The Alberta Oil Sands
Wrestling Bitumen out of the Wild North
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Athabasca Oil Sand Reserve

- Oil sands are contained within the Cretaceous McMurray Formation. (149,000 km²)
- 2.5 trillion barrels of extractable oil (~25% of Canada Crude Oil Production)
- Surface mineable deposits cover 2,800 km²
- 450 billion L of process water used annually
- Currently over 130 km² of tailings ponds (largest man-made structures in the world)
Oil Sand Extraction (1967-2000)

- Annual (million m$^3$)
- Cumulative (million m$^3$)

- **2$/Barrel**

- **1.5 Million barrels/day - 2011**
- **2.5 Million barrels/day - 2020**

**Nearly 100% going to the USA**
Steam Assisted Gravity Drainage

- Minimal Surface Disruption (In Situ)

- Energy Intensive

- Higher GHG emissions than Mining

Environment Canada, 2009

David Dodge, Pembina Institute
Open-pit Oil Sand Mining
Oil Sand Processing Facilities

Suncor plant beside Athabasca River
Bitumen Extraction
(Clark Hot Water Extraction Method)

- Oil sand on conveyor belt
- Ore bin/shaker screen
- Hot water, air, NaOH
- Primary Conditioning
  - Primary tailings
  - Naphtha
- Secondary Conditioning
  - Secondary tailings
  - Bitumen froth
  - To tailings ponds
Ore → Processing → Synthetic Crude Oil
Tailings Discharge to Ponds

Coarse Tailings

Fine Tailings
Unique Characteristics of Oil Sand Tailings Impoundments

- Enormous quantities of tailings.
- Tailings are deposited with process water containing organic compounds toxic to aquatic life. *(naphthenic acids).*
- Fine tailings particles stay in suspension in the pond for a long time: *(decades to centuries).*
- Dykes are constructed using tailings sand: *(very permeable structure.)*

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Syncrude Mine, Process Plant and Tailings

Environmental Issue #1:
Groundwater and surface water quality impacts from tailings pond seepage.
Groundwater Quality Impacts

• Chloride
• Sodium
• Naphthenic Acids

Oiffer et al., 2009
Tailings Water Release to Surface Water Bodies

Decommissioned in Early 1980's
Potential Ground Water Flow Pathways

- Two sources of contaminated ground water: pond, construction water
- Two main pathways for tailings water: foundation, seepage face

Ferguson, Rudolph and Barker (2010)
Simulated Saturation Distribution, 1980 to 2100
Environmental Issue #2: Impacts on regional groundwater and surface water quantity.
Environmental Issue #3:
Impacts of oil sands contaminants on downstream residents.
Environmental Issue #4:
Tailings pond operation and reclamation.
Environmental Issue #5:
Impacts on Greenhouse gas emissions.
• Current evidence on water quality impacts on the Athabasca River system suggests that oil sands development activities are not a current threat to aquatic ecosystem viability.

- There are valid concerns about the current Regional Aquatics Monitoring Program (RAMP) that must be addressed.
- The regional cumulative impact on groundwater quantity and quality has not been assessed.
Observations from the Royal Society Report

- Current industrial water use demands do not threaten the viability of the Athabasca River system

  PROVIDED the Water Management Framework developed to protect in-stream ecosystem flow needs is fully implemented and enforced.
Observations from the Royal Society Report

- There is currently no credible evidence of environmental contaminant exposures from oil sands reaching Fort Chipewyan at levels expected to cause elevated human cancer rates.

- More monitoring focused on human contaminant exposures is needed to address First Nation and community concerns.
Observations from the Royal Society Report

- Technologies for improved tailings management are emerging but the rate of improvement has not prevented a growing inventory of tailings ponds.

- Progress has been made in reducing GHG emissions but growing bitumen production represents major challenge for Canada.
Observations from the Royal Society Report

• The environmental regulatory capacity of the Alberta and Canadian Governments does not appear to have kept pace with the rapid growth of the oil sands industry over the past decade.
Oil sands companies think they are in the oil business ...

They are really in the waste management business, with upgraded oil as a byproduct.