, the AER assessed the reported progress in 2022 for fluid tailings management, including achieving RTR status, trends over time, consistency with previous annual TMRs, and compliance with approval conditions. The intent of the review is to ensure

- operators are implementing their approved fluid TMP, including confirming that conditions related to fluid tailings management are being met and stated milestones are being achieved;
- fluid tailings performance is in accordance with their profiles;
- fluid tailings performance is in accordance with volume triggers and limits;
- fluid tailings management level for each operation is identified;
- fluid tailings deposits are meeting RTR criteria and are on the applicable trajectory; and
- initiated mitigation actions and contingency plans are effective in managing fluid tailings and treated tailings deposit performance.

All oil sands mining operators had an approved TMP by the end of 2019.

4.2 Ready-to-Reclaim Criteria and Trajectory

Operators were required to identify volumes of treated fluid tailings that met RTR criteria in 2022. The *TMF* and *Directive 085* both require that the progress of fluid tailings and treated fluid tailings be tracked from the initial formation (accumulation) through to the initial RTR state and stay on a trajectory that remains in its approved RTR state. RTR criteria are used to track treated tailings during the operational stage of the deposit's trajectory to ensure the deposit can be reclaimed as predicted in the life-of-mine closure plan. Progress of fluid tailings to an RTR state includes processing with an accepted technology,

placing tailings in their final position on the landscape, and achieving the approved RTR performance criteria.

In the 2022 reports, operators reported the treated tailings volumes that achieved RTR status during the reporting period and confirmed that treated tailings in deposits continued to meet the RTR trajectory approval conditions. Operators are required to identify any volumes returned to the fluid tailings inventory. The tailings volumes in this report are presented as reported by the operators and subject to change upon further review of fluid tailings volumes and performance related to meeting RTR criteria.

Under *Directive 085* and the *TMF*, the AER is tasked with evaluating regional performance against the *TMF*'s outcomes and objectives. Future AER reports on tailings management will incorporate a summary evaluation of environmental effects and reclamation performance reporting, which may include references to other required reports (e.g., *Environmental Protection and Enhancement Act* [*EPEA*] reports) and links to *EPEA* and reclamation regulations.

4.3 Environmental Performance Monitoring

Directive 085 requires operators to summarize environmental performance monitoring reports highlighting the operator's management of environmental effects and the potential impacts of fluid tailings management activities.

The AER assesses the groundwater monitoring portion of subobjective 2 in *Directive 085,* which considers fluid tailings management activities and deposit performance concerning approved RTR criteria and alignment with the closure and reclamation trajectory.

The AER may allow operators to refer to other submitted reports (e.g., reclamation progress tracking report, groundwater monitoring report, industrial wastewater monitoring report) to avoid duplicate reporting of performance results for managing and minimizing environmental effects and the implications of fluid tailings management activities. Reporting under *Directive 085* does not relieve an operator from complying with other tailings-related environmental reporting requirements.

Some of the 2022 TMRs refer to other *EPEA* environmental reports or provide information from these reports. Consequently, the AER must complete further reviews to verify the additional reported data and information in the referenced reports. This review of the referenced reports is not part of the evaluation of volumetric measurements for fluid tailings and treated fluid tailings management activities in 2022.

For more information about surface water management, tailings seepage control, and groundwater monitoring concerning subobjective 2, see the operator 2022 TMRs.

Operators are required to report the characterization and quality of water for each treated tailings deposit and fluid tailings pond. In 2022, the AER issued two letters to oil sands mining operators clarifying the *Directive 085* water quality characterization and reporting requirements. The "Notice of Reporting

Requirement Clarification Directive 085 – Fluid Tailings Management Reporting Requirements Water Quality Characterization and Reporting" letter dated February 23, 2022, and the June 28, 2022, "Directive 085 Reporting Requirement Clarification – Water Quality Characterization," letter providing further clarification. The notice provided the following guidance on how operators are to characterize tailings surface water quality:

- The AER specified the chemical and physical water quality parameters to be reported for each treated tailings deposit and fluid tailings pond. Operators must report these parameters at environmentally relevant detection limits and at a frequency to appropriately capture seasonal and temporal variation.
- Each operator was to update and resubmit its MSPs with details of the water quality sampling methods, locations, and frequency.
- The sampling and characterization are to be included in the TMRs.

The water quality parameters specified in the notice apply to water overlying treated tailings deposits and fluid tailings ponds. The sampling and characterization were included in the 2022 TMRs to help the AER evaluate tailings surface water quality. Consistency in reporting across all sites will help the AER evaluate the quality of recycle water contained in tailings ponds.

For details of sampling and analytical methods, the parameters analyzed, and the sample test results for each treated tailings deposit and fluid tailings pond, see the operator 2022 TMRs.

4.4 Next Steps

Where the AER identified gaps or areas requiring clarification in the submitted 2022 TMRs, the AER followed up with the operators, requesting clarification or more information. These follow-ups may lead to data corrections, changes in the RTR status of treated tailings in a deposit, or changes in the fluid tailings inventory. Requests for clarification or additional data are part of an ongoing iterative process between the AER and operators. This report only includes information that was available at the time of writing.

The 2023 report will include any changes to individual company statuses resulting from responses to requests for clarification or information that was unavailable at the time of writing this report.

Changes in the RTR status of a deposit may warrant mitigation or corrective action, and changes in the fluid tailings inventory may warrant additional fluid tailings management responses.

The MSP is a live document that must be regularly updated with changes to reflect current best practices and operations. Operators are required to notify the AER of all plan changes. All operator MSPs are posted on the AER's website under By Topic, Tailings.

A process and schedule are being prepared for audits of the tailings reports in upcoming years. The AER will audit the measurement systems and include the results in the annual *State of Fluid Tailings Management for Oil Sands* report.

5 Tailings Description

About 20% of Alberta's oil sands reserves are recoverable by surface mining using trucks and shovels to excavate oil sands. The oil sands are transported to an extraction plant, where bitumen is separated from the sand. In 2022, mined bitumen accounted for 49% of total bitumen production in Alberta. This bitumen can be sold as a product or upgraded to synthetic crude oil or other products, which are either used on site or sold.

Tailings are a by-product of the process used to extract bitumen from mined oil sands. Tailings are a mixture of sand, clay, water, silt, residual bitumen and other hydrocarbons, salts, and trace metals. During the early stages of mine operations, tailings are deposited into constructed aboveground (out-of-pit) structures called external tailings ponds. Once a mined-out area (pit) becomes available, tailings are stored in these mined-out areas (in-pit tailings ponds). Tailings ponds act as a settling basin to separate the water from tailings and a holding area from which water can be removed and recycled to the bitumen extraction process.

Directive 085 defines fluid tailings as any fluid discard from bitumen extraction facilities containing more than five mass per cent suspended solids and having less than an undrained shear strength of five kilopascals. Any liquid containing less than 5% solids is considered ponded water. See *Directive 085*, appendix 1, for definitions of tailings management terminology.

The particles in a tailings pond settle out of the water at different rates. Sand particles tend to settle quickly. However, smaller particles of clay and silt (i.e., fines), 44 micrometres in diameter or less, tend to remain suspended in the water for long periods, forming fluid tailings. Without intervention, fluid tailings can take decades to settle, which makes managing fluid tailings an ongoing challenge for the oil sands mining industry.

Tailings generated as part of the mining and bitumen extraction process must be managed in accordance with *Directive 085* and the conditions in the operators' approvals.

6 Fluid Tailings Treatment and Deposition

Oil sands mine operators use various technologies to treat fluid tailings, with some operations using multiple technologies. Development and implementation of new technologies and continuous improvement of existing technologies are very important for the successful management of fluid tailings in the oil sands mining industry. The ability to successfully reclaim to target ecosites is also affected by the deposit design and operation, including the size and depth of the deposit, and the capping design, both

of which are reflected in the RTR trajectory. A summary of the treatment technologies and typical treated tailings deposits from the TMPs is included in appendix 1.

The initial uncertainties and risks associated with the in-deposit performance of demonstration technologies, including treated fluid tailings deposit capping, are described in the *Directive 085* decision reports on the AER website. Operators must obtain regulatory authorization before implementing a new tailings treatment technology or constructing a deposit not already included in the current approval.

7 Regional Fluid Tailings Status

Data in this report are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted by the operators. The tailings volumes are subject to change upon further review of fluid tailings volumes, including assessing whether they meet RTR criteria.

The total volume of fluid tailings in the Athabasca oil sands region, including new and legacy fluid tailings, increased between 2014 and 2022, apart from a slight decrease in 2021. This overall increase is expected based on the new and legacy profiles in the operator TMPs approved by the AER.

Total fluid tailings volumes increased from 1075 million cubic metres (Mm^3) in 2014 to 1392 Mm^3 in 2022 (see figure 2 and appendix 3). An aggregate of new and legacy profiles for all operators in each year is included in figure 2. The aggregate of approved fluid tailings volume profiles for all operators by year is shown for comparison. From 2015 to 2022, the reported total volume of fluid tailings in the Athabasca oil sands region was below the aggregate of approved tailings profiles.

Figure 2 and figure 3 present fluid tailings inventory volumes as reported by the operators. Treated fluid tailings volumes identified by the operators as having met RTR status are not included in these volumes.

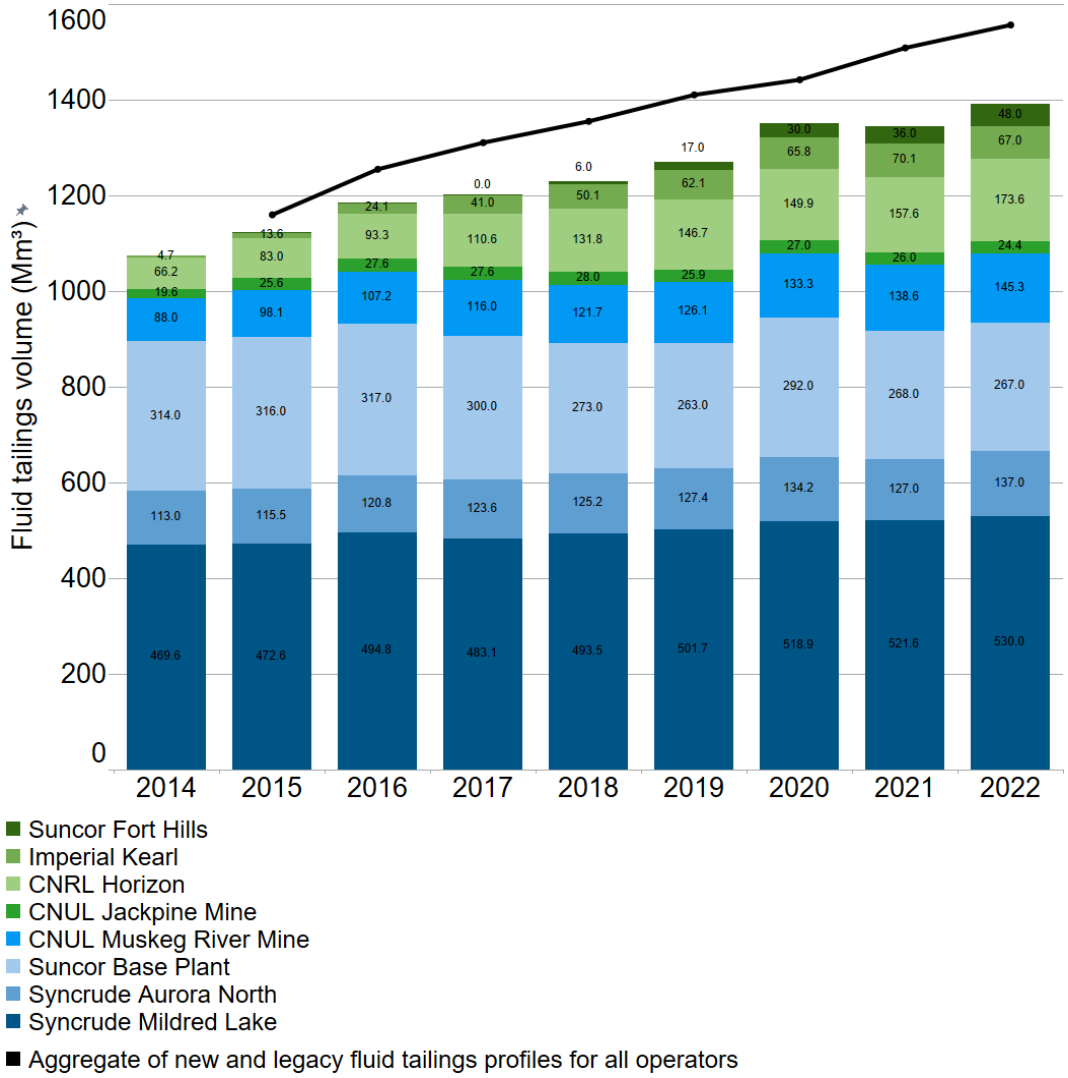
The annual change in fluid tailings volume is the volume of fluid tailings for that reporting year minus the previous year's volume of fluid tailings. Each bar in figure 3 represents the volume of fluid tailings added or removed from the regional inventory in a reporting year. The volume of fluid tailings produced exceeded the volume of tailings reported by industry as achieving RTR status from 2015 to 2022, apart from 2021.

In 2021, the volume of tailings reported by industry as achieving RTR status (i.e., tailings which could be removed from the fluid tailings inventory) exceeded the volume of fluid tailings produced. Modified RTR criteria were approved and applied to the 2021 volumes at Suncor Base mine, contributing to the negative change in fluid tailings volumes reported for 2021.

The reported annual change in volume of fluid tailings in the Athabasca oil sands region increased from a low of −6.2 Mm^3 in 2021 to 47.4 Mm^3 in 2022 (see figure 3). The highest annual change in the regional fluid tailings volume was 81.2 Mm^3 in 2020.

Bitumen production increased from 60.2 Mm³ in 2014 to 93.9 Mm³ in 2022.

Regional fluid tailings volumes were expected to increase in 2022 based on the new and legacy profiles in the TMPs approved by the AER.

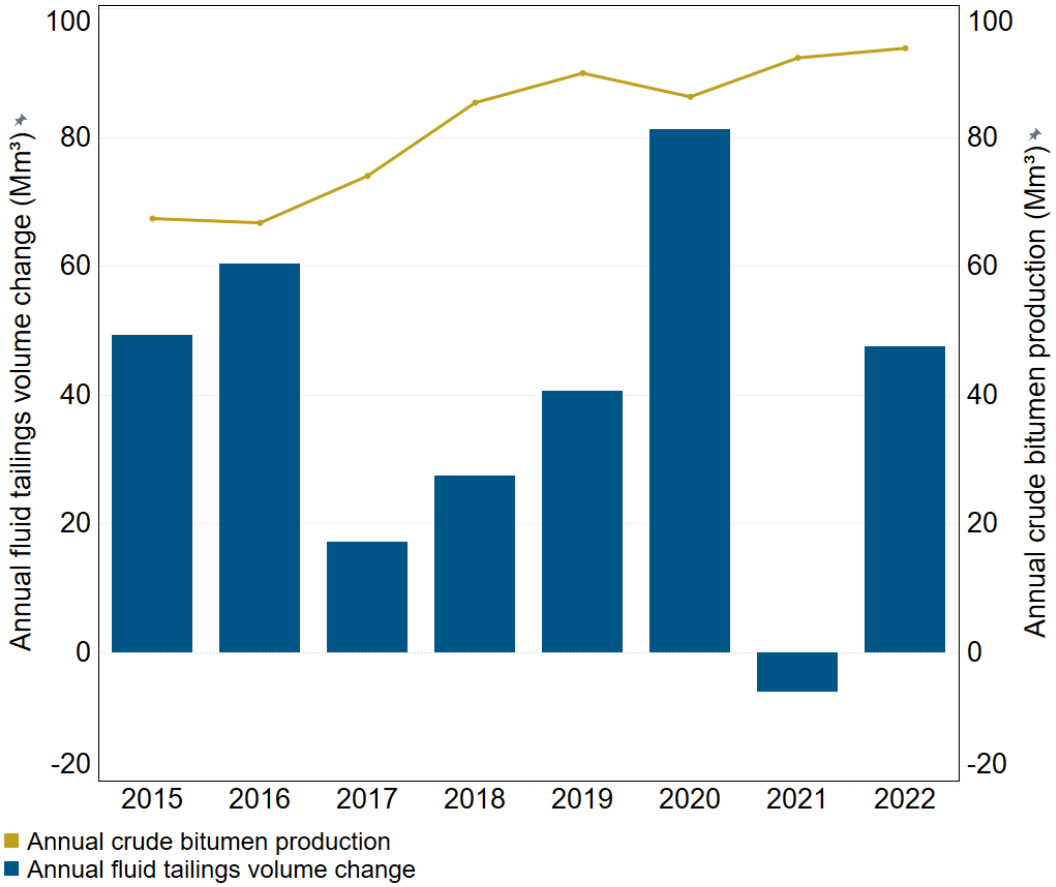


Note: Fluid tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of Directive 085) submitted annually by operators.

In 2018, Syncrude Aurora North and Mildred Lake data are as-measured values, not projected to year-end. Data are as-measured values starting in 2019, except for Imperial Kearl, which provided year-end predicted values for 2019.

Figure 2. Regional fluid tailings volumes and approved aggregate profiles, 2014 to 2022



Note: Fluid tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators. In 2018, Syncrude Aurora North and Mildred Lake data are as-measured values, not projected to year-end. Data are as-measured values starting in 2019, except for Imperial Kearl, which provided year-end predicted values.

Figure 3. Change in annual fluid tailings volume in the Athabasca oil sands region, 2015 to 2022

7.1 Fluid Tailings Treatment and Deposition

The reported volumes of treated fluid tailings produced each year by oil sands operators are shown in table 1. Treated tailings volumes cannot be combined between technologies or sites because of differences in technologies, deposit designs, deposit sizes, in-deposit performance of similar technologies, and differences in closure techniques or target ecosites.

The reported treated fluid tailings volumes do not necessarily equal the volume of treated fluid tailings in deposits meeting approved RTR criteria in the TMRs. The treated fluid tailings volume is a measure of the volume of fluid tailings to which a treatment technology is applied. The volume of treated tailings in a deposit meeting approved RTR criteria is based on the annual measurements of tailings deposit performance.

Due to uncertainties in technology efficacy and deposit performance, uncertainties in capping techniques and capabilities, and uncertainties for deposits to support target ecosites, most RTR criteria require

additional monitoring, modelling, and assessments to prove capabilities and assure accuracy and reliability. Accordingly, future updates to RTR criteria are expected and may result in changes to volumes of treated fluid tailings reported as achieving RTR status.

Table 1. Treated fluid tailings volumes reported by operator, 2014 to 2022, in million cubic metres (Mm^3)

Project	Technology	2014	2015	2016	2017	2018	2019	2020	2021	2022
Suncor Base Plant	Thin-lift drying	11.7	14.8	9.9	18.5	14.0	0.0	0.0	0.0	0.0
	Permanent aquatic storage structure	0.0	0.0	0.0	0.0	14.0	26.7	25.0	21.2	22.0
	Coke capping mitigation	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0
Suncor Fort Hills	To be determined						0.0	0.0	0.0	0.0
Syncrude Mildred Lake	Composite tailings (CT)	5.7	4.9	0.3	2.4	2.1	5.0	0.6	0.0	0.0
	Centrifuge	2.7	4.1	6.0	6.7	6.4	3.8	3.4	5.0	2.6
	Floc-T Plant									1.1
Syncrude Aurora North	CT	5.0	10.9	11.8	13.7[a]	16.3[a]	23.9	4.7	0.0	2.2
CNUL Muskeg River mine[b]	Thin-lift drying	3.9	0.9	0.1	0.0	0.0	1.3	3.6	6.2	5.9
	Fluid fine tailings drying at mine advance area	0.2	0.3	n/a	0.0	0.0	0.0	0.0	0.0	0.0
	CT	0.3	1.3	n/a	0.0	0.0	0.0	0.0	0.0	0.0
	Thickened tailings (TT)	15.1[c,d]	13.6[c,d]	19.4[d]	22.5[e]	22.9	13.0	27.0	24.4	21.7
CNUL Jackpine mine	Centrifuge	1.1	3.9	3.9	2.3	2.2	2.1	1.4	2.6	2.2
	TT	16.4[c,f]	12.6[c,f]	17.5[f]	19.7[g]	16.4	16.3	15.8	12.5	12.9
CNRL Horizon	Nonsegregating tailings (NST)	0.0	7.7[h]	48.7[h]	62.7[h]	131.8	156.3[h]	139.3	125.8	149.9
	Naphtha recovery unit (NRU)	0.0	0.0	0.0	0.0	17.2	20.8	18.6	16.5	17.8
	Enhanced spiked nonsegregating tailings (esNST)	0.0	0.0	0.0	0.0	0.0	1.1	1.5	2.6	4.5
Imperial Kearl	TT	0.0	0.0	2.4[i]	8.5	8.7[i]	13.6	19.0	26.0	28.0

Note: Volumes cannot be added together between technologies or sites because of the differences in technologies and differences in performance of similar technologies at different sites.

[a] Volume of CT slurry volume and CT beach deposit. Revised from CT beach deposit only reported in 2017.

[b] TT combined with coarse sand tailings, whole tailings, and tailings solvent recovery unit material in a single deposit forms NPD type.

[c] Updated in April 2017 submission.

[d] Volume of TT slurry at solids content of average 23.6% from 2014 to 2016.

[e] Volume of TT slurry at solids content of 21.9% in 2017.

[f] Volume of TT slurry at solids content of average 15% from 2014 to 2016.

[g] Volume of TT slurry at solids content of 13.7% in 2017.

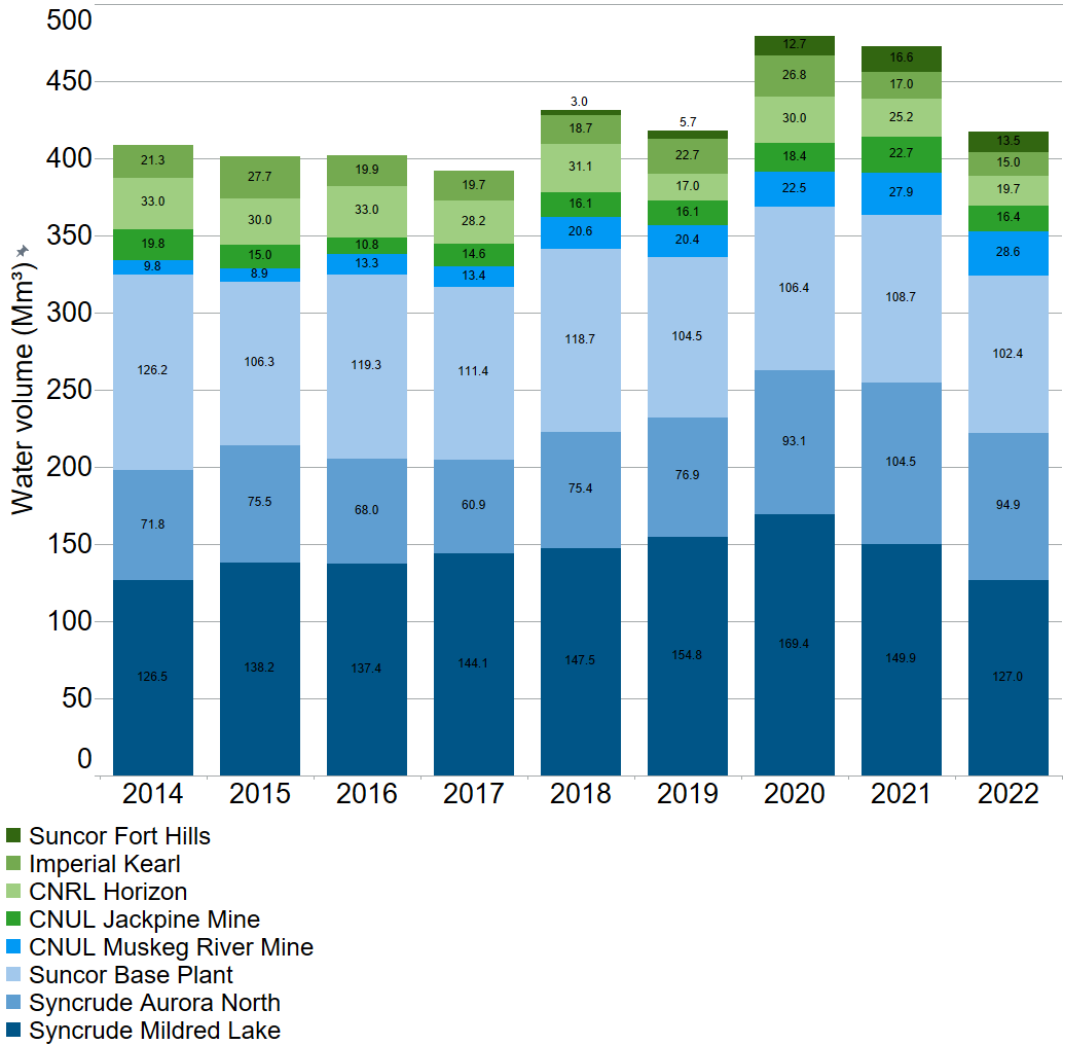
[h] Volume of NST.

[i] Volume of TT in deposit after secondary chemical treatment.

7.2 Water Volumes

Based on the data reported by operators from 2014 to 2022, the volume of water contained in tailings ponds and deposits in the Athabasca oil sands region ranged from a low of 392.3 Mm^3 (2017) to a high of 479.3 Mm^3 (2020). The water volume decreased to 417.5 Mm^3 in 2022 (see figure 4 and appendix 4). The increased ponded water volumes in 2020 compared with other years may have resulted from increased precipitation in the Athabasca oil sands region falling on the mine sites and ending up in the recycle water ponds. The 2022 pond water volume appears consistent with those from 2014 to 2019, likely resulting from using recycle water and the average regional rainfall for 2021 and 2022.

The water volumes are subject to change upon further review of pond and deposit volumes by the AER.



Note: Water volumes are presented as reported by operators and are subject to change upon further review by the AER.

Figure 4. Ponded water volume in tailings ponds, 2014 to 2022

8 Fluid Tailings Status

8.1 Suncor – Base Plant

In 2022, 11 tailings facilities were operating at Suncor Base Mine (see table 2). The tailings facilities vary in their primary function, contents, and size.

Table 2. Tailings facilities operating at Suncor Base Plant

Facility	Function	Contents
Pond 1A	• fluid and solid tailings storage • water recycle	• coarse sand tailings (CST) • fluid tailings
Pond 2/3	• fluid and solid tailings storage • water recycle • froth-treated tailings deposition	• froth-treated tailings • fluid tailings
Pond 5	• fluid and solid tailings storage	• fluid tailings • CST • CT • coke
Pond 6	• fluid and solid tailings storage	• fluid tailings • CST • CT
Pond 7	• fluid and solid tailings storage • water recycle • froth-treated tailings deposition	• froth-treated tailings • fluid tailings • CST • CT
Pond 8B	• fluid and solid tailings storage	• fluid tailings • CST
Dedicated disposal area 1 (DDA1)	• fluid and solid tailings storage and treatment	• fluid tailings • CST
DDA3	• fluid and solid tailings storage and treatment	• fluid tailings • CST
South tailings pond (STP)	• ongoing tailings deposition • water recycle	• fluid tailings • CST
Sand dump 8 (SD8)	• ongoing tailings deposition	• fluid tailings • CST
Mine dump 9 / mine dump 9 south (MD9/MD9S)	• solid tailings deposition and treatment	• overburden • treated fluid tailings

Suncor Base Plant reported using its permanent aquatic storage structure (PASS) technology in which fluid tailings from the STP are treated with a coagulant and flocculant before placement in DDA3. Co-deposition of fluid tailings into MD9/MD9S was reportedly not used in 2022.

Suncor Base Plant treated 22 Mm^3 of fluid tailings as per its treatment commitments in its TMP.

Suncor Base Plant reported that its new and legacy fluid tailings inventories for 2022 were within the approved fluid tailings profiles.

8.1.1 Fluid Tailings

For 2022, Suncor Base Plant reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 267 Mm³, down from 268 Mm³ in 2021.

Volumes reported for 2022 fall within currently approved profiles for new and legacy fluid tailings inventories.

For 2022, Suncor Base Plant reported that 95.6 Mm^3 of fluid tailings met its approved RTR criteria, up from 84.2 Mm³ in 2021.

The RTR status requires Suncor Base Plant to meet the approved subobjective 1 and 2 criteria (see table 3), which are included in appendix C to *OSCA* approval 8535S.

Table 3. RTR criteria for Suncor Base Plant

Deposit	Subobjective	RTR Criteria
Pond 5	subobjective 1	Capping with coke and the installation of vertical strip drains is complete in 2019
	subobjective 2	Surface water and seepage: The closed-circuit water management system is operating as designed Groundwater is monitored as required by *EPEA* approval 94-03-00, as amended or renewed
Pond 6	subobjective 1	Pond 6 mitigation is complete by December 31, 2028
	subobjective 2	Surface water and seepage: The closed-circuit water management system is operating as designed Groundwater is monitored as required by *EPEA* approval 94-03-00, as amended or renewed
Pond 7	subobjective 1	Pond 6 mitigation is complete by December 31, 2033
	subobjective 2	Surface water and seepage: The closed-circuit water management system is operating as designed Groundwater is monitored as required by *EPEA* approval 94-03-00, as amended or renewed
MD9 Co-disposal	subobjective 1	Clay-to-water ratio >0.5 in DDA1 based on deposit sampling Annual overburden to tailings volume ratio >1
	subobjective 2	Surface water and seepage: The closed-circuit water management system is operating as designed Groundwater is monitored as required by *EPEA* approval 94-03-00, as amended or renewed
MD9 South Co-disposal	subobjective 1	Clay-to-water ratio >0.5 in DDA1 based on deposit sampling Annual overburden to tailings volume ratio >1
	subobjective 2	Surface water and seepage: The closed-circuit water management system is operating as designed Groundwater is monitored as required by *EPEA* approval 94-03-00, as amended or renewed
DDA3	subobjective 1	Clay-to-water ratio >0.3 threshold based on deposit sampling An annual average total suspended solids ≤500 parts per million for expressed water from DDA3 treated tailings
	subobjective 2	Surface water and seepage: The closed-circuit water management system is operating as designed

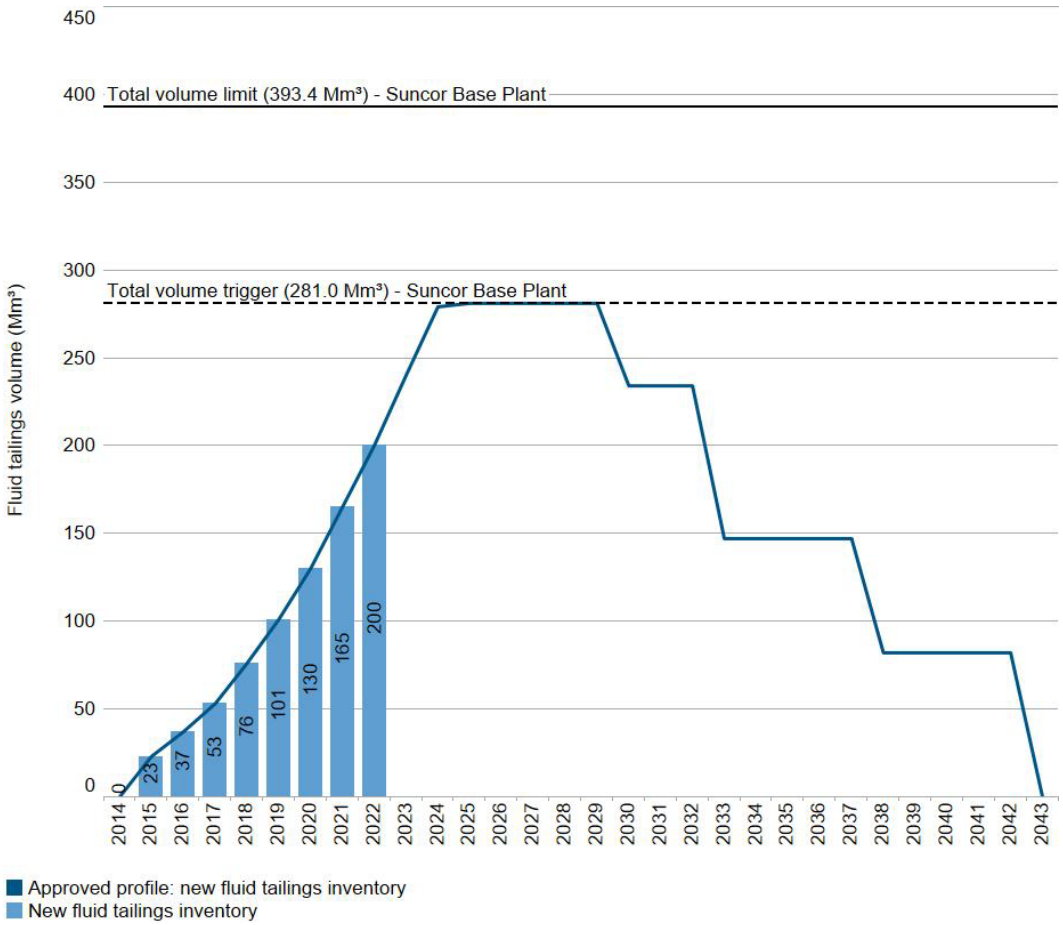
	Groundwater is monitored as required by *EPEA* approval 94-03-00, as amended or renewed

8.1.1.1 New Fluid Tailings

For 2022, Suncor Base Plant reported a new fluid tailings inventory of 200 Mm³ (see figure 5), up from 165 Mm³ in 2021. The approved new fluid tailings inventory for 2022 was 200 Mm³.

Suncor Base Plant has a total volume trigger for new fluid tailings inventory of 281 Mm³ and a total volume limit of 393 Mm³. Based on data reported in its 2022 TMR, Suncor Base Plant was within its approved new fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.

SIRs posed concerning volumes of new tailings based on the 2021 submission were addressed to the AER's satisfaction. Additional SIRs were posed concerning volumes and performance of new fluid tailings based on the 2022 submission.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

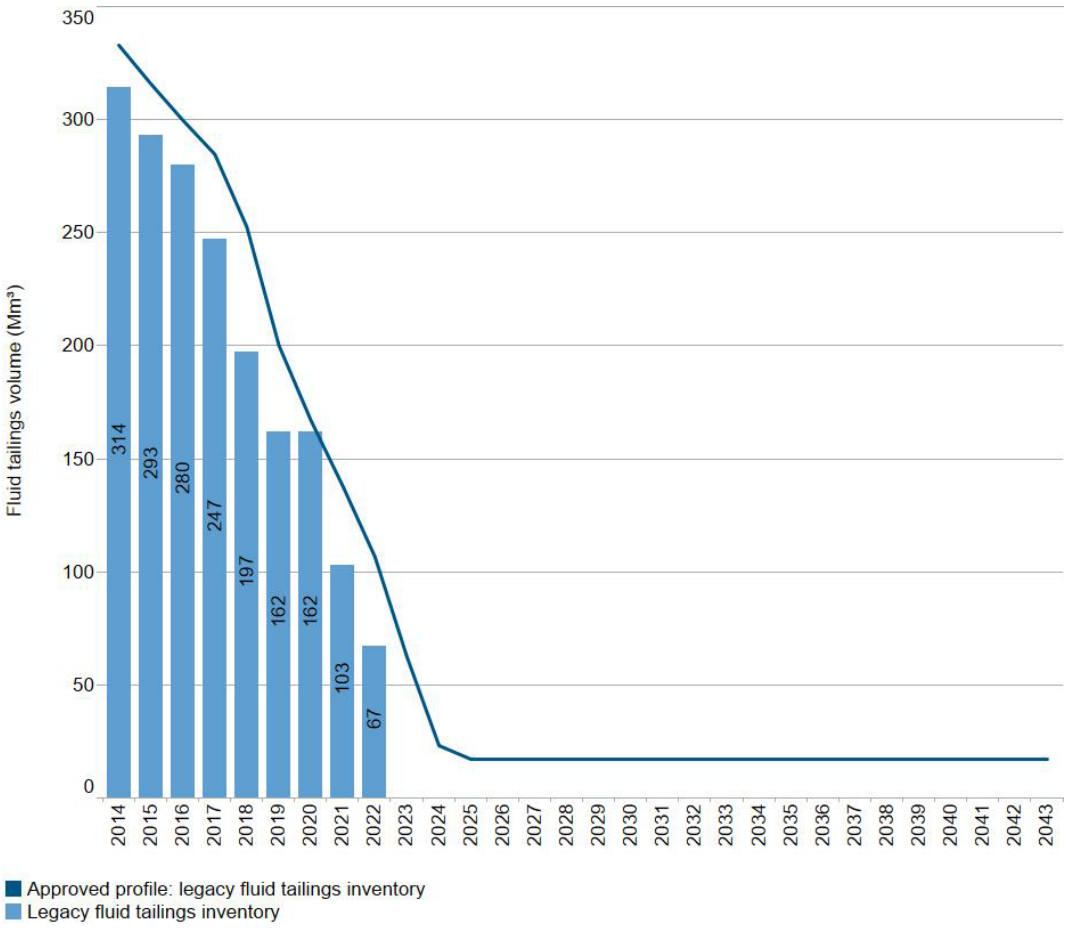
Figure 5. New fluid tailings for Suncor Base Plant, 2014 to 2022

8.1.1.2 Legacy Fluid Tailings

For 2022, Suncor Base Plant reported a legacy fluid tailings inventory of 67 Mm³ (see figure 6), down from 103 Mm³ in 2021. The approved legacy fluid tailings inventory for 2022 was 89 Mm³.

Based on data reported in its 2022 TMR, Suncor Base Plant was within its approved legacy fluid tailings profile and did not exceed its profile deviation trigger for legacy fluid tailings in 2022.

SIRs posed concerning volumes of legacy tailings based on the 2021 submission were addressed to the AER's satisfaction. Additional SIRs were posed concerning volumes and performance of legacy fluid tailings based on the 2022 submission.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 6. Legacy fluid tailings for Suncor Base Plant, 2014 to 2022

8.1.2 Volume of Treated Fluid Tailings by Technology

For 2022, Suncor Base Plant reported that 22 Mm³ of fluid tailings were treated with PASS in DDA3.

As of 2022, Suncor Base Plant reported that 95.6 Mm³ of fluid tailings had achieved RTR status:

- 30.4 Mm³ in pond 5
- 64.9 Mm³ in DDA3
- 0.3 Mm³ in MD9

The RTR volume increased from 84.2 Mm³ reported in 2021.

8.1.3 Treatment Options and Continuous Improvement

Suncor Base Plant reported that its tailings treatment technologies are operating as expected, and deposits are meeting performance criteria and remain aligned with long-term closure and reclamation objectives. Suncor Base Plant reported no issues with its tailings treatment technology in 2022.

Suncor Base Plant reported the following improvements in 2022:

- Polymer injector materials selection: In 2022, different polymer injector metallurgies were tested in an effort to improve equipment lifespan. However, the different metallurgies were proven less effective than the current materials for erosion resistance.
- Dredge asset modifications: Modifications to the dredge control logic and the external structure were made to improve asset reliability and runtime. Asset utilization was primarily affected by the presence of debris in the fluid fine tailings (FFT).

Suncor Base Plant reported no change to the expected treatment capacity based on the improvements.

SIRs were posed concerning performance of fluid tailings based on the 2022 submission.

8.1.4 Technological Innovation in Fluid Tailings Treatment

Suncor Base Plant reported the following technology research and development efforts for 2022:

- **New flocculant addition**: Polymer E-4993SK was successfully added to the treatment system after being proven in lab-scale testing. The field performance of the polymer proved more robust and yielded results meeting or exceeding the quality of the previous chemical. Polymer E-4993SK will be the primary flocculant for tailings treatment in 2023.
- **Coke beaching trial in pond 6**: The trial evaluated the potential of hydraulically placed petroleum coke to improve the treatment and closure outcomes for some of its tailings ponds. Suncor Base Plant's reported results include no significant change in air quality during the trial, and the trial process asset delivered stable and reliable coke slurry concentrations to the beaching process.

For more information about technological innovation, see Suncor Base Plant's TMRs.

8.1.5 Regulatory and Management Actions

Suncor Base Plant operates at management level 1 as described in the *TMF* and *Directive 085.*

Suncor Base Plant submitted its 2022 TMP amendment application (the application) in September 2022, which is currently under review by the AER. The application updates components of the Base Plant's integrated mine, tailings, and closure plans to reduce the net environmental effects of tailings management. Suncor proposes to

- update the forecasted RTR timing for pond 6 and pond 7 fluid tailings,
- update its new fluid tailings profile to address short-term containment risk, and
- remove a planned tailings pond from NSE.

In 2022, Suncor Base Plant applied to extend its timeframe for proposing modified RTR criteria for remnant tailings. The AER approved the application with the conditions that Suncor will provide

- proposed RTR criteria for remnant fluid tailings for sand dump (SD) 8 by December 31, 2025, and for SD 9, SD10, and the STP within five years after the end of the mine's life; and
- a plan for submitting RTR criteria for remnant fluid tailings for pond 1A and pond 2/3 by September 30, 2023.

In 2022, Suncor Base Plant also applied to make changes to the MD9 and MD9 South plan. The proposed changes were to accommodate material placement to support the advance of the Millennium mine into approved mining areas. The AER approved the application.

The AER initiated a desktop inspection of Suncor Base Plant's tailings and site-wide fluid containment capacity in 2022 in response to ongoing concerns about short-term fluid containment constraints. The AER issued the following conditions as a result:

- By April 28, 2023, Suncor will provide a site fluid containment model covering January 1, 2022, to December 31, 2024, for the approved mining/tailings operations plan that includes consideration of variable precipitation events. The submission will include a list of assumptions and source data references. The model should only include activities for which Suncor already has full regulatory approval.
- In addition to the model, by May 31, 2023, Suncor will provide a list of mitigations, with decision triggers and timing, that could be implemented in the event of unfavorable precipitation.

- Starting June 30, 2023, Suncor will report monthly on its available containment (per the containment model) and the mitigation measures and decisions taken during the previous reporting period that could affect the containment model.

The findings and outcome of the desktop inspection will be reported in subsequent reports.

8.1.6 Measurement System Audit Results

Suncor Base Plant submitted an updated MSP on December 19, 2022, in accordance with the AER's February 2022 and June 2022 letters concerning water quality characterization and reporting.

The AER did not audit Suncor Base Plant's MSP in 2022.

8.2 Syncrude – Mildred Lake

In 2022, six tailings facilities were operating at the Mildred Lake mine (see table 4).

Table 4. Tailings facilities operating at Syncrude Mildred Lake

Facility	Function	Contents
Mildred Lake settling basin (MLSB)	• plant recycle water source • fluid storage • solids storage • FFT source for centrifuge cake	• recycle water • FFT • froth treatment tailings • flotation tailings • petroleum coke • CST • centrifuge plant centrate
South west sand storage (SWSS)	• solids storage • fluid storage	• recycle water • FFT • CST
Base mine lake (BML) (formerly west in-pit)	• water-capped tailings demonstration • treated tailings deposits	• fresh water • recycle water • sequestered FFT
South west in-pit (SWIP)	• fluid storage • solids storage • plant recycle water source • FFT source for CT plant • treated tailings storage	• recycle water • CST • CT • FFT • CT cyclone overflow
North mine south pond (NMSP)	• fluid storage • solids storage • treated tailings storage	• CST • CT • FFT • recycle water
North mine south pond east (NMSPE) deep cake (NMSPE deep cake)	• solids storage • treated tailings storage	• centrifuged FFT cake • overburden • CST
North mine centre pit	• solids storage • treated tailings storage	• CST • flocculated tailings • centrifuge FFT cake
W1/SWSS cake	• solids storage • treated tailings storage	• centrifuge FFT cake

The MLSB and the SWSS are the only out-of-pit tailings facilities at the site. The tailings facilities vary in their primary function, contents, and size. The MLSB, SWSS, SWIP, NMSP, NMSPE deep cake and north mine centre pit are currently operating, providing fluid and solid tailings storage for the site. East in-pit (EIP) is in the final stages of reclamation and land forming for closure purposes. BML is a water-capped tailings demonstration pit lake in the west in-pit (WIP) tailings facility.

The fluid tailings treatment technologies approved for commercial operation at the Mildred Lake mine are composite tailings (CT), centrifuge cake, and in-line flocculation (ILF) tailings. Throughout 2022, 2.2 Mm^3 of centrifuge cake and 0.5 Mm^3 of ILF were produced.

The new fluid tailings inventories for 2022 were within the approved fluid tailings profiles. The legacy fluid tailings inventory for 2022 was above the approved legacy tailings profile but remained below the 20% legacy fluid tailings profile deviation trigger.

8.2.1 Fluid Tailings

For 2022, Syncrude Mildred Lake mine reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 530 Mm^3, up 8.4 Mm^3 from 2021. This compares with an approved total fluid tailings inventory of 494 Mm^3.

For 2022, Syncrude Mildred Lake reported that 45.9 Mm^3 of fluid tailings met its approved RTR criteria, up from 32.0 Mm^3 in 2021. The Mildred Lake RTR criteria are shown in table 5.

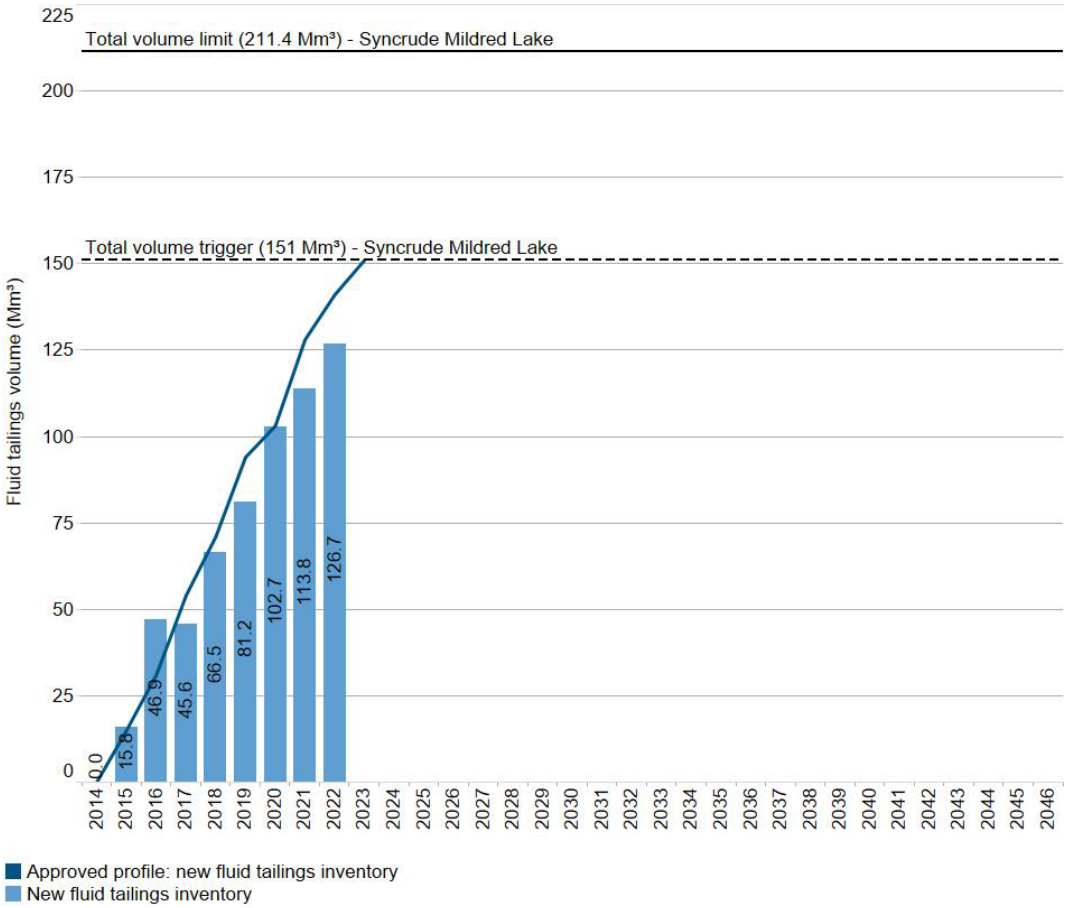
Table 5. RTR criteria for Syncrude Mildred Lake

Deposit	Subobjective	RTR Criteria
CT	subobjective 1	65% solids content by weight within one year of tailings placement based on deposit sampling 75% solids content by weight within one year after sand capping of deposit based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 26-03-00, as amended or renewed
Centrifuge cake deep deposits	subobjective 1	50% solids content by weight within one year of tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 26-03-00, as amended or renewed
Flocculated tailings deposits	subobjective 1	50% solids content by weight within one year of tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 26-03-00, as amended or renewed

8.2.1.1 New Fluid Tailings

For 2022, Syncrude reported a new fluid tailings inventory of 126.7 Mm³ (see figure 7), up from 113.8 Mm³ in 2021. The approved new fluid tailings inventory for 2022 was 141.0 Mm³.

Mildred Lake has a total volume trigger for new fluid tailings inventory of 151 Mm³ and a total volume limit of 211.4 Mm³. Based on data reported in its 2022 TMR, Mildred Lake was within its approved new fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 7. New fluid tailings for Syncrude Mildred Lake, 2014 to 2022

8.2.1.2 Legacy Fluid Tailings

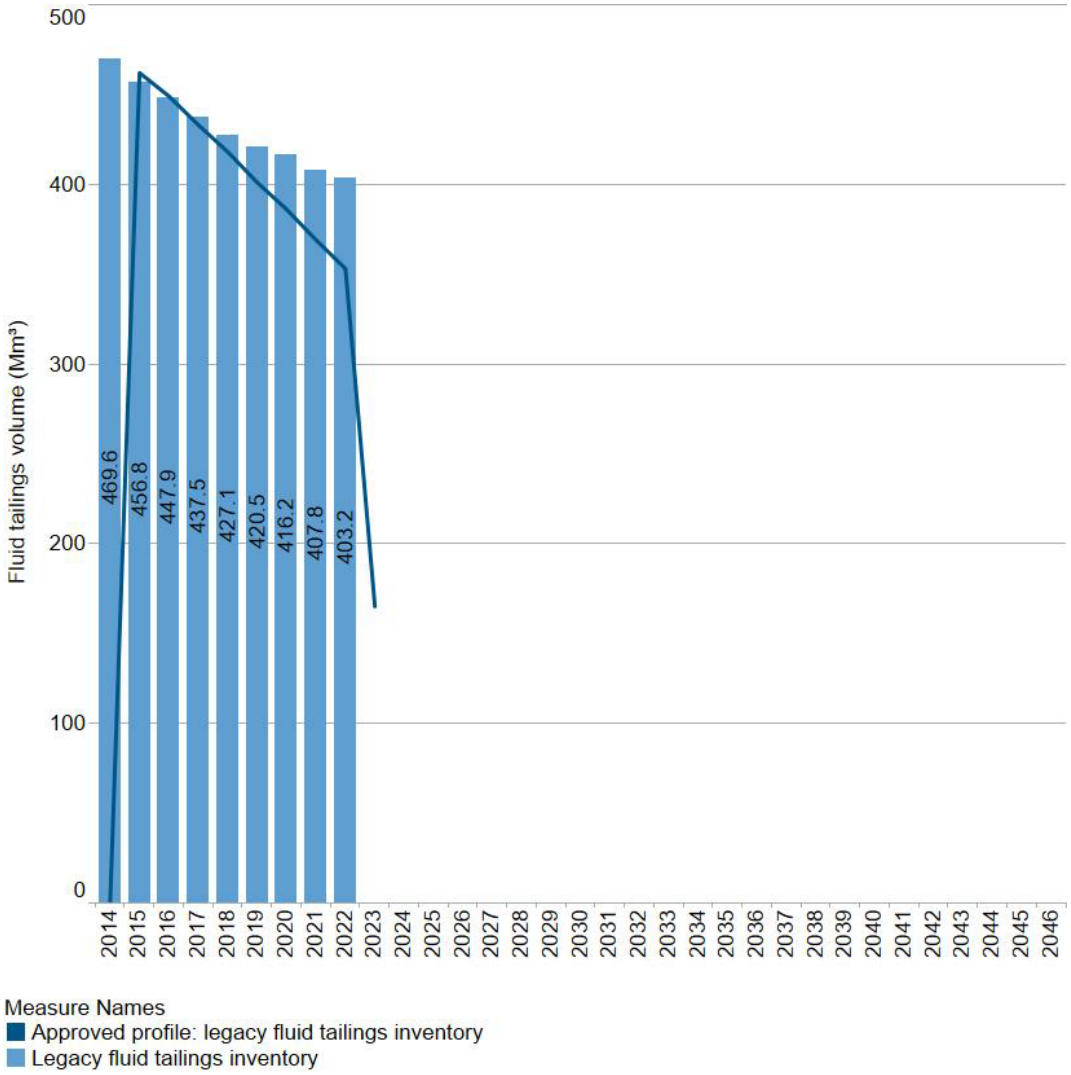
For 2022, Mildred Lake reported a legacy fluid tailings inventory of 403.2 Mm³ (see figure 8), down from 407.8 Mm³ in 2021. The approved legacy fluid tailings inventory for 2022 was 352.7 Mm³.

For the sixth consecutive year, Mildred Lake exceeded its approved legacy fluid tailings profile but remained below the 20% profile deviation trigger for legacy fluid tailings.

Syncrude is addressing this trend by taking the following actions:

- The flocculated tailings pilot treatment plant continued to treat fluid tailings in 2022, with the intent for the pilot plant to become operational in 2023.
- A task force was established in 2019 to improve the feed quality of fluid tailings to both the centrifuge cake and the new flocculated tailings treatment plants.
- The fluid tailings supply source was changed from the MLSB to the NMSP in 2023.

Syncrude submitted an updated legacy fluid tailings profile as part of the 2023 Mildred Lake TMP, which is currently under review.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 8. Legacy fluid tailings for Syncrude Mildred Lake, 2014 to 2022

8.2.2 Volume of Treated Fluid Tailings by Technology

For 2022, Mildred Lake reported that 2.6 Mm^3 of fluid tailings were treated with centrifuge cake technology, producing 2.2 Mm^3 of cake, and 1.1 Mm^3 of fluid tailings were treated using ILF technology producing 0.5 Mm^3 of flocculated tailings.

Mildred Lake did not report producing any CT in 2022.

As of 2022, Mildred Lake reported that 45.9 Mm^3 of fluid tailings had achieved RTR status:

- 5.0 Mm^3 in SWIP major
- 3.6 Mm^3 in NMSP
- 37.3 Mm^3 in NMSPE deep cake

The RTR volume increased from 32.0 Mm^3 reported in 2021.

8.2.3 Treatment Options and Continuous Improvement

No significant changes were made to the centrifuge cake plant at Mildred Lake in 2022.

- A new belt cleaner was installed to help remove belt build-up.
- A block model of the MLSB fluid tailings deposit developed in 2021 was used to target optimal quality fluid tailings material feed to the centrifuge cake and ILF plants.
- The centrifuge cake plant was voluntarily shut down in mid-June 2022 and resumed operations in February 2023 using a new fluid tailings source from the NMSP.
- The AER requested reporting of the MLSB recycle water quality after the fluid tailings supply source changed. This was implemented to ensure recycle water quality parameters were met, thereby reducing use of river water.

Syncrude reported that its tailings treatment technologies are operating as expected, and deposits are meeting performance criteria and remain aligned with long-term closure and reclamation objectives.

8.2.4 Technological Innovation in Fluid Tailings Treatment

Mildred Lake reported the following technology research and development efforts for 2022:

- water-capped tailings technology with the WIP BML commercial-scale demonstration
- flocculated tailings (accelerated dewatering) or ILF
- tailings co-deposition
- co-processing of fresh tailings and FFT
- geochemical characterization of froth treatment tailings

- equipment and process optimizations for current commercial-scale tailings technologies

Syncrude continued to support industry-wide collaborative initiatives such as Canada's Oil Sands Innovation Alliance.

For more information on Syncrude's research and development initiatives, see the 2022 TMR.

8.2.5 Regulatory and Management Actions

The Mildred Lake mine operates at management level 1 as described in the *TMF* and *Directive 085.*

No management level regulatory actions were taken during the 2022 reporting period for tailings management operations at Mildred Lake. In 2022, the AER sought clarification from Syncrude on its intent to use CT technology going forward. Syncrude confirmed CT technology is no longer in use at Mildred Lake and has been replaced by centrifuge cake and ILF. The AER will closely monitor Syncrude's use of centrifuge cake and ILF to reduce the fluid tailings inventory to approved levels.

Syncrude submitted an updated TMP for the Mildred Lake mine in May 2023. The AER will consider Syncrude's past performance and the fluid tailings treatment capacity as part of its review.

8.2.6 Measurement System Audit Results

Syncrude submitted a new tailings MSP for Mildred Lake in December 2022 in response to an industry-wide reporting requirement clarification for tailings surface water quality characterization issued by the AER on February 23, 2022.

The updated MSP is currently under review. The AER will determine if an MSP audit is required in 2023.

The AER did not perform a tailings MSP audit in 2022.

8.3 Syncrude – Aurora North

In 2022, three tailings facilities were operating at Aurora North (see table 6).

Aurora settling basin (ASB) is the only out-of-pit tailings facilities at the site. In July, Aurora east pit north-east (AEPN-E) and Aurora east pit south (AEPS) were connected by a trench to form one in-pit tailings deposit. The tailings facilities vary in their primary function, contents, and size. The ASB, AEPN-E, and AEPS currently provide the fluid tailings storage for the site.

Table 6. Tailings facilities operating at Syncrude Aurora North

Facility	Function	Contents
ASB	• plant recycle water source • fluid storage • solids storage • FFT source for CT plant	• recycle water • CST • flotation tailings • FFT • CT cyclone overflow
AEPN-E	• fluid storage • solids storage • treated tailings deposit • filter sand source	• CT • CST • recycle water • FFT
AEPS	• fluid storage • solids storage • treated tailings deposit	• CT • CST • flotation tailings • FFT • recycle water

The Aurora east pit north-west (AEPN-W) has been filled with coarse sand to form the base of the Fort Hills dump expansion and is no longer an active tailings deposit.

CT is the approved fluid tailings treatment technology for commercial operation at Aurora North. A total volume of 5.6 Mm^3 of CT beach was produced in 2022.

Aurora North reported that its new and legacy fluid tailings inventories for 2022 were within the approved fluid tailings profiles.

8.3.1 Fluid Tailings

For 2022, Aurora North reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 137.0 Mm^3, up from 127.0 Mm^3 in 2021.

Volumes reported for 2022 fall within currently approved profiles for new and legacy fluid tailings inventories.

For 2022, Aurora North reported that 4.0 Mm^3 of fluid tailings met its approved RTR criteria, down from 5.7 Mm^3 in 2021. The Aurora North RTR criteria are shown in table 7.

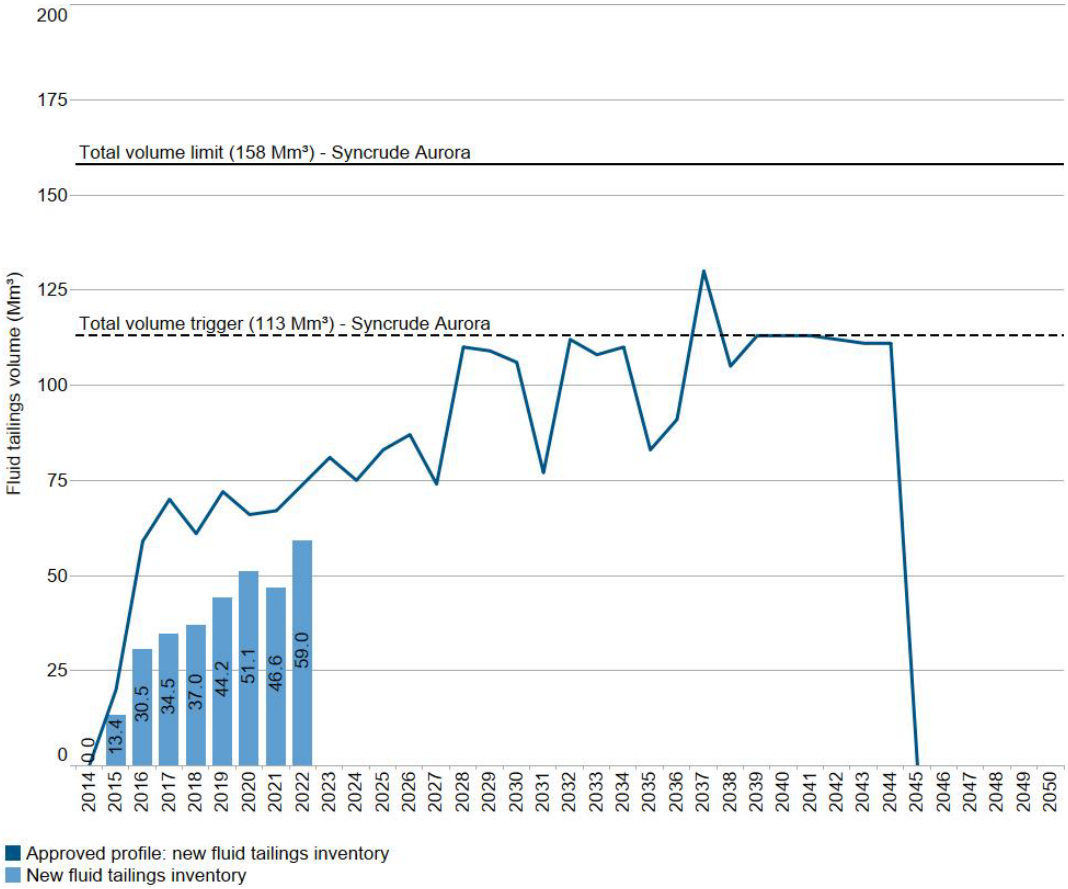
Table 7. RTR criteria for Syncrude Aurora North

Deposit	Subobjective	RTR Criteria
CT deposits	subobjective 1	65% solids by weight within one year of tailings placement based on deposit sampling
		75% solids by weight within one year after sand capping of deposit based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 26-02-00, as amended or renewed

8.3.1.1 New Fluid Tailings

For 2022, Aurora North reported a new fluid tailings inventory of 59.0 Mm³ (see figure 9), up from 46.6 Mm³ in 2021. The approved new fluid tailings inventory for 2022 was 74.0 Mm³.

Aurora North has a total volume trigger for new fluid tailings inventory of 113 Mm³ and a total volume limit of 158 Mm³. Based on data reported in its 2022 TMR, Aurora North was within its approved new fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

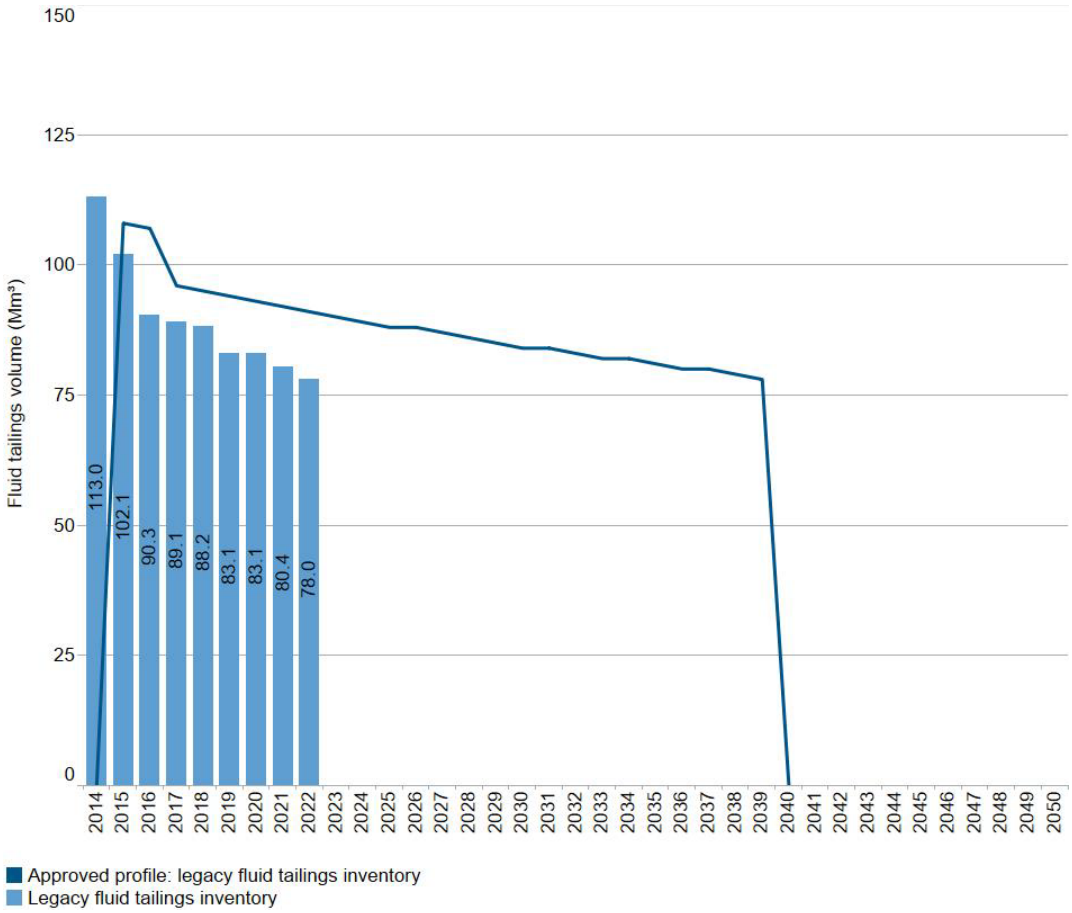
Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 9. New fluid tailings for Syncrude Aurora North, 2014 to 2022

8.3.1.2 Legacy Fluid Tailings

For 2022, Aurora North reported a legacy fluid tailings inventory of 78 Mm³ (see figure 10), down from 80.4 Mm³ in 2021. The approved legacy fluid tailings inventory for 2022 was 91 Mm³.

Based on data reported in its 2022 TMR, Aurora North was within its approved legacy fluid tailings profile and did not exceed its profile deviation trigger for legacy fluid tailings in 2022.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 10. Legacy fluid tailings for Syncrude Aurora North, 2014 to 2022

8.3.2 Volume of Treated Fluid Tailings by Technology

For 2022, Aurora North reported that 2.2 Mm³ of fluid tailings were treated using CT technology and placed in AEPN-E and AEPS. A total of 5.6 Mm³ of CT was produced.

Aurora North reported that 4.0 Mm³ of fluid tailings achieved RTR status in 2022:

- 2.4 Mm³ in AEPN-E
- 1.6 Mm³ in AEPS

The RTR volume decreased from 5.7 Mm³ reported in 2021.

8.3.3 Treatment Options and Continuous Improvement

In 2022 Aurora North resumed CT operations after two years of no CT production. Aurora North reported the following improvements were made to the CT plant and operations:

- New gypsum pumps were added to the gypsum plant to increase the particle passing size and reduce plugging.
- Control of the gypsum pumps was transferred to the gypsum field operators' human-machine interface. This made the plant run more efficiently.
- A new CT subsampling process was added to reduce the variance in CT laboratory sample results. This process made operations more reflective of actual CT product and performance.
- Head-balancing controls were implemented in the CT plant to reduce wear on the CT slurry pumps.

A review of the 2021 Aurora North TMR led the AER to implement quarterly reporting of CT performance, which started in 2023 and will be addressed in the 2023 report.

8.3.4 Technological Innovation in Fluid Tailings Treatment

Aurora North reported the following technology research and development efforts for 2022:

- BML demonstration
- flocculated tailings (accelerated dewatering)
- tailings co-deposition
- co-processing
- tailings equipment and process optimization:
  - alternative coagulant for CT
  - polymer-enhanced CT

For more information on Aurora North's research and development initiatives, see the 2022 TMR.

8.3.5 Regulatory and Management Actions

Aurora North operates at management level 1 as described in the *TMF* and *Directive 085.*

The AER remains concerned about Aurora North CT treatment capacity and performance. In 2022, the AER implemented quarterly reporting on CT performance and the commercial development of ILF tailings at Aurora North and continues to require Syncrude to report quarterly.

Aurora North mine submitted an updated TMP in May 2023, which is currently under review by the AER.

8.3.6 Measurement System Audit Results

Syncrude Aurora North submitted a new tailings MSP in December 2022 in response to an industry-wide reporting requirement clarification for tailings surface water quality characterization issued by the AER on February 23, 2022.

The updated MSP is currently under review. The AER will determine if an MSP audit is required in 2023.

The AER did not perform a tailings MSP audit in 2022.

8.4 Canadian Natural Upgrading Limited – Muskeg River Mine

In 2022, five tailings facilities were operating at Muskeg River mine (see Table 8). The tailings facilities vary in their primary function, contents, and size.

The fluid tailings treatment technologies approved for commercial operation at Muskeg River Mine are atmospheric fines drying (AFD), thickened tailings (TT), and north pool deposit (NPD) type.

Table 8. Tailings facilities operating at CNUL Muskeg River mine

Facility	Function	Contents
External tailings facility (ETF)	• fluid and solid tailings storage	• NPD type • AFD
In-pit cell 1 (IPC1)	• fluid and solid tailings storage • recycle water source	• CST • tailings solvent recovery unit (TSRU) • recycle water
IPC2	• fluid and solid tailings storage	• fluid tailings • TT
IPC3	• fluid and solid tailings storage	• NPD type
IPC4	• fluid and solid tailings storage	• TT and CST mixed deposit • centrifuge fluid fine tailings (CFFT) • AFD

Final placement of AFD in dump 5, dump 6, and IPC4 was reported for the 2022. The ETF is in the ongoing infilling phase. Settlement of the infilled areas are monitored and reported.

Muskeg River mine reported that its new and legacy fluid tailings inventories for 2022 were within the approved fluid tailings profiles.

8.4.1 Fluid Tailings

For 2022, Muskeg River mine reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 145.3 Mm^3, up from 138.6 Mm^3 in 2021.

Volumes reported for 2022 fall within currently approved profiles for new and legacy fluid tailings inventories.

For 2022, Muskeg River mine reported that 7 Mm^3 of fluid tailings met its approved RTR criteria, down from 12.3 Mm^3 in 2021. The RTR status requires meeting the following approved subobjective 1 and 2 criteria at Muskeg River mine (see table 9).

Table 9. RTR criteria for CNUL Muskeg River mine

Deposit	Subobjective	RTR Criteria
NPD type (co-deposition of TT with TSRU tailings, WT, and CST)	subobjective 1	70% solids by weight within five years of tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 20809-02-00, as amended or renewed
AFD	subobjective 1	50% solids by weight within one year of tailings placement based on deposit sampling 75% solids by weight within five years of final tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 20809-02-00, as amended or renewed
TT/CST mixed deposit	subobjective 1	60% solids by weight within three years of tailings placement based on deposit sampling 70% solids by weight within five years of tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 20809-02-00, as amended or renewed
CFFT/CST mixed deposit	subobjective 1	60% solids by weight within three years of tailings placement based on deposit sampling 70% solids by weight within five years of tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 20809-02-00, as amended or renewed

8.4.1.1 New Fluid Tailings

For 2022, Muskeg River mine reported a new fluid tailings inventory of 57.3 Mm^3 (see figure 11), up from 50.6 Mm^3 in 2021. The approved new fluid tailings inventory for 2022 was 64.0 Mm^3.

Muskeg River mine has a total volume trigger for new fluid tailings inventory of 69 Mm^3 and a total volume limit of 97 Mm^3. Based on data reported in its 2022 TMR, Muskeg River mine was within its approved new fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.

SIRs were posed concerning volumes of new fluid tailings based on the 2022 submission. Details are provided in section 8.4.5.

Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

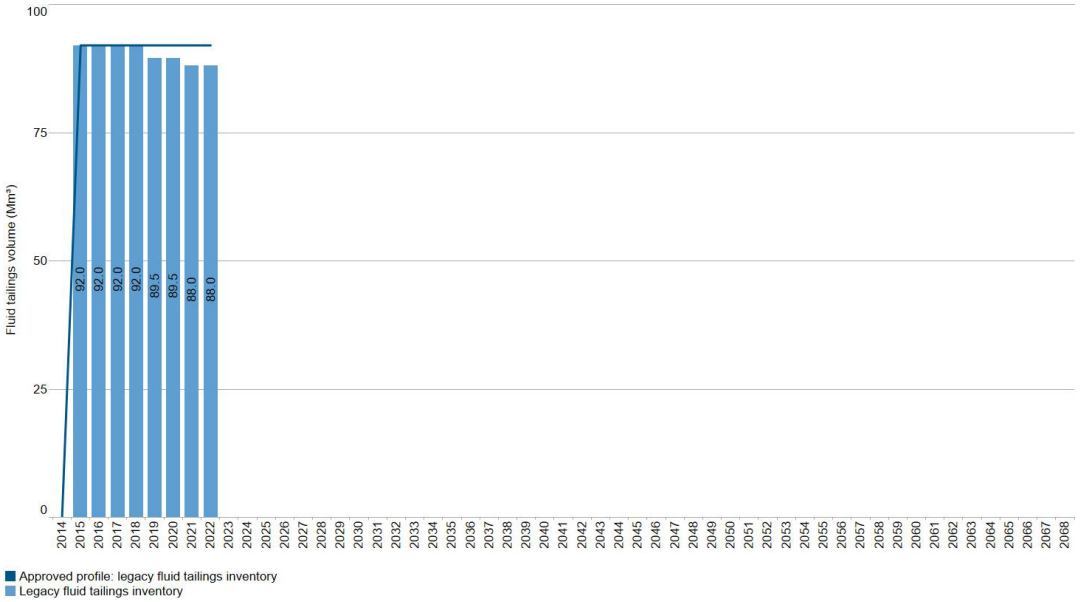
Figure 11. New fluid tailings for CNUL Muskeg River mine, 2014 to 2022

8.4.1.2 Legacy Fluid Tailings

For 2022, Muskeg River mine reported a legacy fluid tailings inventory of 88 Mm³ (see figure 12), unchanged from 2021. The approved legacy fluid tailings inventory for 2022 was 92 Mm³.

Based on data reported in its 2022 TMR, Muskeg River mine was within its approved legacy fluid tailings profile and did not exceed its profile deviation trigger for legacy fluid tailings in 2022.

SIRs were posed relating to volumes of legacy fluid tailings based on the 2022 submission. See section 8.4.5 for more information.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 12. Legacy fluid tailings for CNUL Muskeg River mine, 2014 to 2022

8.4.2 Volume of Treated Fluid Tailings by Technology

For 2022, Muskeg River mine reported that 27.6 Mm³ of fluid tailings were treated through NPD-type co-mixing technology (21.7 Mm^3) and AFD (5.9 Mm^3).

Muskeg River mine reported that 7.0 Mm³ of fluid tailings achieved RTR status in 2022:

- 4.1 Mm³ in ETF
- 2.9 Mm³ in IPC3

The RTR volume increased to 36.3 Mm^3 in 2022, up from 32.5 Mm³ reported in 2021. Volumes of fluid tailings achieving RTR status are as reported and subject to change upon review.

8.4.3 Treatment Options and Continuous Improvement

Muskeg River mine reported that its tailings treatment technologies are operating as expected, and deposits are meeting performance criteria and remain aligned with long-term closure and reclamation objectives.

Muskeg River mine reported the following improvements in 2022:

- progress on the CST infilling of the ETF
- expansion of the AFD drying cell area on the ETF

Muskeg River mine reported no change to the expected treatment capacity based on the improvements. During the 2022 tailings inspection, the AER observed a mound of beach below water material forming above the pond elevation while infilling the ETF. The AER needs to understand the geochemical and wildlife implications from the presence of this material and will work with Muskeg River mine on this matter.

The AER also noted Muskeg River mine reported new RTR material produced in 2022 for the ETF and IPC3. Since the TT and TSRU tailings streams were removed from the ETF, this deposit is created by material from the transition zone (TZ) mixing with beached CST. In IPC3, Muskeg River mine reported "insignificant" TZ development and the removal of the TT stream from the IPC3 in November 2021. The AER issued a SIR to better understand how NPD-type treated tailings are being developed in IPC3 without a TT stream and insignificant TZ material. Muskeg River mine provided a response and updated the RTR volume claimed for IPC3 (2.9 Mm^3) to reflect the lack of a TT source with the absence of a TZ. A TT source is a required component of a NPD type (as defined in appendix C of *OSCA* scheme approval 8512N). The AER will continue to work with Muskeg River mine on this matter.

Finally, Muskeg River mine reported that the IPC1 TSRU deposit material showed vertical movement during the CST capping activities. The recent change in elevation of the TSRU deposit has created concerns regarding alignment with the closure plan. The AER will continue to work with Muskeg River mine on this matter.

8.4.4 Technological Innovation in Fluid Tailings Treatment

Muskeg River mine reported the following technology research and development efforts for 2022:

- **Fluid tailings consolidation casing project**: The geotechnical and continuous monitoring data, collected in annual tailings investigations since 2018, were analyzed in 2022. Muskeg River mine reports minor increases in solids content with no change in bitumen content. Tailings material in all casings were observed to have an increased undrained shear strength of one to five kilopascals, in alignment with the increase in solids content. Tailings material in all casings continues to settle, and the data and analysis results may be used to calibrate predictive consolidation models for the specific tailings materials in the future.
- **Modified AFD (MAFD)**: This trial showed that MAFD is a viable technique for drying fluid tailings, with the additional advantage of minimizing the cost of rehandling AFD. MAFD is not currently in the tailings plan. No future work is planned for the MAFD trial.
- **Soft deposit capping (centrifuge cake test cell capping)**: CNUL stated that the ability of vegetation to grow directly on a soft tailings deposit has been proven, and the plant growth affects surface strength, permitting subsequent capping activities. Instrumentation monitoring will continue in 2023 to collect data on the long-term performance of CFFT within the test cell.

- **Geobag pilot program**: Advanced geotechnical testing (large-strain consolidation, soil water characteristic curve, shrinkage curve, and consolidated isotropic undrained triaxial compression tests) was completed in 2022. CNUL plans to validate the slope stability analysis for stacked geobags using 2021 field investigation data.
- **Fluid tailings pressure filtration pilot**: Triaxial compression tests were completed on samples collected from the 2021 field investigation. Predictive large-strain consolidation modelling was conducted in 2022 to evaluate the consolidation behaviour of filter-press tailings deposits. The consolidation models showed the settlements of the filter-press tailings at the end of primary consolidation were estimated to range between 1.5 and 3.0 m for an initial thickness of 20 m, 4 to 8 m for an initial thickness of 40 m, and 8 to 14 m for an initial thickness of 60 m. The settlement estimates included scenarios with solids content between 64% and 67% and consolidation properties interpreted from consolidation tests and properties derived from centrifuge testing.
- **In-line flocculated fluid tailings and CST mixed deposit field trial**: In the 2022 pilot, the deposited ILF fluid tailings (ILF FT) released water, increasing the solids content (reaching about 45% to 50% in the pond) before introducing CST. Once CST was added into the dewatered ILF FT deposit, it formed mixed deposits similar to those observed in DDA1. In addition, the 2022 pilot indicated that cell geometry and deposition conditions are also important for forming a mixed deposit. A lower-energy CST pour across a pre-existing beach resulted in the formation of an ILF FT/CST mixed deposit up to 15 m thick. It is speculated that an additional beach below water deposit development in front of an active ILF FT/CST deposit aided in confining the ILF FT, thereby improving mixing. Further investigation is required to confirm this observation. The pilot is planned to continue in 2023 to evaluate the ILF FT/CST mixing process, deposition strategy, and mixed deposit performance.
- **Centrifuged FFT and CST mixed deposit continuous**: The 2021 CFFT/CST mixed deposit will continue to be investigated and analyzed as part of the annual tailings investigation, and the data will continue to be published in the Jackpine mine TMR. The results will be used to inform the Jackpine mine ETF closure design and optimize the formation of mixed deposits.

For more information on Muskeg River mine's research and development initiatives, see the 2022 TMR.

8.4.5 Regulatory and Management Actions

Muskeg River mine operates at management level 1 as described in the *TMF* and *Directive 085.*

Muskeg River mine submitted the Muskeg River Mine Fluid Tailings Management Plan Amendment (the application) on April 30, 2022, which is currently under review by the AER. The application updates components of the Muskeg River mine's integrated mine, tailings, and closure plans to reduce the net environmental effects of tailings management. Muskeg River mine is proposing an update to its new fluid

tailings profile, which has lower annual volumes planned for the life of the mine compared with the current approved TMP.

8.4.6 Measurement System Audit Results

Muskeg River mine submitted an updated portion of their MSP on December 31, 2022. The AER is currently reviewing the updated MSP.

The AER did not perform a tailings MSP audit in 2022.

8.5 Canadian Natural Upgrading Limited – Jackpine Mine

In 2022, four tailings facilities were operating at Jackpine mine (see table 10). The tailings facilities vary in their primary function, contents, and size.

Table 10. Tailings facilities operating at CNUL Jackpine mine

Facility	Function	Contents
External tailings facility-western (ETF-W)	• treated tailings (TT/CST, and CFFT/CST) storage • recycle water storage	• TT/CST • CFFT/CST • centrate • recycle water
External tailings facility-eastern (ETF-E)	• fluid and solid tailings storage • CST deposited for cell construction and beaching activities to build containment • recycle water source	• fluid tailings • CST • recycle water
Sand cell 2 (SC2)	• fluid and solid tailings storage • CST deposited for cell construction and beaching activities to build containment • recycle water transfer to ETF	• fluid tailings • CST
Fluid cell 1 (FC1)	• fluid and solid tailings storage • CST deposited for cell construction and beaching activities to build containment • ILF treated tailings storage for piloting purposes • recycle water transfer to ETF	• fluid tailings • CST • ILF • recycle water

ETF-W, ETF-E, and SC2 are the only out-of-pit tailings facilities at the site. The fluid tailings treatment technologies approved for commercial operation at Jackpine mine are CFFT/CST and TT/CST co-mixed deposits.

Jackpine mine reported that its new and legacy fluid tailings inventories for 2022 were within the approved fluid tailings profiles.

8.5.1 Fluid Tailings

For 2022, Jackpine mine reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 24.4 Mm³, down from 26.0 Mm³ in 2021.

Volumes reported for 2022 fall within currently approved profiles for new and legacy fluid tailings inventories.

For 2022, Jackpine mine reported that 5 Mm^3 of fluid tailings met its approved RTR criteria, down from 7.7 Mm³ in 2021.

The RTR status requires meeting the following approved subobjective 1 and 2 criteria at Jackpine mine (see table 11).

Table 11. RTR criteria for CNUL Jackpine mine

Deposit	Subobjective	RTR Criteria
ETF CFFT/CST mixed deposits	subobjective 1	60% solids by weight within three years of tailings placement based on deposit sampling 70% solids by weight within five years of tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 00153125-01-00, as amended or renewed
ETF TT/CST mixed deposit	subobjective 1	70% solids by weight within five years of tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 00153125-01-00, as amended or renewed

There are no approved RTR criteria for SC2 and FC1.

CNUL stated that the 2022 groundwater quality results were consistent with historical results or that trends were not attributable to the tailings. However, the 2022 groundwater monitoring report recommended adding seven ETF network wells and four IPC network wells for further investigation through the Groundwater Response Plan (GRP) delineation stage. These wells have been in the plan's delineation stage for several seasons without resolution. Clarification regarding the interpretation of the groundwater quality results in the TMR and the groundwater monitoring report is required. The AER has issued a SIR. The AER will also follow up on the 2022 monitoring and investigation results when reviewing the 2022 groundwater monitoring report.

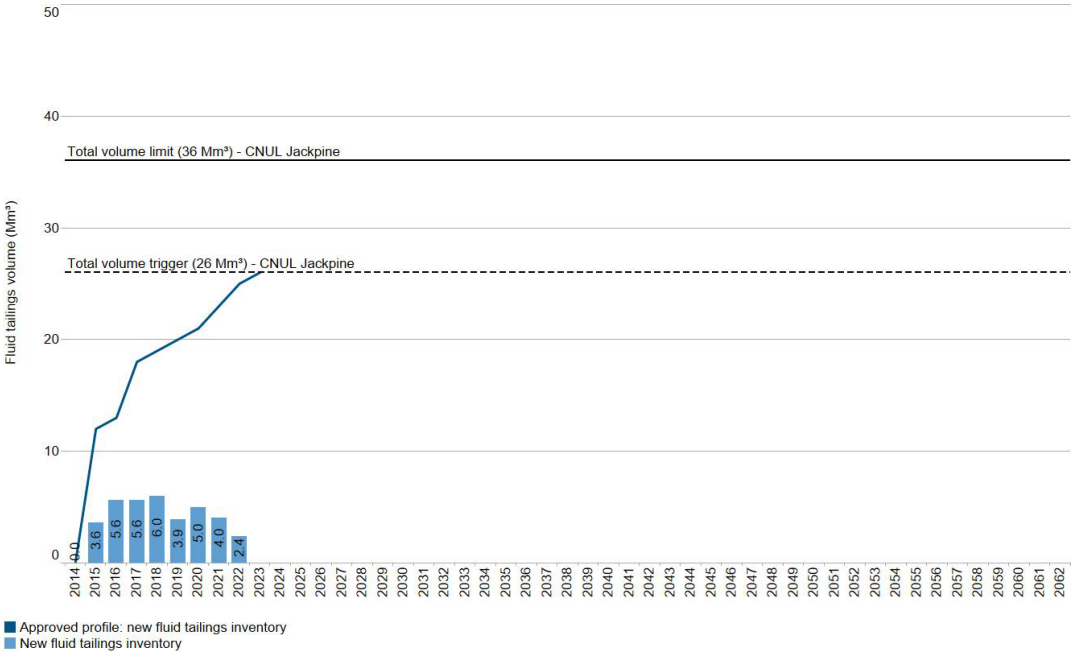
CNUL reported that the RTR subobjective 2 criteria for groundwater in 2022 has been met; no remediation was required in 2022. The AER is pursuing verification, through SIRs, of the adherence to the *EPEA* groundwater monitoring program requirements.

8.5.1.1 New Fluid Tailings

For 2022, Jackpine mine reported a new fluid tailings inventory of 2.4 Mm³ (see figure 13), down from 4.0 Mm³ in 2021. The approved new fluid tailings inventory for 2022 was 25 Mm^3.

Jackpine mine has a total volume trigger for new fluid tailings inventory of 26.0 Mm³ and a total volume limit of 36.0 Mm³. Based on data reported in its 2022 TMR, Jackpine mine was within its approved new fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.

SIRs were posed concerning volumes of new fluid tailings based on the 2022 submission.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

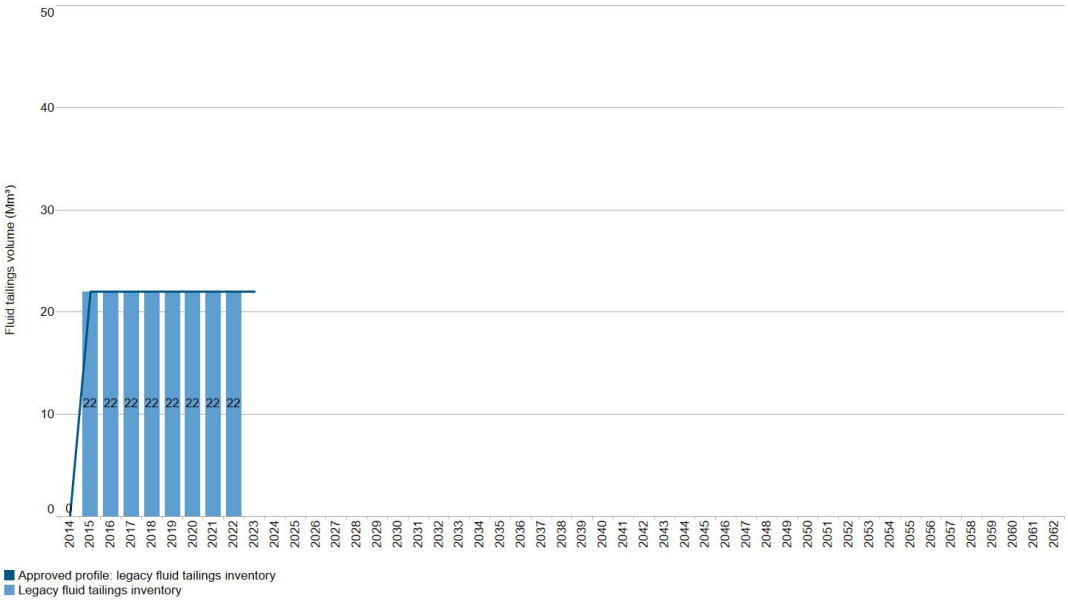
Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 13. New fluid tailings for CNUL Jackpine mine, 2014 to 2022

8.5.1.2 Legacy Fluid Tailings

For 2022, Jackpine mine reported a legacy fluid tailings inventory of 22.0 Mm³ (see figure 14), unchanged from 2021. The approved legacy fluid tailings inventory for 2022 was 22.0 Mm³.

Based on data reported in its 2022 TMR, Jackpine was within its approved legacy fluid tailings profile and did not exceed its profile deviation trigger for legacy fluid tailings in 2022.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 14. Legacy fluid tailings for CNUL Jackpine mine, 2014 to 2022

8.5.2 Volume of Treated Fluid Tailings by Technology

For 2022, Jackpine mine reported that 16.4 Mm³ of fluid tailings were treated with CFFT/CST and TT/CST in ETF-W.

Jackpine mine reported that 5 Mm³ of fluid tailings achieved RTR status in 2022:

- 1.3 Mm³ in TT/CST
- 3.7 Mm³ in CFFT/CST

The RTR volume increased from 24.2 Mm³ reported in 2021. Volumes of fluid tailings achieving RTR status are as reported and subject to change upon review.

8.5.3 Treatment Options and Continuous Improvement

Jackpine mine reported that its tailings treatment technologies are operating as expected, and deposits are meeting performance criteria and remain aligned with long-term closure and reclamation objectives.

Jackpine mine reported that the TZ in ETF-W decreased to the point that modelling it separately was unnecessary. This change was correlated to a more effectively mixed deposit with the CST beach.

Jackpine mine reported improvements in 2022 regarding increased effective mixing for developing TT and CFFT deposits with conventional CST beach.

Jackpine mine reported no change to the expected treatment capacity based on the improvements.

8.5.4 Technological Innovation in Fluid Tailings Treatment

CNUL pursues technological innovation in fluid tailings management at both the Muskeg River mine and Jackpine mine. The findings are applicable to both sites. See section 8.4.4 for details on the current technological research.

8.5.5 Regulatory and Management Actions

Jackpine mine operates at management level 1 as described in the *TMF* and *Directive 085*.

Jackpine mine submitted Jackpine Mine Fluid Tailings Management Plan Amendment (the application), on April 30, 2022, which is currently under review by the AER. The application updates components of the Jackpine mine's integrated mine, tailings, and closure plans to reduce the net environmental effects of tailings management. Jackpine mine is proposing an update to its new fluid tailings profile, which has lower annual volumes planned for the life of the mine compared with the current approved TMP.

8.5.6 Measurement System Audit Results

Jackpine mine submitted an updated portion of their MSP on December 31, 2022. The AER is currently reviewing the updated MSP.

The AER did not audit Jackpine mine's MSP in 2022.

8.6 Canadian Natural Resources Limited – Horizon

In 2022, two tailings facilities were operating at Horizon (see table 12). The tailings facilities vary in their primary function, contents, and size. The ETF/DDA1 is the only out-of-pit tailings facilities at the site.

The fluid tailings treatment technologies approved for commercial operation at Horizon mine are NST, eNST, and esNST.

Table 12. Tailings facilities operating at CNRL Horizon

Facility	Function	Contents
External tailings facility (ETF) / DDA1	• fluid and solid tailings storage • recycle water source	• NST • NRU • recycle water
DDA2	• fluid and solid tailings storage	• NST

Horizon has met their TMP treatment commitments.

Horizon mine reported that its new and legacy fluid tailings inventories for 2022 were within the approved fluid tailings profiles.

8.6.1 Fluid Tailings

For 2022, Horizon mine reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 173.6 Mm³, up from 160.0 Mm³ in 2021.

Volumes reported for 2022 fall within currently approved profiles for new and legacy fluid tailings inventories.

The RTR status requires meeting the following approved subobjective 1 and 2 criteria at Horizon mine (see table 13).

Table 13. RTR criteria for CNRL Horizon

Deposit	Subobjective	RTR Criteria
ETF/DDA1 NST	subobjective 1	70% solids by weight within one year of tailings placement 75% solids by weight within five years of starting backfilling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 149968, as amended or renewed; maintain the water table at a depth between 2 and 4 m
DDA2 NST	subobjective 1	70% solids by weight within one year of tailings placement 75% solids by weight within five years of starting backfilling
	subobjective 2	Groundwater is monitored as required by *EPEA* approval 149968, as amended or renewed; maintain the water table at a depth between 2 and 4 m

In 2022, a modification to subobjective 1 NST RTR criteria was accepted by the AER. See section 8.6.5 for further details.

A 2022 review of subobjective 2 identified the following areas for further investigation by the AER:

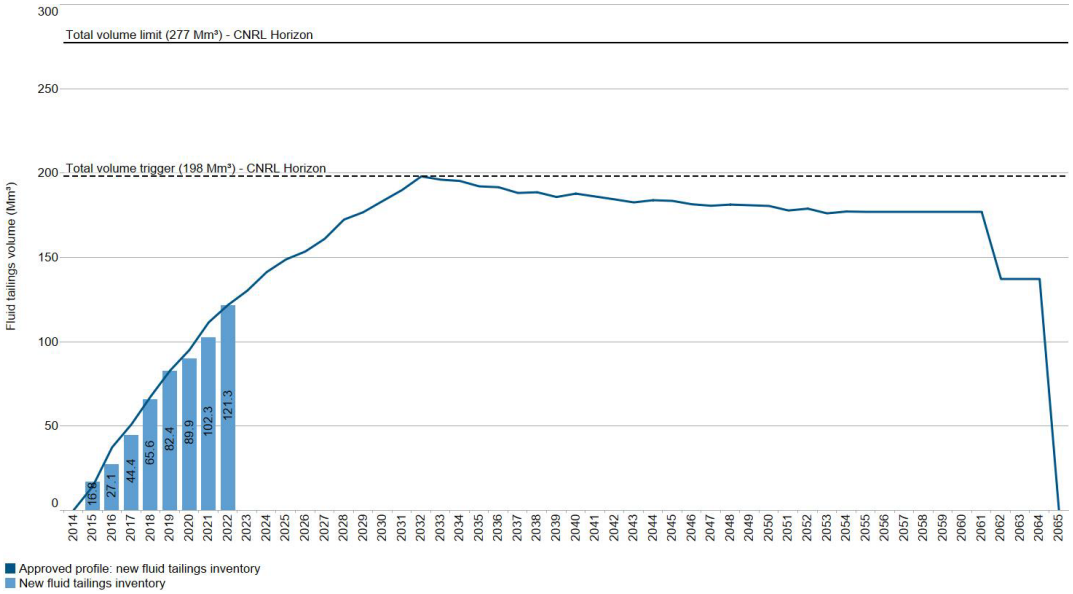
- **ETF/DDA1**: The potential implications of the dike 10 construction schedule, material properties, and foundation loading on the reported groundwater monitoring data. The AER is gathering information to evaluate if porewater seepage from the tailings structure will affect its evaluation of subobjective 2. The AER will continue to work with Horizon mine on this matter.
- **DDA2**: Horizon mine committed to evaluating and modifying its groundwater monitoring program when the water level for DDA2 approaches the Quaternary geology. The evaluation was to be included in the annual groundwater report and supplemental letters to the AER. However, it was observed that Horizon mine is deficient in providing some information required to verify conclusions reported in the 2022 TMR. The AER will continue to work with Horizon mine on this matter.

8.6.1.1 New Fluid Tailings

For 2022, Horizon mine reported a new fluid tailings inventory of 121.3 Mm³ (see figure 15), up from 102.3 Mm³ in 2021. The approved new fluid tailings inventory for 2022 was 121.8 Mm³.

Horizon mine has a total volume trigger for new fluid tailings inventory of 198 Mm³ and a total volume limit of 277 Mm³. Based on data reported in its 2022 TMR, Horizon mine was within its approved new

fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

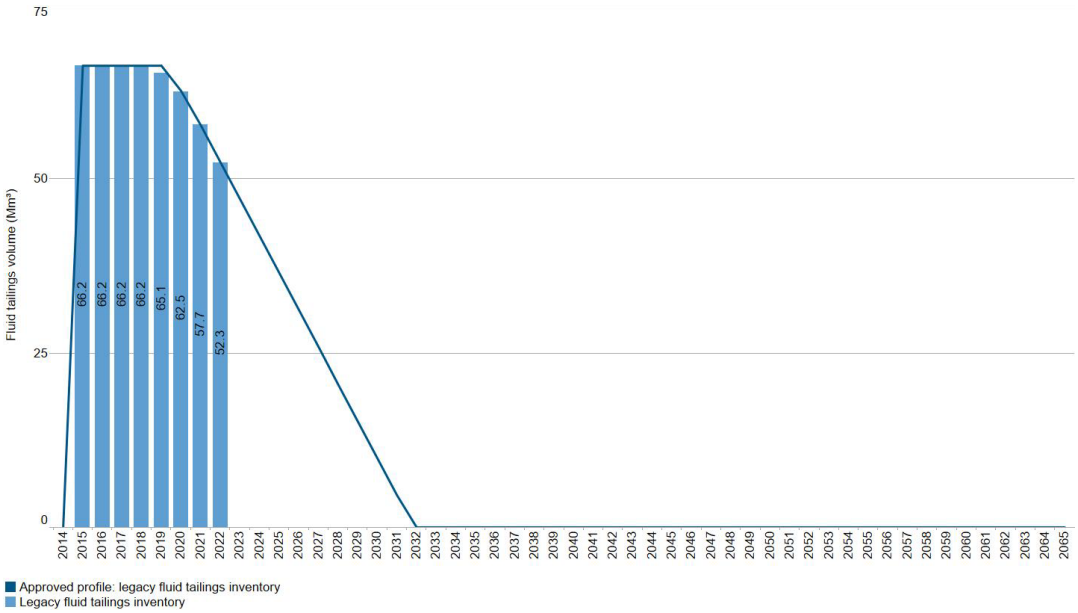
Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 15. New fluid tailings for CNRL Horizon, 2014 to 2022

8.6.1.2 Legacy Fluid Tailings

For 2022, Horizon mine reported a legacy fluid tailings inventory of 52.3 Mm³ (see figure 16), down from 57.7 Mm³ in 2021. The approved legacy fluid tailings inventory for 2022 was 52.4 Mm^3.

Based on data reported in its 2022 TMR, Horizon mine was within its approved legacy fluid tailings profile and did not exceed its profile deviation trigger for legacy fluid tailings in 2022.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 16. Legacy fluid tailings for CNRL Horizon, 2014 to 2022

8.6.2 Volume of Treated Fluid Tailings by Technology

For 2022, Horizon mine reported that 154.3 Mm³ of fluid tailings were treated with the various NST technologies in the ETF/DDA1 and DDA2.

As of 2022, Horizon mine reported that 83.3 Mm³ of fluid tailings had achieved RTR status:

- 26.3 Mm³ in ETF/DDA1
- 57.0 Mm³ in DDA2

The RTR volume increased from 68.6 Mm³ reported in 2021. For 2022, Horizon mine reported a cumulative volume of 652.3 Mm³ of treated tailings met its approved RTR criteria, up from 570 Mm³ in 2021.

Volumes of fluid tailings achieving RTR status are as reported and subject to change upon review.

8.6.3 Treatment Options and Continuous Improvement

Horizon mine reported that its tailings treatment technologies are operating as expected, and deposits are meeting performance criteria and remain aligned with long-term closure and reclamation objectives.

Horizon mine reported that an assessment of the consolidation performance and fines dynamic segregation of eNST and esNST technologies has continued since 2019. The results continue to prove the

robustness of both enhanced technologies compared to NST. Operational improvement of eNST and esNST is ongoing.

Horizon mine reported on continuous improvement, issues, and mitigations regarding aspects of operations in 2022 with thickener, eNST/esNST, and deposition. The following continuous improvements were addressed in 2022:

- maximizing underflow density
- optimizing polymer addition
- targeting higher-solids content fluid tailings in ETF
- improve performance at deposition locations

For more information, see the CNRL Horizon 2022 TMR.

In addition, during the annual tailings inspection in 2022, the AER observed that some exposed NRU beach in the ETF/DDA1 had become yellow. The AER requested follow-up information and is waiting for its submittal. Horizon has requested an extension on this deliverable to September 2023, and the AER is currently reviewing the request.

Horizon mine reported improvements in 2022 concerning NST on-specification density performance and provided the AER with an update. The AER identified deviations from the TMP targets in their 2018-2020 TMR reviews. Horizon mine reported meeting the 2022 TMP target year-end average of 83%.

Horizon mine reported no change to the expected treatment capacity based on the improvements.

8.6.4 Technological Innovation in Fluid Tailings Treatment

Horizon mine reported the following technology research and development efforts for reducing fluid tailings production through improving the NST suite of technologies for 2022:

- MAFD pilot;
- fluid tailings thickener pilot; and
- enhanced NRU (eNRU) tailings pilot. CNRL received authorization from the AER in April 2022 to test the effects of flocculating NRU tailings on fluid tailings production. The trial was deferred, and CNRL will provide the AER with revised pilot milestones for authorization.

Horizon mine submitted a tailings research and development report per its *EPEA* approval 149968-01-00, condition 6.1.2. Horizon continued its industry collaboration through external forums such as Canada's Oil Sands Innovation Alliance.

For more information on Horizon mine's research and development initiatives, see the 2022 TMR.

8.6.5 Regulatory and Management Actions

Horizon mine operates at management level 1 as described in the *TMF* and *Directive 085*.

Horizon mine applied to revise subobjective 1, condition 2, to a measurable RTR performance trajectory based on tailings operations. Horizon mine proposed the following:

- Subobjective 1:
  1) 70% solids by weight within one year of tailings placement; and
  2) 75% solids by weight within five years of commencement of backfilling. Backfilling is defined as the approximate final 5% of the planned NST deposition for each DDA.

The AER approved the proposed amendment to the nonsegregating tailings RTR subobjective 1 performance criteria on June 7, 2023.

8.6.6 Measurement System Audit Results

Horizon mine submitted an updated MSP on December 31, 2022. The AER is currently reviewing the updated MSP.

The AER did not perform a tailings MSP audit in 2022.

8.7 Imperial Oil Limited – Kearl

In 2022, the external tailings area (ETA) was the only tailings facility operating at Kearl. The ETA is subdivided into the east ETA (EETA) and the west ETA (WETA). The EETA and WETA are both out-of-pit tailings facilities (see table 14).

Table 14. Tailings facilities operating at Imperial Kearl

Facility	Function	Contents
EETA	• fluid storage • solids storage	• TT • CST
WETA	• fluid storage • solids storage	• CST • flotation tailings • TSRU tailings

During 2022, the first in-pit tailings facility (in-pit tailings area 1; ITA1) was under development in preparation for a 2023 start-up.

The fluid tailings treatment technology approved for commercial operation at Kearl is TT using thickeners with secondary in-line flocculation, collectively termed the Kearl fine tailings treatment (KFTT) process.

Kearl reported that its total fluid tailings inventory for 2022 was within the approved fluid tailings profile.

For 2022, Kearl reported a total fluid tailings inventory (all new fluid tailings) of 67 Mm³, down from 70.1 Mm³ in 2021.

The volume reported for 2022 falls within the approved profile for new fluid tailings.

As of 2022, Kearl reported that 25.0 Mm^3 of fluid tailings had achieved RTR status, up from 19.9 Mm³ in 2021.

The RTR status requires meeting the following approved subobjective 1 and subobjective 2 criteria at Kearl (see table 15).

Table 15. RTR criteria for Imperial Kearl

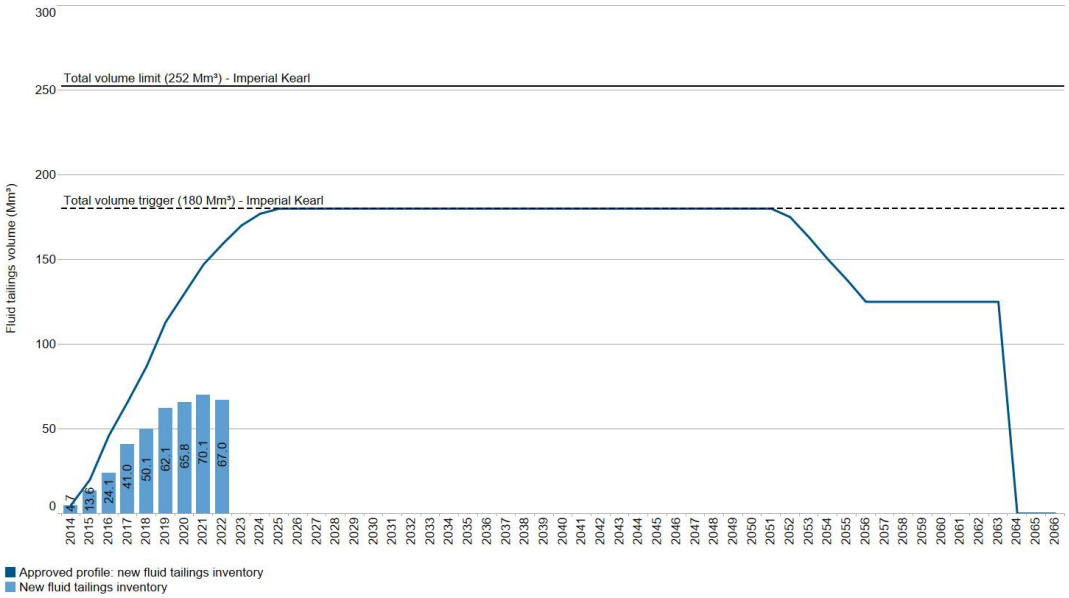
Deposit	Subobjective	RTR Criteria
EETA	subobjective 1	TT deposit: 65% solids content by weight within one year of treated fluid tailings placement based on deposit sampling
	subobjective 2	Groundwater is monitored in accordance with *EPEA* approval 00046586-01-00, as amended or renewed

8.7.1.1 New Fluid Tailings

For 2022, Kearl reported a new fluid tailings inventory of 67 Mm³ (see figure 17), down from 70.1 Mm³ in 2021. The approved new fluid tailings inventory for 2022 was 159 Mm^3.

Kearl has a total volume trigger for new fluid tailings inventory of 180 Mm³ and a total volume limit of 252 Mm³. Based on data reported in its 2022 TMR, Kearl was within its approved new fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.

In March 2022, Kearl submitted a new TMP with a revised fluid tailings profile. The AER is currently reviewing the TMP.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.
Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 17. New fluid tailings for Imperial Kearl, 2014 to 2022

8.7.1.2 Legacy Fluid Tailings

Imperial Kearl does not have any legacy fluid tailings (i.e., fluid tailings in storage before January 1, 2015). The small amount of fluid tailings on the site in 2014 is considered new fluid tailings to simplify fluid tailings management and reporting.

8.7.2 Volume of Treated Fluid Tailings by Technology

For 2022, Kearl reported that 28 Mm^3 of fluid tailings were treated with TT, up from 26 Mm^3 in 2021.

For 2022, Kearl reported that 25.0 Mm^3 of fluid tailings achieved RTR status in the EETA. The RTR volume increased from 20.4 Mm^3 reported in 2021.

8.7.3 Treatment Options and Continuous Improvement

Kearl reported that its tailings treatment technologies are currently performing as expected, and deposits are meeting subobjective 1 criteria.

Kearl reported the following operational challenges and continuous improvement activities ongoing throughout 2022:

- Lower solids throughput from the flotation system to KFTT. This reduction was offset by increasing fluid tailings flow rates to the thickener during times when flotation tailings were available.
- KFTT thickener underflow pumps and piping challenges. Studies were initiated to modify the thickener underflow pump gland water control scheme. Engineering was completed to upgrade the thickener underflow piping system with a chrome carbide overlay.
- Fluid tailings barge reliability issues were caused by debris ingestion. Improvements were made by undertaking a barge pump hydraulic study, improving pump vendor parts inventory, and initiating a study to supplement the barge system with dredge technology.
- Thickener overflow water pump failures. New pumps were ordered, and the bitumen separation tank was cleaned to reduce solids carryover. Initiated the install of a tank recirculation system to reduce solids accumulation upstream of the overflow water pumps.
- Passing valves led to various challenges. A new valve design was tested.
- Fluid tailings potential coning. Installed better seals on pump caissons and engaged external support.

For more information, see the Imperial Kearl 2022 TMR.

8.7.4 Technological Innovation in Fluid Tailings Treatment

Kearl has several ongoing tailings pilots:

- in-line flocculation on-site fluid tailings pilot phase 3 extension
- in-line flocculation on-site fluid tailings pilot phase 4/5 extension
- enhanced beach fines capture field pilot extension

For more information on Kearl's research and development initiatives, see the 2022 TMR.

8.7.5 Regulatory and Management Actions

On May 19, 2022, Imperial reported that discoloured surface water was found on the site and at locations off the site to the north and northeast of the approved Kearl project boundary. The AER inspected the areas and confirmed the presence of discoloured water in muskeg areas and on public lands inhabited by various wildlife species and near a fish-bearing water body and tributaries of the Firebag and Muskeg Rivers.

Imperial conducted sampling from June to August 2022 and confirmed in September that the discoloured water was industrial wastewater. In September 2022, the AER issued a notice of noncompliance to Imperial under its *EPEA* approval 00046586-01-00, as amended, sections 4.2.1 and 4.2.3 for releasing industrial wastewater from its site to the surrounding watershed and for failing to manage and contain the industrial wastewater as per its *EPEA* approval.

In November 2022, Imperial confirmed seepage from the ETA was the source of the industrial wastewater affecting shallow groundwater and surface water on the site and beyond the approved Kearl project boundary. The chemistry of the industrial wastewater exceeded the Alberta Environment and Protected Areas and the Canadian Council of Ministers of the Environment guidelines for several constituents.

In December 2022, Imperial installed additional seepage interception wells and delineation groundwater wells along the perimeter of the ETA and submitted a plan to the AER that included actions both on and off the site to prevent further release of industrial wastewater. However, Imperial identified it would not complete the off-site activities before spring freshet. At the end of January 2023, the ETA continued to release industrial wastewater into the environment.

In February 2023, the AER issued an environmental protection order (EPO) to Imperial for the ETA seepage event and a separate 2023 event where industrial wastewater overflowed from a storage pond. Subsequently, the AER initiated two formal investigations related to these incidents, which are still ongoing.

The AER determined that the ETA seepage incident requires additional work; therefore, it continues to oversee Imperial's compliance with the EPO to ensure the AER's priorities of public safety and environmental protection are met.

Considering the active EPO and the ongoing investigations, the AER cannot determine Imperial Kearl Mine's management level for its tailings operation based solely on the 2022 TMR submission. The AER continues to review the information gathered as part of the EPO and from the ongoing formal investigations. Treated tailings deposits must achieve approved performance criteria in order to evaluate whether they are on the predicted trajectory to allow their removal from the fluid tailing inventory. Each treated tailings deposit will have approved indicators that must be measured to determine if the performance criteria have been achieved. See table 15 for Imperial's subobjectives 1 and 2 RTR criteria. Should the review indicate that Imperial has not met and maintained its approved RTR criteria, the AER will take the following actions:

- Review and potentially deny fluid tailings volumes reported by Imperial as meeting approved RTR criteria and return those volumes back to the fluid tailings inventory; this means Imperial will not have any fluid tailings volumes meeting RTR criteria.
- Determine the appropriate management level classification to Imperial's tailings operation.
- Use any regulatory instruments, including regulatory tools and enforcement actions it deems appropriate, depending on the classification of the management level.
- Formally communicate to Imperial the decision regarding its RTR criteria compliance status, the classification of the management level of its tailings operation, and the applicable regulatory and enforcement actions.

For more information on management levels and potential management actions see section 10 of *Directive 85* on compliance and enforcement.

For more information regarding the EPO, see the AER compliance dashboard and News and Announcements.

Regarding applications related to tailings, Imperial submitted the integrated mine plan amendment, TMP, and life-of-mine closure plan application on March 31, 2022; the application is currently under review by the AER.

This section of the report only contains information available at the time of writing.

8.7.6 Measurement System Audit Results

Imperial Kearl submitted an updated MSP in 2022 in accordance with the AER's February 2022 and June 2022 letters concerning water quality characterization and reporting.

The AER did not audit Kearl's MSP in 2022.

8.8 Suncor – Fort Hills

In 2022, two tailings facilities were operating at the Suncor Fort Hills (see table 16).

Table 16. Tailings facilities operating at Suncor Fort Hills

Facility	Function	Contents
Out-of-pit tailings area (OPTA)	• fluid and solid tailings storage • recycle water source	• CST • fluid tailings • recycle water
Out-of-pit tailings area east stage 1 (OES1)	• solid tailings storage	• CST

OPTA and OES1 are the only tailings facilities at the site and are both out-of-pit facilities. The tailings facilities vary in their primary function, contents, and size. Suncor Fort Hills was managing all its fluid tailings in OPTA until March 2022. Starting in April 2022, Suncor Fort Hills initiated OES1 as a new sand dump facility. OES1 intermittently received tailings sand within the facility. Runoff from the tailings sand, which forms fluid tailings, is pumped back to OPTA.

Suncor Fort Hills does not have an approved tailings treatment technology. The AER has authorized the continued use of existing infrastructure, specifically thickeners, which are expected to benefit tailings management as they can decrease the volume of fluid tailings generated. As part of Suncor Fort Hills' integrated project amendment (IPA) application submitted in 2022, Suncor Fort Hills proposed treating fluid tailings using the PASS technology. The AER is currently reviewing the application. Pending a decision on the IPA, Suncor Fort Hills is subject to multiple conditions as part of decision 20190225A (see section 8.8.5), including the following:

- By September 30, 2023, Suncor Fort Hills is required to submit feasible alternative treatment technologies and an implementation plan to manage the volume of fluid tailings planned to be treated by the PASS technology and subsequently capped by water.

Suncor Fort Hills reported that its new fluid tailings inventories for 2022 were within the approved fluid tailings profiles.

8.8.1 Fluid Tailings

For 2022, Suncor Fort Hills reported a total fluid tailings inventory (all new fluid tailings) of 48 Mm^3, up from 36 Mm^3 in 2021.

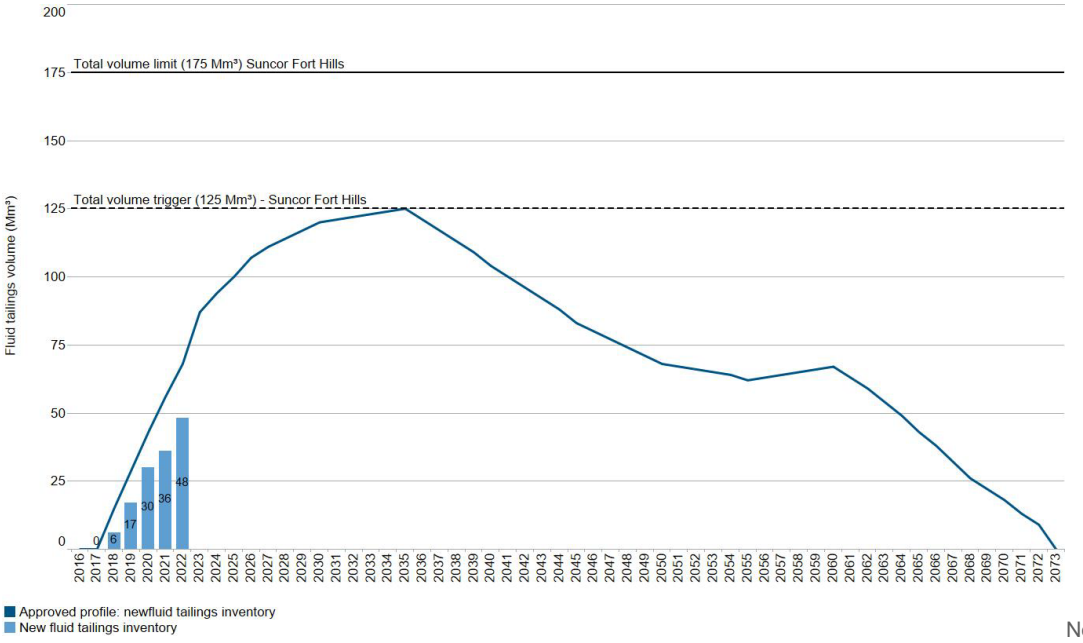
The volumes reported for 2022 fall within the approved profile for new fluid tailings. Suncor Fort Hills did not report any tailings meeting RTR criteria because it does not have approved RTR criteria. As part of its IPA, Suncor Fort Hills has proposed RTR subobjective 1 and 2 criteria for all its fluid tailings deposits. These are currently under review.

8.8.1.1 New Fluid Tailings

For 2022, Suncor Fort Hills reported a new fluid tailings inventory of 48 Mm³ (see figure 18), up from 36 Mm³ in 2021. The approved new fluid tailings inventory for 2022 was 68 Mm³.

Suncor Fort Hills has a total volume trigger for new fluid tailings inventory of 281 Mm³ and a total volume limit of 393 Mm³. Based on data reported in its 2022 TMR, Suncor Fort Hills was within its approved new fluid tailings profile and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2022.

SIRs were posed concerning volumes of new fluid tailings based on the 2022 submission.



Note: Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing whether volumes meet the ready-to-reclaim criteria.

Data are from the site-wide fluid tailings inventory table (appendix 3 of *Directive 085*) submitted annually by operators.

Figure 18. New fluid tailings for Suncor Fort Hills, 2016 to 2022

8.8.1.2 Legacy Fluid Tailings

Suncor Fort Hills does not have any legacy fluid tailings (i.e., fluid tailings in storage before January 1, 2015).

8.8.2 Volume of Treated Fluid Tailings by Technology

For 2022, Suncor Fort Hills did not report any volume of treated fluid tailings because it does not have an approved fluid tailings treatment technology. As part of Suncor Fort Hills' IPA application submitted in 2022, Suncor Fort Hills proposed treating fluid tailings using the PASS technology. The application is currently under review. As part of its IPA, Suncor Fort Hills has proposed RTR subobjective criteria for all its fluid tailings deposits:

8.8.3 Treatment Options and Continuous Improvement

Suncor Fort Hills reported that its tailings treatment technologies are operating as expected, and deposits remain aligned with long-term closure and reclamation objectives.

8.8.4 Technological Innovation in Fluid Tailings Treatment

Suncor Fort Hills reported the following technology research and development efforts concerning the implementation of PASS at Fort Hills for 2022:

- ongoing monitoring of geo-column, large-strain consolidation, and centrifuge testing for data collection related to consolidation of deposits. The data reportedly indicated that deposits continue to consolidate as expected;
- ongoing geochemical analysis of expressed water collected from treated tailings. The data was reported to show on-specification performance for released water;
- completing investigations into biodegradation rates of pentane in tailings after treatment with PASS. The data was reported to demonstrate that the kinetics of pentane biodegradation is very fast.

For more information on Suncor Fort Hills' research and development initiatives, see the 2019, 2020, and 2021 TMRs.

8.8.5 Regulatory and Management Actions

Suncor Fort Hills operates at management level 1 as described in the *TMF* and *Directive 085.*

On February 9, 2022, Suncor Fort Hills submitted the Fort Hills IPA amendment application, which is currently under review by the AER. The application requests amendments to

- update the Suncor Fort Hills mine, tailings, and life-of-mine closure plans and
- adjust the project boundaries to accommodate infrastructure in support of mine development.

Suncor Fort Hills also applied for the geotechnical design of the Fort Hills Aurora pillar dam to be constructed at the boundary between Syncrude's Aurora centre pit north and Fort Hills' south pit tailings storage areas. The design and construction timing of the dam potentially affect the schedule for depositing tailings into each storage area. The AER has approved the application.

No management actions were taken during the 2022 reporting period for tailings management operations at Suncor Fort Hills.

8.8.6 Measurement System Audit Results

Suncor Fort Hills submitted an updated MSP on December 15, 2022, in accordance with the AER's February 2022 and June 2022 letters concerning water quality characterization and reporting.

The AER did not audit Suncor Fort Hills' MSP in 2022.

9 Summary

Tailings management under *Directive 085* continued in 2022. Operators were required to start full *Directive 085* reporting in the 2018 reporting year. By the end of 2019, all eight operating oil sands mines had approved TMPs in place. Seven of eight oil sands mine operators submitted amendments to their TMPs in 2022 and early 2023. The AER is currently reviewing them.

The AER assessed the MSPs submitted by the operators related to determining whether the physical properties of the tailings deposits are on a trajectory to support future stages of activity (subobjective 1 in *Directive 085*, fluid tailings volumetric calculations, laboratory testing).

In addition, the AER assessed the groundwater monitoring portion of subobjective 2 in *Directive 085*. The AER continues to assess MSPs to address the need to minimize the effects the deposits have on the surrounding environment to ensure it will not compromise the ability to reclaim the area to a locally common, diverse, and self-sustaining ecosystem (subobjective 2)—related to water quality characterization and the measurement of chemicals of potential concern—and may issue additional SIRs in the future.

In 2022, the AER issued a notice to oil sands mining operators clarifying the *Directive 085* water quality characterization and reporting requirements for tailings surface water. Operators submitted updated MSPs to reflect the changes. The AER is currently reviewing the updated MSPs. The operators included sampling and characterization of water overlying treated tailings deposits and fluid tailings ponds in their 2022 TMRs.

The tailings MSPs are live documents that must be regularly updated with changes to reflect current best practices and operations. Operators must notify the AER of all plan changes.

The tailings volumes in this report are presented as reported by operators and are subject to change upon further review of fluid tailings volumes, including assessment of whether they meet RTR criteria.

The total volume of fluid tailings (new and legacy tailings combined) on oil sands mine sites in the Athabasca oil sands region increased between 2014 and 2022. New and legacy fluid tailings inventories are projected to continue increasing based on the combined approved fluid tailings profiles. The total regional volume of fluid tailings remains below the new and legacy fluid tailings profiles for all operators combined.

The regional volume of water in tailings ponds decreased from 2014 to 2017, then increased until 2020. The maximum regional volume of water in tailings ponds was 479.3 Mm^3 in 2020. The regional total volume of water in tailings ponds has since decreased to 417.5 Mm^3 in 2022. This may have resulted from recycle water use and a return to average regional rainfall volumes.

Based on the fluid tailings volumes reported in the 2022 annual reports submitted by operators, all operators were below their approved new fluid tailings profiles, total volume triggers, and total volume limits. Other than Syncrude Mildred Lake, all operators were below their legacy fluid tailings profile. Syncrude Mildred Lake was above its legacy fluid tailings profile from 2017 to 2022. All operators, including Syncrude Mildred Lake, were below their 20% deviation triggers for new and legacy fluid tailings.

No change in management level (as described in *Directive 085*) was required for any operators, based on the 2022 TMR submissions, because their volumes were within the total allowable volume triggers and limits.

The AER issued a notice of noncompliance to Imperial Oil Resources Limited (Imperial) Kearl under its *EPEA* approval in September 2022 for releasing industrial wastewater from its site and failing to manage and contain the industrial wastewater. In 2023, the AER issued an EPO to Imperial due to the seepage event and a separate industrial wastewater storage pond overflow that took place in 2023. The AER initiated two formal investigations related to the two incidents. These two investigations are ongoing, and the AER continues to review information gathered from the investigations to determine if treated tailings deposits are achieving subobjective 2 performance criteria. Should the review indicate Imperial has not met and maintained its approved RTR criteria, the AER will determine the appropriate management level and management responses.

Where information was insufficient for the AER to verify operator data or analyses, the AER issued requests for clarification or additional data. Reponses to requests that were not received or reviewed before finalizing this report were not included. Requests for clarification or additional data are part of an ongoing iterative process between the AER and operators. Operators require time to collect data, complete analyses, or review calculations before submitting responses to the AER. This report only includes information that was available at the time of writing. Responses may lead to changes in reported data or analyses from previous years, which will be reflected in the 2023 report.

Operators continue to develop and pilot new technologies to treat fluid tailings and report on improvements in tailings treatment technologies. The AER will review and evaluate technologies and deposit designs that show promise for treating and reducing fluid tailings volumes. The AER expects future submissions and applications regarding updated TMPs to include

- research and monitoring information that resolves outstanding risks and uncertainties about reclaiming treated fluid tailings deposits (including settlement, capping, and capping material availability);
- justification for RTR criteria and trajectories proposed for the demonstrated fluid tailings treatment technologies that will allow operators to achieve their targeted range of ecosites;

- justification that fluid tailings inventory profile requirements can be met; and
- a feasible alternative to water capping at sites wherever it has been proposed as a treatment.

The *TMF* states that the approved fluid TMPs must be reviewed by the AER every five years or as necessary over the course of the mine life. This review will ensure that the profiles and thresholds are in line with projections and reflect current technology, new knowledge, and continuous improvement.

10 Future Major Submissions

The AER will continue public reporting and will ensure the transparency of fluid tailings monitoring data received from operators. Future AER reports on tailings management will

- evaluate regional performance against the *TMF*'s outcomes and objectives and
- identify operators that are performing well and those that need to make improvements (in accordance with *Directive 085*).

Future submissions from operators are required in the coming years that will inform evaluations of regional and individual operations' tailings management performance. These reports include the following:

- Suncor Base Plant:
  - September 30, 2023: A plan that updates MD9 tailings management.
  - September 30, 2023: A plan for updates to tailings management for ponds 1A and 2/3.
  - December 31, 2023: A plan that updates MD9S tailings management, design, and reclamation activities.
  - September 30, 2024: A plan that updates pond 7 fluid tailings management.
- CNUL Muskeg River Mine:
  - An updated TMP one year before fluid or treated tailings are placed in a tailings facility.
- CNUL Jackpine Mine:
  - An updated TMP one year before fluid or treated tailings are placed in a tailings facility.
- CNRL Horizon:
  - June 30, 2024: An updated fluid TMP.
  - A plan that updates fluid tailings management for all tailings facilities one year before placing fluid or treated tailings.
- Imperial Oil Kearl

  - A life-of-mine closure plan
- Suncor Fort Hills:
  - March 31, 2023: A plan for the PASS technology demonstration.
  - September 30, 2023: An update on TSRU tailings management.
  - September 30, 2023: A plan for the feasible alternative technologies to PASS technology.
  - September 30, 2026, or within 24 months of commencement of the PASS technology pilot, whichever date occurs first, application for an updated TMP.

Appendix 1 Tailings Treatment Technologies

Thin-Lift Drying

Thin-lift drying is a process whereby fluid tailings are removed from tailings ponds and mixed with additives that bind the particles in the fluid tailings together. The fluid tailings with the additives are then thinly spread over a large area. Gravity and capillary action allow the water to drain away, and ambient conditions (evaporation and freeze-thaw cycles) facilitate the drying of fluid tailings within a couple of weeks. Once dry, another layer, or "lift," is added, and the process is repeated.

Suncor Base mine uses thin-lift drying technology to move treated fluid tailings that meet the initial drying area ready-to-reclaim (RTR) criteria to the final placement location. This technology is referred to as a tailings reduction operation by Suncor and as atmospheric fines drying by Canadian Natural Upgrading Limited (CNUL) Muskeg River mine.

Thickened Tailings as an Initial Treatment

Tailings thickening is a process whereby fluid tailings from bitumen extraction plants are sent to a thickener where flocculants are added to bind the smaller particles together to create thickened tailings (TT). The warm water released from the tailings is recycled back to the extraction plant. The process is an initial stage of fluid tailings treatment, and operators employ different secondary stages of treatment and placement of TT for treated fluid tailings deposits.

The Suncor Fort Hills mine, CNUL Muskeg River mine, CNUL Jackpine mine, and Imperial Kearl use conventional thickeners to produce a TT stream, with some variations. Operators use the following as a second stage of treatment:

- CNUL Muskeg River mine is co-depositing TT, tailings solvent recovery unit tailings, whole tailings (WT), and coarse sand tailings (CST) in a single deposit, creating a north pool deposit type.
- CNUL Jackpine mine is co-depositing TT, WT, and CST in a single deposit, creating a mixed deposit type.
- Imperial Kearl treats TT with a secondary polymer addition before placement in its tailings deposit.

Operators are targeting a terrestrial closure with wetlands for their deposits and are required to provide updated modelling for the deposits. Suncor Fort Hills does not have an approved closure plan for its TT.

Nonsegregating Tailings and Composite Tailings Deposits

Nonsegregating tailings (NST) technology requires the use of a thickener. The TT is mixed with sand from the extraction plant and a coagulant. The mixture is then placed into a tailings deposit.

Composite tailings are like NST, but instead of using TT, fluid tailings from ponds are mixed with sand from the extraction plant and a coagulant. The mixture is then placed in a tailings deposit.

Canadian Natural Resources Limited (CNRL) Horizon uses NST technology. Syncrude Mildred Lake, Syncrude Aurora North, and CNUL Muskeg River mine all use composite tailings, with some variations.

CNRL Horizon, Syncrude, and CNUL are targeting a terrestrial closure with wetlands for their deposits and are required to provide updated modelling and RTR trajectory for the deposits.

Fluid Tailings Centrifugation

Fluid tailings centrifugation is a process whereby fluid tailings are removed from the tailings ponds and a flocculant is added to bind the small particles together. The mixture is pumped into a centrifuge where the water is spun out. The dewatered tailings are placed in a deposit.

Syncrude Mildred Lake and CNUL Jackpine mine use fluid tailings centrifugation at their sites. Syncrude Mildred Lake is currently pilot testing unique capping techniques required for centrifuge cake deposits. Both operators are targeting a terrestrial closure with wetlands for their deposits. CNUL is required to update its centrifuge initial RTR criteria, and both operators are required to provide updated modelling and RTR trajectory for deposits to understand performance in deposits of increasing sizes.

Permanent Aquatic Storage Structure

Suncor is demonstrating performance of a new treatment technology in its commercial-scale implementation of the permanent aquatic storage structure (PASS) technology. Phase 1 is the initial treatment of fluid tailings with a coagulant and a flocculant with the treated mixture placed in a deposit. The AER has approved the implementation of phase 1 only, subject to approval conditions to manage uncertainties and long-term reclamation risks since performance assumptions have not been verified at the scale and complexity of Suncor's dedicated disposal area 3. Suncor is required to prove the efficacy of a unique capping technique to provide a terrestrial closure on PASS-treated fluid tailings.

Suncor is required to

- validate its RTR criteria and RTR trajectory performance for phase 1 at a large scale and
- submit research and implementation plans for terrestrial or aquatic closure options for phase 1 PASS-treated tailings in DDA3 to support a decision for the proposed closure approach in 2023.

Water-Capped Tailings

Water-capped tailings is an unapproved technology currently in the demonstration and experimental phase at Syncrude and Suncor. Water capping involves placing water above untreated tailings (Syncrude Base Mine Lake at the Mildred Lake mine) or treated tailings (phase 1 PASS-treated tailings in Suncor demonstration pit lake at the Suncor Base mine) to create a water-capped deposit (e.g., a water-capped pit lake) as a landscape feature.

The proposed water capping of untreated or treated fluid tailings at oil sands mines is not authorized by the AER because the technology is subject to further assessment, research, and future policy. Except for the identified demonstrations, all tailings management plan approvals prohibit the creation of a water-capped pit lake. The AER's decision about water-capped pit lakes, including their prohibition and the need for feasible alternative tailings treatment technologies, is provided in the water-capping technology section of the tailings management plan decision reports and in operator approvals.

Appendix 2 Tailings Field Inspection Summaries

Summary of the AER 2022 Tailings Field Inspection for Suncor Base Plant

Summary of the AER 2022 Tailings Field Inspection for Syncrude Mildred Lake and Aurora North

Summary of the AER 2022 Tailing Field Inspection for CNUL Muskeg River Mine

Summary of the AER 2022 Tailings Field Inspection for CNUL Jackpine Mine

Summary of the AER 2022 Tailings Field Inspection for CNRL Horizon

Summary of the AER 2022 Tailings Field Inspection for Imperial Kearl

Summary of the AER 2022 Tailings Field Inspection for Suncor Fort Hills

Summary of the AER 2022 Tailings Site Inspection for Suncor Base Plant

TAILINGS FACILITIES INSPECTION
Suncor Base Plant – MD9 South

Project	Base Plant	**OSCA Approval**	8535S	**Inspection Date:**	2022-06-14
Facility Owner	Suncor	**Fluid Containment Types**	Overburden; Tailings	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Facility operation	No visible concerns. Material is trafficable, but wet.	Photo 1

Photo 01 – MD9 South overburden/treated tailings co-deposition dumping locations

Suncor Base Plant – South Tailings Pond

Project	Base Plant	**OSCA Approval**	8535S	**Inspection Date:**	2022-06-13
Facility Owner	Suncor	**Fluid Containment Types**	Tailings; Process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Facility operation	No visible concerns	Photo 2

Photo 02 – South Tailings Pond Beach and Barge Access

Suncor Base Plant - Pond 8B

Project	Base Plant	**OSCA Approval**	8535S	**Inspection Date:**	2022-06-13
Facility Owner	Suncor	**Fluid Containment Types**	Tailings; Process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Decommissioning	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Facility Operation	On-going dewatering/draining of facility Visible exposed vegetation in pond. ASE inspector to follow up with Suncor operations. No visible bitumen No visible containment concerns	Photo 3

Photo 03 – Dewatering on Pond 8B. Visible vegetation.

Suncor Base Plant - Dedicated Disposal Area 3

Project	Base Plant	**OSCA Approval**	8535S	**Inspection Date:**	2022-06-13
Facility Owner	Suncor	**Fluid Containment Types**	Tailings; Process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Facility Operation	No visible bitumen. No visible containment concerns. No visible concerns.	Photo 4

Photo 04 – DDA 3. No visible concerns

Suncor Base Plant - Lake Miwasin

Project	Base Plant	**OSCA Approval**	8535S	**Inspection Date:**	2022-06-13
Facility Owner	Suncor	**Fluid Containment Types**	Water	**Company staff**	[redacted]
Life Cycle Phase	Operating	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Facility Operation	No visible concerns	Photo 5

Photo 05 – Lake Miwasin

Suncor Base Plant – Sand Dump 8

Project	Base Plant	**OSCA Approval**	8535S	**Inspection Date:**	2022-06-13
Facility Owner	Suncor	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Facility Operation	No visible containment concerns Presence of bitumen mat	Photo 6 Photo 7

Photo 06 – Bitumen mat on Sand Dump 8

Photo 07 – Sand Dump 8 Barge

Summary of the AER 2022 Tailings Site Inspection for Syncrude Mildred Lake and Aurora North

Alberta Energy Regulator

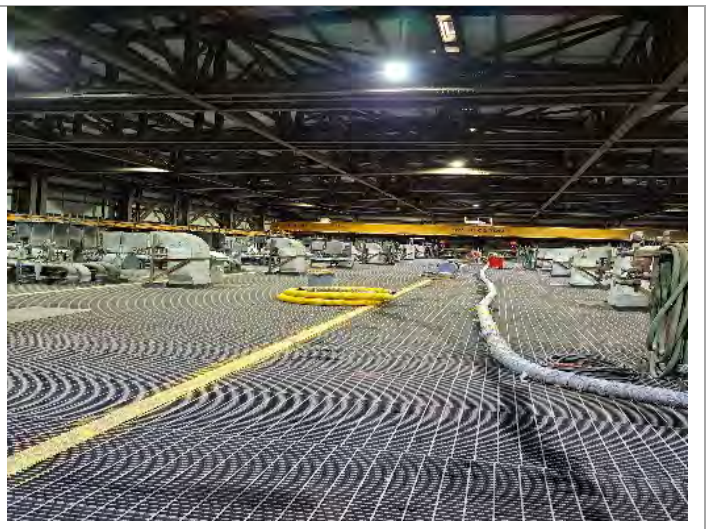
TAILINGS FACILITY INSPECTION
Mildred Lake

Inspection Result
Compliant

Project	Mildred Lake	**OSCA Approval**	8573R	**Inspection Date:**	2022-10-03
Facility Owner	Syncrude	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
MLSB FT Transfer Station	Observed valve transfer station to divert FT to CC/ILF or to NMSP. Important for maintaining mudline and free water cap quality	

Centrifuge Cake (CC) Plant	Observed CC plant centrifuge building; process currently S/D for the year; target production volume achieved	 

In-Line Flocculation (ILF) Plant	Observed ILF pilot plant	 
CC Deposit	Observed the CC deposit showing drying and desiccation of deposit crust	

ILF Deposit	Observed ILF deposit from a distance; deposit appeared flat, consistent with a fine tails deposit	
TMP	• No CT is being produced at ML • CC plant S/D despite FT inventory above target 3 years running; SCL claims they met their CC production target for the year • ILF plant is only a pilot plant; no where near large enough yet to make a difference in reducing FT inventory • ILF to full capacity by 2025; target compliance to FT inventory by 2027 with combined capacity of CC and ILF	

Findings: Observation, non-conformance, safety deficiency, or Critical safety deficiency

Type of finding	Description	Compliance
Observation	No visible concerns	Compliant

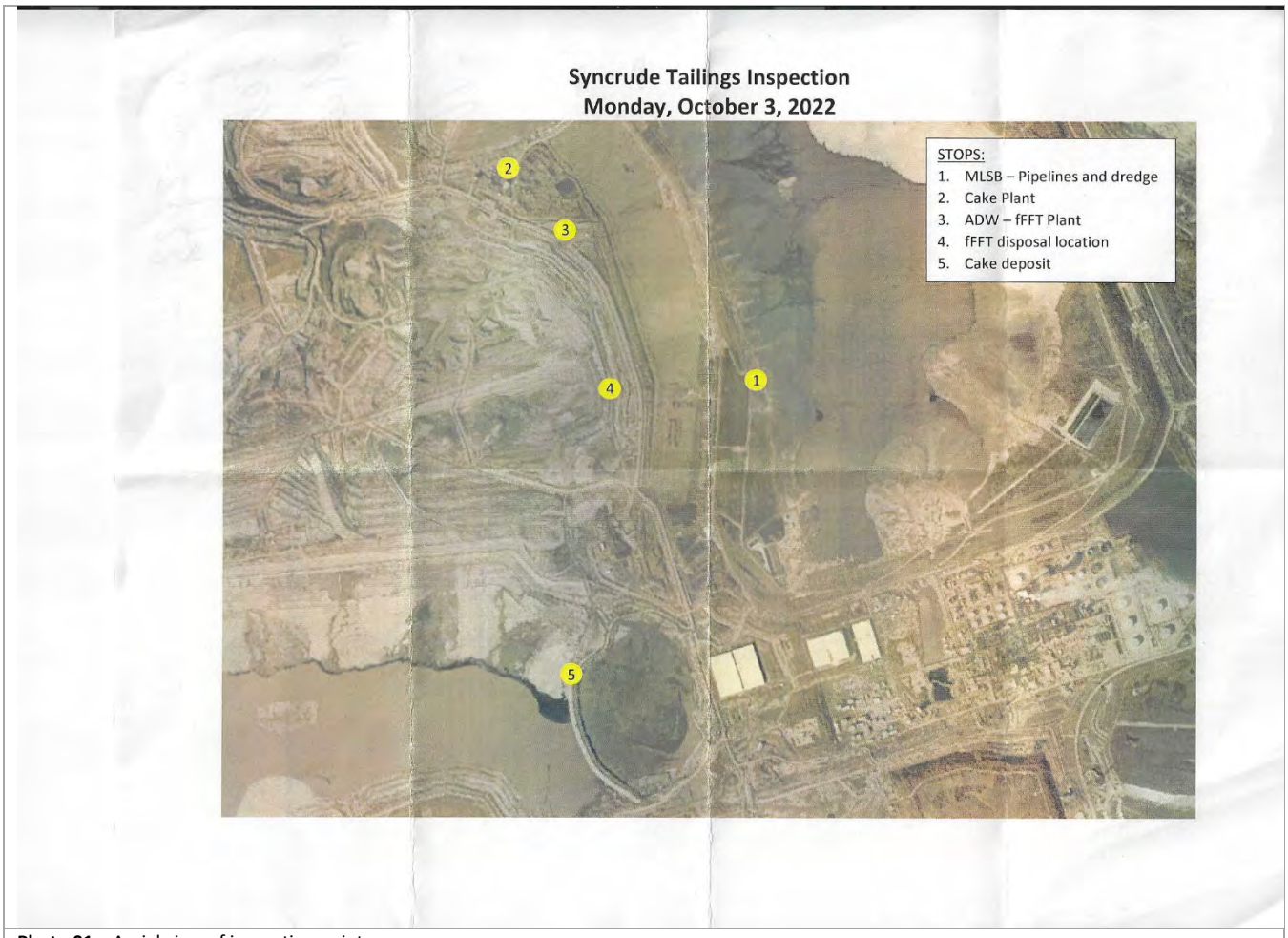


Photo 01 – Aerial view of inspection points

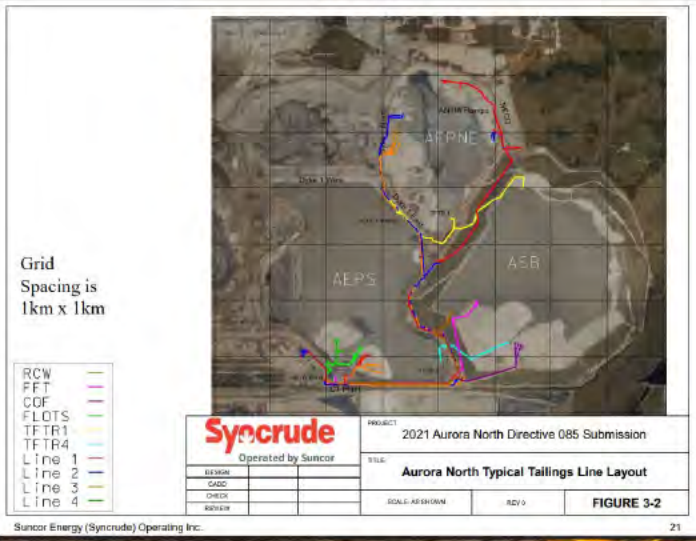
TAILINGS FACILITY INSPECTION
Aurora North (AN)

Alberta Energy Regulator

Inspection Result
Compliant

Project	Aurora North	**OSCA Approval**	10781P	**Inspection Date:**	N/A
Facility Owner	Syncrude	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
General	No in-person on-site tailings inspection deemed necessary for AN (virtual inspection only) • CT operations resumed in 2022, • New and legacy FT inventories below approved volumes and on a downward trend • AN operations compliant with approved D85 FT profile • Schedule to be provided for ILF plant development in AN TMP for 2023 • ILF pilot at ML applicable to AN	
CT Operations	CT operations resumed in 2022 to plan Aurora CT plant and deposit 2022	 

In-Line Flocculation or Accelerated Dewatering (ADW) Pilot development /testing.		 Figure 7-4 ADW Mixing Pilot Field Overview (2013)  Figure 7-3 Overview of ADW Pilot Phase 1 Deposit

Findings: Observation, non-conformance, safety deficiency, or Critical safety deficiency

Type of finding	Description	Compliance
Observation	No visible concerns	Compliant

Summary of the AER 2022 Tailings Site Inspection for CNUL Muskeg River Mine

Alberta Energy Regulator

TAILINGS FACILITY INSPECTION
Canadian Natural Upgrading Ltd.
Muskeg River Mine

Inspection Result
Compliant

Project	Muskeg River Mine	**OSCA Approval**	8512 N	**Inspection Date:**	2022-09-14
Facility Owner	Canadian Upgrading Limited	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Active deposition into facility	• AFD interim placement location success is mainly contributed to surface water management / removal. • ETF infilling progress is substantial. Treated beach below water (BBW) is coming to surface as CST deposition pushes the BBW toward the northern shallower area. The pushed-up material rises to a certain extent and then fails under its own weight to shallow out once again. This beach behaviour has been occurring for the past few years. • The deepest location in the ETF has been infilled, significantly progressing the ETF towards closure as per plan.	Photos 1-2
Active withdrawal from facility	• In recent years fluid tailings (FT) transfer in the ETF was difficult to maintain due to the lack of recharge occurring in the zone of influence of the dredge. • CNUL MRM has deployed up to 3 floating backhoes to disturb the FT to enhance its movement toward the dredge. • The last year of FT transfer has been one of the best for the history of the ETF, which led to the highest year of AFD production. • The ETF is anticipated to complete the Blanket Cap layer in the next 5 years.	Photos 1-2
Beach above water	• BAW development from BBW in ETF has been happening for ~ 2 years. It rises and then falls with the aid of floating backhoes destabilizing the deposit to encourage flow towards the fluid transfer system (dredge). While in the raised phase, the surface drains and dries to a certain extent creating a crust at surface. This may be of concern for creation of potential bird islands. CNUL has executed their bird protection protocol and no incidents have been recorded to date. • The AER geotechnical SME is to be consulted on potential dam safety concerns with the potential of a wave creation from the rise and fall of material risking containment for current and future infilling activities. • A small volume of material was observed to have a green colour. Questions of whether this colour was due to vegetation or the drying and draining of froth tailings treated material was raised. EPEA coordinator is to be notified consulted on whether additional path forward is required.	Photos 1-2
Beach below water	• In the ETF the BBW material slope that is pushed up to surface is failing intentionally with the aid of the floating backhoe activity. These BBW failures have been instrumental in ensuring feed to the dredge for tailings treatment.	Photos 1-2

Containment	• The newly constructed ETF Ring Berm has allowed for a raise in the ETF pond elevation. The increased freeboard allowed for infilling activity to progress efficiently and safely to maintain trajectory to closure.	Photos 1,2 and 10
Exposed vegetation in pond	• A small green coloured volume of material was observed on the beach of the ETF. It is unclear to the AER if the material was floating vegetation or drained (oxidized) froth tailings. Follow-up may be required on this matter.	Photo 16
Presence of hydrocarbons / bitumen	• Bitumen was observed along the pond edge of IPC 3 where froth tailings is currently being deposited.	Photos 12-13
Instrumentation / Testing (condition of/access to)	• Settlement plate field instrumentation setup in the AFD interim placement cells were visited. • Additional information on collected data and analysis is required as follow up documentation to share current learnings and application of these learnings to future TMP and LMCP plans.	Photo 8
TMP	• IPC 3 5m Blanket Cap layer was observed. The current TMP and LMCP basis is 3m, follow-up questions required regarding material balance for full site capping strategy.	Photo 13
OSCR /EPEA	• EPEA Coordinator – Consultation on potential vegetation or oxidized froth tailings in ETF. • OSCA – Geotechnical SME consultation of potential dam safety concern of infilling activity observations.	Photo 13

Findings: Observation, non-conformance, safety deficiency, or Critical safety deficiency

Type of finding	Description	Compliance
Observation	ETF infilling beach performance / behaviour to be brought to the attention of Geotechnical SME for assessment.	Compliant
Observation	Blanket Cap layer thickness exceeds the planning basis in TMP and LMCP. Follow-up questions are required via current TMP application.	Compliant
Observation	Provide AER with consolidation modeling input data collection, analysis, and application to TMP and LMCP plans.	Compliant
Observation	Consultation on potential vegetation or oxidation of froth tailings in ETF.	Follow-up Required

Photo 01 – South view from the north end of ETF treated tailings deposit BBW pushed to surface due to infilling.

Photo 02 – North view from the south end of ETF treated tailings deposit BBW pushed to surface due to infilling.

Photo 03 – South view of ETF treated tailings deposit BAW beach development due to infilling.

Photo 04 – Northwest view of freshly deposited AFD on ETF (lower slope).

Photo 05 – Northwest view of freshly deposited AFD on ETF (upper slope).

Photo 06 –West view of older AFD deposit ETF.

Photo 07 – South view of partially drained deposited AFD on ETF.

Photo 08 – East view of partially drained deposited AFD on ETF.

Photo 09 – East view of partially drained deposited AFD on ETF.

Photo 10 – East view of partially drained deposited AFD on ETF (upper to lower slope).

Photo 11 – North view from south end of ETF showing advancement of infilling.

Photo 12 – Northeast view from CST peninsula in IPC 3 showing active deposition and bitumen collection along mixed deposit beach.

Photo 13. North view from IPC 3 peninsula showing 5 m elevation of Blanket Cap layer.

Photo 14. Northeast view from East side of IPC 4 showing establishment of deposition lines.

Photo 15. West south view from the east side of IPC 4 showing establishment of first deposit.

Photo 16. Northwest view from the east side of ETF showing establishment of BBW rising above pond elevation.

Summary of the AER 2022 Tailing Site Inspection for CNUL Jackpine Mine

Alberta Energy Regulator

TAILINGS FACILITY INSPECTION
Canadian Natural Upgrading Ltd.
Jackpine Mine

Inspection Result
Compliant

Project	Jackpine Mine	**OSCA Approval**	9756 I	**Inspection Date:**	2022-09-14
Facility Owner	Canadian Natural Upgrading Limited	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Active deposition into facility	• All beach development was as described in the TMR. • No concerns regarding deposition activity in all facilities.	Photo 1
Active withdrawal from facility	• No withdrawal activity identified during inspection. • It was noted that DDA1 / ETF is coming close to final closure elevation. (Blanket development, as defined by COSIA).	Photo 1 and 3
Beach Above Water (BAW)	• DDA1 / ETF Beach above water was forming around the splitter dike. This observation raised concerns regarding BBW development potentially occurring in SC 1, which does not have RTR criteria at this time. It is noted that The JPM Tailings Management Amendment Application was current submitted and in review for RTR criteria in SC 1. • FC 1 CST and ILF pilot area showed development of a small BAW for both streams. Pilot executed and data is in current review. • No activity was observed at the current beach borrow pit on DDA 1 / ETF where bird noncompliance occurred.	Photo 1-3
Beach Below Bater (BBW)	• Potential development of BBW of treated tailings deposit in SC 1. Indicating the splitter dike no longer is holding back treated tailings solids.	Photo 1
Containment	• No major concerns noted.	N/A
Exposed vegetation in pond	• None observed.	N/A
Presence of hydrocarbons / bitumen	• Floating bitumen was observed in SC 1, along the BAW edge and collecting along a floating walkway. The observed amount was no considered alarming.	Photos 4-5
Instrumentation / Testing (condition of/access to)	• 2022 Annual Tailings Investigation (ATI) was completed. Some data was still outstanding from the lab, all other data is under review.	N/A
TMP	• The verification of treated tailings BBW is required to ensure no deviation from the current TMP SC 1 approvals. • Ensure field conditions align with current RTR Criteria application for SC 1, which is under review.	Photo 1
OSCR /EPEA	• SC 1 deposit verification for RTR criteria compliance.	Photo 1

Findings: Observation, non-conformance, safety deficiency, or Critical safety deficiency

Type of finding	Description	Compliance
Observation	• Evidence of potential beach above water (BAW) forming, which may indicate treated tailings deposited in SC 1. SC 1 has no RTR Criteria assigned. • Follow-up required to obtain 2022 Tailings Investigation cone data to indicate whether treated tailings was deposited in SC 1.	Follow-up required

Photo 01 – South view of over-topped splitter dike between ETF / DDA1 and SC 1.

Photo 02 –North view of FC 1 ILF pilot area.

Photo 03 –West view of DDA 1/ ETF treated tailings (CFFT/TT/CST) deposit.

Photo 04 –South / East view of SC 1 pond with floating bitumen along pond edge.

Photo 05 –South / East view of SC 1 pond with floating bitumen along floating walkway.

Photo 06 –North / West view of FC 1 ILF / CST deposition for pilot.

Summary of the AER 2022 Tailings Site Inspection for CNRL Horizon

TAILINGS FACILITY INSPECTION
Horizon Mine and Processing Plant ("Horizon")

Inspection Result
Compliant

Project	Horizon	**OSCA Approval**	9752I	**Inspection Date:**	2022-09-13
Facility Owner	Canadian Natural Resources Limited	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER (Alberta Energy Regulator) Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Active deposition into facility	NST (non-segregating tailings) discharge lines NST 1 (active); NST 2 (flushed/offline); NST 3 (offline); NST 4 (Y-discharge, active); NST 5 (active) NST 4 line: Horizon was executing a trial using a Y-shaped discharge piece. This study is being undertaken to determine if splitting the flow into 2, (i.e., reducing the flow by half) would provide a less turbulent discharge placement. The intent is to optimize the depositional method to provide an enhanced fines capture in the treated tailings deposit beach. Note: All discharges range between 2-10 m above beach (sub-aerial) NRU3 (active); NRU2 (offline) The fluid transfer from DDA2 to ETF results in the DDA2 pond being kept as low as possible (3-4 m deep small south pond) to maintain dredge floating and gland water pumps functioning. The low/small pond has allowed an increased beach above water length which has been providing promising performance with respect to fines capture. Fluid transfer from DDA2 to ETF to plant. Hundreds of meters between discharge lines. No concerning signs of segregation. Directly at discharge locations due to flushing thin layers of gravel are present near containment structure. This presence of gravel will need to be considered during future consolidation modeling assessments and Life of Mine Closure Plan reviews. No concerns identified during this inspection.	All Photos
Active withdrawal from facility	BWSP2 follow-up presentation regarding closure strategy required for AER to ensure risk, if any, to the Tailings Management Plan (TMP) is addressed.	N/A
Beach above water (BAW)	BAW for the NST (family) technology developing well, colour is light, texture is fine with ~3-inch rocks scattered throughout. Cutting is minor during active discharge. Cutting is visible during switching lines due to flushing activities. This is standard operational activity, no concerns. DDA2 NST beaches are longer, and the pond is smaller. This is showing improvements in NST deposit performance over the last few years. This is in alignment with the indicated sloping in the Tailings Management Report cross sections. BAW for the active NRU (naphtha recovery unit) discharge locations are darker in colour, fine in texture, small cutting observed in non-active beaches, no concerns. Non-active NRU BAW presented a yellow colour on surface. Horizon indicated this BAW was left uncapped for several months, the longest ever. Horizon is currently investigating the presence of this substance with a XRD laboratory test. Follow-up is required on this matter.	All Photos
Beach below water (BBW)	No evidence of instability.	N/A

Containment	The Basal Water Storage Pond 2 (BWSP2) has available storage until 2027. Horizon is approved to increase dike elevation by 2m to achieve 416 m elevation equivalent to a storage capacity of 7.1 Mm^3. In 2019-2020, a buttress was placed to allow this containment construction. The new containment would provide storage until 2031. A 2 m lift is planned to commence in Q4 2022. This construction is of interest to the tailings file because if it is not executed in time, there may be a risk to requiring the use of tailings containment for the basal water. In addition, the closure of the storage facility is of interest as the structure has been penetrated by saline water and if left non-reclaimed, may collect precipitation water. Follow-up is required for the planned schedule of both the dike construction and facility closure. We were unable to visit the site due to time but were given a verbal update. No other containment concerns observed.	N/A
Exposed vegetation / islands in pond	In DDA2 islands were observed surrounded by treated tailings deposits. These islands may be potential bird attractants. No birds were observed during the inspection. AER was told it was In-Pit Dump 1. The AER requires confirmation if the piles in DDA2 observed were from In-Pit Dump 1 South or IPEP Deposition Site.	N/A
Presence of hydrocarbons / bitumen	NRU BAW is darker in colour than NST. Additionally, bitumen was observed at the beach/pond edge.	Photos 2, 3,4,7,9, and 10
Instrumentation / Testing (Condition of/access to)	XRD laboratory testing for presence of new yellow matter on NRU beaches.	Photo 1 and 2
Tailings Management Plan	Potential concerns with containment due to BWSP2 strategy uncertainty.	N/A
Enactments / Conditions	EPEA (Environmental Protection and Enhancement Act): Items are to be flagged to EPEA coordinator and handled by CLM: 1. Wildlife / Birds: a. Potential bird concerns, due to islands. 2. Water quality (surface water and groundwater): a. NRU BAW discolouration that could result in impacts on water quality (and potential for acid rock drainage or ARD). OSCA (TMP): Execution of the current TMP: 1. Implications of froth treatment placement with respect to closure aspects and elevation of water table.	Photos 1 and 2

Findings: Observation, non-conformance, safety deficiency, or critical safety deficiency

Type of finding	Description	Compliance
Observation	NRU Beach discolouration requires follow-up with respect to potential for acid rock drainage (ARD). With respect to EPEA considerations, ARD could result in impacts (increased risk) to water quality (surface water and groundwater) and on closure outcomes. There are associated OSCA impacts on the execution of the approved TMP. Follow-up would be a report/response from Canadian Natural Resources Limited (CNRL) Horizon indicating the composition of the NRU beach (i.e., XRD analysis, etc.).	N/A
Observation	The BWSP2 construction plan was briefly discussed. Follow-up is required as the implication to timeline for execution of BWSP2 containment strategy is not clear, and thus the potential risk to	N/A

	Tailings Management Plan is unclear. Follow-up via OSCA or EPEA will be needed regarding the closure plans for BWSP2.	

Photo 01 –View of exposed NRU beach above water from 1s coke bench: yellow colouring

Photo 02 – View of exposed NRU beach above water from 1s coke bench: bitumen observed.

Photo 03 –View of active discharge line NST 1, beach development.

Photo 04 – View of active discharge line NST 2, beach development, presence of bitumen and gravel.

Photo 05 –View of active discharge line NST 3, beach development, presence of bitumen and gravel.

Photo 06 (a and b) – View of active discharge line NST 4, beach development, lack of bitumen and gravel, split 'Y-Joint' flow.

Photo 07 –View of active discharge line NST 5 beach development, presence of bitumen and gravel.

Photo 08 – Ground view of DDA2 pond and BAW development at pond edge.

Photo 09 –North view from ETF 1s Bench, recently placed NRU beach.

Photo 10 – West view from active NRU line, beach development.

Summary of the AER 2022 Tailings Site Inspection for Imperial Kearl

Alberta Energy Regulator

TAILINGS FACILITY INSPECTION

EETA, WETA, ITA1

Inspection Result
Compliant

Project	Kearl	**OSCA Approval**	10829M	**Inspection Date:**	2022-08-29
Facility Owner	Imperial Oil Resources	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	[redacted]
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
EETA	• TT line running south west corner of EETA • Witnessed dry desiccated TT deposit adjacent TT line discharge • Flocculant plant addition points for KFTT and FT pilot facilities • Co-mixed TT with CST deposit west side of EETA • TT run-off fluid transfer barges to WETA (in background) • Bird deterrent program devices (running, various noises, effective; no birds witnessed on ponds)	Photo 2 • CST beach on TT deposit in background • desiccated TT deposit foreground
WETA	• TSRU jetties/discharge, one leg running (observed black asphaltene beaches) • CST lines running into WETA (foreground) • WETA appears mostly full	Photo 3 WETA facing NW from the dyke between WETA and EETA, active pour
ITA1	• Under construction • No operation (awaiting TMP approval) • TSRU line extensions under construction • No barrier wall construction observed yet	Photo 4 ITA1, SW facing, view from the SW corner of ITA TSRU line extensions down centre of picture
	Picture gallery	

Findings: Observation, non-conformance, safety deficiency, or critical safety deficiency

Type of finding	Description	Compliance
Observation	No visible concerns	Compliant

Photo 01 – Aerial view of guide to picture gallery. Above numbers reference picture numbers.

Photo 02 – CST beach on TT deposit in background, desiccated TT deposit in foreground

Photo 03 – WETA facing NW from the dyke between WETA and EETA, active pour

Photo 04 –ITA1, SW facing, view from the SW corner of ITA

Summary of the AER 2022 Tailings Site Inspection for Suncor Fort Hills

Alberta Energy Regulator

TAILINGS FACILITY INSPECTION
Fort Hills – OPTA and OPTA East

Project	Fort Hills Oil Sands Project	**OSCA Approval**	9241I	**Inspection Date:**	2022-06-13
Facility Owner	Suncor	**Fluid Containment Types**	Fluid tailings and process affected water	**Company staff**	
Life Cycle Phase	Operating / Construction	**Inspection Type**	Proactive	**AER Inspector/Staff**	[redacted]

Observations

Component	Observations	Photos
Active deposition into facility	Coarse tailings cell construction in OPTA. Standard procedures.	Photo 1
Presence of hydrocarbons / bitumen	Visible hydrocarbon in OPTA	Photo 1 Photo 2
Beach above water	No visible concerns in OPTA or OPTA East	Photo 2
Beach below water	No visible concerns in OPTA or OPTA East	
Containment	No visible concerns in OPTA or OPTA East	
Exposed vegetation in pond	No visible concerns in OPTA or OPTA East	

Component	Observations	Photos
Active deposition into facility	Coarse tailings cell construction in OPTA East. No visible concerns	Photo 3

Photo 01 – Cell Construction in OPTA. South perimeter looking NNW

Photo 02 – Cell discharge in OPTA. Noticeable bitumen content.

Photo 03 – OPTA East Beach Above Water

Appendix 3 Fluid Tailings Volume Data

Project	Pond/Facilities	Fluid tailings (Mm^3)								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
Suncor Base Plant	Pond 1A	10.1	10.1	10.1	10.1	10.4	10.4	10.4	10.4	10.4
	Pond 2/3	38.3	35.0	30.7	32.7	33.6	29.8	37.3	36.9	36.9
	Pond 5	18.4	18.4	20.2	-	-	-	-	-	-
	Pond 6	35.2	34.5	35.0	35.5	36.5	37.0	37.0	37.0	32.4
	Pond 7	68.9	69.9	74.5	74.2	73.8	79.3	77.4	75.1	76.9
	Dedicated disposal area 1 (DDA1) (Pond 8A)	0.3	0.3	0.0	-	-	-	-	-	-
	Dedicated disposal area 3 (DDA3)	-	-	-	-	-	-	21.1	1.3	0.5
	Pond 8B	38.5	38.9	36.8	38.9	20.9	14.5	12.5	12.6	11.9
	South tailings pond (STP)	101.0	105.0	105.4	105.7	95.8	90.7	95.9	93.5	97.1
	Sand dump 8 (SD8)	3.4	4.0	3.7	3.2	2.3	0.9	0.8	1.5	0.5
	Total	**314.1**	**316.1**	**316.4**	**300.3**	**273.3**	**262.6**	**292.4**	**268.3**	**266.6**
Syncrude Mildred Lake	Mildred Lake settling basin (MLSB)	177.6	168.1	167.5	141.5	141.2	137.1	133.7	121.2	115.5
	South west sand storage (SWSS)	71.0	80.9	94.2	112.5	116.3	123.1	137.7	137.1	138.5
	Base mine lake / west in-pit (BML)	182.6	182.6	177.4	175.1	172.9	171.5	171.5	169.1	167.7
	East in-pit (EIP)	3.3	1.7	1.4	2.0	1.3	0.8	0.1	0.1	0.0
	South west in-pit junior (SWIP junior)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	South west in-pit major (SWIP major)	33.7	39.4	35.5	37.2	43.6	35.5	28.5	23.6	25.6
	North mine south pit west major (NMSP / NMSPW major)	1.4	3.6	16.0	16.2	18.1	37.8	51.5	73.9	91.4
	North mine south pit east (NMSPE)	N/A	N/A	3.4	4.3	7.3	-	-	-	-
	North mine south pit east deep cake (NMSPE deep cake)	N/A	N/A	5.8	13.3	13.9	19.7	25.6	28.7	37.3
	Total	**469.6**	**476.3**	**501.2**	**502.1**	**514.6**	**525.5**	**548.6**	**553.7**	**576.0**
Syncrude Aurora North	Aurora settling basin (ASB)	83.1	77.6	74.7	72.3	70.4	75.6	86.0	79.1	93.9
	Aurora east pit north-east (AEPN-E)	27.5	38.7	43.5	51.1	50.2	42.5	34.0	24.7	6.8

Project	Pond/Facilities	Fluid tailings (Mm^3)								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
	Aurora east pit north-west (AEPN-W)	2.4	3.1	2.1	0.3	0.0	0.0	-	-	-
	Aurora east pit south (AEPS)	N/A	8.4	10.9	13.2	12.6	18.9	23.8	28.9	40.3
	Total	**113.0**	**127.9**	**131.2**	**136.9**	**133.2**	**137.0**	**143.8**	**132.7**	**141.0**
CNUL Muskeg River mine	External tailings facility (ETF)	62.4	63.7	58.3	57.9	51.7	50.4	43.1	36.3	31.0
	South expansion area (SEA)	0.5	0.8	1.5	1.3	0.2	0.0	-	-	-
	In-pit cell 1 (IPC1)	23.0	24.3	32.8	31.5	31.4	30.8	30.3	30.1	30.3
	In-pit cell 2 (IPC2)	-	-	-	-	26.5	28.1	30.0	32.4	35.9
	In-pit cell 2A (IPC2A)	N/A	N/A	6.8	7.7	-	-	-	-	-
	In-pit cell 2B (IPC2B)	2.1	5.6	9.5	12.5	-	-	-	-	-
	In-pit cell 3 (IPC3)	N/A	N/A	0.8	5.7	11.9	16.8	29.9	39.8	41.2
	In-pit cell 4 north (IPC4N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.7
	In-pit cell 4 South (IPC4S)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.2
	Total	**88.0**	**94.4**	**109.7**	**116.6**	**121.7**	**126.1**	**133.3**	**138.6**	**145.3**
CNUL Jackpine mine	Dedicated disposal area 1 (ETF-W/DDA1)	6.8	12.0	7.8	11.7	12.8	12.5	11.0	-	-
	Sand cell 1 (ETF-E/SC1)	12.8	10.6	11.2	9.4	8.6	8.1	10.3	-	-
	External tailings facility (ETF, i.e., ETF-W and ETF-E)								19.0	17.1
	Sand cell 2 (SC2)	N/A	1.0	2.4	5.7	5.2	4.1	4.6	5.8	5.5
	Fluid cell 1(FC1)	N/A	N/A	2.8	1.6	1.4	1.2	1.1	1.2	1.8
	Total	**19.6**	**23.6**	**24.2**	**28.4**	**28.0**	**25.9**	**27.0**	**26.0**	**24.4**
CNRL Horizon	External tailings facility/dedicated disposal area 1 (ETF/DDA1)	66.2	82.1	99.5	114.5	131.8	146.7	146.4	155.3	162.9
	Dedicated disposal area 2 (DDA2)	-	-	-	-	-	-	3.5	2.3	7.1
	Total	**66.2**	**82.1**	**99.5**	**114.5**	**131.8**	**146.7**	**149.9**	**157.6**	**170.0**
Imperial Kearl	External tailings area west (ETA-W)	4.7	13.6	24.1	39.3	46.5	55.1	62.1	62.0	59.0
	External tailings area east (ETA-E)	N/A	Negligible	Negligible	0.4	1.0	2.5	3.0	2.0	2.0

Project	Pond/Facilities	Fluid tailings (Mm^3)								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
	West thickened tailings (TT) panel	N/A	N/A	Negligible	0.8	1.5	4.5	9.9	6.1	6.0
	East thickened tailings (TT) panel	N/A	N/A	Negligible	0.5	1.1	-	-	-	-
	Total	**4.7**	**13.6**	**24.1**	**41.0**	**50.1**	**62.1**	**75.0**	**70.1**	**67.0**
Suncor Fort Hills	Out-of-pit tailings area (OPTA)	-	-	-	-	6.0	17.0	30.0	36.0	48.0
	Out-of-pit tailings area east stage 1 (OES1)									0.0
	Total	**-**	**-**	**-**	**-**	**6.0**	**17.0**	**30.0**	**36.0**	**48.0**
Industry total		**1075.2**	**1134.0**	**1206.3**	**1239.8**	**1258.7**	**1302.9**	**1400.0**	**1383.0**	**1438.3**

N/A: Not applicable

Tailings volume totals in this table may not match the company reports due to rounding. Data provided by operators in their TMRs were only to one decimal place. Reported data may not include the removal of volumes considered ready to reclaim (RTR).

Tailings volumes for 2017 year-end are estimates based on midyear survey data and estimates based on production from end of surveys to 2017 year-end, except for Suncor.

Syncrude Mildred Lake and Aurora North volumes for 2018 are as measured and not year-end projections, which the other operators provided.

Imperial Kearl volumes for 2019 are year-end projections and not as measured, which the other operators provided.

Some of the volumes above may include ready-to-reclaim volumes. Suncor Base Plant pond 5, DDA3, and MD9 data do not include RTR fluid tailings.

Variances for monitoring requirements were granted to operators in 2020 due to COVID-19. As a result, there was a mix of measured and estimated volumes for 2020. Pond surveys were not conducted for Imperial Kearl, Syncrude Mildred Lake, and Syncrude Aurora. Reduced pond surveys were completed for Suncor Base Plant, CNUL Muskeg River mine, CNUL Jackpine mine and CNRL Horizon.

Tailings volumes are presented as reported by operators and are subject to change upon further review by the AER, including assessing volumes that meet the RTR criteria.

Appendix 4 Water Volume Data

Project	Pond	Water (Mm^3)								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
Suncor Base Plant	Pond 1A	2.1	2.1	2.5	2.5	2.2	2.2	2.2	2.2	2.2
	Pond 2/3	5.0	2.6	4.8	1.9	2.1	5.8	3.8	4.0	4.0
	Pond 5	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Pond 6	6.0	6.9	6.9	5.7	7.1	7.3	7.3	7.3	9.5
	Pond 7	49.3	40.4	41.7	37.1	42.7	33.5	36.9	35.8	32.1
	Dedicated disposal area 1 (DDA1) (Pond 8A)	N/A	N/A	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	Dedicated disposal area 3 (DDA3)	-	-	-	8.1	7.4	12.6	17.4	21.6	19.2
	Pond 8B	43.3	39.1	42.3	30.8	28.6	10.4	7.3	0.0	0.0
	South tailings pond (STP)	19.0	13.7	17.6	24.4	26.2	32.1	30.6	36.6	34.9
	Sand dump 8 (SD8)	1.5	1.5	3.4	0.9	1.7	0.7	0.9	1.1	0.5
	Total	**126.2**	**106.3**	**119.3**	**111.4**	**118.0**	**104.6**	**106.4**	**108.6**	**102.4**
Syncrude Mildred Lake	Mildred Lake settling basin (MLSB)	5.6	10.8	3.4	7.5	8.3	10.0	8.1	10.8	10.8
	South west sand storage (SWSS)	34.0	42.6	47.5	48.4	43.9	48.4	33.0	29.5	29.5
	Base mine lake / west in-pit (BML)	57.4	55.7	60.2	63.6	67.1	70.5	69.5	71.6	71.6
	East in-pit (EIP)	0.2	0.5	1.2	0.7	0.0	0.0	0.1	0.0	0.0
	South west in-pit junior (SWIP junior)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	South west in-pit major (SWIP major)	14.0	13.9	20.9	19.2	14.6	14.9	19.5	14.6	14.6
	North mine south pit west major (NMSP / NMSPW major)	15.3	14.7	2.5	0.6	6.2	12.1	39.2	30.1	30.1
	North mine south pit east (NMSPE)	N/A	N/A	1.7	4.1	7.4	-	-	-	-
	North mine south pit east deep cake (NMSPE deep cake)	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	**126.5**	**138.2**	**137.4**	**144.1**	**147.5**	**155.9**	**169.4**	**156.6**	**156.6**
Syncrude Aurora North	Aurora settling basin (ASB)	50.5	38.9	40.1	37.9	43.2	37.2	27.4	32.5	22.5
	Aurora east pit north-east (AEPN-E)	20.0	7.5	0.1	1.6	4.8	6.0	3.8	1.8	0.1
	Aurora east pit north-west (AEPN-W)	0.3	0.8	0.1	0.0	0.0	0.0	-	-	-
	Aurora east pit south (AEPS)	1.0	28.3	27.7	21.4	27.4	35.1	61.9	62.8	75.0

Project	Pond	Water (Mm^3)								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
	Total	**71.8**	**75.5**	**68.0**	**60.9**	**75.4**	**78.3**	**93.1**	**97.1**	**97.6**
CNUL Muskeg River mine	External tailings facility (ETF)	2.8	1.7	0.5	0.3	0.0	0.0	0.0	0.0	0.0
	South expansion area (SEA)	0.4	0.1	0.4	0.8	0.2	0.0	-	-	-
	In-pit cell 1 (IPC1)	4.6	6.4	8.4	7.9	9.6	9.8	10.5	9.9	9.7
	In-pit cell 2 (IPC2)	-	-	-	-	8.4	7.6	4.4	13.1	13.1
	In-pit cell 2A (IPC2A)	N/A	N/A	0.3	1.0	-	-	-	-	-
	In-pit cell 2B (IPC2B)	2.0	0.7	2.1	4.2	-	-	-	-	-
	In-pit cell 3 (IPC3)	N/A	N/A	1.6	2.1	2.4	3.0	7.6	4.9	1.6
	In-pit cell 4 north (IPC4N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.9
	In-pit cell 4 south (IPC4S)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.3
	Total	**9.8**	**8.9**	**13.3**	**16.3**	**20.6**	**20.4**	**22.5**	**27.9**	**34.6**
CNUL Jackpine mine	Dedicated disposal area 1 (ETF-W/DDA1)	0.4	0.0	0.1	0.4	0.0	0.0	0.0	-	-
	Sand cell 1 (ETF-E/SC1)	17.0	10.1	6.4	4.9	7.1	8.0	9.6	-	-
	External tailings facility (ETF, i.e., ETF-W and ETF-E)								12.4	8.3
	Sand cell 2 (SC2)	2.4	4.9	3.6	0.5	2.2	4.0	1.2	1.1	2.2
	Fluid cell 1(FC1)	N/A	N/A	0.7	6.4	6.7	7.8	7.6	9.2	10.0
	Total	**19.8**	**15.0**	**10.8**	**12.2**	**16.0**	**19.8**	**18.4**	**22.7**	**20.5**
CNRL Horizon	External tailings facility/dedicated disposal area 1 (ETF/DDA1)	33.0	30.0	33.0	28.2	31.1	31.1	28.0	21.2	19.7
	Dedicated disposal area 2 (DDA2)	-	-	-	-	-	-	2.0	4.0	4.0
	Total	**33.0**	**30.0**	**33.0**	**28.2**	**31.1**	**31.1**	**30.0**	**25.2**	**23.7**
Imperial Kearl	External tailings area west (ETA-W)	21.3	27.4	18.4	17.3	18.0	20.1	23.8	16.0	14.0
	External tailings area east (ETA-E)	N/A	0.3	0.8	1.7	0.5	2.3	2.1	1.0	1.0
	West thickened tailings (TT) panel	N/A	N/A	0.5	0.4	0.1	0.3	0.9	0.0	0.0
	East thickened tailings (TT) panel	N/A	N/A	0.2	0.3	0.1	-	-	-	-
	Total	**21.3**	**27.7**	**19.9**	**19.7**	**18.7**	**22.7**	**26.8**	**17.0**	**15.0**
Suncor Fort Hills	Out-of-pit tailings area (OPTA)	-	-	-	-	3.0	5.7	12.7	16.6	13.0
	Out-of-pit tailings area east stage 1 (OES1)									0.5
	Total	**-**	**-**	**-**	**-**	**3.0**	**5.7**	**12.7**	**16.6**	**13.5**
Industry total		**408.4**	**401.6**	**401.7**	**392.8**	**430.3**	**438.5**	**479.3**	**471.7**	**463.9**

N/A: Not applicable.

Water volume totals in this table may not match the company reports due to rounding. Data provided by operators in their TMRs were only to one decimal place.

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