

# State of Fluid Tailings Management for Mineable Oil Sands, 2020

September 2021



## Alberta Energy Regulator

State of Fluid Tailings Management for Mineable Oil Sands, 2020

September 2021

Published by Alberta Energy Regulator Suite 1000, 250 – 5 Street SW Calgary, Alberta T2P 0R4

Telephone: 403-297-8311 Inquiries (toll free): 1-855-297-8311 Email: <u>inquiries@aer.ca</u> Website: <u>www.aer.ca</u>

# Contents

| Abb                     | oreviat       | ions  |  |  |  |  |
|-------------------------|---------------|---|--|--|--|--|
| Exe                     | ecutive       | Summa   | aryviii  |  |  |  |
| 1                       | Introduction1 |   |  |  |  |  |
| 2                       | Purpo         | Purpose2                                      |  |  |  |  |
| 3                       | Regu          | latory ar                                     | nd Operational Context                               |  |  |  |
|                         | 3.1           | Regulat                                       | tory Context   |  |  |  |
| 3.2 Operational Context |               |   |  |  |  |  |
| 4                       | 2020          | 2020 Reporting                                |  |  |  |  |
|                         | 4.1           | 2020 R  | eport Review6  |  |  |  |
|                         |               | 4.1.1   | Ready-to-Reclaim Criteria and Trajectory             |  |  |  |
|                         |               | 4.1.2   | Environmental Performance Monitoring7                |  |  |  |
|                         | 4.2           | Next St                                       | eps7   |  |  |  |
| 5                       | Tailin        | gs Desc                                       | ription8   |  |  |  |
| 6                       | Fluid         | Tailings                                      | Treatment and Deposition                             |  |  |  |
| 7                       | Regio         | Regional Fluid Tailings Status9               |  |  |  |  |
|                         | 7.1           | 7.1 Fluid Tailings Treatment and Deposition12 |  |  |  |  |
|                         | 7.2           | Water \                                       | /olumes  |  |  |  |
| 8                       | Fluid         | id Tailings Status                            |  |  |  |  |
|                         | 8.1           | Suncor  | - Base Plant   |  |  |  |
|                         |               | 8.1.1   | Fluid Tailings15                                     |  |  |  |
|                         |               | 8.1.2   | Volume of Treated Fluid Tailings by Technology       |  |  |  |
|                         |               | 8.1.3   | Treatment Operation and Continuous Improvement       |  |  |  |
|                         |               | 8.1.4   | Technological Innovation in Fluid Tailings Treatment |  |  |  |
|                         |               | 8.1.5   | Regulatory and Management Actions                    |  |  |  |
|                         |               | 8.1.6   | Measurement System Audit Results                     |  |  |  |
|                         | 8.2           | Syncru  | de – Mildred Lake                                    |  |  |  |
|                         |               | 8.2.1   | Fluid Tailings21                                     |  |  |  |
|                         |               | 8.2.2   | Volume of Treated Fluid Tailings by Technology       |  |  |  |
|                         |               | 8.2.3   | Treatment Operation and Continuous Improvement       |  |  |  |
|                         |               | 8.2.4   | Technological Innovation in Fluid Tailings Treatment |  |  |  |
|                         |               | 8.2.5   | Regulatory and Management Actions                    |  |  |  |
|                         |               | 8.2.6   | Measurement System Audit Results                     |  |  |  |

| 8.3 | Syncru | ude – Aurora North                                   | 26 |
|-----|--------|--|----|
|     | 8.3.1  | Fluid Tailings                                       | 27 |
|     | 8.3.2  | Volume of Treated Fluid Tailings by Technology       | 29 |
|     | 8.3.3  | Treatment Operation and Continuous Improvement       | 30 |
|     | 8.3.4  | Technological Innovation in Fluid Tailings Treatment | 30 |
|     | 8.3.5  | Regulatory and Management Actions                    | 31 |
|     | 8.3.6  | Measurement System Audit Results                     | 31 |
| 8.4 | Canac  | lian Natural Upgrading Limited – Muskeg River Mine   | 31 |
|     | 8.4.1  | Fluid Tailings                                       | 32 |
|     | 8.4.2  | Volume of Treated Fluid Tailings by Technology       | 34 |
|     | 8.4.3  | Treatment Operation and Continuous Improvement       | 35 |
|     | 8.4.4  | Technological Innovation in Fluid Tailings Treatment | 35 |
|     | 8.4.5  | Regulatory and Management Actions                    | 36 |
|     | 8.4.6  | Measurement System Audit Results                     | 36 |
| 8.5 | Canac  | lian Natural Upgrading Limited – Jackpine Mine       | 37 |
|     | 8.5.1  | Fluid Tailings                                       | 38 |
|     | 8.5.2  | Volume of Treated Fluid Tailings by Technology       | 40 |
|     | 8.5.3  | Treatment Operation and Continuous Improvement       | 41 |
|     | 8.5.4  | Technological Innovation in Fluid Tailings Treatment | 41 |
|     | 8.5.5  | Regulatory and Management Actions                    | 41 |
|     | 8.5.6  | Measurement System Audit Results                     | 42 |
| 8.6 | Canac  | lian Natural Resources Limited – Horizon             | 42 |
|     | 8.6.1  | Fluid Tailings                                       | 43 |
|     | 8.6.2  | Volume of Treated Fluid Tailings by Technology       | 45 |
|     | 8.6.3  | Treatment Operation and Continuous Improvement       | 46 |
|     | 8.6.4  | Technological Innovation in Fluid Tailings Treatment | 47 |
|     | 8.6.5  | Regulatory and Management Actions                    | 48 |
|     | 8.6.6  | Measurement System Audit Results                     | 48 |
| 8.7 | Imperi | al Oil Limited – Kearl                               | 49 |
|     | 8.7.1  | Fluid Tailings                                       | 49 |
|     | 8.7.2  | Volume of Treated Fluid Tailings by Technology       | 51 |
|     | 8.7.3  | Treatment Operation and Continuous Improvement       | 51 |
|     | 8.7.4  | Technological Innovation in Fluid Tailings Treatment | 52 |

|                 | 8.7.5   | Regulatory and Management Actions  | . 52 |  |  |  |
|-----------------|---------|--|------|--|--|--|
|                 | 8.7.6   | Measurement System Audit Results   | . 52 |  |  |  |
| 8.8             | Suncor  | - Fort Hills   | . 53 |  |  |  |
|                 | 8.8.1   | Fluid Tailings   | . 53 |  |  |  |
|                 | 8.8.2   | Volume of Treated Fluid Tailings by Technology   | . 55 |  |  |  |
|                 | 8.8.3   | Treatment Operation and Continuous Improvement   | . 55 |  |  |  |
|                 | 8.8.4   | Technological Innovation in Fluid Tailings Treatment                                   | . 55 |  |  |  |
|                 | 8.8.5   | Regulatory and Management Actions  | . 55 |  |  |  |
|                 | 8.8.6   | Measurement System Audit Results   | . 56 |  |  |  |
| 9 Sumr          | nary    |  | . 56 |  |  |  |
| 10 Futur        | e Repor | ts   | . 58 |  |  |  |
| Appendix        | 1 Ta    | ilings Treatment Technologies  | . 61 |  |  |  |
| Appendix        | 2 Ta    | ilings Field Inspection Summaries  | . 65 |  |  |  |
| Appendix        | 3 Flu   | 3 Fluid Tailings Volume Data   |      |  |  |  |
| Appendix        | 4 Wa    | ater Volume Data   | 124  |  |  |  |
| Figures         |         |  |      |  |  |  |
| Figure 1.       | Oper    | ating and approved oil sands mining projects and tailings ponds/deposits in 2020       | 5    |  |  |  |
| Figure 2.       | Regio   | onal fluid tailings volumes (new and legacy combined) and aggregate tailings profiles, | ,    |  |  |  |
|                 | 2014    | to 2020  | . 10 |  |  |  |
| Figure 3.       | Chan    | ge in annual fluid tailings volume in the Athabasca oil sands region, 2015 to 2020     | . 11 |  |  |  |
| Figure 4.       | Pond    | ed water volume in tailings ponds, 2014 to 2020  | . 14 |  |  |  |
| Figure 5.       | New     | New fluid tailings for Suncor Base Plant, 2014 to 202016                               |      |  |  |  |
| Figure 6.       | Lega    | Legacy fluid tailings for Suncor Base Plant, 2014 to 202017                            |      |  |  |  |
| Figure 7.       | New     | New fluid tailings for Syncrude Mildred Lake, 2015 to 2020                             |      |  |  |  |
| Figure 8. Legac |         | cy fluid tailings for Syncrude Mildred Lake, 2014 to 202023                            |      |  |  |  |
| Figure 9. Ne    |         | w fluid tailings for Syncrude Aurora North, 2014 to 2020                               |      |  |  |  |
| Figure 10. Leg  |         | egacy fluid tailings for Syncrude Aurora North, 2014 to 2020                           |      |  |  |  |
| Figure 11       | . New   | New fluid tailings for CNUL Muskeg River mine, 2015 to 2020                            |      |  |  |  |
| Figure 12       | . Lega  | cy fluid tailings for CNUL Muskeg River mine, 2015 to 2020                             | 34   |  |  |  |

| Figure 13. | New fluid tailings for CNUL Jackpine mine, 2015 to 2020                                    | 39 |
|------------|--|----|
| Figure 14. | Legacy fluid tailings for CNUL Jackpine mine, 2015 to 2020                                 | 40 |
| Figure 15. | New fluid tailings for CNRL Horizon, 2015 to 2020  | 44 |
| Figure 16. | Legacy fluid tailings for CNRL Horizon, 2015 to 2020                                       | 45 |
| Figure 17. | New fluid tailings for Imperial Kearl, 2014 to 2020  | 50 |
| Figure 18. | New fluid tailings for Suncor Fort Hills, 2016 to 2020                                     | 54 |
| Table      |  |    |
| Table 1.   | Treated fluid tailings volumes reported by operator, 2014 to 2020, in million cubic metres |    |
|            | (Mm <sup>3</sup> )   | 13 |

# Abbreviations

| AEPN-E | Aurora east pit north - east                   |
|--------|--|
| AEPS   | Aurora east pit south                          |
| AER    | Alberta Energy Regulator                       |
| AFD    | atmospheric fines drying                       |
| ASB    | Aurora settling basin                          |
| BAW    | beach above water                              |
| BBW    | beach below water                              |
| BML    | base mine lake (used interchangeably with WIP) |
| CFFT   | centrifuge FFT                                 |
| CNRL   | Canadian Natural Resources Limited             |
| CNUL   | Canadian Natural Upgrading Limited             |
| COPCs  | chemicals of potential concern                 |
| CPT    | cone penetration testing                       |
| CST    | coarse sand tailings                           |
| СТ     | composite tailings                             |
| CWR    | clay-to-water ratio                            |
| DDA    | dedicated disposal area                        |
| EETA   | east external tailings area                    |
| EIP    | east in-pit                                    |
| EPEA   | Environmental Protection and Enhancement Act   |
| eNST   | enhanced NST                                   |
| esNST  | enhanced spiked NST                            |
| ETA    | external tailings area                         |
| ETF    | external tailings facility                     |
| fFFT   | flocculated FFT                                |
| FFT    | fluid fine tailings                            |

| FLT             | flotation tailings                       |
|-----------------|--|
| HSCFT           | high solids content fluid tailings       |
| ILF             | in-line flocculation                     |
| IPC             | in-pit cell                              |
| K1              | Kearl plant 1                            |
| K2              | Kearl plant 2                            |
| MD9             | mine dump 9                              |
| MLSB            | Mildred Lake settling basin              |
| Mm <sup>3</sup> | million cubic metres                     |
| NMCP            | north mine centre pit                    |
| NMSP            | north mine south pond                    |
| NMSPE           | north mine south pond east               |
| NORM            | naturally occurring radioactive material |
| NPD             | north pool deposit                       |
| NRU             | naphtha recovery unit                    |
| NST             | nonsegregating tailings                  |
| PASS            | permanent aquatic storage structure      |
| RTR             | ready-to-reclaim                         |
| SC              | sand cell                                |
| SFR             | sand-to-fines ratio                      |
| SIR             | supplemental information request         |
| SWIP            | south west in-pit                        |
| SWSS            | southwest sand storage                   |
| TMF             | Tailings Management Framework            |
| TSRU            | tailings solvent recovery unit           |
| TSS             | total suspended solids                   |
| TT              | thickened tailings                       |

- WETA west external tailings area
- WIP west in-pit (used interchangeably with BML)
- WT whole tailings

# **Executive Summary**

Alberta has eight operating oil sands mines, and by the end of 2019, each site had an approved tailings management plan. Under *Directive 085: Fluid Tailings Management for Oil Sands Mining Projects*, mine operators must annually submit tailings management reports that show how they are implementing their tailings management plans. This report summarizes the information for the 2020 reporting year and assesses the operators' progress in managing fluid tailings. Operators will continue to report improvements in their tailings treatment technologies and the piloting and development of new technologies.

In 2020, monitoring and reporting of fluid tailings were affected by the COVID-19 pandemic. The Alberta Energy Regulator (AER) temporarily relieved operators of some monitoring and reporting requirements during the initial phases of the pandemic. Consequently, some operators did not conduct part or all of their annual tailings volume surveys to limit the number of people at the mine sites. The operators that did not conduct annual tailings volume surveys provided estimated volumes for 2020 based on historical data and modelling. As part of their 2021 pond surveys, operators will be required to complete sampling and reporting a back-analysis of their fluid tailings and ready-to-reclaim volume estimates for 2020. The AER will review the back-analysis for acceptability.

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) stored on oil sands mine sites in the Athabasca oil sands region increased between 2014 and 2020, which was expected based on the approved fluid tailings profiles. The total regional volume of fluid tailings remains below the new and legacy fluid tailings profiles combined for all operators. From 2014 to 2017, the volume of water in the tailings ponds within the region decreased. However, from 2017 to 2020, water volumes increased. This occurred with an overall increase in bitumen production and an increase in the number of mines operating between 2014 and 2019, followed by a decrease in production in 2020. This was the first decrease in production since 2016 and occurred during the COVID-19 pandemic and related drop in global oil demand.

The tailings management plans include profiles for both legacy and new fluid tailings volumes. All operators were below their approved new fluid tailings profiles, total volume triggers, and total volume limits. Also, all operators were below their 20 per cent deviation triggers for new and legacy fluid tailings. Three sites, however, were above their legacy fluid tailings profiles: Syncrude Mildred Lake from 2017 to 2020 and Suncor Base Plant and Canadian Natural Resources Limited (CNRL) Horizon in 2020. No change in management level as described in *Directive 085* was required for these operators because their volumes were within the total allowable volume triggers and limits.

The tailings volumes described in this report are presented as reported by the operators. The AER requested clarification or additional data from all operators relating to their 2020 tailings management

reports but did not receive responses before finalizing this report. Those responses, and any further review of the fluid tailings volumes, including assessing if they meet ready-to-reclaim criteria, may lead to changes in the reported data or analyses from previous years and will be reflected in the 2021 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 prior to submitting responses to the AER. This report only includes information that was available at the time of writing.

Operators are required to submit measurement system plans showing how they measure and report fluid tailings volumes and the performance of their tailings deposits. The AER completed assessments of the measurement system plans 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 measurement system plans to address the need to minimize the effect the 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 (subobjective 2)—related to water quality characterization and the measurement of chemicals of potential concern and naturally occurring radioactive material—and may issue additional supplemental information requests in the future. The tailings measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan 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 life cycle.

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

For 2020, monitoring and reporting of fluid tailings were affected by the COVID-19 pandemic. The AER temporarily relieved operators of some monitoring and reporting requirements during the initial phases of the pandemic. Because of the pandemic, some operators did not conduct part or all of their annual tailings volume surveys to limit the number of people at the mine sites. The operators that did not conduct annual tailings volume surveys provided estimated volumes for 2020 based on historical data and modelling. As part of their 2021 pond surveys, operators will be required to complete sampling and reporting a back-analysis of their fluid tailings and ready-to-reclaim (RTR) volume estimates for 2020. The AER will review the back-analysis for acceptability. In addition, the AER conducted the annual fluid tailings site visits for 2020 virtually.

An approved tailings management plan and an assessed measurement system plan are both required for the AER to assess the data in the operators' annual tailings management reports. In addition, both are required for the AER to assess fluid tailings inventory data as they allow for the determination of what volumes are considered RTR and can be removed from the operator's fluid tailings inventory. Operator reports for 2020 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, except for variances granted due to the COVID-19 pandemic.

The AER completed assessments of the measurement system plans 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 measurement system plans to address the need to minimize the effect the 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 (subobjective 2)—related to water quality characterization and the measurement of chemicals of potential concern (COPCs) and naturally occurring radioactive material (NORM)—and may issue additional supplemental information requests (SIRs) in the future. The tailings measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>. 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 tailings management reports submitted by operators are reviewed by the AER's expert staff. Their review may lead to the AER requesting 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 2020, 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 2021 edition of this report, which will be issued by September 30, 2022.

# 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 for the region;
- water volumes stored in tailings facilities for each operator and for 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 the development of treatment technologies;
- project-specific performance;
- progress made in managing fluid tailings; and
- alignment with approved tailings management plans.

This report also includes a summary of regulatory and management actions related to tailings taken by the AER.

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 (<u>www.aer.ca</u>) or the Alberta Environment and Parks oil sands information portal (<u>http://osip.alberta.ca/</u>). This report also 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 virtual tailings-related regulatory site inspections from 2020 (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 it establishes the following policy outcomes:

- land use must be returned to Albertans,
- sustainable ecosystem (after reclamation),
- liability is minimized to Albertans, and
- 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* states the objective that fluid tailings accumulation be minimized by ensuring that fluid tailings are treated and reclaimed progressively during the life of an oil sands mining project and by ensuring that all a project's fluid tailings are ready to reclaim 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*, 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.

## 3.2 Operational Context

Eight oil sands mining projects were operating in 2020:

- 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

On November 15, 2018, the AER approved the transfer of Total E&P Canada Limited's Joslyn North mine to CNRL. On November 8, 2019, CNRL applied to the AER to integrate CNRL Horizon South into the existing Horizon mine lease. This application included an updated tailings management plan and life-of-mine plan. However, this integrated application was still under review at the end of 2020.

On July 25, 2019, a joint review panel approved Teck Resources Limited's (Teck's) application for its Frontier mine, but the project still requires federal approval. However, Teck withdrew its federal application in February 2020. Fluid tailings management reporting for the Frontier mine will be required if the mine is constructed and operations begin.

The locations of operating and approved oil sands mining projects and their tailings ponds are shown in figure 1.



Base data contains information licensed under the Open Government Licence - Alberta

#### Figure 1. Operating and approved oil sands mining projects and tailings ponds/deposits in 2020

# 4 2020 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, 2020 marked the fourth year for submitting annual tailings management reports. It was also the third year where all operators were required to meet full reporting requirements under *Directive 085* and their conditions of approval. Operator submissions for 2020 were posted on the AER website on May 26, 2021, under <u>By Topic, Tailings</u>.

On January 27, 2020, the AER directed the operators to provide the previous year's measured tailings and fluid volumes in the electronic 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, however, notify the AER prior to the end of the reporting year to change the year-end reporting date. As a result, tailings and fluid volumes in this report are as-measured volumes beginning in 2019 unless otherwise stated.

## 4.1 2020 Report Review

As part of its review of annual tailings reports submitted by operators, the AER assessed the reported progress in 2020 for fluid tailings management, including achieving RTR status, trends over time, consistency with previous annual tailings reports, and compliance with approval conditions. The intent of the review is to ensure that

- operators are implementing their approved fluid tailings management plan, 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 tailings management plan by the end of 2019.

## 4.1.1 Ready-to-Reclaim Criteria and Trajectory

In 2020, operators were required to identify volumes of treated fluid tailings that met RTR criteria. The *TMF* and *Directive 085* both require that the progress of fluid tailings and treated fluid tailings be tracked from initial formation (accumulation) through to the initial RTR state and stay on a trajectory that remains in its approved RTR state. Tracking of fluid tailings progress includes processing with an accepted

technology, final placement of the tailings on the landscape, and achievement of the approved RTR trajectory and performance criteria. RTR criteria are used to track treated fluid tailings during the operational stage of the deposit to ensure that the deposit can be reclaimed as predicted in the life-of-mine closure plan.

In their 2020 reports, operators reported on the treated fluid tailings volumes that achieved RTR status during the current reporting period and confirmed that treated fluid tailings in deposits continued to meet the RTR trajectory approval conditions, identifying any volumes that need to be returned to the fluid tailings inventory. The tailings volumes described in this report are presented as reported by the operators and are subject to change upon further review of fluid tailings volumes and performance with respect to meeting RTR criteria.

#### 4.1.2 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.

To avoid reporting duplication, the AER noted during the development of *Directive 085* that it may allow operators to refer to other reports (e.g., annual reclamation progress tracking report, groundwater monitoring report, industrial wastewater monitoring report) already submitted to provide performance results for managing and minimizing environmental effects and the implications of fluid tailings management activities. Some of the 2020 tailings management reports refer to other *Environmental Enhancement and Protection Act (EPEA)* environmental reports or provide information from these reports. As a result, the AER must complete further reviews to verify the additional data and information or clarify reported data and information in the referenced reports. This additional review of the referenced reports is not part of the evaluation of volumetric measurements for fluid tailings and treated fluid tailings management activities in 2020.

#### 4.2 Next Steps

Where the AER identified gaps or areas requiring clarification in the 2020 annual tailings management reports submitted, the AER followed up with the operators requesting clarification or more information. This may lead to data corrections, changes in the RTR status of treated fluid tailings in a deposit, or changes in the fluid tailings inventory. Relevant information from responses to these requests for clarification was not available at the time of writing this report but will be included in the 2021 report issued in September 2022. 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 prior to submitting responses to the AER. This report only includes information that was available at the time of writing.

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. In addition, for the 2020 reporting year, any volumes that were estimated due to the COVID-19 pandemic will need to be verified by operators in their 2021 reports.

# 5 Tailings Description

About 20 per cent of Alberta's oil sands reserves are recoverable by surface mining using trucks and shovels to excavate oil sands. The oil sands are then transported to an extraction plant, where bitumen is separated from the sand. In 2020, mined bitumen accounted for 50 per cent 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 holding area from which water can be removed and recycled to the bitumen extraction process and act as a settling basin to separate the water from tailings. *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. Ponded water is considered any liquid that contains less than five per cent solids. See *Directive 085*, appendix 1, for definitions of terms related to tailings management.

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 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. This makes the management of 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 is 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 tailings management plans is included in appendix 1.

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

# 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, including both legacy and new fluid tailings, in the Athabasca oil sands region increased between 2014 and 2020, this is expected based on the new and legacy profiles in the tailings management plans approved by the AER. Total fluid tailings volumes increased from 1075 million cubic metres (Mm<sup>3</sup>) in 2014 to 1360 Mm<sup>3</sup> in 2020 (see figure 2 and appendix 3). An aggregate of both profiles for all operators in each year is included in figure 2.

From 2015 to 2020, the reported total volume of fluid tailings in the Athabasca oil sands region was below the aggregate of approved fluid 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. This differs from the 2018 report, where volumes identified as having met RTR status were included.

The reported volume of fluid tailings added in the Athabasca oil sands region ranged from a high of 90.4 Mm<sup>3</sup> in 2020 to a low of 17.1 Mm<sup>3</sup> in 2017 (see figure 3). The drop in 2017 compared with 2016 occurred because some operators removed tailings volumes from their inventory that were claimed to have met RTR criteria. Bitumen production increased from 60.2 Mm<sup>3</sup> in 2014 to 90.0 Mm<sup>3</sup> in 2019 and then decreased to 86.3 Mm<sup>3</sup> in 2020. This was the first decrease in oil sands mining production since 2016 and occurred during the COVID-19 pandemic and related drop in global oil demand.

The 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 to the inventory. From 2015 to 2020, the volume of fluid tailings produced exceeded the volume of tailings reported by industry as achieving RTR status in its final landscape position, tailings which could then be removed from the fluid tailings volume inventory.



Notes: 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. Beginning in 2019, data are as-measured values, except for Imperial Kearl, which provided year-end predicted values for 2019.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling) and as a result, 2020 volumes were estimated. 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, and CNUL Jackpine mine, resulting in a mix of measured and estimated volumes. A partial pond survey program was completed at CNRL Horizon due to high winds and freezing conditions.

# Figure 2. Regional fluid tailings volumes (new and legacy combined) and aggregate tailings profiles, 2014 to 2020



# Annual fluid tailings volume change

Notes: 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. Beginning in 2019, data are as-measured values, except for Imperial Kearl, which provided year-end predicted values for 2019.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling), and as a result, 2020 volumes were estimated. 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, and CNUL Jackpine mine, resulting in a mix of measured and estimated volumes. A partial pond survey program was completed at CNRL Horizon due to high winds and freezing conditions.

#### Figure 3. Change in annual fluid tailings volume in the Athabasca oil sands region, 2015 to 2020

# 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 between sites because of differences in technologies, deposit designs, deposit sizes, in-deposit performance of similar technologies, and differences in closure techniques or target ecosites.

Reported treated fluid tailings volumes do not necessarily equal the volume of treated fluid tailings in deposits meeting approved tailings management plan RTR criteria. 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 the tailings deposits.

Due to uncertainties in technology efficacy and deposit performance, uncertainties in capping techniques and capabilities, and deposit uncertainties 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.

| Project                  | Technology  | 2014                | 2015                | 2016              | 2017              | 2018             | 2019               | 2020  |
|--------------------------|---|---------------------|---------------------|-------------------|-------------------|------------------|--------------------|-------|
| Suncor Base Plant        | Thin-lift drying  | 11.7                | 14.8                | 9.9               | 18.5              | 14.0             | 0.0                | 0.0   |
|                          | Permanent aquatic<br>storage structure  | 0.0                 | 0.0                 | 0.0               | 0.0               | 14.0             | 26.7               | 25.0  |
|                          | Coke capping<br>mitigation  | 0.0                 | 0.0                 | 0.0               | 20.0              | 0.0              | 0.0                | 0.0   |
| Suncor Fort Hills        | To be determined  |                     |                     |                   |                   |                  | 0.0                | 0.0   |
| Syncrude Mildred<br>Lake | Composite tailings<br>(CT)  | 5.7                 | 4.9                 | 0.3               | 2.4               | 2.1              | 5.0                | 0.6   |
|                          | Centrifuge  | 2.7                 | 4.1                 | 6.0               | 6.7               | 6.4              | 3.8                | 3.4   |
| Syncrude Aurora<br>North | СТ  | 5.0                 | 10.9                | 11.8              | 13.7ª             | 16.3ª            | 23.9               | 4.7   |
| CNUL Muskeg              | Thin-lift drying  | 3.9                 | 0.9                 | 0.1               | 0.0               | 0.0              | 1.3                | 3.6   |
| River mine <sup>b</sup>  | Fluid fine tailings<br>drying at mine advance<br>area                                       | 0.2                 | 0.3                 | N/A               | 0.0               | 0.0              | 0.0                | 0.0   |
|                          | СТ  | 0.3                 | 1.3                 | N/A               | 0.0               | 0.0              | 0.0                | 0.0   |
|                          | Thickened tailings (TT)   | 15.1 <sup>c,d</sup> | 13.6 <sup>c,d</sup> | 19.4 <sup>d</sup> | 22.5 <sup>e</sup> | 22.9             | 13.0               | 27.0  |
| CNUL Jackpine            | Centrifuge  | 1.1                 | 3.9                 | 3.9               | 2.3               | 2.2              | 2.1                | 1.4   |
| mine                     | TT  | 16.4 <sup>c,f</sup> | 12.6 <sup>c,f</sup> | 17.5 <sup>f</sup> | 19.7 <sup>g</sup> | 16.4             | 16.3               | 15.8  |
| CNRL Horizon             | Nonsegregating<br>tailings (NST),<br>enhanced NST<br>(eNST), enhanced<br>spiked NST (esNST) | 0.0                 | 7.7 <sup>h</sup>    | 48.7 <sup>h</sup> | 62.7 <sup>h</sup> | 131.8            | 156.3 <sup>h</sup> | 139.3 |
|                          | NST, eNST, esNST –<br>legacy tailings   | 0.0                 | 0.0                 | 0.0               | 0.0               | 0.0              | 1.1                | 1.5   |
|                          | Naphtha recovery unit   | 0.0                 | 0.0                 | 0.0               | 0.0               | 17.2             | 20.8               | 18.6  |
| Imperial Kearl           | ТТ  | 0.0                 | 0.0                 | 2.4 <sup>i</sup>  | 8.5               | 8.7 <sup>i</sup> | 13.6               | 19.0  |

Table 1. Treated fluid tailings volumes reported by operator, 2014 to 2020, in million cubic metres (Mm<sup>3</sup>)

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

<sup>a</sup> Volume of CT slurry volume and CT beach deposit. Revised from CT beach deposit only reported in 2017.

<sup>b</sup> TT combined with coarse sand tailings, whole tailings, and tailings solvent recovery unit material in a single deposit forms a northpool-deposit-type deposit.

- <sup>c</sup> Updated in April 2017 submission.
- <sup>d</sup> Volume of TT slurry at solids content of average 23.6 per cent from 2014 to 2016.
- <sup>e</sup> Volume of TT slurry at solids content of 21.9 per cent in 2017.
- <sup>f</sup> Volume of TT slurry at solids content of average 15 per cent from 2014 to 2016.
- <sup>g</sup> Volume of TT slurry at solids content of 13.7 per cent in 2017.
- <sup>h</sup> Volume of NST.
- <sup>i</sup> Volume of TT in deposit after secondary chemical treatment.

#### 7.2 Water Volumes

Based on the data reported by operators, the volume of water contained in tailings ponds and deposits in the Athabasca oil sands region ranged from 408.4 Mm<sup>3</sup> in 2014 to 392.3 Mm<sup>3</sup> in 2017, then increased to 431.1 Mm<sup>3</sup> in 2018, and ranged from 431.1 Mm<sup>3</sup> in 2018 to 479.3 Mm<sup>3</sup> in 2020 (see figure 4 and appendix 4). The increased ponded water volumes in 2020 compared with previous years may have

resulted because 2020 was an exceptionally wet year in the Athabasca oil sands region, with increased precipitation that fell on the mine sites potentially ending up in the recycle water ponds.



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

Notes: Water volumes are presented as reported by operators and are subject to change upon further review by the AER. Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling), and as a result, 2020 volumes were estimated. 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, and CNUL Jackpine mine, resulting in a mix of measured and estimated volumes. A partial pond survey program was completed at CNRL Horizon due to high winds and freezing conditions.

#### Figure 4. Ponded water volume in tailings ponds, 2014 to 2020

# 8 Fluid Tailings Status

#### 8.1 Suncor – Base Plant

For 2020, Suncor Base Plant reported using its permanent aquatic storage structure (PASS) technology in which fluid tailings from the south tailings pond and pond 8B are treated with a coagulant and a

Alberta Energy Regulator

flocculant prior to placement in the dedicated disposal area 3 (DDA3) deposit. In-line flocculation (ILF) with thin-lift drying in DDA1 was reportedly not used in 2020.

Suncor Base Plant reported that its new and legacy fluid tailings inventories for 2020 were within the approved fluid tailings profiles based on *unapproved* subobjective 1 RTR criteria. However, the AER notes that Suncor Base Plant is above its fluid tailings profiles for 2020 by 13 Mm<sup>3</sup> using the *approved* RTR criteria.

Due to the COVID-19 pandemic and subsequent public health emergency, Suncor Base Plant made the decision to reduce staffing and alter its tailings operations compared with the approved tailings management plan. Suncor also reported that its measurement system plan would be modified for 2020, such that assessments would be deferred for assets where no significant physical or chemical changes were expected in 2020, and the baseline surveys from 2019 or older could be used in modelling for the 2020 measurement year. Suncor reported that modified sampling in active assets for 2020, including changes such as increased sample spacing or elimination of selected measurement methods, would not affect Suncor's understanding of the performance of an asset. The AER acknowledges the reported fluid tailings volumes in the 2020 annual tailings management report are an estimate based on historical data and modelling. As such, as part of its 2021 pond survey, Suncor Base Plant will be required to complete sampling and reporting a back-analysis of its fluid tailings volume estimates for 2020, which the AER will review for acceptability.

#### 8.1.1 Fluid Tailings

For 2020, Suncor Base Plant reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 292 Mm<sup>3</sup>, up from 263 Mm<sup>3</sup> reported in 2019.

Suncor Base Plant did not report a volume of fluid tailings that met its approved RTR criteria in 2020. However, Suncor Base Plant states that 21.9 Mm<sup>3</sup> of the fluid tailings in DDA3 have achieved RTR status to date and that the tailings inventory in DDA3 has achieved the following subobjective 1 RTR criteria:

- Fluid tailings achieved a clay-to-water ratio (CWR) greater than 0.5 in DDA3 based on deposit sampling.
- Expressed water from DDA3 treated tailings achieved an annual average total suspended solids (TSS) concentration less than or equal to 500 ppm.

The volumes reported for 2020 are above the currently approved profiles for the total fluid tailings inventories. Suncor Base Plant submitted a data correction for fluid tailings volumes in Pond 2/3 based on reported improved accuracy of pond bottom survey using cone penetration testing (CPT) instead of CT-09 sounding apparatus. This resulted in an increase from 29.8 Mm<sup>3</sup> reported in 2019 to 37.3 Mm<sup>3</sup> in 2020. Suncor Base Plant does not account for consolidation of the fluid tailings inventories.

#### 8.1.1.1 New Fluid Tailings

For 2020, Suncor Base Plant reported 130 Mm<sup>3</sup> of new fluid tailings inventory, which was an estimated volume (see figure 5), up from 101 Mm<sup>3</sup> in 2019. The approved new fluid tailings inventory for 2020 was 130 Mm<sup>3</sup>. The estimated 2020 new fluid tailings inventories are equal to the approved new fluid tailings profile.

Suncor Base Plant has a total volume trigger of 281.0 Mm<sup>3</sup> and a total volume limit of 393.4 Mm<sup>3</sup> for new fluid tailings in its tailings management approval. Based on data reported in its 2020 annual tailings management report, Suncor Base Plant was within its new fluid tailings profile between 2015 and 2020 and did not exceed its total volume trigger or total volume limit for new fluid tailings in 2020.



Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). Suncor Base Plant completed a reduced pond survey program in 2020, resulting in a mix of measured and estimated volumes.

#### Figure 5. New fluid tailings for Suncor Base Plant, 2014 to 2020

#### 8.1.1.2 Legacy Fluid Tailings

Suncor Base Plant's approved legacy fluid tailings volume was 149 Mm<sup>3</sup> for 2020. Suncor reported 162 Mm<sup>3</sup> of legacy fluid tailings inventory for 2020, which exceeded its legacy fluid tailings profile (see figure 6) and was unchanged from the 2019 volume. The estimated 2020 fluid tailings inventories exceed the approved legacy tailings profile for the first time but remain below the 20 per cent legacy fluid tailings profile deviation trigger.



# Approved profile: legacy fluid tailings inventory

#### Legacy fluid tailings inventory

Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). Suncor Base Plant completed a reduced pond survey program in 2020, resulting in a mix of measured and estimated volumes.

#### Figure 6. Legacy fluid tailings for Suncor Base Plant, 2014 to 2020

# 8.1.2 Volume of Treated Fluid Tailings by Technology

For 2020, Suncor Base Plant reported that 25.0 Mm<sup>3</sup> of fluid tailings were treated with PASS technology in DDA3. Suncor reported that the cumulative volume of treated fluid tailings in DDA3 that achieved the approved RTR criterion was 21.9 Mm<sup>3</sup>.

The expressed water quality reported for 2020 achieved an average TSS of 20 ppm, which meets the approved RTR criterion, but was higher than the TSS of 13 ppm reported in 2019.

Suncor Base Plant reported that DDA1 was decommissioned in 2020 and did not contribute additional volume to fluid tailings inventory reduction. Additionally, for 2020, no fluid tailings treatment was reported for mine dump 9 (MD9). The AER has noted apparent inconsistencies with Suncor's report respecting treatment at MD9 and has requested further information to determine the appropriate volume of fluid tailings to be removed from the fluid tailings inventory.

# 8.1.3 Treatment Operation and Continuous Improvement

Suncor Base Plant reported that its tailings treatment technologies are operating as expected and are meeting performance criteria. Suncor also reported the following improvements in 2020:

- Assessment of online measurements of flocculant solution concentration. This work reportedly included installation of near-infrared meters on each flocculant injector to measure flocculant concentrations being mixed with the fluid tailings.
- Installation of an at-line clay measurement system. This work reportedly included stationing an at-line near-infrared meter near dredges for clay-in-feed measurements.

No change to expected treatment capacity was reported by Suncor based on the improvements stated above.

## 8.1.4 Technological Innovation in Fluid Tailings Treatment

For 2020, Suncor Base Plant reported technology research related to its PASS technology, the Lake Miwasin (formerly Demonstration Pit Lake) pilot project test site, and froth-treated tailings:

- Suncor reported PASS technology research was bench-scale and pilot-scale work, including development of polymer injectors designed to reduce polymer demand, improve flocculation efficiency and injector reliability. Additional reported PASS-related research included modelling of gases and dissolved COPCs from the deposit expressed water and porewater.
- The Lake Miwasin pilot project was reported as continuing to confirm the technology performance of wetlands as a sustainable ecosystem goal.

• Froth-treated tailings research was reported as ongoing and includes geocolumns used to measure settlement, release water quality, and gas generation from PASS-treated material.

Further information about technological innovations can be found in Suncor Base Plant's 2019 and 2020 tailings management reports.

#### 8.1.5 Regulatory and Management Actions

In 2020, the AER requested further information from Suncor Base Plant to determine the appropriate volume of fluid tailings to be considered as reaching RTR status. The reason for this request was that Suncor Base Plant had claimed RTR status in 2019 for DDA1 and DDA3 fluid tailings with a deposit-wide CWR average greater than 0.5 but contained fluid tailings that were less than 0.5 CWR.

The AER determined that for 2018 and 2019, no volumes would be returned to Suncor's fluid tailings inventory given that Suncor Base Plant had been adhering to the RTR criteria performance methodology described in its 2018 measurement system plan. However, the AER determined that Suncor would not be credited with any material measured with a CWR less than 0.5 for 2020. The AER expected Suncor to update its measurement system plan accordingly.

In September 2020, the AER approved Suncor to commence co-disposal of tailings and overburden in MD9 south, subject to the following RTR criteria:

- a clay to water ratio > 0.5 in DDA1 based on deposit sampling;
- annual overburden to tailings volume ratio > 1;
- closed-circuit water management system is operating as designed; and,
- groundwater is monitored as required by EPEA Approval No. 94-03-00.

The AER also required Suncor to submit a plan that updates MD9 south tailings management, design, and reclamation activities by December 31, 2023, that

- includes life-of-facility operational milestones;
- includes a consolidation settlement model for the life of the structure;
- identifies the mitigation of settlement that can be implemented during landform construction and before reclamation activities begin;
- identifies specific capping objectives; and,
- provides a spatially explicit description of the reclamation cover designs and ecosite targets.

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

## 8.1.6 Measurement System Audit Results

The AER reviewed Suncor's Base Plant measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing Suncor's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

## 8.2 Syncrude – Mildred Lake

In 2020, there were six tailings facilities operating at Mildred Lake:

- Mildred Lake settling basin (MLSB)
- southwest sand storage (SWSS)
- east in-pit (EIP)
- south west in-pit (SWIP)
- north mine south pond (NMSP)
- north mine south pond east deep cake (NMSPE deep cake)

MLSB and 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 and NMSPE Deep Cake currently provide fluid and solid tailings storage for the site. West in-pit / Base Mine Lake (WIP/BML) is a water-capped demonstration lake, and EIP is a continued closure landform construction.

Composite tailings (CT) and fluid fine tailings (FFT) centrifugation are the current approved fluid tailings treatment technologies operating at a commercial scale at Mildred Lake. No significant changes were made to the CT or FFT centrifugation process in 2020.

Syncrude stated, "Due to the COVID-19 pandemic and subsequent state of public health emergency, Syncrude made the decision to cancel third-party contractor for tailings pond sampling and testing campaign in 2020." Therefore, the tailings volumes reported for 2020 are based on a combination of modelling and field measurements. The 2020 new fluid tailings inventory was below the approved new fluid tailings profile. And the 2020 legacy fluid tailings inventory is slightly above the approved legacy tailings profile but remains below the 20 per cent legacy fluid tailings profile deviation trigger.

Alberta Energy Regulator

The AER acknowledges the reported fluid tailings and RTR volumes in the 2020 annual tailings management report are estimates based on historical data and modelling. The AER will not be able to complete its review of the reported volumes until they are confirmed by the measurements according to Syncrude's tailings measurement system plan. However, the AER is accepting the 2020 volume estimates on an interim basis due to the unique circumstances in 2020. As such, as part of its 2021 pond survey, Syncrude will be required to complete sampling and reporting a back-analysis of its fluid tailings and RTR volume estimates for 2020, which the AER will review for acceptability.

#### 8.2.1 Fluid Tailings

For 2020, Syncrude Mildred Lake reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 548.6 Mm<sup>3</sup>. The tailings volumes reported for 2020 are based on a combination of modelling and field measurements. Mudline surfaces were measured in the fall of 2020 for each tailings deposit to allow for measurement of the water volume on site. Aerial surveys were also completed in the fall of 2020 to account for changes in topography. Hardbottom surfaces used to calculate the fluid tailings volume were created using the 2019 measurements as a starting point and modelled similarly to how year-end volumes were reported in years past.

For 2020, Syncrude reported that its new fluid tailings inventories were within the approved new fluid tailings profile. Syncrude also reported that its legacy fluid tailings inventory was slightly above the approved legacy tailings profile in 2020 but remained below its 20 per cent profile deviation trigger.

Syncrude claimed that 29.8 Mm<sup>3</sup> of fluid tailings have met subobjective 1 RTR criteria, which requires the following:

- CT to achieve 65 per cent solids content by weight within one year of tailings placement based on deposit sampling.
- Centrifuged cake deep deposits to achieve 50 per cent solids content by weight within one year of tailings placement based on deposit sampling.

During 2020, no consolidation was assumed to have happened due to lack of measurements to compare with the previous year's surveys. No additional RTR was assumed for CT deposits; the RTR volume reported is as measured in 2019. However, Syncrude is claiming all centrifuge cake produced in 2020 to be RTR (based on samples collected at the plant) and has been included in the RTR volumes for 2020, where the RTR criteria of centrifuge cake is 50% solids by weight.

The AER is seeking further clarification from Syncrude regarding the discrepancy between the claimed RTR volume and the accounting table.

#### 8.2.1.1 New Fluid Tailings

For 2020, Syncrude Mildred Lake reported 102.7 Mm<sup>3</sup> of new fluid tailings inventory (see figure 7), up from 81.2 Mm<sup>3</sup> in 2019. The approved new fluid tailings inventory in 2020 was 103 Mm<sup>3</sup>. The estimated 2020 fluid tailings inventories are below the approved new fluid tailings profile. The total volume trigger for new fluid tailings volume is 151.0 Mm<sup>3</sup> and a total volume limit of 211.4 Mm<sup>3</sup>. Syncrude reports not exceeding either the total volume trigger or total volume limit in 2020. The new fluid tailings inventory for 2016 exceeded the profile; however, this was before Syncrude Mildred Lake had an approved fluid tailings profile. From 2017 to 2020, Mildred Lake's new fluid tailings inventory was within the approved new fluid tailings profile.



# Approved profile: new fluid tailngs inventory New fluid tailings inventory

Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). Pond surveys were not conducted for Syncrude Mildred Lake in 2020 and volumes were estimated.

#### Figure 7. New fluid tailings for Syncrude Mildred Lake, 2015 to 2020

#### 8.2.1.2 Legacy Fluid Tailings

For 2020, Syncrude Mildred Lake reported a legacy tailings inventory of 416.2 Mm<sup>3</sup> (see figure 8), down from 420.5 Mm<sup>3</sup> in 2019. The approved legacy tailings profile in 2020 was 386 Mm<sup>3</sup>. The estimated 2020 fluid tailings inventories are above the approved legacy tailings profile for the fourth consecutive year but remain below the 20 per cent legacy fluid tailings profile deviation trigger.



# Approved profile legacy fluid tailings inventory Legacy fluid tailings inventory

Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). Pond surveys were not conducted for Syncrude Mildred Lake in 2020 and volumes were estimated.

#### Figure 8. Legacy fluid tailings for Syncrude Mildred Lake, 2014 to 2020

# 8.2.2 Volume of Treated Fluid Tailings by Technology

For 2020, Syncrude Mildred Lake reported treating a total of 4.0 Mm<sup>3</sup> of fluid tailings. Treatment by CT technology accounted for 0.6 Mm<sup>3</sup> within the CT beach deposit and 3.4 Mm<sup>3</sup> of centrifuge cake in the NMSPE.

For 2020, Syncrude reported 29.8 Mm<sup>3</sup> of fluid tailings achieved RTR status as follows:

- 2.8 Mm<sup>3</sup> of CT in SWIP (major)
- 1.4 Mm<sup>3</sup> of CT in NMSP
- 25.6 Mm<sup>3</sup> of centrifuge cake in NMSPE deep cake

No consolidation was assumed to have happened due to lack of measurements to compare with the previous year's surveys. No additional RTR was assumed for CT deposits. However, Syncrude is claiming all centrifuge cake produced in 2020 to have achieved RTR (based on samples collected at the plant).

The volumes reported to have achieved RTR status do not seem to be properly totalled in the Syncrude Mildred Lake report. The AER will seek further clarification from Syncrude on the reported RTR volumes.

## 8.2.3 Treatment Operation and Continuous Improvement

Syncrude Mildred Lake reported no significant changes were made to the CT process in 2020. Syncrude states that, "In response to the crude oil market crisis and global COVID-19 pandemic, Syncrude decided to halt CT production in the first quarter of 2020 until the end of the year." This was reflected within Syncrude's 2020 report.

The AER issued a SIR on July 9, 2020, asking Syncrude to discuss the issues and challenges concerning its 2019 CT operation at Mildred Lake. Syncrude responded, "In 2019, the coarse sand used in CT production at Mildred Lake was lower than planned primarily due to reliability issues with the fluid tailings supply dredge, which was down for 2.5 months. As a result, fluid tailings feed to the CT plant was restricted and CT production was down for 2 months. When the CT plant is unavailable (e.g., due to upsets and/or planned maintenance), tailings sand is directed to the next highest priority in order to maintain the long-term sand balance."

The AER notes that Syncrude's CT production has steadily declined over the last couple of years. The AER is concerned with the continuous decrease in CT production compared with its approved tailings management plan. As a result, the AER is seeking further clarification from Syncrude on why CT production was halted but not the production of centrifuge cake.
Syncrude reported no significant changes were made to the centrifugation plant in 2020. According to the approved 2016 tailings management plan, Syncrude indicated that cake placement in the NMSP cake deposit would be completed in 2020 and cake placement in the north mine centre pit (NMCP) facility would begin. A SIR was issued last year seeking clarification on the issues and challenges Syncrude Mildred Lake faced during its 2019 centrifuge operation.

Also, the AER asked how the reduced cake production affected NMSP timing and other deposits and about Syncrude's plans for mitigation. In response, Syncrude stated, "Syncrude has established a multidisciplinary Centrifuge Cake Taskforce focused on mitigating issues with cake production volumes," and plans to continue using this venue to resolve treatment uncertainties. Syncrude expects to continue depositing cake in the NMSPE deep cake deposit up to the end of 2022 or 2023. The delay in completing cake placement in the NMSPE deep cake deposit will subsequently delay the timing to begin the next deep cake deposit in NMCP. The AER notes, production of centrifuge cake remains an issue for Syncrude. The AER will continue to monitor and ensure Syncrude has overcome its issues and challenges. The AER will seek an update on Syncrude progress on resolving its cake production volumes, treatment uncertainties, and dredge and plant availability.

At the EIP, Syncrude continued closure landform construction, placement of reclamation material, and vegetation planting toward the ecosite targets in 2020 for the area. Closure landform shaping was conducted primarily in the east and southern areas.

At waste dump 1 and SWSS, Syncrude continued to place reclamation material on shallow deposits of centrifuge cake in 2020.

## 8.2.4 Technological Innovation in Fluid Tailings Treatment

Syncrude Mildred Lake reported the following operational changes and field tests to improve tailings treatment performance in 2020:

- Base Mine Lake demonstration: Syncrude submitted an updated Base Mine Lake Monitoring and Research Plan to the AER on November 13, 2020. The last summary report (2019 Base Mine Lake Monitoring and Research Summary Report: Results from 2013-2018) was submitted to the AER on June 27, 2019.
- FFT accelerated dewatering phase 3 (ADW3): Monitoring continued for two cells constructed in 2017 (phase 2) and the additional two cells constructed in 2018 (phase 3). There were plans in 2020 for FFT ADW phase 4, but on May 1, 2020, Syncrude notified the AER that it had cancelled the phase 4 pilot. At the end of 2020, Syncrude indicated that there are plans to apply for the commercialization of ADW in 2021.

Further details can be found in Syncrude Mildred Lake's 2020 tailings management report.

## 8.2.5 Regulatory and Management Actions

The Syncrude Mildred Lake site is operating at management level 1 as described in the *TMF* and *Directive 085*. No management actions were taken during the 2020 reporting period for Mildred Lake's tailings management operations.

## 8.2.6 Measurement System Audit Results

The AER reviewed Syncrude's Mildred Lake measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing Syncrude's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

### 8.3 Syncrude – Aurora North

In 2020, there were three tailings facilities operating at Aurora North:

- Aurora settling basin (ASB)
- Aurora east pit north east (AEPN-E)
- Aurora east pit south (AEPS)

The ASB is the only out-of-pit tailings facility at the site. The tailings deposits vary in their primary function, contents, and size. The ASB, AEPN-E and AEPS currently provide the fluid tailings storage for the site. Aurora east pit north - west has been filled with coarse sand to form the base of the Fort Hills dump expansion and is no longer an active tailings deposit.

Syncrude Aurora North continued to use CT as its primary fluid tailings treatment technology in 2020. No significant changes were made to the CT process.

Syncrude stated, "Due to the COVID-19 pandemic and subsequent state of public health emergency, Syncrude made the decision to cancel third-party contractor for tailings pond sampling and testing campaign in 2020." Therefore, the tailings volumes reported for 2020 are based on a combination of modelling and field measurements. Syncrude reported that its 2020 fluid tailings inventory was within the approved new and legacy fluid tailings profiles for Aurora North.

Alberta Energy Regulator

The AER acknowledges the reported fluid tailings and RTR volumes in 2020's annual tailings management report are estimates based on historical data and modelling. The AER will not be able to complete its review of the reported volumes until they are confirmed by the measurements according to Syncrude's tailings measurement system plan. However, the AER is accepting the 2020 volume estimates on an interim basis due to the unique circumstances in 2020. As such, Syncrude will be required to complete, as part of its 2021 pond survey, sampling and reporting a back-analysis of its fluid tailings and RTR volume estimates for 2020, which the AER will review for acceptability.

## 8.3.1 Fluid Tailings

For 2020, Syncrude Aurora North reported a **projected** total fluid tailings inventory (new and legacy fluid tailings combined) of 143.8 Mm<sup>3</sup>. The tailings volumes reported for 2020 are based on a combination of modelling and field measurements. Mudline surfaces were measured in the fall of 2020 for each water-capped tailings deposit to allow for an accurate measurement of the water volume on site. Aerial surveys were also completed in the fall of 2020 to account for changes in topography. Hardbottom surfaces used to calculate the fluid tailings volume were created using the 2019 measurements as a starting point and modelled similarly to how year-end volumes were reported in years past.

Syncrude claims 9.6 Mm<sup>3</sup> of fluid tailings have met subobjective 1 RTR criteria, which requires CT to achieve 65 per cent solids content by weight within one year of tailings placement based on deposit sampling. The RTR volume claimed in 2020 is the same volume as reported in 2019.

In 2020, no consolidation was assumed to have happened due to lack of measurements to compare with the previous year's surveys. Therefore, no additional RTR was assumed for CT deposits and the RTR volume reported is as measured in 2019.

The approach for volume accounting is seemingly different from Mildred Lake and Aurora North. As a result, the AER is seeking further clarification from Syncrude.

## 8.3.1.1 New Fluid Tailings

For 2020, Syncrude Aurora North reported 51.1 Mm<sup>3</sup> of new fluid tailings inventory (see figure 7), up from 44.2 Mm<sup>3</sup> in 2019. The approved new fluid tailings inventory in 2020 was 66 Mm<sup>3</sup>. The estimated 2020 fluid tailings inventories are below the approved new fluid tailings profile. The total volume trigger for new fluid tailings is 113 Mm<sup>3</sup> and the total volume limit is 158 Mm<sup>3</sup>, neither of which were exceeded in 2020. The new fluid tailings inventory was within the approved new fluid tailings profile from 2015 to 2020.



Approved profile: new fluid tailings inventory

New fluid tailings inventory

Notes: 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. Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). Pond surveys were not conducted for Syncrude Aurora in 2020 and volumes were estimated.

### Figure 9. New fluid tailings for Syncrude Aurora North, 2014 to 2020

### 8.3.1.2 Legacy Fluid Tailings

For 2020, Syncrude Aurora North reported a legacy fluid tailings inventory of 83.1 Mm<sup>3</sup> (see figure 8), which is the same volume as 2019. The approved legacy fluid tailings inventory for 2020 was 93.0 Mm<sup>3</sup>. The estimated 2020 fluid tailings inventories are below the approved new fluid tailings profile. The legacy fluid tailings inventory was below the approved legacy tailings profile from 2015 to 2020.



## Legacy fluid tailings inventory

Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). Pond surveys were not conducted for Syncrude Aurora in 2020 and volumes were estimated.

#### Figure 10. Legacy fluid tailings for Syncrude Aurora North, 2014 to 2020

### 8.3.2 Volume of Treated Fluid Tailings by Technology

For 2020, Syncrude Aurora North reported treating a total of 4.7 Mm<sup>3</sup> of fluid tailings using CT technology. The breakdown of treatment by CT technology was 5.9 Mm<sup>3</sup> of CT slurry and 4.7 Mm<sup>3</sup> of CT beach deposit in the AEPS.

For 2020, Syncrude reported 9.6 Mm<sup>3</sup> of fluid tailings achieved RTR status as follows:

- 8.9 Mm<sup>3</sup> of CT in AEPN-E
- 0.7 Mm<sup>3</sup> of CT in AEPS

No consolidation was assumed to have happened due to lack of measurements to compare with the previous year's surveys. Therefore, no additional RTR was assumed for CT deposits and the RTR volume reported is as measured in 2019.

## 8.3.3 Treatment Operation and Continuous Improvement

Syncrude Aurora North reported no significant changes were made to the CT process in 2020. However, in response to the crude-oil market crisis and global COVID-19 pandemic, Syncrude decided to stop CT production in the first quarter of 2020 until the end of the year. This was reflected within Syncrude's 2020 report.

The AER issued a SIR on July 9, 2020, asking Syncrude to discuss the issues and challenges concerning its 2019 CT operation at Aurora North. Syncrude responded, "In 2019, the coarse sand used in CT production at Aurora North was lower than planned primarily due to unplanned equipment reliability events associated with the CT plant. Early in the year [2019], reliability issues with the fluid tailings supply dredge and the cyclone overflow system limited the CT plant availability. When the CT plant is unavailable (e.g., due to upsets and/or planned maintenance), tailings sand is directed to the next highest priority in order to maintain the long-term sand balance." Furthermore, Syncrude states, "Syncrude addressed the key contributors to the loss of CT plant availability throughout 2019 by implementing solutions to the various issues. For example, in 2019 a new fluid tailings supply dredge was commissioned, and the operating parameters of the cyclone overflow system were modified. Both changes minimized the downtime of these systems in the latter portion of the year."

The AER notes, Syncrude's CT production has steadily declined over the last couple of years. The AER is concerned with the continuous decrease in CT production when comparing with its approved tailings management plan. As a result, the AER is seeking further clarification from Syncrude on how it plans to make up for the loss in 2020.

## 8.3.4 Technological Innovation in Fluid Tailings Treatment

Syncrude Aurora North reported the following operational changes and field tests to improve tailings performance in 2020:

• Tailings co-deposition: On July 18, 2019, Syncrude obtained authorization to conduct a flocculated FFT (fFFT) and CT co-deposition field pilot within the AEPS tailings pond. However, on May 1, 2020, Syncrude notified the AER that it no longer plans to conduct the field pilot in 2020 but will continue to evaluate opportunities to incorporate fFFT co-deposition in upcoming mining and tailings plans.

Further details can be found in Syncrude Aurora North's 2020 tailings management report.

### 8.3.5 Regulatory and Management Actions

The Syncrude Aurora North site is operating at management level 1 as described in the *TMF* and *Directive 085*. No management actions were taken during the 2020 reporting period for Aurora North's tailings management operations.

### 8.3.6 Measurement System Audit Results

The AER reviewed Syncrude's Aurora North measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing Syncrude's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

### 8.4 Canadian Natural Upgrading Limited – Muskeg River Mine

CNUL Muskeg River mine reported four active tailings facilities in 2020:

- one out-of-pit facility (the external tailings facility [ETF])
- three in-pit facilities (in-pit cell [IPC] 1, IPC2, and IPC3)

The ETF currently contains atmospheric fines drying (AFD) material during the early stages of treatment, which are placed in drying cells on the northeast beach above water (BAW). The ETF is also a source of fluid tailings for IPC2.

IPC1 currently acts as a clarification pond by accepting water transfers from the ETF, IPC2, and IPC3 before the water is transferred to the recycle water pond. IPC1 also stores tailings solvent recovery unit (TSRU) tailings and coarse sand tailings (CST).

IPC2 is classified as an "emergency out" facility to be used for deposition of thickened tailings (TT) to manage recycle water quality, control the rate of rise in IPC3 pond elevation, and allow for unplanned TT pipeline maintenance. IPC3 stores active north pool deposit (NPD) type and CST deposits.

Muskeg River mine's primary strategies for treating fluid tailings are TT, NPD-type deposits (codeposition of TT, CST, whole tailings [WT], TSRU tailings), and AFD.

Due to the COVID-19 pandemic and subsequent public health emergency, CNUL Muskeg River mine made the decision to modify its program for tailings pond sampling and testing campaign in 2020.

Therefore, the tailings volumes reported for 2020 are based on a combination of modelling and field measurements.

The new and legacy fluid tailings volumes reported by CNUL Muskeg River mine in 2020 were within the approved profiles for both new and legacy fluid tailings inventories.

The AER acknowledges the reported fluid tailings and RTR volumes in 2020's annual tailings management report are estimates based on historical data and modelling. The AER will not be able to complete its review of the reported volumes until they are confirmed by the measurements according to CNUL's tailings measurement system plan. However, the AER is accepting the 2020 volume estimates on an interim basis due to the unique circumstances in 2020. As such, CNUL will be required to complete, as part of its 2021 pond survey, sampling and reporting a back-analysis of its fluid tailings and RTR volume estimates for 2020, which the AER will review for acceptability.

## 8.4.1 Fluid Tailings

In 2020, CNUL Muskeg River mine altered its annual tailings program using the review of historical data under the premise that a reduced scope would minimally impact the calculation of the fluid tailings inventory. The investigation was conducted with reduced scopes that included sonar bathymetry and a lidar survey but not sampling, CPT, or drop soundings. Pond bottom surfaces were modelled and reviewed against previous surveys, laboratory sampling, satellite imagery, and any additional available data to produce a representative fluid inventory. As a result, volumes reported are a mix of measured and estimated data.

For 2020, CNUL Muskeg River mine reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 133.3 Mm<sup>3</sup>, up from 126.1 Mm<sup>3</sup> in 2019. CNUL Muskeg River mine also reported that a total of 16.8 Mm<sup>3</sup> of material achieved RTR status in 2020.

In the 2019 and 2020 annual tailings management reports submitted by CNUL Muskeg River mine, CNUL reported that the 2015–2018 fluid tailings profile inventory volumes in its accounting table were interpolated to mid-year (June 30) volumes from year-end predicted values submitted in previous years. The AER is reporting previously submitted values for 2015–2018 for consistency.

The volumes reported by CNUL in 2020 were within the approved profiles for new and legacy fluid tailings inventories.

## 8.4.1.1 New Fluid Tailings

For 2020, CNUL Muskeg River mine reported 43.8 Mm<sup>3</sup> of new tailings inventory (see figure 11), up from the 36.6 Mm<sup>3</sup> reported in 2019. The total volume trigger for new fluid tailings is 69 Mm<sup>3</sup> and a total volume limit of 97 Mm<sup>3</sup>, neither of which were exceeded in 2020. The new tailings inventory also did not exceed the new fluid tailings profile between 2015 and 2020.



Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). A reduced pond survey program was completed for CNUL Muskeg River mine, resulting in a mix of measured and estimated volumes.

#### Figure 11. New fluid tailings for CNUL Muskeg River mine, 2015 to 2020

8.4.1.2 Legacy Fluid Tailings

125

For 2020, CNUL Muskeg River mine reported a legacy fluid tailings inventory of 89.5 Mm<sup>3</sup>, which is below its approved legacy fluid tailings profile (see figure 12). There is no change from 2019.



Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). A reduced pond survey program was completed for CNUL Muskeg River mine, resulting in a mix of measured and estimated volumes.

### Figure 12. Legacy fluid tailings for CNUL Muskeg River mine, 2015 to 2020

### 8.4.2 Volume of Treated Fluid Tailings by Technology

For 2020, CNUL Muskeg River mine reported that 62.8 Mm<sup>3</sup> of treated tailings were deposited in IPC3 to develop an NPD-type deposit, 27.0 Mm<sup>3</sup> of which was treated using TT. CNUL Muskeg River mine also reported that 3.6 Mm<sup>3</sup> of fluid tailings were treated in the AFD drying area within the ETF.

CNUL Muskeg River mine reported that 3.1 Mm<sup>3</sup> of treated fluid tailings in the ETF within the beach below water (BBW) area of the NPD and 0.8 Mm<sup>3</sup> of AFD achieved RTR status.

### 8.4.3 Treatment Operation and Continuous Improvement

CNUL Muskeg River mine reported continued improvement of its tailings technologies and deposition strategies in 2020.

New cell design techniques were employed in 2020 to optimize "AFD material deposition and passive dewatering drainage." Using a simplified spigot design and optimized spigot spacing improved operational efficiency and operations developed experience in adjusting parameters (i.e., initial deposition rates of flocculant addition) to account for feed variability. Also, excavation, haulage, and placement were more efficient in winter conditions. These improvements made in 2020 resulted in a material quality increase in AFD materials that requires less mixing with underlying tailings sand.

IPC3 was the primary location for the NPD-type deposit development in 2020. CNUL Muskeg River mine has reported that a CST "jetty" was strategically formed on the northeast corner of the beach to direct the flow of tailings and improve mixing of the separate tailings streams for the formation of the NPD.

In 2020, CNUL continued transferring process water and fluid tailings out of the ETF. Infilling with CST also continues primarily from the southern half of the pond to progress the beach northward.

Infilling and capping of the south expansion area were completed in February 2019, with the placement of reclamation material in 2020.

### 8.4.4 Technological Innovation in Fluid Tailings Treatment

In 2020, CNUL reported the following operational changes and field tests to improve tailings treatment performance at both the Muskeg River mine and Jackpine mine. The findings are applicable to both sites:

- Tailings consolidation casing experimental pilot project: Monitoring of treatment casings (vertical tubes) continued through 2020 to measure the properties that govern storage and settlement of tailings needed to evaluate consolidation.
- Modified AFD: The program was deferred to 2021.
- Soft deposit capping-centrifuge cake test cell capping: In 2020, multiple field programs and evaluations were completed on the centrifuge cake cells to study other capping options for improving strength and consolidation.
- Geotube pilot program: In 2020, a limited scope of vane shear testing within the geotubes was completed. CNUL indicated the geotubes will be mined out in 2021.
- FFT pressure filtration pilot: Further sampling and monitoring was completed in 2020 and is also planned for 2021.

- ILF and CST mixed deposit field trial: ILF tailings co-deposited with CST is a potential approach capable of producing an ILF/CST mixed deposit. This pilot seeks to evaluate the role of sand content in modifying and improving the consolidation properties of ILF tailings. If a mixed ILF/CST deposit can be shown to perform the same or better than a centrifuge FFT (CFFT)/CST mixed deposit, then application of ILF/CST at a commercial scale could result in significant cost savings.
- CFFT and CST mixed deposit continuous improvement: CNUL Muskeg River mine is currently
  using the co-deposition of CST with CFFT in Jackpine mine DDA1 to improve the geotechnical
  performance of the CFFT deposits. This research is intended to optimize the formation of these mixed
  deposits. CNUL Muskeg River mine has been conducting several trials at various scales to evaluate
  the role of sand content in modifying and improving the consolidation properties of CFFT.

Further details can be found in the CNUL Muskeg River mine 2020 tailings management report.

## 8.4.5 Regulatory and Management Actions

The following is a list of regulatory actions that occurred in the 2020 reporting year:

- The AER approved a change to the submission date for the tailings management plan amendment applications for Muskeg River mine and Jackpine mine to April 30, 2022.
- In December 2020, CNUL Muskeg River mine obtained approval for both the relocation and placement zones for AFD. The AER approved the relocation of AFD produced in 2020 for early 2021 and the placement zones of IPC4, the non-trafficable waste zone of in-pit dike 5 (IPC5), and a contingency location for in-pit dump 2C.

The CNUL Muskeg River mine is operating at management level 1 as described in the *TMF* and *Directive 085*. No management actions were taken during the 2020 reporting period for tailings management operations.

## 8.4.6 Measurement System Audit Results

The AER reviewed CNUL's Muskeg River mine measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing CNUL's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

### 8.5 Canadian Natural Upgrading Limited – Jackpine Mine

CNUL Jackpine mine reported four tailings facilities operating in 2020:

- fluid cell 1 (FC1)
- the ETF/DDA1
- sand cell 1 (SC1)
- sand cell 2 (SC2)

FC1 is classified as an in-pit facility, whereas all others are considered out-of-pit facilities. The ETF consists of three storage areas: DDA1, SC1, and SC2. These ETF facilities all store fluid and CST, but DDA1 also stores treated tailings.

The fluid tailings and water generated from DDA1 flow to SC1 through an open channel established in 2018. In mid-2020, the cross-dike separating DDA1 and SC1 was overtopped, and the two ponds were merged for reporting purposes and renamed the Jackpine mine ETF. DDA1 receives water from seepage pond 1 (SP1) and FC1 depending on water management requirements. At the end of the 2020 reporting period, DDA1 and SC1 were formally merged. When discussing events occurring before June 2020, SC1 is now referred to as "SC1" and when discussing event occurring after June 2020, SC1 is now referred to as "ETF-East (ETF-E)" where a distinction is required between the eastern or western halves; or simply "ETF" if no distinction is required.

CNUL's Jackpine mine lists the primary methods of treatment for fluid tailings as the co-deposition of TT with CST and CFFT with CST, referred to as a "mixed deposit" (different from Muskeg River mine's NPD-type deposit). The CFFT technology and associated RTR criteria were approved by the AER in mid-2020. TT and CFFT products were both placed in DDA1, the primary deposit location for treated tailings in 2020, while also receiving CST for dike construction.

Due to the COVID-19 pandemic and subsequent public health emergency, CNUL Jackpine mine made the decision to modify its program for tailings pond sampling and testing campaign in 2020. Therefore, the tailings volumes reported for 2020 are based on a combination of modelling and field measurements.

The new and legacy fluid tailings volumes reported by CNUL Jackpine mine for 2020 were within the approved profiles for both new and legacy fluid tailings inventories.

The AER acknowledges the reported fluid tailings and RTR volumes in 2020's annual tailings management report are estimates based on historical data and modelling. The AER will not be able to complete its review of the reported volumes until they are confirmed by the measurements according to CNUL Jackpine mine's tailings measurement system plan. However, the AER is accepting the 2020 volume estimates on an interim basis due to the unique circumstances in 2020. As such, CNUL Jackpine

will be required to complete, as part of its 2021 pond survey, sampling and reporting a back-analysis of its fluid tailings and RTR volume estimates for 2020, which the AER will review for acceptability.

## 8.5.1 Fluid Tailings

CNUL Jackpine mine stated that based on historical tracking and 2020 production rates, there was no risk for Jackpine mine to exceed the allowable volume specified in the current tailings management plan. This resulted in a reduced scope prepared for the annual tailings investigation. The reduced scope included sonar bathymetry and a lidar survey but not sampling, CPT, or drop soundings.

CNUL Jackpine mine noted that a conservative approach was always taken where uncertainty was identified due to the impacts on the reduced scope resulting from COVID-19. It is anticipated that if a revision is required in subsequent reporting, it will likely be a reduction in the estimated 2020 fluid tailings inventory, correcting for overly conservative assumptions used in the generation of 2020 pond bottom surfaces.

For 2020, CNUL Jackpine mine reported a total fluid tailings inventory (new and legacy fluid tailings combined) of 27.0 Mm<sup>3</sup>, up from 25.9 Mm<sup>3</sup> in 2019. CNUL Jackpine mine reported that 6.2 Mm<sup>3</sup> of fluid tailings met RTR criteria for the TT mixed deposit in DDA1 for 2020.

In the 2019 and 2020 annual tailings management reports submitted by CNUL Jackpine mine, CNUL reported that the 2015–2018 fluid tailings profile inventory volumes in its accounting table (appendix 3 of *Directive 085*) were interpolated to mid-year (June 30) volumes from year-end predicted values submitted in previous years. The AER is reporting previously submitted values for 2015–2018 for consistency.

The volumes reported by CNUL in 2020 were within the approved profiles for new and legacy fluid tailings inventories.

## 8.5.1.1 New Fluid Tailings

For 2020, CNUL Jackpine mine reported 5.0 Mm<sup>3</sup> of new fluid tailings (see figure 13), up from the 3.9 Mm<sup>3</sup> reported in 2019. Jackpine mine has a total volume trigger of 26 Mm<sup>3</sup> and a total volume limit of 36 Mm<sup>3</sup> for new fluid tailings, which were not exceeded in 2020. The new fluid tailings inventory also did not exceed the profile between 2015 and 2020.



Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). A reduced pond survey program was completed for CNUL Jackpine mine, resulting in a mix of measured and estimated volumes.

#### Figure 13. New fluid tailings for CNUL Jackpine mine, 2015 to 2020

#### 8.5.1.2 Legacy Fluid Tailings

For 2020, CNUL Jackpine mine reported a legacy fluid tailings inventory of 22 Mm<sup>3</sup>, which is within its legacy fluid tailings profile (see figure 14) and is unchanged from 2019. According to its profile, no legacy tailings will be treated, and the legacy volume will remain unchanged until 2023.



Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). A reduced pond survey program was completed for CNUL Jackpine mine, resulting in a mix of measured and estimated volumes.

#### Figure 14. Legacy fluid tailings for CNUL Jackpine mine, 2015 to 2020

### 8.5.2 Volume of Treated Fluid Tailings by Technology

CNUL Jackpine mine reported that a total volume of 15.8 Mm<sup>3</sup> of TT was deposited in DDA1. The TT deposited obtained an average solid content of 18.25 per cent and an average fines content of 59.7 per cent. CNUL Jackpine mine reported an estimated volume of 1.4 Mm<sup>3</sup> in DDA1 achieved the RTR criteria.

In 2019, CNUL Jackpine mine applied for a new subobjective 1 RTR criteria for CFFT and CST mixed deposits as follows:

- 60 per cent solids by weight based on deposit sampling within three years of tailings placement; and
- 70 per cent solids by weight based on deposit sampling within five years of tailings placement.

Also, a subobjective 2 was proposed for groundwater monitoring as required by *EPEA* Approval No. 00153125-01-00.

The AER approved the proposed criteria in 2020.

For 2020, CNUL Jackpine mine reported a production volume of 1.4 Mm<sup>3</sup> of centrifuged tailings with an average solids content of 45.2 per cent.

CNUL Jackpine mine has produced and deposited CFFT in DDA1 since 2014 as part of research required to support its technology assessment. Volumes deposited in DDA1 from 2014 to 2020 have been reported. Due to COVID-19-related scope reductions, no characterization of 2020 material was provided, but a historical characterization of the material produced prior to 2019 was provided for reference. A total estimated volume of 8.1 Mm<sup>3</sup> of CFFT/CST co-deposited tailings was reported as achieving RTR in 2020.

## 8.5.3 Treatment Operation and Continuous Improvement

Thickened tailings and CST have been deposited in DDA1, resulting in a mixed deposit that is a combination of TT and CST. TT deposition produced a zone of treated fluid tailings on the BBW slope of the TT deposit, which has been classified as a transition zone. The performance of the TT deposit transition zone is being monitored to identify if it is on a trajectory towards reclamation outcomes or meets the required RTR criteria. This material is not included in performance monitoring and is currently accounted for in the fluid tailings inventory. The TT/CST mixed deposit does not account for the entire beach formed in DDA1 and is an approximation because the exact flow patterns of the TT and CST below the pond surface are based on engineering judgement.

CFFT/CST mixed deposits are formed where CST are deposited into pure CFFT during normal dike construction and where CST and CFFT are co-deposited. SC1 is the primary source for untreated fluid tailings at Jackpine mine. CFFT was deposited in DDA1, which is currently the only location approved for CFFT/CST mixed deposit.

## 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

The following is a list of regulatory actions that occurred in the 2020 reporting year:

• The AER approved a change to the submission date for the tailings management plan amendment applications for Muskeg River mine and Jackpine mine to April 30, 2022.

CNUL Jackpine mine CFFT/CST mixed deposit RTR criteria: Subobjective 1 – 60 per cent solids by weigh based on deposit sampling within three years of tailings placement, and 70 per cent solids by weight based on deposit sampling within five years of tailings placement. Subobjective 2 – Groundwater is monitored as required by *EPEA* Approval No. 00153125-01-00 (as amended or renewed), which was approved on July 6, 2020.

The CNUL Jackpine mine is operating at management level 1 as described in the *TMF* and *Directive 085*. No management actions were taken during the 2020 reporting period for tailings management operations.

## 8.5.6 Measurement System Audit Results

The AER reviewed CNUL's Jackpine mine measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing CNUL's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

## 8.6 Canadian Natural Resources Limited – Horizon

CNRL Horizon has one operating out-of-pit tailings facility (ETF/DDA1) and one in-pit tailings facility (DDA2). The ETF/DDA1 contains WT, nonsegregating tailings (NST), and naphtha recovery unit (NRU) treatment streams, and also serves as a recycle water pond to the plant. Deposition of NST commenced in DDA2 in 2020. NST is the primary fines tailings treatment process at Horizon, in conjunction with its Mature Fine Tailings Reduction Mine Plan (MFTRMP), which targets a low fines ore to reduce fluid tailings generation. At the end of 2020, CNRL Horizon was operating five NST lines and three NRU lines, with carbon dioxide being injected into NST and NRU lines.

In its 2020 pond investigation, CNRL Horizon reported that the planned BAW tasks were not completed in DDA2 due to poor ground conditions. Also, ETF/DDA1 had only some of the planned BBW sampling completed due to an extended period of high winds followed by a rapid, deep freeze, creating unsafe conditions. CNRL Horizon has identified a change to the pond survey execution schedule to mitigate this issue from reoccurring in future reporting years. In the future, CNRL Horizon plans to execute pond survey activities in early September. The AER is assessing the pond survey activities completed in 2020 to determine how they affect the estimated RTR volumes reported by CNRL Horizon.

The new and legacy fluid tailings volumes reported by CNRL Horizon Mine in 2020 were within the approved profiles for both new and legacy fluid tailings inventories.

The AER acknowledges the reported fluid tailings and RTR volumes in 2020's annual tailings management report are estimates based on historical data and modelling. The AER will not be able to complete its review of the reported volumes until they are confirmed by the measurements according to CNRL's tailings measurement system plan. However, the AER is accepting the 2020 volume estimates on an interim basis due to the unique circumstances in 2020. As such, CNRL will be required to complete, as part of its 2021 pond survey, sampling and reporting a back-analysis of its fluid tailings and RTR volume estimates for 2020, which the AER will review for acceptability.

### 8.6.1 Fluid Tailings

For 2020, CNRL Horizon reported a total fluid tailings inventory of 149.9 Mm<sup>3</sup>, up from 146.7 Mm<sup>3</sup> in 2019. A total volume of 78.3 Mm<sup>3</sup> was claimed for NST beach volume achieving the approved RTR criteria.

CNRL Horizon reported an NRU treated tailings volume of 2.1 Mm<sup>3</sup>. Currently, there is no approved RTR criteria for NRU treated tailings. Thus, the reported volume was not removed from the approved fluid tailings profile. The associated fluid tailings volume will therefore remain on the fluid profile until one is approved.

### 8.6.1.1 New Fluid Tailings

For 2020, CNRL Horizon reported 86.7 Mm<sup>3</sup> of new fluid tailings inventory (see figure 15), up from 81.6 Mm<sup>3</sup> in 2019. The site has a total volume trigger of 198 Mm<sup>3</sup> and a total volume limit of 277 Mm<sup>3</sup> for new fluid tailings, which were not exceeded in 2020. The new tailings inventory did not exceed the approved profile between 2015 and 2020.

CNRL Horizon reported 2.1 Mm<sup>3</sup> of NRU treated tailings but excluded it from the fluid tailings volumes. This decision was based on NRU treated tailings material not fitting the definition of fluid tailings as defined in *Directive 085*.

CNRL Horizon reported that due to high solids content fluid tailings (HSCFT) material meeting the RTR subobjective 1 criteria and extensive consultation with a member of its external geotechnical review board, it decided to exclude HSCFT from the reported 2020 fluid tailings inventory. The AER will seek further clarification with CNRL to obtain additional information regarding this decision to change its reporting approach.



Notes: 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. Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). A partial pond survey program was completed at CNRL Horizon due to high winds and freezing conditions.

### Figure 15. New fluid tailings for CNRL Horizon, 2015 to 2020

### 8.6.1.2 Legacy Fluid Tailings

For 2020, CNRL Horizon reported a legacy fluid tailings inventory of 63.2 Mm<sup>3</sup>, a decrease of 1.9 Mm<sup>3</sup> (see figure 16) from an inventory of 65.1 Mm<sup>3</sup> in 2019. CNRL Horizon was within its approved legacy fluid tailings profile between 2015 and 2019. In 2020, CNRL slightly exceeded its legacy fluid tailings profile but remained below the 20 per cent profile deviation trigger for legacy fluid tailings.



Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). A partial pond survey program was completed at CNRL Horizon due to high winds and freezing conditions.

#### Figure 16. Legacy fluid tailings for CNRL Horizon, 2015 to 2020

8.6.2 Volume of Treated Fluid Tailings by Technology

For 2020, CNRL Horizon reported treating a total of 159.4 Mm<sup>3</sup> of fluid tailings. The breakdown of treatment by NST technology was 139.3 Mm<sup>3</sup> of NST slurry and 78.3 Mm<sup>3</sup> of NST beach deposit in total between ETF/DDA1 and DDA2 deposits.

In 2020, CNRL Horizon reported 78.3 Mm<sup>3</sup> of fluid tailings achieved RTR status as follows:

- 69.0 Mm<sup>3</sup> of NST in ETF/DDA1
- 9.3 Mm<sup>3</sup> of NST in DDA2

CNRL Horizon reported 2.1 Mm<sup>3</sup> of NRU treated tailings deposited in the ETF/DDA1. However, this volume was excluded from the reported RTR classified tailings volumes. This is due to NRU treated tailings material not having an approved RTR criterion.

## 8.6.3 Treatment Operation and Continuous Improvement

CNRL Horizon reported in its 2016 tailings management plan an on-specification runtime target of 85 per cent for its NST plant generation before 2023. CNRL Horizon reported improvement in NST on-specification runtime in 2020 of 71 per cent compared with the reported 56.6 per cent in 2019.

In the 2016 tailings management plan, it was stated that the on-specification runtime target for 2020 was 78 per cent. However, the reported performance was 71 per cent, an improvement from 56.6 per cent in both 2018 and 2019. The AER specified in the closing letter for the 2019 tailings management report that it required "an update regarding the specifications presented in the 2016 TMP [tailings management plan] reflective of the learnings from operation execution stated in the 2019 TMR [tailings management report], in the 2020 TMR [tailings management report]." CNRL Horizon has indicated a change in performance monitoring approach from past reporting years. In its original tailings management plan, CNRL Horizon proposed "…targeting to meet NST/MFT Spiked NST design specifications a minimum of 85% of the time. When meeting specifications, 85% of fines will be captured in these deposits." In 2020, CNRL Horizon reported a change of only targeting the 85 per cent fines capture in NST beaches. The AER will seek further information regarding the implication of the removal of the on-specification runtime component of performance monitoring to the achievement of the approved fluid tailings profile.

Horizon reported having difficulty following the prescribed mine plan due to the high rainfall encountered during the spring and summer of 2020. Flooding events within the mine pit created significant operational challenges, which forced deviations from the plan to ensure the bitumen production targets were met. The result was an increase of fines in the ore mined (i.e., over the MFTRMP) and therefore an increase of fines in the tailings produced. CNRL Horizon states that continuing to adhere to the mine plan, as outlined in the MFTRMP, will be essential in meeting fluid tailings inventory targets. The AER continues to monitor the progress of the MFTRMP and its effectiveness at reducing fluid tailings volumes.

CNRL Horizon reported that NST density can be improved by addressing the condition of equipment in extraction and reported implementing a series of improvements in 2020:

- Thickener: Two incumbent flocculants were trialed in 2020, and one will continue to be trialed in 2021. The trials were intended to maximize thickener underflow with varying feed conditions to produce appropriate NST densities and reduce water which reported to the pond.
- Primary cyclones: CNRL Horizon optimized its maintenance strategy for the primary cyclones to consider process performance and not running to failure to increase overall NST production.

- Secondary cyclones: CNRL Horizon has replaced all worn units on existing trains and developed a new maintenance strategy in 2020 to include live monitoring of unworn parts. This improvement has aided in maintaining the highest NST density appropriate to the feed, reducing water reporting to the pond.
- Enhanced NST (eNST) and enhanced spiked NST (esNST): Polymer dosage strategy for varying slurry characteristics were studied in 2020. The optimization of the relationship between polymer dosage and yield stress under various conditions will continue to occur throughout 2021.

## 8.6.4 Technological Innovation in Fluid Tailings Treatment

In 2020, CNRL Horizon developed plans for the fluid tailings thickener / NST co-mixed pilot at DDA2, consisting of co-deposition (mixing) of the thickened fluid tailings product with NST. CNRL Horizon intends to produce a co-deposit thickener product and NST mixed product that will perform similarly to the co-mixed deposits at CNUL Jackpine mine.

CNRL Horizon reported continued refinement of its existing tailings technologies and deposition strategies. The following are the main technologies in development throughout the 2020 reporting period at Horizon:

- Fluid tailings spraying: CNRL Horizon continued to evaluate the technology performance at a larger scale. Due to the technology significantly relying on favorable weather conditions, CNRL has discontinued further development of this technology.
- HSCFT treatment pilot: A pilot to test the hypothesis that hydraulically loading HSCFT with beach sand can accelerate its consolidation rate in comparison to an undisturbed analogue area was completed and analysis is in progress. The pilot involved dredging about 3000 tonnes of sand from the ETF/DDA1 beach and depositing it on HSCFT.
- NST (eNST and esNST): In 2020, test results confirmed that an esNST sand-to-fines ratio (SFR) of 4.5, when sufficiently flocculated, has favourable hydraulic conductivity properties, whereas the current chemical and specified dosage are insufficient to provide enhanced consolidation properties for an SFR of 3.5. Preliminary results show that for the same SFR, eNST performed better than NST. Data collection and analysis is ongoing to optimize polymer injection and operation of eNST. CNRL reports that results show both eNST and esNST treatments have improved performance of consolidation and fines dynamic segregation than NST.
- Proprietary third-party bitumen and naphtha recovery: CNRL engaged in developing the scope and cost for deploying a bitumen and naphtha recovery technology at Horizon. Primary goals are to recover the bulk of residual bitumen and naphtha in the NRU. In addition, an experimental program to test the thickening and consolidation behaviour of the NRU tailings was conducted with varying levels of residual bitumen and naphtha. This work was meant to be complete by mid-2020, but further

opportunities for improvement were identified. An updated timeline for completion was expected in April 2021, at which time the business case was to be revised and a decision taken on how to proceed.

- NST revegetation: Objective to address some of the knowledge gaps to the potential success of NST reclamation, a project comprising seven studies is being undertaken by the University of Alberta and CNRL. Study 3 was conducted in 2020. However, due to restrictions related to the COVID-19 pandemic, Study 4 was delayed and will be completed in 2021.
- In-pit extraction process: This is an alternative bitumen extraction process that separates oil sands ore into coarse and fine solids, bitumen froth, and water. After separation, the bitumen froth is transported to the froth treatment plant for further processing, and the coarse and fine solids are recombined into dry tailings. The pilot campaign was suspended in early March 2020 as part of the company's initiatives to mitigate the dual impacts of the global pandemic and decline in oil price.
- Coke pour benches on NST beach: The use of coke to construct pour benches on the NST deposit in the ETF/DDA1. In 2020, the construction of the FST pour bench and 2S pour bench were completed with similar monitoring results to the previous 3N bench construction. The new bench designs consist of a strategic combination of coke and overburden to optimize the function of each material in the performance of the structure, while managing material volume requirements.

Further details can be found in CNRL Horizon's 2020 tailings management report, appendix C and D.

## 8.6.5 Regulatory and Management Actions

CNRL Horizon is operating at management level 1 as described in the *TMF* and *Directive 085*. No management actions were taken during the 2020 reporting period for Horizon's tailings management operations.

### 8.6.6 Measurement System Audit Results

The AER reviewed CNRL's Horizon measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing CNRL's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

## 8.7 Imperial Oil Limited – Kearl

Imperial reported one tailings facility operating at Kearl in 2020, called the external tailings area (ETA). The ETA is split into two areas: the west ETA (WETA) and east ETA (EETA). The EETA contains the approved area where Imperial Kearl places its treated tailings within designated panels. The WETA contains flotation tailings (FLT) and TSRU tailings from both Kearl plants K1 and K2. Coarse sand tailings were discharged to both the WETA and EETA.

Imperial Kearl's primary approved tailings treatment technology is the production of TT by flocculating FLT and fluid tailings in the thickeners and reflocculating the stream using chemical injection (secondary chemical treatment) before discharge to the TT panels. No significant changes were made to the treatment process; its thickener is performing as expected, with some variations observed in the deposit.

Imperial states, "A tailings field investigation was not completed during 2020 due to COVID-19, however, available process data and modelling techniques were utilized to provide estimates for normally field measured data." Therefore, the tailings volumes reported for 2020 are based on a combination of modelling and data from prior field measurements. Imperial Kearl reported that it was managing its fluid inventory within its approved fluid tailings profile.

The AER acknowledges the reported fluid tailings and RTR volumes in 2020's annual tailings management report are estimates based on historical data and modelling. The AER will not be able to complete its review of the reported volumes until they are confirmed by the measurements according to Imperial's tailings measurement system plan. However, the AER is accepting the 2020 volume estimates on an interim basis due to the unique circumstances in 2020. As such, Imperial will be required to complete, as part of its 2021 pond survey, sampling and reporting a back-analysis of its fluid tailings and RTR volume estimates for 2020, which the AER will review for acceptability.

## 8.7.1 Fluid Tailings

For 2020, Imperial Kearl reported a total fluid tailings inventory of 75.0 Mm<sup>3</sup>, which was below its approved fluid tailings volume profile of 130 Mm<sup>3</sup>. The total fluid tailings inventory volume was estimated for 2020 instead of a measured volume. Due to COVID-19, the tailings field investigation program was not conducted in 2020, therefore the total fluid tailings inventory and RTR volume were estimated from satellite surveys, thickener underflow process data, and previously estimated deposit properties.

Imperial Kearl is claiming 9.1 Mm<sup>3</sup> of fluid tailings has achieved RTR criteria since the start of TT production. The claimed volume has met subobjective 1 RTR criteria, which requires the east ETA to achieve 65 percent solids by weight within one year of treated fluid tailings placement based on deposit sampling. Imperial Kearl took a conservative approach and is not reporting any new RTR volume for

2020 because solid content of the deposit was not measured in 2020. As a result, the claimed RTR volume is the same as reported in the 2019 annual tailings report.

### 8.7.1.1 New Fluid Tailings

For 2020, Imperial Kearl reported 75.0 Mm<sup>3</sup> of new fluid tailings inventory (see figure 17), up from 62.1 Mm<sup>3</sup> in 2019. The approved new fluid tailings inventory for 2020 was 130.0 Mm<sup>3</sup>. The total volume trigger for new fluid tailing is 180 Mm<sup>3</sup> and the total volume limit is 252 Mm<sup>3</sup>, neither of which were exceeded. The new fluid tailings inventory was also within the new fluid tailings profile from 2014 to 2020.



Notes: 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.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys, core penetration tests, tailings characteristic sampling). Pond surveys were not conducted for Imperial Kearl and volumes were estimated.

Figure 17. New fluid tailings for Imperial Kearl, 2014 to 2020

## 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 tailing that were on site in 2014 were considered new fluid tailings to simplify fluid tailings management and reporting.

### 8.7.2 Volume of Treated Fluid Tailings by Technology

For 2020, Imperial Kearl reported 19.0 Mm<sup>3</sup> of TT within the TT panels and is claiming 9.1 Mm<sup>3</sup> volume of TT determined to have reached RTR status. As mentioned above, the reported volume to be determined as RTR criteria is the same as last year's reported volume. In the absence of a tailings field investigation program on the TT deposit in 2020, all TT produced in 2020 was considered to be fluid tailings.

### 8.7.3 Treatment Operation and Continuous Improvement

For 2020, Imperial Kearl reported that both the thickener operation and the TT deposit generally met expectations; the thickener underflow achieved the required density and fines loss to the thickener overflow was lower than expected. However, based on process surveillance, the thickeners produced an underflow in the lower-than-expected range of 40 to 50 per cent solids content during the first half of 2020. This was due to lower solids loading rates from the FLT feeds fed by Kearl plants K1 and K2. It was rectified in the second half of 2020. Challenges were primarily due to physical availability of specific pieces of equipment, winter operation, and other operational challenges related to commissioning and start-up. The performance of the overall system will be confirmed with next year's sampling campaign and reported in next year's annual report. The AER notes, although Imperial Kearl is still facing challenges with its thickener underflow performance, Imperial Kearl has shown signs of progress and improvement, which is reflected in its quarterly monitoring of thickener for solids content and SFR.

Continuous improvements and developments in 2020 to overcome operational challenges and difficulties included:

- Relocating the fluid tailings line and power and communications outside the active tailings beach. This has resolved past operational challenges.
- Installing new pipe supports in Q1 and surge tank installation in Q4 to resolve vibration issues in the secondary chemical injection system.
- Replacing and upgrading several valves and evaluating and identifying other improvements, which are underway in 2021.
- Modifying the pump maintenance strategy to prevent future simultaneous failures and planning pump upgrades that increase pump run life and reduce the time to repair.

# 8.7.4 Technological Innovation in Fluid Tailings Treatment

Imperial Kearl submitted the following pilot applications in 2020:

- In-line flocculation on-site tailings pilot update phase 1: The ILF Phase 1 pilot was conducted during the latter part of the plant annual maintenance period in 2020. Fluid tailings were extracted from the WETA tailings pond using the fluid tailings barge and directly pumped to the in-line polymer injection location. After polymer injection, ILF treated fluid tailings were sent to the deposition area in the EETA. The results of the field pilot deposit surveillance demonstrated better than expected performance. The ILF treatment of fluid tailings is an excellent opportunity to use excess capacity of the current treatment system to increase overall treatment capacity.
- In-line flocculation on-site fluid tailings pilot phase 2: The pilot was carried out from July to October 2019. Analysis of the results from the second field investigation and continuous monitoring data are in progress.
- In-line flocculation on-site fluid tailings pilot phase 3: The pilot was not able to start in 2020 as originally planned due to the impact to site operations from COVID -19 pandemic public health measures. Imperial Kearl plans to start the pilot in September 2021, followed by a field investigation in October 2021.
- In-line flocculation on-site fluid tailings pilot phase 4: Analysis of the deposit is still in progress to evaluate the commercial application of the treatment and the deposition strategy.
- Enhanced beach capture: Deposition started in September 2020 and completed in November 2020. The laboratory testing and data analysis are in progress.
- Alternative flocculant field trial: Commercial authorization was requested from the AER on October 27, 2020, and approval was granted on November 10, 2020.

Further details can be found in Imperial Kearl's 2020 tailings management report.

## 8.7.5 Regulatory and Management Actions

Imperial Kearl mine site is operating at management level 1 as described in the *TMF* and *Directive 085*. No management actions were taken during the 2020 reporting period for Imperial Kearl's tailings management operations.

# 8.7.6 Measurement System Audit Results

The AER reviewed Imperial's Kearl measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing Imperial's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to

be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

## 8.8 Suncor – Fort Hills

The Fort Hills mine started production in December 2017, which is when tailings placement began in the out-of-pit tailings area. Suncor Fort Hills is proposing to start fluid tailings treatment and placement in its DDA in 2024.

Since Suncor Fort Hills did not have any fluid tailings inventory prior to 2016, it does not have any legacy fluid tailings, and all its fluid tailings are considered new fluid tailings.

Suncor Fort Hills does not have an approved tailings treatment technology. The AER has authorized the continued use of existing infrastructure, specifically the continued use of thickeners, which are expected to provide a benefit to tailings management as they can decrease the volumes of fluid tailings generated. As part of Fort Hills' tailings management plan, Suncor proposed treating fluid tailings using a single technology, which is the PASS technology. The AER has not approved the PASS technology and has imposed multiple conditions on Suncor Fort Hills as part of *Decision 20190225A*, including the following:

- By September 30, 2021, Suncor Fort Hills is required to submit a plan for conducting a demonstration to test the performance of PASS technology.
- 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 water capped.

Suncor Fort Hills reported that the new fluid tailings inventory was within its approved profile for 2020.

Suncor Fort Hills maintained its volumetric testing of fluid tailings throughout the COVID-19 pandemic and subsequent public health emergency, so no further action is required in 2021 by Suncor Fort Hills to validate its 2020 reported volumes.

### 8.8.1 Fluid Tailings

For 2020, Suncor Fort Hills reported 30 Mm<sup>3</sup> of new fluid tailings inventory. Suncor Fort Hills did not report any tailings meeting RTR criteria because it does not have approved RTR criteria. Suncor Fort Hills is required to provide RTR criteria as part of its updated tailings management plan to be submitted

within two years from the start of its demonstration of PASS technology, or by September 30, 2026, whichever date occurs first.

#### 8.8.1.1 New Fluid Tailings

For 2020, Suncor Fort Hills reported an inventory of 30 Mm<sup>3</sup> of new fluid tailings (see figure 18), up from 17 Mm<sup>3</sup> in 2019. The 13 Mm<sup>3</sup> increase is below Suncor's approved new fluid tailings profile of 43 Mm<sup>3</sup> for 2020.

Fort Hills has a total volume trigger of 125 Mm<sup>3</sup> and a total volume limit of 175 Mm<sup>3</sup> for new fluid tailings, neither of which were exceeded in 2020. The tailings inventory has been within the new fluid tailings profile since 2018.



Notes: 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 2020

#### 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

Suncor Fort Hills is not reporting any volume of treated fluid tailings for 2020 because it does not have an approved fluid tailings treatment technology. Suncor Fort Hills is required to submit a plan for demonstrating the PASS technology by September 30, 2021. Suncor Fort Hills is also required to provide RTR criteria as part of its updated tailings management plan to be submitted within two years from the start of its PASS technology demonstration, or by September 30, 2026, whichever date occurs first.

### 8.8.3 Treatment Operation and Continuous Improvement

Suncor Fort Hills reported that tailings management is progressing as planned. However, the underperformance of Suncor Fort Hills' thickener noted in 2019 has not been fully addressed. The AER is currently monitoring this aspect of the Fort Hills tailings operations and has requested more information.

### 8.8.4 Technological Innovation in Fluid Tailings Treatment

Suncor Fort Hills reported the following bench and pilot-scale research in 2020 with respect to its PASS technology development:

- Settlement monitoring and gamma spectrometer testing within test columns to monitor the consolidation and expressed water and gas to improve understanding of the biogeochemical evolution of fluid tailings deposits.
- Geotechnical centrifuge testing for rapid settlement and consolidation evaluation to screen fluid tailings treatment options within the out-of-pit tailings area.
- Microcosm and serum bottle work to model the kinetics of biogas exsolution in a PASS deposit to enable prediction of the deposit's biogeochemical trajectory.
- Settlement and consolidation model development for feed forward forecasting of the treatment envelope and the settlement trajectory of the deposit.

Further details can be found in the Suncor Fort Hills 2019 and 2020 tailings management reports.

### 8.8.5 Regulatory and Management Actions

On April 4, 2019, Suncor requested that the AER reconsider *Decision 2019225A* pursuant to section 42 of the *Responsible Energy Development Act*. The request for reconsideration was withdrawn in 2020, pending the submission of an integrated tailings management plan amendment expected in 2021.

Suncor Fort Hills is operating at management level 1 as described in the *TMF* and *Directive 085*. No management actions were taken during 2020 for tailings management operations at Fort Hills.

### 8.8.6 Measurement System Audit Results

The AER reviewed Suncor's Fort Hills measurement system plan regarding fluid tailings volumetric calculations, laboratory testing, and groundwater monitoring. The AER will continue reviewing Suncor's plans concerning water quality characterization, measurement of COPCs and NORM and may issue additional SIRs in the future. The measurement system plans are live documents that are required to be updated regularly with changes that reflect current best practices and operations, and operators are required to notify the AER of all plan changes.

An audit process and schedule are being prepared for future 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. All operator measurement system plans are posted on the AER's website under <u>By Topic, Tailings</u>.

## 9 Summary

Tailings management under *Directive 085* continued in 2020. Beginning with the 2018 reporting year, full *Directive 085* reporting was required from operators. By the end of 2019, all eight operating oil sands mines had approved tailings management plans in place.

In 2020, monitoring and reporting of fluid tailings were affected by the COVID-19 pandemic. The AER temporarily relieved operators of some monitoring and reporting during the initial phases of the pandemic. Consequently, some operators did not conduct part or all of their annual tailings volume surveys to limit the number of people at the mine sites. The operators that did not conduct annual tailings volume surveys provided estimated volumes for 2020 based on historical data and modelling. As part of their 2021 pond surveys, operators will be required to complete sampling and reporting a back-analysis of their fluid tailings and RTR volume estimates for 2020. The AER will review the back-analysis for acceptability. In 2020, the annual fluid tailings site visits were conducted virtually.

The AER completed assessments of the measurement system plans 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 measurement system plans to address the need to minimize the effect the 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 (subobjective 2)—related to water quality characterization and the measurement of COPCs and NORM—and may issue additional SIRs in the future. The tailings measurement system plans are live documents that are required to be

Alberta Energy Regulator

updated regularly with changes that reflect current best practices and operations, and operators are required to 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. In addition, for the 2020 reporting year, any volumes that were estimated due to the COVID-19 pandemic will need to be verified by operators in their 2021 reports.

The total volume of fluid tailings (new and legacy tailings combined) on oil sands mine sites in the Athabasca oil sands region has increased between 2014 and 2020, as reported by the individual operators and as expected based on their combined approved fluid tailings profiles. The total regional volume of fluid tailings remains below the new and legacy fluid tailings profiles combined for all operators. The regional volume of water in tailings ponds decreased slightly between 2014 and 2017. It then increased from 2017 to 2020. This occurred with an overall increase in bitumen production from 2014 to 2019, followed by a decrease in production in 2020. This was the first decrease in oil sands mining production since 2016, occurring during the COVID-19 pandemic and related drop in global oil demand. In addition, more mines became operational between 2014 to 2020.

Based on the fluid tailings volumes reported in the 2020 annual reports submitted by operators, all operators were below their approved new fluid tailings profiles, total volume triggers, and total volume limits. Also, all operators were below their 20 per cent deviation triggers for new and legacy fluid tailings. Three sites, however, were above their legacy fluid tailings profiles: Syncrude Mildred Lake from 2017 to 2020 and Suncor Base Plant and CNRL Horizon in 2020. No change in management level as described in *Directive 085* was required for these operators because their volumes were within the total allowable volume triggers and limits. Where information was insufficient for the AER to verify operators' data or analyses, the AER issued requests for clarification or additional data. Reponses to these requests were not received 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 prior to 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 2021 report.

Operators continue to report on improvements in tailings treatment technologies, pilot new technologies, and work on developing new technologies to treat fluid tailings. The AER will review and evaluate technologies and deposit designs that show promise for treating and reducing fluid tailings volumes. Based on operating conditions, future submissions and applications to the AER are expected from the operators on

• updated tailings management plans;

- 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 AER and Government of Alberta review the *TMF*, *Directive 085*, and operator tailings management plans every five years. Operator *EPEA* approvals are required to be renewed every 10 years. These review timelines ensure that updates and changes based on changes to policy and performance can be made.

# **10** Future Reports

The AER will continue public reporting and ensure the transparency of fluid tailings monitoring data received from operators. Now that all operators' tailings management plans are approved, future AER reports on tailings management will

- evaluate regional performance against the *TMF*'s outcomes and objectives;
- identify operators that are performing well and those that need to make improvements (in accordance with *Directive 085*); and
- incorporate a summary evaluation of environmental effects and reclamation performance reporting that may include references to other required reports (e.g., *EPEA* reports) and linkages to *EPEA* and reclamation regulation.

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, 2022: An integrated pond 6 fluid tailings management plan and site-wide water and fluid tailings balance.
  - 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.
  - September 30, 2024: A plan that updates pond 7 fluid tailings management.
- Syncrude Mildred Lake:
  - January 31, 2023: An updated tailings management plan.

- Syncrude Aurora North:
  - December 31, 2023: An updated tailings management plan.
- CNUL Muskeg River mine:
  - April 30, 2022: An amendment application for its tailings management plan.
  - One year prior to fluid or treated tailings placement in a tailings facility, an updated tailings management plan.
- CNUL Jackpine mine:
  - April 30, 2022: An amendment application for its tailings management plan.
  - One year prior to fluid or treated tailings placement in a tailings facility, an updated tailings management plan.
- CNRL Horizon:
  - September 30, 2021: An updated plan for froth tailings management.
  - June 30, 2024: An updated fluid tailings management plan.
  - One year prior to placement of fluid or treated tailings, a plan that updates fluid tailings management for all tailings facilities.
- Imperial Kearl:
  - December 31, 2021: An updated tailings management plan.
- Suncor Fort Hills:
  - September 30, 2021: 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 tailings management plan.

Alberta Energy Regulator
# 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 has used 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 (AFD) 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 (TSRU) 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

Nonsegrating 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 (CT) 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.

CNRL Horizon uses NST technology. CT is used by Syncrude Mildred Lake, Syncrude Aurora North, and CNUL Muskeg River mine, 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 the 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 (DDA3). 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 tailings management plan decision reports and in operator approvals.

Alberta Energy Regulator

# Appendix 2 Tailings Field Inspection Summaries

- Summary of the AER 2020 Tailings Field Inspection for Suncor Base Plant
- Summary of the AER 2020 Tailings Field Inspection for Syncrude Mildred Lake and Aurora North
- Summary of the AER 2020 Tailings Field Inspection for CNUL Muskeg River Mine
- Summary of the AER 2020 Tailing Field Inspection for CNUL Jackpine Mine
- Summary of the AER 2020 Tailings Field Inspection for CNRL Horizon
- Summary of the AER 2020 Tailings Field Inspection for Imperial Kearl
- Summary of the AER 2020 Tailing Field Inspection for Suncor Fort Hills

Summary of the AER 2020 Tailings Field Inspection for Suncor Base Plant



# Summary of the AER 2020 Regulatory Virtual Desktop Tailings Site Inspection

Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

www.aer.ca

Suncor Energy Inc. - Base Plant OSCA Approval No. 8535 EPEA Approval No. 92-04-18

#### DATE

October 27, 2020

#### PURPOSE

Due to COVID-19 public health concerns restricting travel and access to the Suncor Base Plant site, the Alberta Energy Regulator (AER) participated in a virtual desktop site inspection of the site, in lieu of a physical inspection. The AER subject matter experts (SMEs) were provided with regulatory updates on Suncor's Base Plant progress in tailings management, tailings technology research and developments, and ongoing operations.

#### HIGHLIGHTS

No deficiencies were observed.

#### **OBSERVATIONS**

**Dedicated Disposal Area (DDA) 1**: No deficiencies were observed. 7 Mm<sup>3</sup> of fluid tailings was reported treated from South Tailings Pond (STP), with reported greater than 98% no longer deemed fluid tailings.



**Figure 2** – DDA1 Material Being Rehandled for Permanent Placement in Mine Dump 9 (MD9)



Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

www.aer.ca

**Mine Dump 9 and MD9 South**: No deficiencies were observed. Suncor reported instability on the MD9 dump shell in 2019, with buttress construction scheduled in 2020-21 to support any factor of safety (FOS) risk areas with pre-cautionary geotechnical buttressing.





Figure 4 – Placement in MD9 Co-disposal Cell

**Figure 5** – No placement of tailings as of 2020 in MD9 South

**PASS Technology**: No deficiencies were observed; however, Suncor reported 15  $Mm^3$  from 33  $Mm^3$  deposited is > 0.5 CWR. Ongoing follow up with respect to meeting RTR criteria.



Figure 6 – DDA3 facility on September 20, 2020



Clay/water (%) – June 2020 Data

|           | 0 -> 20   |
|-----------|-----------|
|           | 20 -> 30  |
|           | 30 -> 40  |
|           | 40 -> 50  |
|           | 50 -> 60  |
|           | 60 -> 70  |
| · · · · · | 70 -> 100 |

 $Figure \ 7-Cross-section \ of \ clay \ to \ water \ ratio$ 

Tailings Technology Pilot Tests: No deficiencies were observed.



Figure 8 – Reported successful demonstration of online clay measurement for dosing control (At-line and in-line near infrared (NIR) spectroscopy)

Lake Miwasin Demonstration Pit Lake: No deficiencies were observed.



**Figure 9** – Construction reported completed in 2019, with commissioning deferred to 2021

Pond 8B Drainage: Reported one year behind 2015 approval schedule



Figure 10 – Status of Pond 8 Drainage.

Red = Current Infill Purple = Exposed Beach Blue = Current Pond

**Pond 5 Coke Cap**: Reported further data collection being required now that additional coke has been placed.



Figure 11 – Pond 5 Coke Cap Status

**Pond 6:** Suncor reported challenges with meeting the 2028 RTR date for Pond 6.

Figure 11 – Pond 5 Coke Cap Status



Summary of the AER 2020 Tailings Field Inspection for Syncrude Mildred Lake and Aurora North



# Summary of the AER 2020 Regulatory Virtual Tailings Site Visit

Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

www.aer.ca

Syncrude Canada Ltd. Mildred Lake Mine Site and Aurora North Mine Site OSCA Approval No. 8573, as amended OSCA Approval No. 10781, as amended

DATE

November 25, 2020

#### PURPOSE

Due to COVID-19, both the Alberta Energy Regulation (AER) and Syncrude encountered many challenges in 2020. To overcome these challenges, Syncrude agreed to conduct a virtual site visit of their sites, instead of a physical site visit to provide the AER with regulatory updates on their progress in tailings management, tailings technology research and developments, and ongoing operations.

#### **OBSERVATION**

#### Accelerated Dewatering/Flocculated FFT Technology Development

Syncrude provided the AER with an overview of their Accelerated Dewatering/Flocculated FFT technology development. Syncrude provided the timelines of their research and development of this technology since 2009 and its field results and analyses. They also included their next step plans and how it will implement commercially in the future.



#### **ADW/fFFT Research & Development**



#### Mildred Lake Tailings

Syncrude provided an update on all of their deposits (including deposits without treated tailings) and shared current status of each with the AER. Field pictures and satellite images were shared to demonstrate its deposit progression. Syncrude also shared challenges they in their 2019 operations, providing clarity and relevant information on those challenges.



Mildred Lake Settling Basin (MLSB) - Progression





Fall 2020

#### O Mildred Lake 2020 Annual AER Tailings Update W1/SWSS Thin Cake - Field Photos

September 2019:



#### August 2020:

September 2020 (bioengineered swale):





SYNCRUDE 24



#### Aurora North Tailings

Syncrude provided an update on all of their deposits (including deposits without treated tailings) and shared current status of each with the AER. Field pictures and satellite images were shared to demonstrate its deposit progression. Syncrude also shared challenges they encountered in 2019, providing clarity and relevant information on those challenges. And lastly, Syncrude showed how it has tied its AEPN-W to Suncor's Fort Hills' Dump.

Aurora Settling Basin (ASB) - Progression





Sept 2019

Sept 2020

Sept 2019

Sept 2020

Aurora East Pit North-East (AEPNE) - Progression



Summary of the AER 2020 Tailings Field Inspection for CNUL Muskeg River Mine



Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

#### www.aer.ca

Canadian Natural Upgrading Limited. Muskeg River Mine OSCA Approval No. 8512M, as amended

Summary of the AER 2020 Regulatory Virtual Tailings

DATE

October 29, 2020

#### PURPOSE

Site Visit

Due to COVID, both Alberta Energy Regulator (AER) and Canadian Natural Upgrading Limited (Canadian Natural) encountered many challenges in 2020. To overcome these challenges, Canadian Natural had agreed to conduct a virtual site visit of their Muskeg River Mine site, instead of a physical site visit to provide the AER with regulatory updates on their progress in tailings management, tailings technology research and developments, and ongoing operations.

#### **OBSERVATION**

MRM Ponds Fluid Cell 1 (FC1):

Discussions:

• FC1 partial pond survey was completed based on operational activity and data review.

MRM Ponds (IPC1):

Discussions:

• Milestones achieved and future activities which include operational execution of beach development.

| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |

# IPC1





MRM Ponds (IPC2):

Discussions:

• IPC2 TT lines were removed from Cell 2 and put into Cell 3.



# IPC2









### MRM Ponds (IPC3):

Discussions:

- Milestones achieved and future activities which include operational execution of beach development.
- IPC3 deposition methodology consists of is a layering approach, so is not homogeneous deposit.

# IPC3



| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |



MRM Ponds (IPC4):

Discussions:

• Future operational execution plans for tailings deposition.



# **IPC4 (Future)**



**MRM Projects Filter Press:** 

- This phase was to determine commercial scale performance both operationally and economically.
- Had issues with tears in the filter cloth which was improved by applying learnings.
- Water quality was monitoring, an anticipated increase in Calcium and potential options for mitigation were investigated.
- Learnings for the Measurement Plan were made via a comparison of CPT and VST results, this confirms both are similar.
- It was concluded that commercial scale is feasible operationally, but, economically is not as desired. The path forward is to find optimization in flock and coagulation to reduce cost.

Observation: Update on the filter press required to satisfies an AER requirement for a pilot update.

| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |





Ball Penetration Test (BPT)

Parky Piston Sampling



#### **MRM Projects Geobags:**

#### Discussions:

Continue to monitor the existing Geobags. •

#### Geobags



MRM Projects Lower AFD:

Discussions:

Met AFD tailings treatment production goal. •

#### Lower AFD



Lower AFD cells as seen from a Satellite photo, taken August 2020. These Cells were last deposited in 2019

Oct 25th 2020



MRM Projects ETF NPD and Upper AFD:

Discussions:

- ETF area available for the next 5 years, as berms incorporated with final landscape surface.
- ETF AFD drying performed well this wet summer season due to surface/under drainage.
- 2019 Haulage completed April; AFD deposition started May; AFD deposition ended October.

#### Photo 1 Photo

#### ETF - NPD and Upper AFD

MRM Projects ETF South Infilling:

Discussions:

• Milestones achieved and future activities which include operational execution of beach development.

Sept 18th 2020

| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |

#### **ETF - South Infilling**



MRM Projects ETF West Beaching:

Discussions:

• Milestones achieved (closed out 340m crest from October 18<sup>th</sup>, 2020) and future activities which include operational execution of cell construction for containment development.



ETF - West Infilling

| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |

## **ETF - West beaching**



**ETF - West beaching** 





MRM Projects SEA R&C Activities:

Discussions:

• Microtopography determined to help vegetation and slope stability.



#### **SEA- R&C Activity**

**Overall Observation:** 

• Overall, appropriate alignment between what was observed during the virtual inspection with what was reported in the Tailings Management Report (TMR).

Summary of the AER 2020 Tailing Field Inspection for CNUL Jackpine Mine



Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

#### www.aer.ca

Canadian Natural Upgrading Limited. Jackpine Mine OSCA Approval No. 9756J, as amended

Summary of the AER 2020 Regulatory Virtual Tailings

DATE

October 29, 2020

#### PURPOSE

Site Visit

Due to COVID, both Alberta Energy Regulator (AER) and Canadian Natural Upgrading Limited (Canadian Natural) encountered many challenges in 2020. To overcome these challenges, Canadian Natural had agreed to conduct a virtual site visit of their Jackpine Mine site, instead of a physical site visit to provide the AER with regulatory updates on their progress in tailings management, tailings technology research and developments, and ongoing operations.

#### **OBSERVATION**

#### JPM DDA1 – CFFT & TT:

Discussions:

- On production, deposition and performance of CFFT/CST and TT/CST tailings deposits.
- On current monitoring of transition zone development between different Tailings Deposits, and how this may influence future laboratory testing for ultimate settlement development. It has noted that current data is provided in a recent application.
- On the existence of layering within the currently monitored CFFT/CST and TT/CST deposits. These layers are being monitored have not indicated any performance issues.
- On optimization of discharge setup, such as discharge height, and spacing for individual types of treated tailings.





JPM ILF Trial:

Discussions:

- On deployment of the infrastructure for the trial, indicated as smooth.
- Identifying mixing as a key study parameter for this pilot.
- Monitoring of implications of discharge setup with mixing performance.









#### JPM SC2 MAFD:

Discussions:

- Milestones achieved and future activities which include operational execution of a CST layer placed over MAFD deposit.
- Placement of MAFD August October 2018.
- Monitoring and testing of the placed cap (March-September 2020) to be main focus of next performance evaluation.





JPM Closure Wrap Progression:

Discussions:

• Milestones achieved and future activities which include operational execution of cell construction for containment development.



JPM Closure Wrap Progression:

Discussions:

• Milestones achieved and future activities which include operational execution of cell construction for containment development.







**Ball Penetration Test (BPT)** 



Subsamples (tested for Solids Content, Dean-Stark, MBI)



Parky Piston Sampling



**Overall Observation:** 

• Overall, there was appropriate alignment between what was observed during the virtual inspection with what was reported in the Tailings Management Report (TMR).
Summary of the AER 2020 Tailings Field Inspection for CNRL Horizon



# Summary of the AER 2020 Regulatory Virtual Tailings Site Visit

Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

www.aer.ca

Canadian Natural Resources Ltd. Horizon Mine OSCA Approval No. 9752I, as amended

DATE

October 28, 2020

#### PURPOSE

Due to COVID, both AER and Canadian Natural Resources Limited (Canadian Natural) encountered many challenges in 2020. To overcome these challenges, Canadian Natural had agreed to conduct a virtual site visit of their Horizon Mine site, instead of a physical site visit to provide the Alberta Energy Regulator (AER) with regulatory updates on their progress in tailings management, tailings technology research and developments, and ongoing operations.

#### **OBSERVATION**



| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |



esNST:

Discussions:

- The Learnings from operational execution of NST and its enhancements.
- MFT Dredging is efficient, while optimizations surrounding pump reliability and winterization are areas of focus.



| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |

#### FT Harvesting Facility

#### FT Harvesting Facility



FT Harvesting Facility



FT Injection Points

**Polymer Injection Spool** 



| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |



#### **Polymer Injection Spool**



| inquiries | 1-855-297-8311 |
|-----------|----------------|
| 24-hour   | 1-800-222-6514 |
| emergency | 1-800-222-0514 |

Pour Point and NST Beach



| ian Natural              | NST1 Pour Point | 17 |
|--------------------------|-----------------|----|
| Pour Point and NST Beach |                 |    |





Pour Point and NST Beach



NST2 Pour Point & Beach 2(



#### **Pour Point and NST Beach**

**Pour Point and NST Beach** 



#### Spray Pilot:

Discussions:

- Misters Operational Execution and Learnings.
  - Alteration of equipment components improved performance (macerators).
  - Rain was a key concern due to a) Limiting run hours, and b) Drying time is still being determined. c) Further investigation on effects of wind required due to short run times.
- Additional observations a) Bitumen was observed in front, b) Fines found behind mister, c) evaluate location of air quality monitoring.
- Future data review to determine if they will extend the pilot.
- Farm sprayer
  - Due to weather (rain) did not perform as anticipated.

| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |

### Spray Pilot



Spray Pilot

**Pilot Location** 





**Ecomister Macerators** 



www.aer.ca

| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |



| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |



HSCFT Pilot:

Discussions:

- The operational execution of subaqueous deposition of dredged material to rain on a selected tailings deposit.
- Dredge density was lower due to the capability of the dredge.
- Data collection and analysis is still ongoing.

| inquiries            | 1-855-297-8311 |
|----------------------|----------------|
| 24-hour<br>emergency | 1-800-222-6514 |

#### Sand load BAW >25%w/w BBW Fluid Tailings HSCFT : Ceda Dredge 🖕 : Barge digging arm ---- Floating line Anchoring system E Float n Netural Pilot Schematic 38

Ceda Dredge

HSCFT Pilot

Ceda Dredge



Dredge and Floating Pipe during Deposition

Ceda Dredge

in Natural



Side view at ETF Marina



**Coke Bench Pilot:** 

Discussions:

- The key area of focus was the ideal combination of Coke, Over Burden (O/B), and geogrid to build access for pipeline discharge advancement on NST Beach.
- Future updates will be provided for this pilot stage as learnings are analyzed.
- Performance of Phase one were positive and this phase adding additional understanding of optimum design for benches.
- Coke Bench pilot will be incorporated in the upcoming Capping Research Plan.

May 2020 Horizon ETF Satellite Imagery



www.aer.ca





**Overall Observation:** 

• Overall, there was appropriate alignment between what was observed during the virtual inspection with what was reported in the Tailings Management Report (TMR).

Summary of the AER 2020 Tailings Field Inspection for Imperial Kearl



# Summary of the AER 2020 Regulatory Virtual Tailings Site Visit

Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

www.aer.ca

Imperial Oil Resource Ltd. Kearl Mine OSCA Approval No. 10829, as amended

#### DATE

December 1, 2020

#### PURPOSE

Due to COVID-19, both the Alberta Energy Regulation (AER) and Imperial Oil encountered many challenges in 2020. To overcome these challenges, Imperial agreed to conduct a virtual site visit of their Kearl mine site, instead of a physical site visit to provide the AER with regulatory updates on their progress in tailings management, tailings technology research and developments, and ongoing operations

#### **OBSERVATION**

#### Performance Update on TT Panels

Imperial provided the AER with a progress update of its TT panels in the East ETA. Imperial provided the following in their update:

- Update of TT panels progress with field pictures and satellite images;
- Provided clarity on its assessments and analysis of its TT performances;
- Provided discussions on its accomplishments and challenges in 2020; and
- Provided discussions on their potential future strategies, one of which could be a CST co-deposition with inline flocculated FT to enhance fines capture in the panels.





#### Drainage Issues Between Center Dyke

Imperial provide the AER with an update on how Centre Dyke construction is progressing and comment on their current understanding of the state and characteristics of the TT deposit in the west TT panel. Imperial provided the AER with construction history and background, improvement & construction performance, west TT Panel deposit condition, and conclusions. Imperial will include within their CPT program in 2021 an assessment of the characteristics of TT in West Panel to determine its effects.



--- General drainage path

#### Progress of WETA - TSRU

Imperial provided an update on the progress of the WETA, more specifically on their management of TRSU. Imperial also provided their plans on how they intend to evaluate material properties and consolidation rates to understand the impact for capping and reclamation of TSRU material. Imperial has made plans with the AER to further dive into this evaluation program in 2021.





#### **Tailings Pilots**

The objective of this section of the virtual site visit was to provide the AER with an update of all of Imperial's ongoing and completed pilots.

In-line Flocculation Pilot (ILF):

- Phase 1 Completed in 2020
- Phase 2 Completed in 2019
- Phase 3 Postponed until 2021
- Phase 4 Completed in 2020

Observation:

- Provided clarity on all phases of their ILF pilots.
- Provided clarity on some of their findings, results, and analyses.
- Provided some plans for next step pilots.



Dean-Stark, MBI)

Ball Penetration Test (BPT)

Parky Piston Sampling



#### OSPW - Treatment Wetland Pilot

The objective of this section of the virtual site visit was to provide the AER with an update of its Treatment Wetland pilot. Imperial provided clarity on the background and objective of the treatment wetland pilot.



Summary of the AER 2020 Tailing Field Inspection for Suncor Fort Hills



### Summary of the AER 2020 Regulatory Virtual Desktop Tailings Site Inspection

Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

www.aer.ca

Suncor Energy Inc. – Fort Hills OSCA Approval No. 9241 EPEA Approval No. 1511469-01 (as amended)

#### DATE

September 29, 2020

#### PURPOSE

Due to COVID-19 public health concerns restricting travel and access to the Suncor Fort Hills Mine site, the Alberta Energy Regulator (AER) participated in a virtual desktop site inspection the site, in lieu of a physical inspection. The AER subject matter experts (SMEs) were provided with regulatory updates on Suncor's Fort Hills progress in tailings management, tailings technology research and developments, and ongoing operations.

#### HIGHLIGHTS

No deficiencies were observed.

#### **OBSERVATIONS**

Fort Hills South Pit: Future location of in-pit deposit. No deficiencies noted. No concerns raised.



Figure 1 – South Pit ongoing development



**Figure 2** – South Pit active mining



**PASS technology development**: Introduction to potential fluid tailings treatment facilities. No concerns noted.

Calgary Head Office Suite 1000, 250 - 5 Street SW Calgary, Alberta T2P 0R4 Canada

www.aer.ca



**Figure 3** – Potential schematic in OPTA of PASS technology

**OPTA** (North End): No deficiencies were observed. No concerns noted.



**Figure 4** – TSRU pouring area



**Figure 5** – TSRU discharge beach

# Appendix 3 Fluid Tailings Volume Data

| Drojact  | Dend/Equilities                                       |       |       | Fluid | d tailings (M | m³)   |       |       |
|--|---|-------|-------|-------|---------------|-------|-------|-------|
| Project  | Pond/Facilities                                       | 2014  | 2015  | 2016  | 2017          | 2018  | 2019  | 2020  |
|  | Pond 1A   | 10.1  | 10.1  | 10.1  | 10.1          | 10.4  | 10.4  | 10.4  |
|  | Pond 2/3  | 38.3  | 35.0  | 30.7  | 32.7          | 33.6  | 29.8  | 37.3  |
| Project         Suncor Base Plant         Syncrude Mildred Lake         Syncrude Aurora North         CNUL Muskeg River mine | Pond 5  | 18.4  | 18.4  | 20.2  | -             | -     | -     |       |
|  | Pond 6  | 35.2  | 34.5  | 35.0  | 35.5          | 36.5  | 37.0  | 37.0  |
|  | Pond 7  | 68.9  | 69.9  | 74.5  | 74.2          | 73.8  | 79.3  | 77.4  |
| Suncor Base Plant  | Dedicated disposal area 1 (DDA1) (Pond 8A)            | 0.3   | 0.3   | 0.0   | -             | -     | -     | -     |
|  | Dedicated disposal area 3 (DDA3)                      | -     | -     | -     | -             | -     | -     | 21.1  |
|  | Pond 8B   | 38.5  | 38.9  | 36.8  | 38.9          | 20.9  | 14.5  | 12.5  |
|  | South tailings pond (STP)                             | 101.0 | 105.0 | 105.4 | 105.7         | 95.8  | 90.7  | 95.9  |
|  | Sand dump 8 (SD8)                                     | 3.4   | 4.0   | 3.7   | 3.2           | 2.3   | 0.9   | 0.8   |
|  | Total   | 314.1 | 316.1 | 316.4 | 300.3         | 273.3 | 262.6 | 292.4 |
|  | Mildred Lake settling basin (MLSB)                    | 177.6 | 168.1 | 167.5 | 141.5         | 141.2 | 137.1 | 133.7 |
| Project         Suncor Base Plant         Syncrude Mildred Lake         Syncrude Aurora North         CNUL Muskeg River mine | Southwest sand storage (SWSS)                         | 71.0  | 80.9  | 94.2  | 112.5         | 116.3 | 123.1 | 137.7 |
|  | West in-pit (WIP, i.e., BML)                          | 182.6 | 182.6 | 177.4 | 175.1         | 172.9 | 171.5 | 171.5 |
|  | East in-pit (EIP)                                     | 3.3   | 1.7   | 1.4   | 2.0           | 1.3   | 0.8   | 0.1   |
|  | Southwest in-pit junior (SWIP junior)                 | N/A   | N/A   | N/A   | N/A           | N/A   | N/A   | N/A   |
| Syncrude Mildred Lake  | Southwest in-pit major (SWIP major)                   | 33.7  | 39.4  | 35.5  | 37.2          | 43.6  | 35.5  | 28.5  |
|  | North mine south pit west major (NMSPW major)         | 1.4   | 3.6   | 16.0  | 16.2          | 18.1  | 37.8  | 51.5  |
|  | 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  |
|  | Total   | 469.6 | 476.3 | 501.2 | 502.1         | 514.6 | 525.5 | 548.6 |
|  | Aurora settling basin (ASB)                           | 83.1  | 77.6  | 74.7  | 72.3          | 70.4  | 75.6  | 86.0  |
|  | Aurora east pit northeast (AEPN-E)                    | 27.5  | 38.7  | 43.5  | 51.1          | 50.2  | 42.5  | 34.0  |
| Syncrude Aurora North  | Aurora east pit northwest (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  |
|  | Total   | 113.0 | 127.9 | 131.2 | 136.9         | 133.2 | 137.0 | 143.8 |
|  | External tailings facility (ETF)                      | 62.4  | 63.7  | 58.3  | 57.9          | 51.7  | 50.4  | 43.1  |
| CNUL Muskeg River mine   | 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  |

| Project   | Bend/Essilition   |         | Fluid tailings (Mm <sup>3</sup> ) |            |         |         |   |         |  |
|---|---|---------|-----------------------------------|------------|---------|---------|---|---------|--|
| Project   | Fond/Facilities   | 2014    | 2015                              | 2016       | 2017    | 2018    | 2019  | 2020    |  |
|   | In-pit cell 2 (IPC2)  | -       | -                                 | -          | -       | 26.5    | 28.1  | 30.0    |  |
|   | In-pit cell 2A (IPC2A)  | N/A     | N/A                               | 6.8        | 7.7     | -       | -   | -       |  |
| CNUL Jackpine mine CNRL Horizon Imperial Kearl  | 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    |  |
|   | Total   | 88.0    | 94.4                              | 109.7      | 116.6   | 121.7   | 126.1   | 133.3   |  |
|   | Dedicated disposal area 1 (DDA1)                                | 6.8     | 12.0                              | 7.8        | 11.7    | 12.8    | 12.5  | 11.0    |  |
|   | Sand cell 1 (SC1)   | 12.8    | 10.6                              | 11.2       | 9.4     | 8.6     | 8.1   | 10.3    |  |
| CNUL Jackpine mine  | Sand cell 2 (SC2)   | N/A     | 1.0                               | 2.4        | 5.7     | 5.2     | 4.1   | 4.6     |  |
|   | Fluid cell 1 (FC1)  | N/A     | N/A                               | 2.8        | 1.6     | 1.4     | 1.2   | 1.1     |  |
|   | Total   | 19.6    | 23.6                              | 24.2       | 28.4    | 28.0    | 25.9  | 27.0    |  |
|   | External tailings facility/dedicated disposal area 1 (ETF/DDA1) | 66.2    | 82.1                              | 99.5       | 114.5   | 131.8   | 146.7   | 146.4   |  |
| CNRL Horizon  | Dedicated disposal area 2 (DDA2)                                | -       | -                                 | -          | -       | -       | -   | 3.5     |  |
|   | Total   | 66.2    | 82.1                              | 99.5       | 114.5   | 131.8   | 146.7   | 149.9   |  |
|   | External tailings area west (ETA-W)                             | 4.7     | 13.6                              | 24.1       | 39.3    | 46.5    | 55.1  | 62.1    |  |
|   | External tailings area east (ETA-E)                             | N/A     | Negligible                        | Negligible | 0.4     | 1.0     | 2.5   | 3.0     |  |
| Imperial Kearl  | West thickened tailings (TT) panel                              | N/A     | N/A                               | Negligible | 0.8     | 1.5     | 4.5   | 9.9     |  |
|   | 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    |  |
| Project CNUL Jackpine mine CNRL Horizon Imperial Kearl Suncor Fort Hills Industry total | Out-of-pit tailings area  | -       | -                                 | -          | -       | 6.0     | 17.0  | 30.0    |  |
| Suncor Fort Hills   | Total   | -       | -                                 | -          | -       | 6.0     | 2019       28.1       -       16.8       12.5       8.1       4.1       12.5       8.1       4.1       12.5       8.1       4.1       12.5       8.1       4.1       1.2       25.9       146.7       55.1       2.5       4.5       -       62.1       17.0       17.0       1,302.9 | 30.0    |  |
| Industry total  |   | 1,075.2 | 1,134.0                           | 1,206.3    | 1,239.8 | 1,258.7 | 1,302.9   | 1,400.0 |  |

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 tailings management reports were only to one decimal place. Reported data may not include the removal of volumes considered ready to reclaim.

Tailings volumes for 2017 year-end are estimates based on mid-year 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.

Suncor Base Plant pond 5, DDA3, and MD9 data do not include ready-to-reclaim fluid tailings.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys) and as a result, 2020 volumes were estimated. 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, and CNUL Jackpine mine resulting in a mix of measured and estimated volumes. A partial pond survey program was completed at CNRL Horizon due to high winds and freezing conditions. 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 ready-to-reclaim criteria.

Alberta Energy Regulator

## Appendix 4 Water Volume Data

| Drainet  | Dand  |       | Water (Mm <sup>3</sup> ) |       |       |       |       |       |  |
|--|---|-------|--------------------------|-------|-------|-------|-------|-------|--|
| Project  | Pona  | 2014  | 2015                     | 2016  | 2017  | 2018  | 2019  | 2020  |  |
|  | Pond 1A   | 2.1   | 2.1                      | 2.5   | 2.5   | 2.2   | 2.2   | 2.2   |  |
|  | Pond 2/3  | 5.0   | 2.6                      | 4.8   | 1.9   | 2.1   | 5.8   | 3.8   |  |
| Project         Suncor Base Plant         Suncor Base Plant         Syncrude Mildred Lake         Syncrude Aurora North         CNUL Muskeg River Mine | Pond 5  | N/A   | N/A                      | 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   |  |
|  | Pond 7  | 49.3  | 40.4                     | 41.7  | 37.1  | 42.7  | 33.5  | 36.9  |  |
| Suncor Base Plant  | Dedicated disposal area 1 (DDA1 (Pond 8A)             | N/A   | N/A                      | 0.1   | 0.0   | 0.0   | 0.0   | 0.0   |  |
|  | Dedicated disposal area 3 (DDA3)                      | -     | -                        | -     | 8.1   | 7.4   | 12.6  | 17.4  |  |
|  | Pond 8B   | 43.3  | 39.1                     | 42.3  | 30.8  | 28.6  | 10.4  | 7.3   |  |
|  | South tailings pond (STP)                             | 19.0  | 13.7                     | 17.6  | 24.4  | 26.2  | 32.1  | 30.6  |  |
|  | Sand dump 8 (SD8)                                     | 1.5   | 1.5                      | 3.4   | 0.9   | 1.7   | 0.7   | 0.9   |  |
|  | Total   | 126.2 | 106.3                    | 119.3 | 111.4 | 118.0 | 104.6 | 106.4 |  |
|  | Mildred Lake settling basin (MLSB)                    | 5.6   | 10.8                     | 3.4   | 7.5   | 8.3   | 10.0  | 8.1   |  |
| Project         Suncor Base Plant         Syncrude Mildred Lake         Syncrude Aurora North         CNUL Muskeg River Mine                           | Southwest sand storage (SWSS)                         | 34.0  | 42.6                     | 47.5  | 48.4  | 43.9  | 48.4  | 33.0  |  |
|  | West in-pit (WIP, i.e., BML)                          | 57.4  | 55.7                     | 60.2  | 63.6  | 67.1  | 70.5  | 69.5  |  |
|  | East in-pit (EIP)                                     | 0.2   | 0.5                      | 1.2   | 0.7   | 0.0   | 0.0   | 0.1   |  |
|  | Southwest in-pit junior (SWIP junior)                 | N/A   | N/A                      | N/A   | N/A   | N/A   | N/A   | N/A   |  |
| Syncrude Mildred Lake  | Southwest in pit major (SWIP major)                   | 14.0  | 13.9                     | 20.9  | 19.2  | 14.6  | 14.9  | 19.5  |  |
|  | North mine south pit west major (NMSPW major)         | 15.3  | 14.7                     | 2.5   | 0.6   | 6.2   | 12.1  | 39.2  |  |
|  | 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   |  |
|  | Total   | 126.5 | 138.2                    | 137.4 | 144.1 | 147.5 | 155.9 | 169.4 |  |
|  | Aurora settling basin (ASB)                           | 50.5  | 38.9                     | 40.1  | 37.9  | 43.2  | 37.2  | 27.4  |  |
|  | Aurora east pit northeast (AEPN-E)                    | 20.0  | 7.5                      | 0.1   | 1.6   | 4.8   | 6.0   | 3.8   |  |
| Syncrude Aurora North  | Aurora east pit northwest (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  |  |
|  | Total   | 71.8  | 75.5                     | 68.0  | 60.9  | 75.4  | 78.3  | 93.1  |  |
|  | External tailings facility (ETF)                      | 2.8   | 1.7                      | 0.5   | 0.3   | 0.0   | 0.0   | 0.0   |  |
| CNUL Muskeg River Mine   | 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  |  |

| Project            | Pond  |       | Water (Mm <sup>3</sup> ) |       |       |       |       |       |  |
|--------------------|---|-------|--------------------------|-------|-------|-------|-------|-------|--|
|                    |   | 2014  | 2015                     | 2016  | 2017  | 2018  | 2019  | 2020  |  |
|                    | In-pit cell 2 (IPC2)  | -     | -                        | -     | -     | 8.4   | 7.6   | 4.4   |  |
|                    | 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   |  |
|                    | Total   | 9.8   | 8.9                      | 13.3  | 16.3  | 20.6  | 20.4  | 22.5  |  |
| CNUL Jackpine Mine | Dedicated disposal area 1 (DDA1)                                | 0.4   | 0.0                      | 0.1   | 0.4   | 0.0   | 0.0   | 0.0   |  |
|                    | Sand cell 1 (SC1)   | 17.0  | 10.1                     | 6.4   | 4.9   | 7.1   | 8.0   | 9.6   |  |
|                    | Sand cell 2 (SC2)   | 2.4   | 4.9                      | 3.6   | 0.5   | 2.2   | 4.0   | 1.2   |  |
|                    | Fluid cell 1 (FC1)  | N/A   | N/A                      | 0.7   | 6.4   | 6.7   | 7.8   | 7.6   |  |
|                    | Total   | 19.8  | 15.0                     | 10.8  | 12.2  | 16.0  | 19.8  | 18.4  |  |
| 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  |  |
|                    | Dedicated disposal area 2 (DDA2)                                | -     | -                        | -     | -     | -     | -     | 2.0   |  |
|                    | Total   | 33.0  | 30.0                     | 33.0  | 28.2  | 31.1  | 31.1  | 30.0  |  |
| Imperial Kearl     | External tailings area west (ETA-W)                             | 21.3  | 27.4                     | 18.4  | 17.3  | 18.0  | 20.1  | 23.8  |  |
|                    | External tailings area east (ETA-E)                             | N/A   | 0.3                      | 0.8   | 1.7   | 0.5   | 2.3   | 2.1   |  |
|                    | West thickened tailings (TT) panel                              | N/A   | N/A                      | 0.5   | 0.4   | 0.1   | 0.3   | 0.9   |  |
|                    | 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  |  |
| Suncor Fort Hills  | Out-of-pit tailings area  | -     | -                        | -     | -     | 3.0   | 5.7   | 12.7  |  |
|                    | Total   | -     | -                        | -     | -     | 3.0   | 5.7   | 12.7  |  |
| Industry total     |   | 408.4 | 401.6                    | 401.7 | 392.8 | 430.3 | 438.5 | 479.3 |  |

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 tailings management reports were only to one decimal place.

Due to COVID-19, variances were granted to operators for monitoring requirements (e.g., pond surveys) and as a result, 2020 volumes were estimated. 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, and CNUL Jackpine mine resulting in a mix of measured and estimated volumes. A partial pond survey program was completed at CNRL Horizon due to high winds and freezing conditions.

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