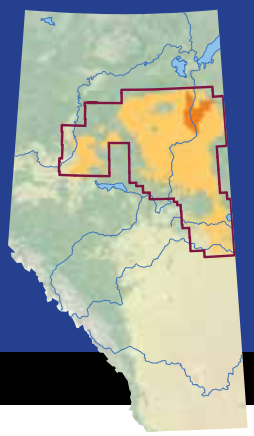


Mining VS In Situ

FACT SHEET

LAND USE • FRAGMENTATION • AIR EMISSIONS • WATER USE • CLIMATE CHANGE

What is the highest environmental impact oil?

The Alberta oil sands underlie approximately 140,000 km^2 — an area about the size of Florida that covers 20% of the province. As of June 2009, the Alberta government had granted oil sands extraction leases covering 84,000 km^2, which accounts for almost 60% of the total oil sands area.

Surface mining, which accounted for 52% of bitumen production in Alberta in 2008, is only feasible for the shallow oil sands deposits found north of Fort McMurray. Over 80% of Alberta's oil sands are too deep for mining and require "in situ" (Latin for "in place") extraction techniques.

The environmental impacts of in situ oil sands development have so far received little public attention. In fact, proponents of in situ development increasingly assert that it has considerably lower environmental impacts than mine-based production and are trying to distance it from the oil sands mining sector. However, without an environmental impact intensity comparison between the two means of production, it is difficult for stakeholders to adequately evaluate this claim.

In 2008, the Pembina Institute report *Under-Mining the Environment* evaluated and compared the environmental performance of 10 existing and proposed oil sands mines. Our 2010 report *Drilling Deeper* provides a similar evaluation of nine operational in situ facilities. Combining the results of these two reports provides an initial comparison between oil sands mining and in situ development.

In Situ/Mining Report Cards

Unless indicated otherwise, all data in this fact sheet is derived from the Pembina Institute's two oil sands report cards:

Under-Mining the Environment: The Oil Sands Report Card
www.oilsandswatch.org/pub/1571

Drilling Deeper: The In Situ Oil Sands Report Card
www.oilsandswatch.org/pub/1981

Oil SANDS Fever SERIES

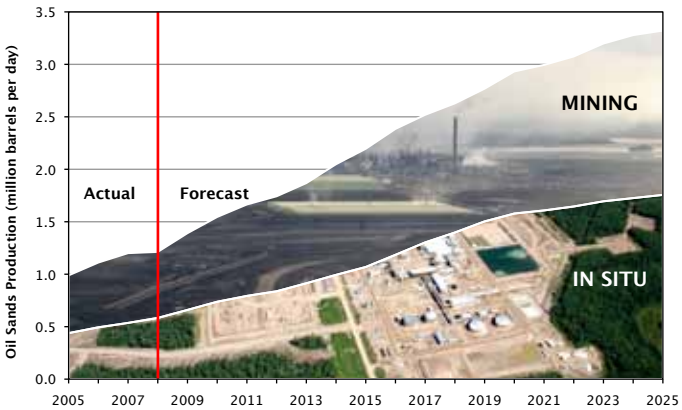
Oil Sands Impacts: Mining vs. In Situ

	In situ	Mining
Cleared Area Intensity (hectares/million barrels)	1.4	**9.4**
NO_x Intensity (grams/barrel)	132	**146**
SO_2 Intensity (grams/barrel)	**112**	30
Water Use Intensity (barrels/barrel)	1.1	**2.1**
Greenhouse Gas Intensity (kilograms CO_2e/barrel)	**91**	36

Note: These values are weighted averages that represent the impacts associated with the production of bitumen. The additional impacts associated with upgrading bitumen to synthetic crude are not included. Information on upgrading emissions and water use is available in *Upgrader Alley* (www.oilsandswatch.org/pub/1654).

IN SITU'S GROWING ROLE

According to the Canadian Association of Petroleum Producers (CAPP), in situ oil sands production is growing slightly faster than mining. Surface mining accounted for 52% of oil sands production in Alberta in 2008. CAPP projections show that in situ production is likely to surpass mining by 2017.



In situ oil sands production is expected to surpass mining production by 2017.

Oil Sands Extraction Techniques

In Situ

The most common forms of in situ extraction involve drilling several wells into a deep oil sands deposit and then injecting high-pressure steam underground. The steam heats the bitumen so it can flow to a well and be pumped to the surface. In situ producers are investigating techniques that use solvents and other extraction methods, but to date none are employed in commercial operations.

Surface Mining

In mining operations, bitumen-laden oil sands are mined using trucks and shovels. The trucks transport the oil sands to a preparation plant, where the oil sands are crushed and mixed with water before being transported to the bitumen extraction plant. At the bitumen extraction plant the bitumen is separated from the water and sand.

In situ to disturb more land than mining

Potential direct forest loss associated with current areas leased for oil sands development:

- Mining: 4,800 km^2 (more than 1.5 times the size of Yosemite National Park)
- In Situ: 6,500 km^2 (based on the direct disturbance of 8.3% of the total lease area)

Oil sands development has significant impacts on forests and wildlife

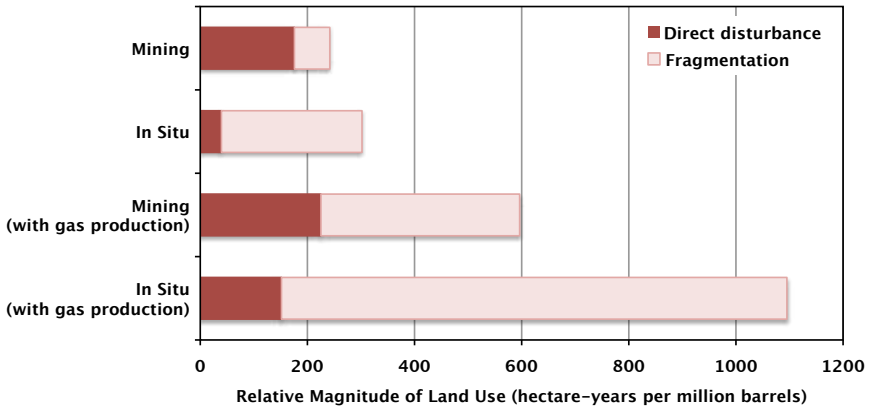
With surface mining operations, forests and wetlands are cleared and the land is dug up, which permanently alters the landscape. In situ developments have less visible impacts on the land than surface mining, but the potential scale of future in situ development may lead to serious cumulative impacts that could outweigh mining impacts.

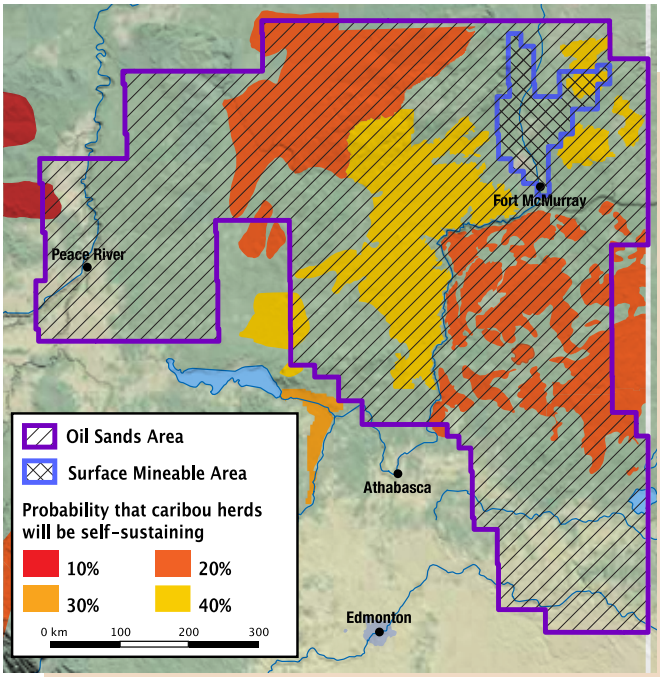
Mining operations show a direct footprint intensity (9.4 hectares per million barrels of bitumen produced) that is almost six times greater than for in situ operations (1.4 hectares per million barrels). Given the difference in the type of land disturbance, however, it is difficult to directly compare these land impacts. The direct land disturbances of in situ operations, like seismic lines, roads, pipelines, power lines and well pads, also contribute to the reduced use of habitats adjacent to in situ operations through forest fragmentation.

It is also important to consider the cumulative impacts of oil sands development across the region. The land area leased for in situ development (79,000 km^2 in 2009) is already 16 times greater than the total mineable area (4,800 km^2). If in situ oil sands are developed over the total available area, that development could occupy an area 30 times larger than the oil sands mines. Extensive fragmentation over such a large region would cause significant harm to the boreal forest.

Furthermore, a 2009 report in the journal *Environmental Research Letters* compared oil sands land disturbances from a full life-cycle perspective. It found that the in situ land area influence is greater than mining when land fragmentation is considered.

Data from the report also shows that in situ land disturbance is nearly double that of mining when direct and fragmentation disturbances are considered for the production facility and for oil sands–related natural gas production.





CARIBOU PROJECTED TO BE LOST FROM NORTHEASTERN ALBERTA

The woodland caribou is a threatened species in Canada and Alberta A 2008 study by Environment Canada concluded that all woodland caribou herds will likely be lost from northeastern Alberta, as a result of cumulative disturbances within their ranges.

Industrial development within caribou ranges is largely responsible for these declines. In situ oil sands development occurs within the ranges of a number of herds in northern Alberta. Habitat restoration is necessary if these populations are to be maintained. In the absence of a balanced land use plan that identifies how woodland caribou habitat is to be protected, in situ oil sands development is contributing to the loss of this wildlife species from Alberta.

Probability that woodland caribou ranges in Alberta will support a self-sustaining population given current range conditions and extent. Source: Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada.

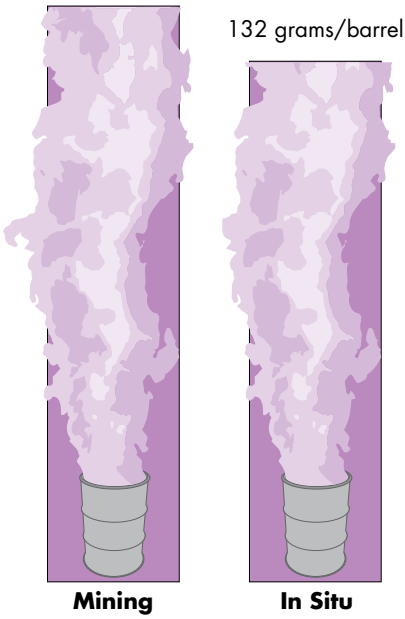
Oil sands projects are major emitters of air pollutants

Air emissions of particular importance generated at oil sands operations include nitrogen oxides and sulphur dioxide. Both emission types have the potential for human health effects and are contributors to acid rain.

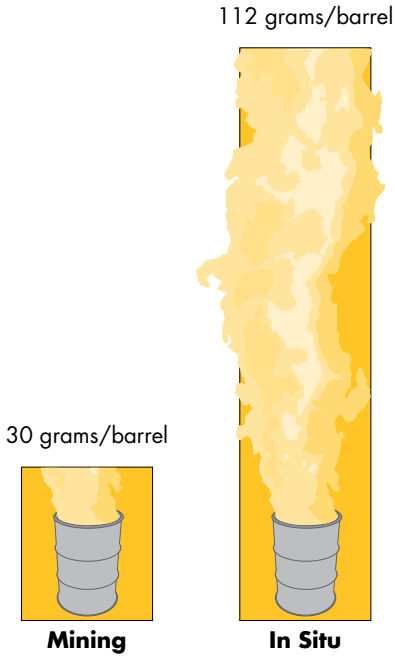
When comparing air emissions from oil sands facilities, the Pembina Institute incorporated the additional emissions associated with natural gas production and electricity generation. These components are significant sources of emissions that typically get left out of the equation because they can occur off site.

According to the weighted averages, nitrogen oxides emissions from mining and in situ are within a similar range. At 132 grams of nitrogen oxides per barrel of bitumen, in situ operations have a slightly lower emission intensity than mining operations, which release 146 grams per barrel.

In contrast, in situ operations release over three times as much sulphur dioxide per barrel of bitumen (112 grams per barrel) than mining operations (30 grams per barrel). This difference arises largely because mining operations produce steam and electricity primarily with commercial grade natural gas, which has a lower sulphur content than the gas mixture used by in situ facilities. The mining trucks used to transport oil sands ore run on diesel, which emits sulphur dioxide, but the resulting emission intensity per barrel is lower than for in situ operations.



Mining and in situ operations have comparable nitrogen oxides emission intensities.



Sulphur dioxide emission intensity is three times as high for the average in situ operation as for mining.

Disposing of oil sands' toxic liquid waste

In situ operations produce 0.4 barrels of liquid waste material for each barrel of bitumen. This waste is different from the tailings produced from mining operations and it is not stored in tailings ponds. Typically, it is sent either to a disposal site or re-injected into the deep underground wells.

Mining operations produce 1.5 barrels of waste material for every barrel of bitumen produced. This waste, called mature fine tailings, is sent for further processing before being disposed of in tailings lakes. In 2010, after over 40 years of oil sands mining, these toxic tailings lakes contained over 840 billion litres of tailings waste and covered 170 km^2, an area larger than the city of Vancouver.

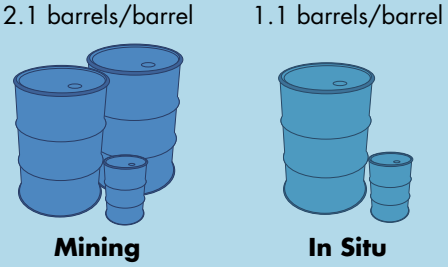
MORE WATER IN THAN BITUMEN OUT

Because of the cumulative scale of oil sands projects, both in situ and mining operations consume considerable amounts of water. Both types of oil sands extraction make use of some degree of water recycling, so this comparison is based on make-up water volumes. Make-up water, which is pulled from wells, rivers or lakes, is water that is required for bitumen production in addition to recycled water.

On average, in situ operations use 1.1 barrels of water for every barrel of bitumen produced (a barrel is 159 litres). However, actual in situ water intensities vary by project from 0.5 barrels to just under 5 barrels of water for every barrel of bitumen produced.

The average oil sands mine uses 2.1 barrels of water for each barrel of bitumen produced — about twice as much as the average in situ operation. Mining operations draw water primarily from the Athabasca River. Much of this water ends up in tailings lakes.

In situ operations use either surface water, fresh or saline groundwater, or any combination of these sources. They are increasingly using saline sources (defined as water with a sodium content above 4,000 parts per million). According to data collected for *Drilling Deeper*, 39% of the water used by in situ facilities in 2007 was saline water.

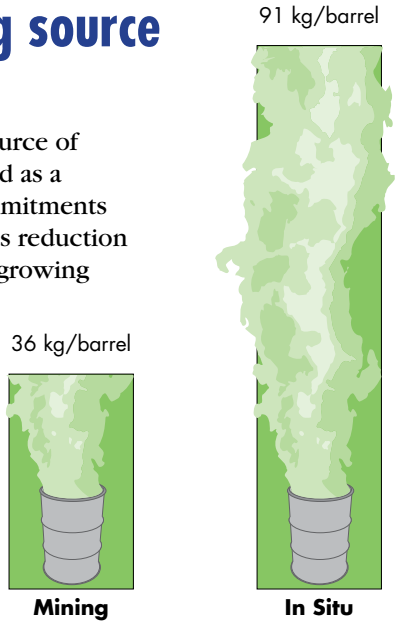


Water use intensity is twice as high for the average oil sands mine as for in situ production. In situ production uses either fresh or saline water, or a combination of the two.

Canada's fastest-growing source of greenhouse gases

Oil sands operations are the fastest growing source of greenhouse gas emissions in Canada. They stand as a potential barrier to Canada's international commitments to reduce greenhouse gas emissions. To meet its reduction targets, Canada needs to address the large and growing greenhouse gas emissions that are derived from oil sands operations.

A full accounting of greenhouse gas emissions from bitumen production includes emissions from direct extraction activities as well as those associated with natural gas production and electricity generation. Even though these latter activities may occur away from oil sands operations, they are part of the bitumen extraction process and are significant sources of greenhouse gases.



In situ operations generate two and half times as much greenhouse gas per barrel of bitumen as oil sands mines.

In situ operations require more energy than oil sands mining to produce a barrel of bitumen. As a result, in situ operations generate two and half times as much greenhouse gas per barrel of bitumen as oil sands mines (91 kg/barrel vs. 36 kg/barrel, excluding the emissions associated with bitumen upgrading). Even the lowest greenhouse gas emissions intensity for an in situ operation is just under twice that of an average oil sands mine.

Reclamation challenges

With large open mine pits and hundreds of square kilometers of tailings lakes, oil sands mining presents very unique challenges to reclamation. Of the 600 km^2 of land disturbed by oil sands mining, only 0.2% (1.04 km^2) is certified by the government as reclaimed. According to mine operators, an additional 54 km^2 has been reclaimed but not yet certified. Little publicly available data supports this claim.

In situ development does not result in tailings lakes or open pit mines, which makes reclamation efforts significantly less challenging. However, given the substantial area that may be affected and the current lack of a regional plan for in situ development, there is concern over long-term impacts to wildlife populations even if reclamation is successful.

Both in situ and mining developments result in disturbance to wetlands. To date, there is no known method for recreating peatlands lost through oil sands mining.

KEY OIL SANDS REPORTS

For more information on the impacts of mining and in situ oil sands extraction, consult the following Pembina Institute reports:

- *Drilling Deeper: The In Situ Oil Sands Report Card* www.oilsandswatch.org/pub/1981
- *Under-Mining the Environment: The Oil Sands Report Card* www.oilsandswatch.org/pub/1571
- *Oil Sands Fever: The Environmental Implications of Canada's Oil Sands Rush* www.oilsandswatch.org/pub/203
- *Troubled Waters, Troubling Trends: Technology and Policy Options to Reduce Water Use in Oil and Oil Sands Development in Alberta* www.oilsandswatch.org/pub/612
- *Death by a Thousand Cuts: The Impacts of In Situ Oil Sands Development on Alberta's Boreal Forest* www.oilsandswatch.org/pub/1262
- *Fact or Fiction: Oil Sands Reclamation* www.oilsandswatch.org/pub/1639
- *Danger in the Nursery: Impact on Birds of Tar Sands Oil Development in Canada's Boreal Forest* www.oilsandswatch.org/pub/1760
- *Clearing the Air on Oil Sands Myths* www.oilsandswatch.org/pub/1839
- *Upgrader Alley: Oil Sands Fever Strikes Edmonton* www.oilsandswatch.org/pub/1654
- www.oilsandswatch.org (reports, photos, fact sheets, videos and more)

Full impacts of oil sands development still poorly understood

All types of oil sands extraction are **intensive operations** that present unique environmental challenges. While this analysis is the most in-depth environmental comparison of oil sands mining and in situ to date, it doesn't include many aspects that require further investigation. Tailings seepage, groundwater impacts, volatile organic compound emissions and other air emissions are a few examples of **key environmental concerns** that should be included in a more in-depth comparison.

Our analysis allows us to make some key conclusions:

- Mining and in situ oil sands extraction both have **significant environmental impacts** on a per barrel basis and on a cumulative scale. Impacts from all types of oil sands operations should be considered on a cumulative scale. We need to **look beyond** the project-by-project basis.
- In situ operations are not a low-impact form of oil sands development. They have significant, **cumulative** and **long-term** environmental impacts.
- Given the overall pace and scale of oil sands development, there is a need for management that imposes **strict limits** on environmental impacts to ensure that regional environmental thresholds are not exceeded.