Oil Sands Mining Water Use and Management

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Abstract The oil sands region of northern Alberta, along the Athabasca River, is home to four operating companies with bitumen mining operations. This paper describes the water licences, historical makeup water use, the various uses of water, and the future direction of water management for oil sands mining operations. The information is based on work recently completed for the Oil Sands Developers Group (OSDG), ongoing work for the Canadian Association of Petroleum Producers (CAPP), and based on numerous mine site water balance analyses for proposed mines to support water licensing and infrastructure investment decisions.

Key Words oil sands mining, water use, water management

Introduction

There are currently four operating companies with bitumen mining operations in northern Alberta Canada. These open-pit truck and shovel operations utilize the Athabasca River as the primary makeup water source. The makeup water requirement depends on several factors such as climate conditions, ore characteristics, and tailings performance. They can also vary greatly over time, based on the mine schedule. Overall, industry manages the uncertainty and variation of makeup water requirements while meeting regulatory obligations. Oil sands mine water use is subject to various regulations, including water licences issued under the Alberta Water Act, limits on industry water withdrawal based on the Athabasca River Water Management Framework (AENV and DFO 2007), and tailings management regulations (ERCB 2009) that also affect mine water management.

Typical Mine Site Water Balance

The makeup water requirement for oil sands mines is predominately due to the tailings porewater storage in ponds and other dedicated disposal areas. The makeup water is necessary because oil sands mines are normally a closed-loop water system, and porewater is stored in the tailings products. Porewater accumulates over time, even while each mine recycles the release water from tailings consolidation over time. The net storage of porewater drives the requirement for makeup water, as shown on Figure 1, despite significant efforts from the operating companies to recycle

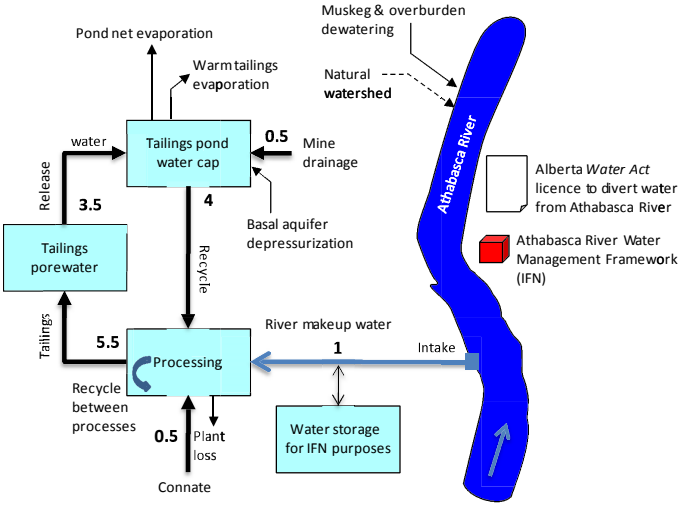

Figure 1 *Typical oil sands mine site water balance.*

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water within the various processes of the bitumen extraction plant. Typically, every 1 m^3 of makeup water withdrawn from the Athabasca River is utilized alongside about 4 m^3 of recycle water from tailings and collection of on-site drainage water. This ratio differs depending on the selected tailings products and on-site drainage conditions.

Over the life of a mine, the makeup water from the Athabasca River is typically reduced over time. The maximum water requirement normally occurs within the initial years of mine startup, as processing systems are optimized, as bitumen production is ramped-up, and prior to steady-state conditions for recycle/reclaimed water from tailings. As the mine expands, the river makeup water is typically reduced because the expanding mine footprint results in the collection of a greater on-site drainage water volume. Eventually, the water volume from on-site drainage collection can be equal to the river makeup water. The overall trend for river makeup water is shown on Figure 2 for two typical tailings management scenarios.

Oil Sands Mining Water Use Rates

Each oil sands mine has various water source licences, including water diversion within the closed-loop system, and collection of any groundwater that enters the mine through the pit walls. However, the majority of water use is due to makeup water withdrawal from the Athabasca River. The potential maximum makeup water requirement from the Athabasca River is the basis for water licences under the Alberta Water Act. The licensed annual limit is typically between 3.5 and 6 times the expected bitumen production.

Actual water use by oil sands mines, by definition of the licence conditions, must always be less than the licensed limit. The historical water use is presented on Figure 3, including 2008 during the startup of the newest mine – the Canadian Natural Resources Limited Horizon Project. Athabasca River makeup water is about 75% of the total water diversion by the oil sands mines. The ratio of Athabasca River makeup water to bitumen production is about 2.3 (water:bitumen), based on the 2005 to 2007 average withdrawal of 3.0 m^3/s (AENV 2009) and 730 thousand barrels per day (kbpd) average bitumen production (CAPP 2010).

In terms of the environmental footprint of the makeup water use, the 118 Mm^3 Athabasca River withdrawal in 2008 is about 50% of the 256 Mm^3 licensed allocation of Athabasca River water for oil sands mining. The 2008 withdrawal rate is about 3.8 m^3/s or 0.5% of the 745 m^3/s long-term annual average water yield for the Athabasca River basin (Golder 2008). During the winter low flow period, the 2008 withdrawal would have been about 4% of the 88 m^3/s historical minimum river flow recorded in December 2001 during river freeze-up (weekly average flow in the Athabasca River, as measured by Environment Canada near Ft. McMurray).

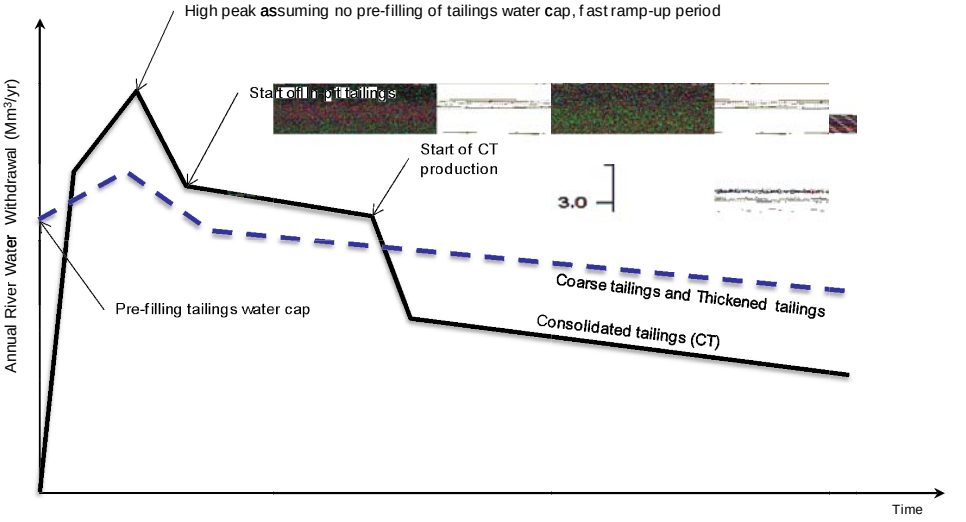

Figure 2 *Typical oil sands mine life makeup water*

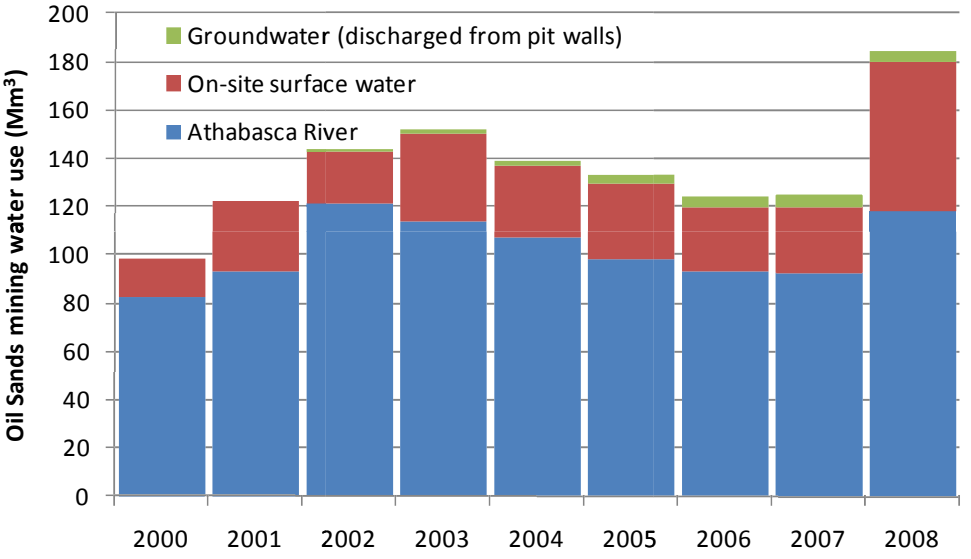

Figure 3 *Historical oil sands mining water use*

Future Direction of Water Management for Oil Sands Mining

Oil sands mining production is currently projected to increase from about 730 kbpd to about 1,800 kbpd by 2025 (CAPP 2010). If the current water use trend continues, the oil sands mining industry will need about 7.6 m^3/s from the Athabasca River or about 9% of the historical minimum recorded flow in the river. The more likely water use rate is lower as oil sands mines tend to withdraw less water from the river as a mine expands.

Water use and water management by oil sands mines will also be affected by several factors:

- The Athabasca River Water Management Framework (AENV & DFO 2007) will be updated in 2011. It currently limits the total instantaneous withdrawal of Athabasca River water, with the most restrictive limits during winter low flows. As a result of this Framework, future mines may require additional water storage or delayed reclamation of some mine areas to help offset the loss of water availability during winter low flow periods.
- The Directive 074 (ERCB 2009) is a tailings management regulation that requires oil sands mines to store tailings in dedicated disposal areas and to begin reclamation of those areas within five years of the end of deposition, based on soil strength targets for trafficability purposes: 5 kPa undrained shear strength within one year, and 10 kPa within five years. This regulation affects selection of tailings management strategies, such as thin-lift drying techniques, that may or may not reduce the requirement for makeup water.
- Release criteria are still being developed for on-site water within the closed-loop mine operation. Criteria are needed for mine operators to choose appropriate mine closure strategies or technology investments needed to release water to the environment.

Overall, the oil sands mining industry will need to balance several factors related to water use.

Conclusion

Water use by oil sands mining operations in Alberta Canada has been a popular topic of discussion. This paper presents some key information to help understand the overall use of water by the industry.

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