May 2006

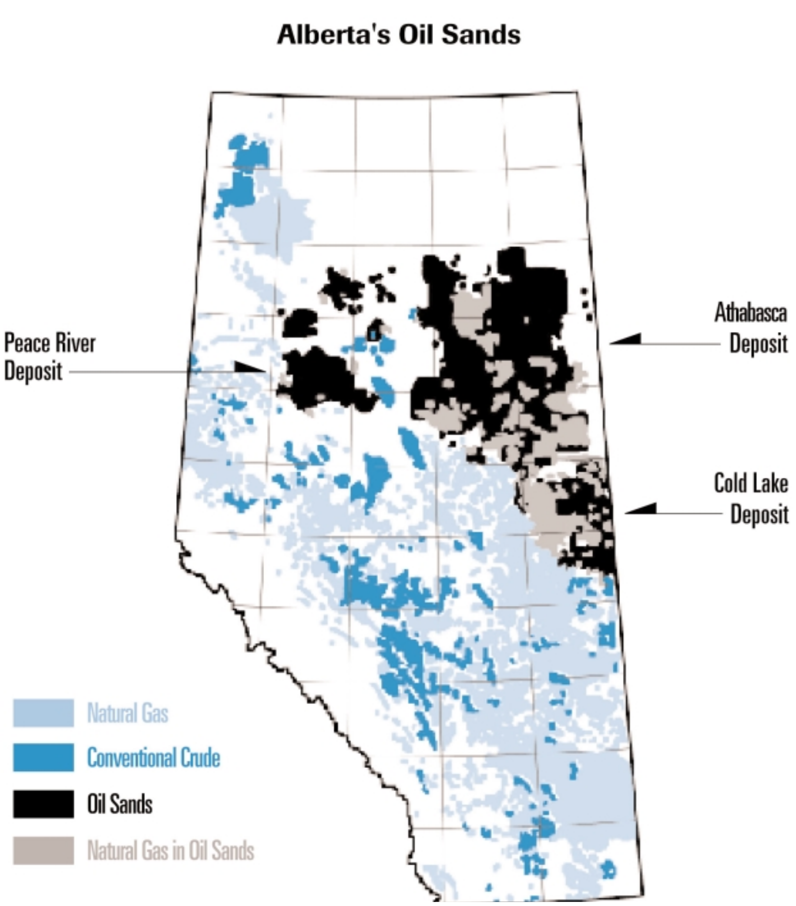
Troubled Waters, Troubling Trends

SUMMARY REPORT

The need to reduce the oil industry's use of water in Alberta and how to do it

▲ *Suncor's oil sands upgrader from the Athabasca River.*

SOURCE: DAN WOYNILLOWICZ, THE PEMBINA INSTITUTE



▲ *Figure 1 – Alberta's Oil Sands and Conventional Oil and Gas Resource.*

SOURCE: CANADA WEST FOUNDATION FROM THE ALBERTA DEPARTMENT OF ENERGY

▲ *The Athabasca River, the biggest demand for water use is for oil sands.*

SOURCE: DAVID DODGE, THE PEMBINA INSTITUTE

The oil industry in Alberta has a great thirst for water. Oil sands mining, steam injection oil sands drilling (in situ production), and conventional oil production currently place considerable demand on water resources. And the pressure is increasing.

Alberta's reserves of bitumen are among the largest oil deposits in the world, second only to Saudi Arabia. Production of these reserves is expected to double within five to seven years, and to triple by 2020. Unless policies and practices change, this will create huge new demands for water.

The trends are troubling. In some parts of the province, Alberta will soon have to decide which is more important: water or oil.

THE FACTS

Oil and Gas Industry

- *The oil industry has licences to divert and use a considerable volume of water. Unlike water used for municipal purposes, for example, most of this water does not return to the watershed from which it was taken.*
- *The oil and gas sector has 7% of all water allocations in Alberta.*
- *Of all fresh groundwater allocations, 37% are for the oil and gas industry.*

Oil Sands Mining

- *Of the total water allocated in the Athabasca basin, 66% is for oil sands mining.*
- *To produce one barrel of oil from oil sands requires 2 to 4.5 barrels of water.*
- *In 2005, more than twice the volume of water used annually by the City of Calgary was allocated for withdrawal from the Athabasca River for oil sands mining and production.*
- *Water used to extract bitumen from oil sands becomes contaminated and is stored in vast tailings ponds. A portion is recycled in the extraction process.*
- *When the already planned oil sands projects go ahead, demand for water will increase 36%. The entire Muskeg River watershed will likely be affected beyond recovery.*
- *Land that was once boreal forest and wetlands is now covered by 50 km^2 of toxic tailings ponds.*
- *After more than 30 years of oil sands mining, no lands are certified as "reclaimed" by the Alberta Government.*
- *Though technologies are being developed, none are expected to reduce the oil sands industry's thirst for water before 2030.*

Oil Sands In Situ Drilling Operations

- *Of all the oil sands, 93% are too deep to mine. In most in situ projects, steam is injected deep into the Earth, so that the bitumen flows and can be pumped to the surface.*
- *The use of fresh and saline water for in situ operations has increased fivefold since 1999.*
- *Growth is so rapid that in 2004 the use of fresh water was three times higher than that predicted by the Alberta government using 2001 data. The use of saline water was twice that predicted.*

Conventional Oil Operations

- *In 2004, the volume of water used to recover crude oil was 40% of that used in 1977.*
- *Three-quarters came from surface water and fresh (non-saline) groundwater.*
- *Farmers in water poor areas are concerned about fresh surface water and groundwater pumped down wells, since it is doesn't flow back to the watershed.*

SELECTED RECOMMENDATIONS

- *No more oil sands mining should be permitted until*
  - *the cumulative impacts are clearly understood and managed;*
  - *a wetlands policy has been implemented;*
  - *clear expectations for tailings management have been established.*
- *Alberta Environment must strictly implement its new policy that requires companies to seek alternatives before applying for fresh water allocations for conventional oil and in situ production.*
- *Water use targets must be established for the oil sector, as proposed in the Water for Life strategy.*
- *The oil industry should pay fees for their use of fresh water.*
- *Revenue from these fees should be used to learn more about the status of the groundwater resource in Alberta, research new technologies and improve water management.*

▲ *Oil sands mining and processing use vast amounts of water and have a dramatic effect on the watershed.*

SOURCE: CHRIS EVANS, THE PEMBINA INSTITUTE

Use of water for oil sands and oil recovery

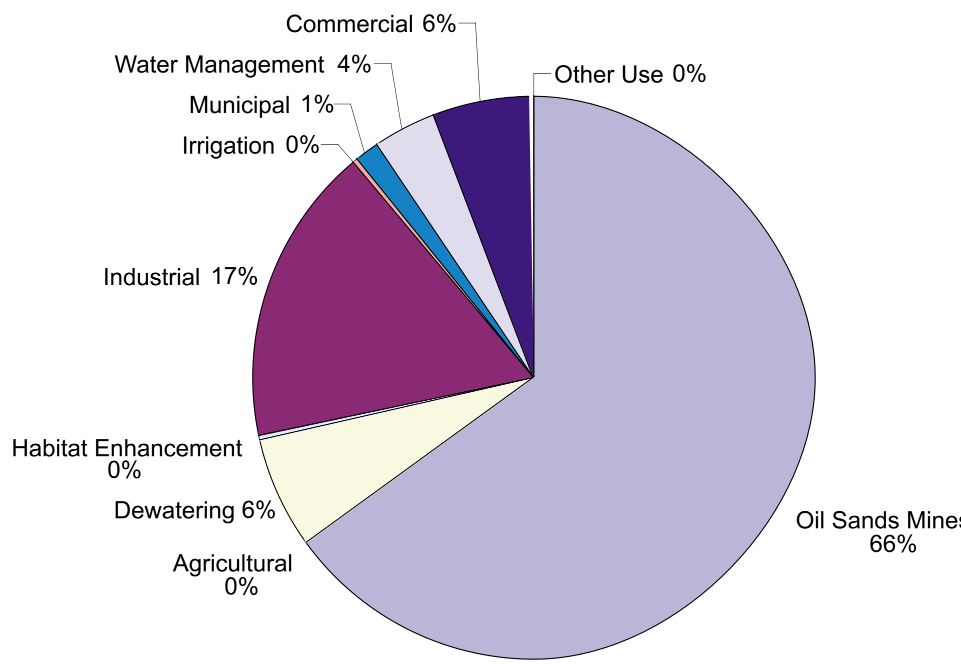
The oil and gas sector in Alberta has been allocated over 7% of all water allocations, including over one-third of all groundwater allocations.

Within the Athabasca River Basin, two-thirds of all surface water allocations are for oil sands mining (Figure 2).

Oil sands mining

Oil sands mining requires a vast amount of water. Companies are licensed to divert over 500 million m^3 of water in the Athabasca River Basin, including water from the rivers, surface runoff and groundwater. The 2005 allocation was 359 million m^3, more than twice the volume used annually by the entire City of Calgary. As more and more projects get underway, the demand for water stands to steadily increase (see Figure 3).

Only 10% of water taken from the Athabasca for oil sands mining returns to the river; the rest is used or diverted to tailings ponds. This is in contrast to municipal water withdrawals, where most of the water returns to the river after use. In the winter, water flows are low in the Athabasca and over 10% of low-flow volumes have already been allocated. While it is known that low river flows can affect fish populations, it is not yet well understood what minimum flows are necessary in this river to keep the aquatic ecosystem healthy.



▲ *Figure 2 – Licensed surface water allocations from the Athabasca River and its tributaries, 2005* [1]

1] Source: Golder Associates Ltd. 2005. *A Compilation of Information and Data on Water Supply and Demand in the Lower Athabasca River Reach.* Prepared for the CEMA Surface Water Working Group.

▲ *Only 10 per cent of the water used in oil sands mining and upgrading is returned to the Athabasca River.*

SOURCE: DAVID DODGE, THE PEMBINA INSTITUTE

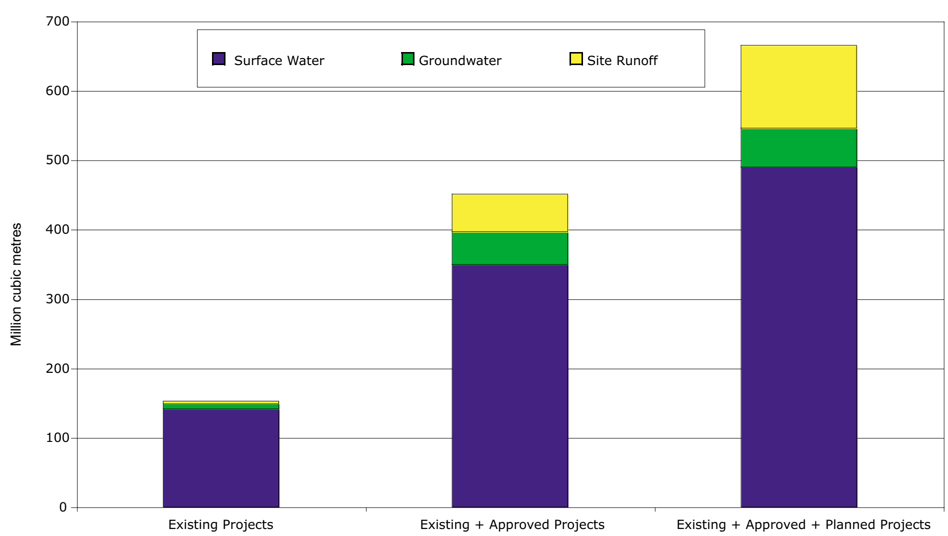
Since the Cumulative Environmental Management Association failed to identify the instream flow needs (IFN) for the river, in 2006 Alberta Environment introduced an interim IFN and management system.[2]

It isn't only rivers that stand to be negatively impacted by water withdrawal. Extensive areas of wetland habitat are lost when the muskeg overlying the bitumen is drained and removed. The basal aquifer that underlies the bitumen is also drained to prevent the mine pits from flooding. This negatively affects adjacent groundwater and potentially surface waters and wetlands.

Hot water is used to extract bitumen from the sand; while some of this is recycled, the residual wastewater contains tailings – fine clay particles and residues of bitumen and various pollutants, such as napthenic acids. About 6 m^3 of tailings are created for every 1 m^3 of bitumen mined. The tailings pollutants become concentrated in the tailings ponds where the wastewaters are collected, making them toxic to fish and birds. These wastewater dumps already cover an area of 50 km^2.

At a minimum it will take decades before the fine clay particles in tailings ponds settle out and the waters can be reclaimed. Although new technology that produces consolidated or thickened tailings may reduce the volume of fine tailings produced, the remaining fluid fine tailings will still need special management.

Potentially irreversible negative effects are expected in the Muskeg river watershed from



▲ *Figure 3 – Cumulative water allocations for existing, approved and planned oil sands mining operations*[3]

2] For the Pembina Institute's critique of this system please see *Down to the Last Drop: The Athabasca River and Oil Sands*, available at http://www.oilsandswatch.org

3] Source: Golder Associates Ltd. 2005. *A Compilation of Information and Data on Water Supply and Demand in the Lower Athabasca River Reach.* Prepared for the CEMA Surface Water Working Group. Table 13. & *Water Act* licences issued to oil sands mine operators.

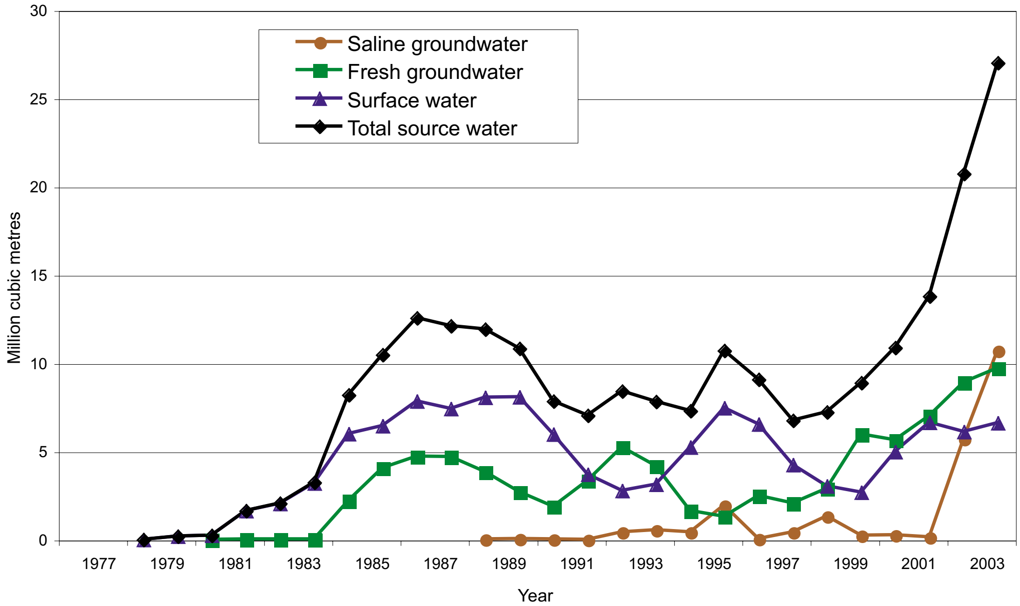
▲ *In situ oil sands drilling leases have been issued for 30,000 square kilometres of the boreal forest.*

SOURCE: COPYRIGHT, ALBERTA GOVERNMENT AERIAL SURVEY

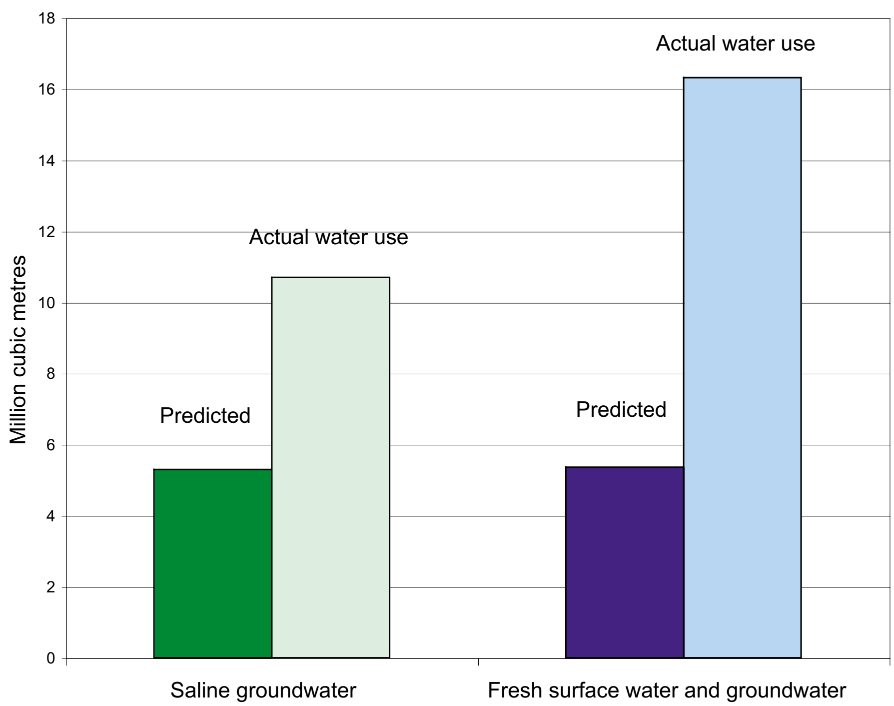
oil sands mining; wetlands and peatlands across the entire region will be removed or altered. Once mining is complete, mature fine tailings will be pumped into the mined area to create end pit lakes, but it is not known if these lakes will support a sustainable ecosystem. The exact impacts of oil sands mining cannot be determined – only monitored, as in a giant experiment.

In situ production

In 2004 about one-third of bitumen in Alberta was recovered using in situ processes. As production increases, so does the demand for water (Figure 4).



▲ *Figure 4 – Total fresh and saline groundwater and surface water use for in situ enhanced recovery in Alberta, 1977-2004*[4]



▲ *Figure 5 – Predicted and actual use of saline and fresh water for in situ enhanced oil recovery in Alberta, 2004*[5]

Steam is usually injected through pipes, warming the bitumen and making it less viscous, so it can be pumped to the surface. After water recycling, the net volume of water used to generate steam for in situ recovery is usually between 0.2 m^3 and 0.5 m^3; total water consumption may actually be greater, however, as over time groundwater will gradually infiltrate the voids left by the removal of the bitumen. Although in situ processes use much less water than do mining, many projects use some fresh groundwater, with over one-third of total water supply expected to come from this source. This is a big concern, since Alberta does not have a good grasp of its groundwater resources. Monitoring is required to determine whether the long-term, cumulative withdrawals are sustainable. And, the full impacts may not appear until a project is over.

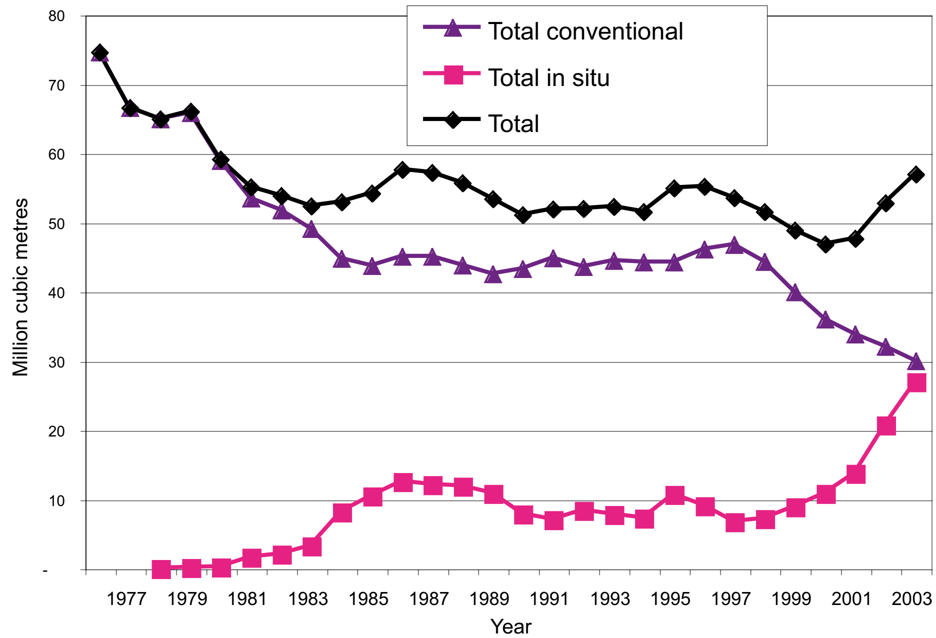
For in situ production, it is better to use deep saline water than fresh shallow groundwater. When saline water is used to create steam, it must first be treated. The wastes from treating saline and recycled water are either put into deep wells or sent to landfill, where there is a risk that they may eventually leach into fresh groundwater. This is another reason why it is preferable to move to a water-free technology, particularly if in situ oil sands development expands as expected.

4] Data source: Alberta Energy and Utilities Board. The saline volumes in 2003 and 2004 in this figure include cold water injection for bitumen recovery.

5] Derived using data from Alberta Environment and the Alberta Energy and Utilities Board.

In some wells in the Cold Lake area, heat from the steam used in in situ production has mobilized naturally occurring arsenic in the rocks close to and down gradient from some well bores. In the 1990s there were incidents when the release of production fluids during casing failures or seepage from the well bore contaminated adjacent fresh water aquifers and required remediation.

Using 2001 data, Alberta Environment predicted the annual demand for water for in situ production from 2004 until 2020. However, due to the rapid growth in in situ production, by 2004 withdrawals were two or three times greater than those estimated (Figure 5).



▲ *Figure 6 – Total source water use for conventional and in situ enhanced oil recovery in Alberta, 1977-2004*[6]

Can new technology reduce the demand for water for oil sands recovery?

No major breakthrough in technologies related to water use in oil sands mining is expected before 2030. A pilot project is being developed to test a dry tailings technology, and experiments are underway to speed the rate at which the fine material in tailings ponds settles out so that the water can be reused. Much water is used for cooling processes and, as energy becomes more expensive, companies will have an incentive to further reduce water for cooling. However, it is unlikely that the reduction in water use per unit of production will offset the rapid growth in oil production and hence gross demand for water.

Technologies are being developed to avoid or reduce water use for in situ production. Solvents can be used, either with water or alone, to reduce the viscosity of the bitumen. A pilot process, Toe-to-Heel Air Injection (THAI™), will burn bitumen in situ, to warm adjacent bitumen so it can be pumped. This avoids the use of water, but it is too early to say if this process will be successful or how widely it could be applied.

Conventional enhanced oil recovery

Water is pumped into older conventional oil reservoirs to maintain pressure and recover more oil. Both fresh and saline water are used in this process, but in 2004 only one-quarter of the water used was saline; over 22 million m^3 of surface water and fresh groundwater was injected to get oil from the ground. Much of the water can be recycled so less additional water is required as oil production declines. Demand for water for conventional wells has decreased (Figure 6), but landowners in water-short areas are concerned about this use of fresh water, since the water stays permanently underground and does not flow back into the watershed. With high oil prices there may be new interest in enhanced recovery from conventional wells. Even when an alternative substance such as carbon dioxide is injected to stimulate well production, some water is required.

6] Data source: Alberta Energy and Utilities Board.

▲ *No more mining should be permitted until the cumulative effects are properly managed.*

SOURCE: DAVID DODGE, THE PEMBINA INSTITUTE

New policies can help reduce the demand for water

To minimize its impact, no more mining should be permitted until the cumulative effects of existing development in the region are properly managed. A wetlands policy must be implemented, and water licences should require a staged reduction in water use. Clear expectations must be set for tailings management and reclamation.

Alberta Environment's Water Conservation and Allocation Policy for Oilfield Injection, introduced in April 2006, requires companies to look for alternatives before they apply for fresh water for either conventional or in situ production. This policy must be strictly implemented to reduce demand for water, especially in water-short areas and for large projects.

The Pembina Institute recommends that the government establish water use targets for the oil sector, as has been proposed in the Water for Life strategy. It must also implement user fees on fresh water consumption and further evaluate other policy options if reduction targets for the oil sector are not met.

Money raised through fees on water used by the oil industry could fund research into new technologies and improve water management. Since knowledge is the basis for wise management, baseline information on Alberta's groundwater resources must be improved. Watershed budgets will help bring water demand in line with supply.

Want more information?

Our full report provides detailed information on the problems identified in this summary and discusses a range of options to address them. Read *"Troubled Waters, Troubling Trends: Technology and Policy Options to Reduce Water Use in Oil and Oil Sands Development in Alberta"* on the Pembina Institute website at http://www.pembina.org

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