OSRIN's Did You Know Series: The Collected Works

Oil Sands Research and Information Network

School of Energy and the Environment

University of Alberta

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Oil Sands Research and Information Network

The Oil Sands Research and Information Network (OSRIN) is a university-based, independent organization that compiles, interprets and analyses available knowledge about managing the environmental impacts to landscapes and water affected by oil sands mining and gets that knowledge into the hands of those who can use it to drive breakthrough improvements in regulations and practices. OSRIN is a project of the University of Alberta's School of Energy and the Environment (SEE). OSRIN was launched with a start-up grant of $4.5 million from Alberta Environment and a $250,000 grant from the Canada School of Energy and Environment Ltd.

OSRIN provides:

- **Governments** with the independent, objective, and credible information and analysis required to put appropriate regulatory and policy frameworks in place
- **Media, opinion leaders and the general public** with the facts about oil sands development, its environmental and social impacts, and landscape/water reclamation activities – so that public dialogue and policy is informed by solid evidence
- **Industry** with ready access to an integrated view of research that will help them make and execute environmental management plans – a view that crosses disciplines and organizational boundaries

OSRIN recognizes that much research has been done in these areas by a variety of players over 40 years of oil sands development. OSRIN synthesizes this collective knowledge and presents it in a form that allows others to use it to solve pressing problems.

Citation

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Copies of this report may be obtained from OSRIN at osrin@ualberta.ca or through the OSRIN website at http://www.osrin.ualberta.ca/en/OSRINPublications.aspx or directly from the University of Alberta's Education & Research Archive at http://hdl.handle.net/10402/era.17507.

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REPORT SUMMARY

The Oil Sands Research and Information Network (OSRIN) developed the Did You Know series as a means of highlighting interesting current and historical facts about development, economics and environmental management related to the oil sands. The series expanded to cover items of interest in the broader Lower Athabasca region. Each Did You Know piece was released on the website and often included links to other related resources.

ACKNOWLEDGEMENTS

The Oil Sands Research and Information Network (OSRIN), School of Energy and the Environment (SEE), University of Alberta provided funding for this project.

INTRODUCTION

The Oil Sands Research and Information Network (OSRIN) developed the Did You Know series as a means of highlighting interesting current and historical facts about development, economics and environmental management in the oil sands region. The series expanded to cover items of interest in the oil sands region. Each Did You Know piece was released on the website and often included links to other related resources.

A total of 66 Did You Know pieces were released.

This report is a compilation of the Did You Know series in chronological order. **Where necessary text and links have been updated to reflect changes since the piece was originally released**.

OSRIN regrets that some links contained in this report may not be live at the time you read this as a result of media outlets removing links or organizations reorganizing their websites[1].

[1] You can still go the old fashioned route and head to your local library to dig up the articles.

First Reclamation Certificate – *July 2, 2010*

Located just off Highway 63 are the Wood Bison Viewpoint and the Wood Bison Trails. The Viewpoint is home to 300 wood bison, the descendants of 32 animals initially brought there in 1993 by Syncrude. Across the Highway are the Trails. Also known as Gateway Hill, this is the 104-hectare former overburden dump that in March 2008 earned Syncrude Alberta's first ever oil sands land reclamation certificate from the government.

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Lakes in Reclaimed Landscapes – *July 3, 2010*

Lakes will be a significant component of the reclaimed landscape in the oil sands region. A 2007 report by Clearwater Environmental Consultants for the Cumulative Environmental Management Association (CEMA) indicates that the lakes will vary greatly in size, shape, volume and the amount of oil sands tailings that may be present[2].

The CEMA End Pit Lake Subgroup developed the following definition: an end pit lake (EPL) is an engineered water body, located below grade in oil sands post-mining pits. An EPL may contain oil sands by-product materials and will receive surface and groundwater from surrounding reclaimed and undisturbed landscapes. EPLs will be permanent features in the final reclaimed landscape, discharging water to the downstream environment.

CEMA has an interactive map of 29 lakes showing location and design characteristics and has summarized some of the key characteristics in a table format. Some of the highlights:

Characteristic	**Total**	**Average**	**Low**	**High**
Lake Area	115.5 km^2	3.98 km^2	0.4 km^2	14 km^2
Lake Volume	4,972 Mm^3	171.45 Mm^3	3 Mm^3	916 Mm^3
Tailings Volume	1,049 Mm^3	95.4 Mm^3	2 Mm^3	215 Mm^3
% Volume that is Tailings		45%	2%	87%
Lake Depth		25 m	6 m	90 m

To put the lake area in context of natural lakes in the area, Kearl Lake is almost 6 km^2 and Gregoire Lake is almost 26 km^2.

To put the lake depth in context of natural lakes in the area Kearl Lake is very shallow, with a maximum depth of just 2.5 m, while Gregoire Lake has a maximum depth of just over 7 m.

Only 11 of the 39 lakes are planned to have tailings.

The lakes will finish filling anywhere from 2015 to 2065.

Read the CEMA report for more background on end pit lakes including their physical, chemical and biological characteristics. The report also identifies knowledge gaps and future research needs.

[2] Note: since this Did You Know was published CEMA produced the following end pit lake report: Hrynyshyn, J. (Ed.), 2012. End pit lakes guidance document 2012. Cumulative Environmental Management Association, Fort McMurray, Alberta. CEMA Contract No. 2010-0016 RWG. 434 pp. http://cemaonline.ca/index.php/administration/doc_download/174-end-pit-lake-guidance-document

Environmental Assessments – *July 9, 2010*

You can sign-up for e-mail updates from Alberta Environment on the status of environmental assessments in Alberta. Oil sands projects form the majority of environmental impact assessments conducted in Alberta. There is a great deal of information on the Environmental Assessment website, including a description of the provincial environmental assessment process and a listing of past EIAs by subject area so you can quickly see what oil sands assessments have been done to date. Recent EIAs are available electronically - see our Web Links page.

Related Links

Sign up for Alberta Environment's EIA e-mail notification system

Alberta's environmental assessment process

List of past provincial EIAs

EIAs on OSRIN site

Canadian Environmental Assessment Agency

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Parsons Creek Aggregates Limestone Quarry Project – *August 25, 2010*

Parsons Creek Aggregates has submitted an Environmental Impact Assessment as well as regulatory applications to Alberta Environment and the Natural Resources Conservation Board for their proposed Parsons Creek Aggregates Limestone Quarry Project located just north of the Fort McMurray Urban Service Boundary. The 391 hectare quarry will be developed in three distinct phases using conventional quarry mining operations including drilling, blasting, excavating, crushing, screening and stockpiling procedures. Nominal capacity of the project at start-up will be 250,000 tonnes/year of construction stone and chemical stone products, with peak production of 2,000,000 t/yr after 10 years. The quarry will be in production for approximately 40 years.

This is an excellent reminder that there is more to development in the Fort McMurray area than just oil sands – this quarry will join two others in the area plus the Susan Lake gravel pit (one of the largest in Canada) and forestry operations, among others.

Related Links

Parsons Creek Aggregates

Project Environmental Impact Assessment report

Susan Lake pit

Fort McMurray quarries of Hammerstone Corporation

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Project Oilsand – *September 22, 2010*

The general principle behind in-situ extraction of oil sands is to heat up the bitumen in place to a temperature at which it will flow to a collection well bore to be pumped to the surface. The most common method of heating is injection of steam (Steam Assisted Gravity Drainage or SAGD). Other methods are under active investigation including THAI (Toe to Heel Air Injection) or direct heating via electrical resistance.

However in 1958, the Richfield Oil Corporation approached Alberta regulators with a proposal to use a small nuclear device to heat the bitumen and cause it to flow. The nine kiloton device was to be placed in a well located approximately six miles (10 km) northwest of the community of Chard and exploded at a depth of approximately 1,220 feet (372 m) which is approximately 20 feet (6 m) below the surface of the Beaverhill Lake Limestone bitumen-bearing layer. The "handling, assembly, arming, timing an firing of the device would be handled by the United States Atomic Energy Commission or contractors responsible to them" but "a Canadian should be given overall veto powers over the entire project or any part of it prior to or after the detonation" (Alberta Technical Committee 1959; p. 9).

The theory was that the explosion, and resulting nine trillion calories of heat, would create a cavern approximately 230 feet (70 m) in diameter extending about 100 feet (30 m) into the oil sand. It was "hoped that a large volume of the oil would be heated to a temperature of 100^{o}C at which temperature the viscosity of the oil would be sufficiently reduced to render it producible by normal oil field methods" (Alberta Technical Committee 1959; p. 10).

After consideration of the application the Committee noted "Moreover, the Committee believes that it is to the advantage of the Province of Alberta, being the owner of the oil resources in the McMurray area, that the test be carried out. The Committee, therefore, recommends that the Lieutenant Governor in Council approve the project …" subject to a list of 10 conditions (Alberta Technical Committee 1959; p. 50).

Ultimately the project did not proceed for a variety of reasons including the increasing debate in Canada over radiation and nuclear power, the threat of nuclear war in the early 60s, and a series of international non-proliferation agreements (Payne n.d.(b)).

Quotes

Some additional quotes from the Alberta Technical Committee report:

- "The area is sparsely populated, with approximately 12 persons at Chard, 25 at Leismer and about 22 others throughout the remainder of the area" (p. 12)
- "Generally speaking the overall effect of the proposed explosion would be the creation of an underground debris filled chamber … which would contain all radioactivity and into which heated oil may be expected to flow … Little radioactivity is expected in the oil." (p. 34) because "the radioactivity would be preferentially associated with mineral matter rather than the oil" (p. 37)

- "Radioactive products are produced; some of them are entrapped in a shell lining the cavity and the balance are dispersed into nearby formations by water movement" (p. 10)
- "Although no airborne radioactivity is anticipated precautionary monitoring for it would be provided" (p. 9)
- "All factors considered the Committee is convinced that with proper precautions there would be no hazard to public health from the detonation of the underground explosion as discussed" (p. 41)
- "The experience from the underground Nevada tests suggests that a nine kiloton device might be felt by observers for distances up to 15 miles" (24 km) (p. 19)
- "It is most important that breakthrough to the earth's surface does not occur …" (p. 20)
- "Just prior to the arrival of the nuclear explosive in the area, a strict security program should be instituted. An area of about 600 square miles (1,554 km^2) surrounding the placement well should be closed off to the public …" (p. 40)

References

Alberta Technical Committee, 1959. Report to the Minister of Mines and Minerals and the Oil and Gas Conservation Board. Government of the Province of Alberta, Edmonton, Alberta. 55 pp. plus appendices.

Additional reading

Moore, S.D., 1975. Nuclear energy as a subsurface heavy oil recovery technique. IN: The Athabasca Oil Sands. Proceedings of the First Regional Conference of the Western Region Engineering Institute of Canada. Engineering Institute of Canada, Montreal, Quebec. pp. 411-429.

Related Links

Johnson, G.W., 1960. Nuclear explosions in science and technology. Bulletin of the Atomic Scientists 16(5): 155-161.

Nordyke, M.D., 1973. Nuclear Explosive Method for Stimulating Hydrocarbon Production From Petroliferous Formations. Canadian Patents Database, Ottawa, Ontario.

Payne, M., n.d.(a) Project Oil Sands, Alberta's Experience with the Atomic Bomb. Transcript of Program #31; Part 1 of a two-part Innovation Alberta interview with Dr. Michael Payne, Head of Research and Publications, Historic Sites and Cultural Facilities, Alberta Community Development.

Payne, M., n.d.(b) Project Oil Sands, Alberta's Experience with the Atomic Bomb. Transcript of Program #32; Part 2 of a two-part Innovation Alberta interview with Dr. Michael Payne, Head of Research and Publications, Historic Sites and Cultural Facilities, Alberta Community Development.

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Joslyn North Mine Hearing – *September 24, 2010*

The regulatory hearing of the proposed Joslyn North Mine Project started on September 21, 2010 in Fort McMurray, Alberta. The hearing is being conducted by a Review Panel representing the Energy Resources Conservation Board and the Government of Canada (Minister of Environment). This is the first oil sands mine hearing since 2006 when three hearings occurred.

The Joslyn North Mine project proposed by Total E&P Canada Ltd. includes the construction, operation, and reclamation of an oil sands surface mine and bitumen extraction facilities located approximately 70 kilometres north of Fort McMurray on Oil Sands Leases. The proposed development includes an open pit, truck and shovel mine; an ore handling facility; bitumen extraction facilities; tailings processing facilities; support infrastructure; water and tailings management plans; and an integrated reclamation plan. The Joslyn North Mine project is designed to produce 15,900 cubic metres per day (100,000 barrels per day) of bitumen.

The Review Panel's website contains background information related to this project hearing.

Related Links

Joslyn North Mine Project Environmental Impact Assessment

Report of the Joint Review Panel

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The Alberta Salt Company Ltd. – *September 24, 2010*

The Fort McMurray, Alberta area is well known as the centre of oil sands operations in Alberta. What is not well known is that salt was mined in the Fort McMurray area from 1924 to 1950.

J.A. Allen, a professor at the University of Alberta was sent by the government of Alberta to report on minerals in the area. His report First annual report on the mineral resources of Alberta was published in 1919 and recommended further tests on the salt resource in the area. In October of 1919, the government drilled the first salt well and then a second well in 1923. After the second well, the Government declared that a salt industry could be maintained in the district. This attracted private investors.

The Alberta Salt Company Ltd. was Alberta's first commercial salt plant. It began production in 1925 and closed down in 1927. In the two years of operation, it sold 2,907 tons (2,616 tonnes) of salt. The salt plant was located on the north bank of the mouth of the Horse River on the Athabasca River. John Gillespie of Edmonton was the owner of the Alberta Salt Company and its president. Mr. Gillespie was able to secure the common salt mining rights of the "La Salina" mineral claim. The problem was that this area was six miles (10 km) away from the end of the rail line. Salt was delivered six miles to the railway station with coal being brought back the same distance. In the end, Mr. Gillespie wasn't able to convince railway officials or the Alberta government to build a spur closer to the plant even if he offered to pay for it. The problem for the government was that Mr. Gillespie wanted sole shipping rights on this spur but because the government had their own well drilled in the same are, they wouldn't grant it. Because of transportation issues, the Alberta Salt Company was closed.

Prior to the first government salt well, Alfred Von Hammerstein came to Fort McMurray as part of the Northern Exploration looking for oil. As Northern Exploration drilled along the Athabasca River they found salt. Von Hammerstein returned to the area in 1925 to help establish the Alberta Salt Company with John Gillespie.

Even though the Alberta Salt Company Ltd. only operated for a short time, it needs to be given credit for helping the residents' transition from wood burning stoves to coal burning stoves. The town would buy coal from the company as it was much cheaper than wood. The salt industry also helped Fort McMurray make the transition from the fur trade to industry.

A second commercial salt plant was opened in 1936 and situated in an area called Waterways. This plant was owned and operated by the Dominion Tar and Chemical Company. The plant closed in 1950. The site of the second plant is home for mobile home development called Ptarmigan Park.

Related Links

Hein, Francis J., 2000. Historical Overview of the Fort McMurray Area and Oil Sands Industry in Northeast Alberta (PDF). Earth Sciences Report 2000-05. Alberta Geological Survey, Edmonton, Alberta. http://www.ags.gov.ab.ca/publications/ESR/PDF/ESR_2000_05.pdf. Retrieved 2010-09-21.

Waterways Takes the Lead (1921-1959) - http://www.albertasource.ca/realestate/regions/fortmac/waterways.html - retrieved Sept.21, 2010

Oil Sands History - http://www.syncrude.ca/users/folder.asp?FolderID=5657 - retrieved Sept.21, 2010

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Rat Root – *October 29, 2010*

Rat root is an important plant in the reestablishment of marsh reclamation. It is an integral part of the habitats for moose, muskrat and beavers. It is also a culturally significant medicinal plant to the aboriginal community. Rat root got its name because it one of the favourite foods for muskrats.

Rat root has been used to treat coughs, colds, sore throats, toothaches and stomach problems. It can also be smoked with tobacco to relieve migraine headaches. Rat root is one of the most widely known and used medicines from nature.

Rat root grows in wetland areas or along the borders of streams. It has long, sword-like leaves and small, brownish flowers crowded onto a spadix. The root is thick, with many smaller rootlets dangling from it.

Rat root is also known as sweet flag or Acorus calamus. It is funny that it is also named sweet flag because the root actually has a bitter taste to it.

Photo by Elaine Haug, courtesy of Smithsonian Institution.

Related Links

Alberta Environment. 2008. *Guideline for wetland establishment on reclaimed oil sands leases (2nd edition)*. Prepared by Harris, M.L. of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, AB. December 2007. http://environment.gov.ab.ca/info/library/8105.pdf

USDA, NRCS. 2010. The PLANTS Database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. http://plants.usda.gov/java/profile?symbol=ACCA4 – retrieved Oct. 27, 2010.

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Environmental Protection Security Fund Annual Report – *November 10, 2010*

Alberta Environment has released the 2009/10 Environmental Protection Security Fund Annual Report. Oil sands mine companies are required to provide reclamation security to Alberta Environment pursuant to Division 2 of the *Conservation and Reclamation Regulation*. The reclamation security amounts are revised each year based on the outstanding amount of reclamation work required – the amount goes up if there is more disturbance, and down if disturbances have been reclaimed. The purpose of security is to ensure the government has funds available to undertake reclamation if the company defaults and cannot do the work. Government has never had to use security for an oil sands mine.

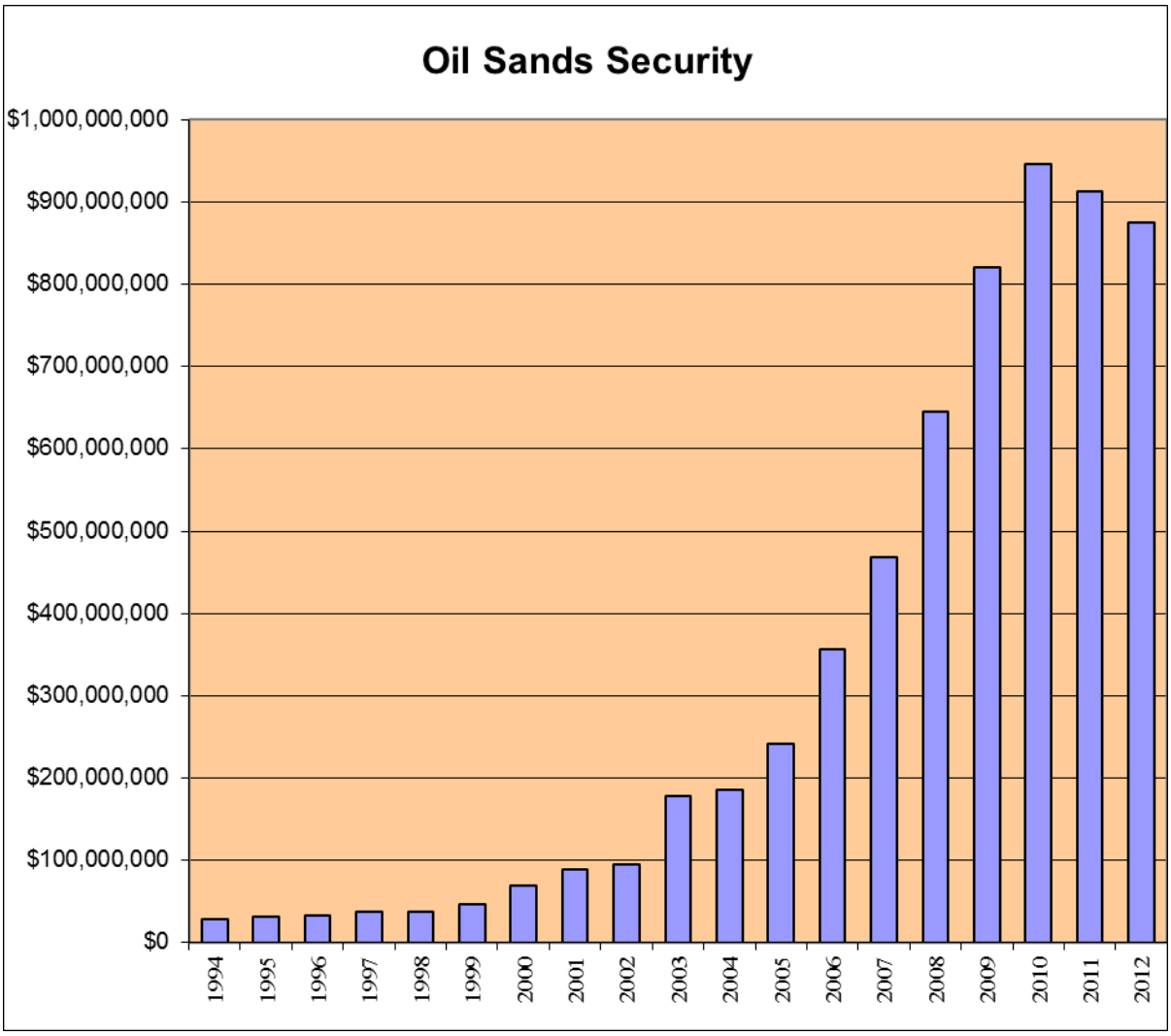
Security is collected for each operating approval issued under the *Environmental Protection and Enhancement Act*. Some operating companies have several partners (called Working Interest Participants) who each put up their share of the reclamation security (e.g., Syncrude).

For the year ending March 31, 2010 the oil sands companies had posted a total of $946,270,732.86, up from a total of $820,484,138.00 in 2008/09 (an increase of 15% - the chart shows the increases in security from 1994 to 2010). Suncor's Millennium Mine has the largest security deposit at $359,096,654.00, which includes security at full cost for the newer developments on the east side of the Athabasca River and security at 3 cents/barrel of production for the older mining area on the west side of the river[3]. Fort Hills Energy Corporation's Fort Hills Mine has the lowest amount of security at $52,443,768.23, reflecting their relatively early stage of development.

Suncor is also a Working Interest Partner in two other mine approvals – Syncrude and Fort Hills. As a result the total amount of reclamation security provided by Suncor for all three mines is $411,101,034.82 or 43% of all oil sands security.

All security deposits are provided in the form of Letters of Credit, which are a commitment from a bank to the government to pay the face value of the security on demand by the government.

[3] Since this Did You Know was published the government changed the security program. The older 3 cents/bbl provision was removed and reclamation security is provided based on the new Mine Financial Security Program.



Related Links

Environmental Protection Security Fund Annual Report (this is the 2011/2012 Annual Report; numbers are therefore different than reported in 2010)

Conservation and Reclamation Regulation

OSRIN reclamation security links page

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Reclamation Material Stockpiles – the Reclamation Savings Bank – *December 1, 2010*

Often in the media we read that oil sands mining consists of cutting down the trees, stripping off the overburden and excavating the oil sands for processing in the plant. What is missing in this brief overview is the critical first step of reclamation – the salvage of the valuable soil materials that will form the basis for plant growth after project development.

Mine companies are required through their Environmental Protection and Enhancement Act approval to salvage soils for use in reclamation. Ideally these are used as soon as they are salvaged; that is, they are directly placed onto land that is ready for reclamation. However, as more soil is salvaged than can be directly placed in any given year the companies store these valuable materials in Reclamation Material Stockpiles.

Historically the companies were salvaging peat or a mix of peat and the underlying mineral soils for use in reclamation. However after the 2006 regulatory hearings for the Albian Sands Muskeg River Mine Expansion, Suncor North Steepbank Mine Extension and Voyageur Upgrader, and Imperial Kearl projects, regulators began requiring that companies also separately salvage and stockpile the surface layers of upland forested soils (variously called mineral soils or the LFH layer).

As of December 2009, eight operating mines had stockpiled over 67 million cubic metres of soils for use in reclamation. That's enough soil to provide 16 cm cover on the 41,803 hectares of disturbed oil sands mine land that doesn't already have soil placed or is reclaimed as a water body. This calculated depth of replaced stockpiled soil is based on an average placement across the entire disturbed footprint, and does not consider where there may be areas of open water planned, such as wetlands or end pit lakes, where soil is not necessary. Over 56 million cubic metres of this total is comprised of the historical peat:mineral mix and the remainder is mineral soils. This is in addition to subsoil materials which are also salvaged and stockpiled for use in reclamation as the first soil layer between the underlying mine or plant substrate and the peat:mineral mix or mineral soils.

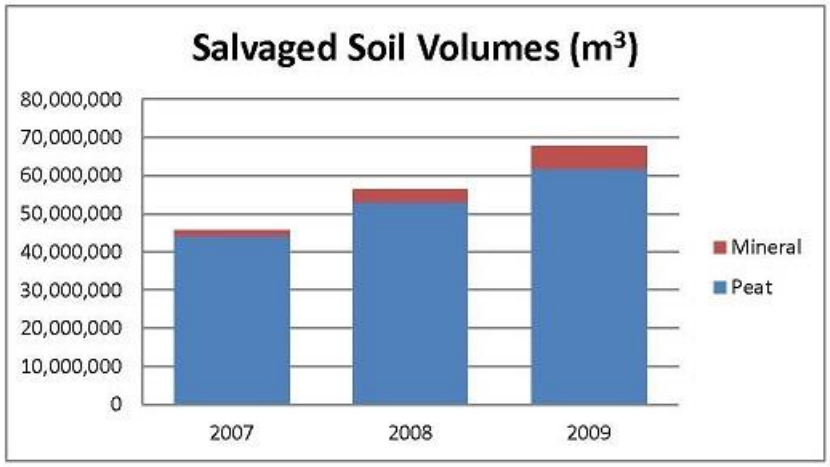
All data were taken from the annual conservation and reclamation reports filed by the mining companies with Alberta Environment and which are available for public viewing in the Government of Alberta Library at the Great West Life Building, 6th Floor, 9920 - 108 Street, Edmonton.

Data caveats:

- he labels in the table and graph have been shortened for convenience. "Peat" means stockpiles variously labeled peat or peat:mineral mix or muskeg. "Mineral" means stockpiles of materials labeled variously as mineral, surface soil, or LFH.
- Data required interpretation of the information supplied by the mining companies in their reports and therefore should be taken as a general indication of the soil volumes rather than an absolute measure

- When it was clear that a stockpile was not subsoil, but it was not possible to determine if it was peat or mineral (due to unclear labels in the reports), the material was placed in the peat category
- Due to unclear labels in the reports some stockpiles could not reliably be allocated to either subsoil or surface material. As a result there is likely more salvaged surface material in stockpiles than is reported here.

Year	Peat	Stockpiled Mineral	Total
2007	44,403,442	1,345,782	45,749,224
2008	52,950,654	3,560,312	56,510,966
2009	61,835,710	5,972,641	67,808,351



Related Links

Albian Sands Muskeg River Mine Expansion Decision Report

Suncor North Steepbank Mine Extension and Voyageur Upgrader Decision Report

Imperial Kearl Decision Report

Sample oil sands mine approval (Suncor) – see section 3.2.10 to 3.2.26 for soil salvage rules

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Oil Sands Theses – *December 8, 2010*

Library and Archives Canada maintains the Theses Canada Portal, which is a collection of masters and doctoral theses from Canadian universities. A search of the database using the terms "oil sands" or "oilsands" or "tar sands" yielded 333 records (on December 8, 2010). Some of the theses are available in digital format. The number of theses from a variety of universities shows the extensive interest in the subject and the significant academic horsepower being applied to oil sands development and environmental management.

> **NOTE**: after publication of this Did You Know OSRIN started using the AMICUS database as an alternative tool to search for theses. Click on Search AMICUS then click on Advanced Search (upper right in box), enter a search term (e.g., "oil sands"), then select Theses in the Publication type drop down menu at the bottom.
>
> **NOTE**: We published another article on the number and source of oil sands theses in August 2013.

Related Links

Theses Canada site

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Choosing End Land Uses for Oil Sands Mines – *December 17, 2010*

In both the OSRIN Reclamation Challenge Dialogue Workshop and the OSRIN Equivalent Land Capability Workshop participants discussed the importance of the provincial government document Oil Sands Mining End Land Use Committee Report and Recommendations but noted a general lack of awareness of its existence and value. Here is a short summary of the report.

In June 1996, Alberta Environmental Protection recommended that a committee be established with membership from the oil sands mining industry; Alberta Environmental Protection; Alberta Energy and Utilities Board; and representative of the interests that may be directly affected by oil sands mining. The committee would make recommendations to the Government of Alberta and industry to assist decision-making during the regulatory review and approval process for reclamation and end land use planning. The End Land Use Committee focused on minimizing impacts on other uses and industry (e.g., forestry) while at the same time respecting oil sands mining as an important regional activity. An important product of the committee was a framework that would help the industry and government make decisions using a common understanding of legal, social and economic factors affecting reclamation and end land use.

The End Land Use Committee prepared recommendations focusing on four areas in the reclamation process:

> **Baseline Information/Data for End Land-Use Decision-Making – Pre-Disturbance Land Capability:** This includes recommendations on baseline data collection for new oil sands development, existing oil sands operations and verification of baseline vegetation data for existing oil sands development.
>
> **Reclamation Plan Coordination:** Recommendations deal with the need for regional coordination of end land-use decisions through a group consisting of regulatory agencies, industry and key stakeholders in the Regional Municipality of Wood Buffalo, requirements for coordination between government and industry, and coordination of plans and reclamation activities among industry operators.
>
> **Land Use Categories and Allocation:** The committee provided recommendations for major land-use categories: Natural and Conservation Areas, Human Development, and Forestry as well as guidelines for implementation and allocation.
>
> **Priority of Establishing End Land Uses:** Recognizing that development of land uses on reclaimed land will happen over long periods of time, the committee provided recommendations for setting end land-use priorities.

Related Links

Oil Sands Mining End Land Use Committee Report and Recommendations

Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan

Lower Athabasca Regional Plan

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Other Industrial Facilities are Associated with Oil Sands Plants – *January 10, 2011*

When people think of oil sands plants they tend to focus on the facilities that extract the bitumen from the sand. In reality, oil sands plants are industrial complexes with other associated facilities playing supporting roles to the primary function of producing oil. Examples of some associated facilities currently operating are provided below (summary text is taken from the corporate websites). This integrated approach to oil sands processing allows the oil sands companies to focus on their areas of expertise while their partners take care of various specialized services. In some cases, it also allows waste products to be used for other industrial purposes.

EPCOR

Since 2003, EPCOR has been operating a growing number of water and wastewater treatment plants at Suncor and Albian Sands sites, which have provided essential services to camps and sites operating in the area.

Marsulex Inc. (Note: in 2011 Chemtrade acquired Marsulex)

Chemtrade (Marsulex) provides Syncrude a package of technology and services and owns and operates a portion of the environmental compliance facilities at the Mildred Lake site. The system incorporates the Company's proprietary ammonium sulphate scrubbing technology and utilizes a waste ammonia stream to scrub emissions, including SO_2, which will be reduced by 95%. The process creates high quality granular ammonium sulphate fertilizer as a value added by-product.

TransAlta

TransAlta owns and operates the $315 million Poplar Creek cogeneration facility at Suncor's oil sands site near Fort McMurray. TransAlta also operates Suncor's 70-megawatt utility plant. Any surplus power not used by Suncor is available for sale directly to the Alberta power grid. The environmental benefits of this project further the sustainable development goals of both Suncor and TransAlta. Since the project uses waste heat from electrical production to produce steam, it is 45 per cent more efficient than conventional utility plants.

Williams

As the only processor of oil sands off-gas in the world and the owner of the only fractionator capable of processing off-gas liquids in Canada, Williams is well-positioned for growth. Through their operations in Fort McMurray and in Sturgeon County near Edmonton, they are providing both significant environmental benefits and high-value oil and gas upgrading services to oil sands upgraders.

Titanium Corporation

Other associated facilities are being considered. For example, Titanium Corporation's vision is to create a new industry in Alberta by processing waste material into valuable products. The company is developing technology to recover heavy minerals, primarily zircon, and bitumen contained in the waste tailings streams from oil sands mining operations near Fort McMurray, Alberta.

Related Links

Chemtrade

EPCOR

TransAlta

Williams

Titanium Corporation

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The Tailings Ponds are Alive! – *May 31, 2011*

Researchers at the University of Alberta and University of Calgary have identified numerous species of bacteria inhabiting oil sands tailings ponds, including methanogen, sulphur-reducing bacteria and nitrite-reducing bacteria groups. The methanogens are responsible for release of methane from the tailings ponds. The bubbling action leading to the methane release has been shown to help in tailings aggregation and sedimentation.

Related Links

Bordenave, S., V. Kostenko, A. Grigoryan, R. J. Martinuzzi and G. Voordouw, 2010. Relation between the activity of anaerobic microbial populations in oil sands tailings ponds and the sedimentation of tailings. Chemosphere 81(5): 663-668.

Holowenko, F. M., M. D. MacKinnon and P. M. Fedorak, 2000. Methanogens and sulfate-reducing bacteria in oil sands fine tailings waste. Canadian Journal of Microbiology 46: 927-937.

Penner, T. J. and J. M. Foght, 2010. Mature fine tailings from oil sands processing harbour diverse methanogenic communities. Canadian Journal of Microbiology 56: 459-470.

SciGuru, 2010. Microbiology could help clean up oilsands tailings ponds.

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Oil Sands Companies are Included in Socially Responsible Investments – *June 30, 2011*

Socially Responsible Investing (SRI) is an investment philosophy that includes non-financial, ethical (e.g., social and environmental) objectives in investment selection criteria. This investment philosophy is gaining traction in Canada and elsewhere.

Socially responsible investors encompass a wide range of individuals and groups interested in criteria other than just return on investment. Ethical investors work to enhance the bottom lines of the companies they invest in and, in so doing, deliver more long-term wealth to shareholders. In addition, socially responsible investors may seek to build wealth in underserved communities worldwide. With SRI, investors can put their money to work to build a more sustainable world while earning competitive returns. Socially responsible investors should look at potential investments carefully to see what the fund invests in to ensure that the fund matches their own personal ethical investment criteria.

Socially responsible investors include individuals and also institutions, such as corporations, universities, hospitals, foundations, insurance companies, public and private pension funds, nonprofit organizations, and religious institutions. Institutional investors represent the largest and fastest growing segment of the SRI world.

Given the definition of Socially Responsible Investing, and the ongoing negative media and public sentiments against oil sands, it may surprise some people to find out that oil sands developers and related companies can form significant holdings in ethically-focused investment vehicles. Ethical investment managers need to balance ethical investment goals with financial returns. As a result, ethical investment managers do invest in oil sands companies that exhibit leadership in the field of social, environmental and/or corporate governance. In other words, ethical investing and oil sands are not mutually exclusive. The reasons for this are varied, but include:

- Some companies are clear leaders in their particular sector in terms of social, environmental and/or governance approaches to development. Thus, while the sector may generally be seen to be a poor choice for an ethical investment, if an investment is to be made it should be made in one of the leading companies.
- The limited pool of large-cap companies in Canada means that investment managers are likely to have to select at least one of the large oil sands companies in a Canadian-focused equity portfolio of any size.
- Belief that ownership of a company (through stocks or debt) provides an opportunity to change company behaviours to more closely mimic the desired (ethical) behaviours. This is a technique commonly employed by Environmental Non-Government Organizations (ENGO) – they purchase a limited number of shares and then table resolutions at company Annual Meetings designed to meet the ENGO's goals. The process of dialogue and filing shareholder resolutions generates investor pressure on company management, often garners media attention, and educates the public on social, environmental and labor issues. Such resolutions filed by SRI

investors are aimed at improving company policies and practices, encouraging management to exercise good corporate citizenship and promoting long-term shareholder value and financial performance.

There are a number of ethically-focused investment fund companies in Canada. In June 2011 OSRIN reviewed the websites of seven of these Canadian companies and found the following oil sands-related companies in the top holdings of one or more of the funds: Athabasca Oil Sands Corp., Canadian Natural Resources Ltd., Canadian Oil Sands Ltd., Cenovus Energy Inc., Enbridge Inc., Nexen Inc., Royal Dutch Shell PLC, Suncor Energy Inc., and Teck Resources Ltd.

Related Links

Canadian ethical, environmental and social funds – lists and links to funds.

Community Foundations of Canada Resources: Community Foundations & Responsible Investing – socially responsible investing tips for people working within foundations.

OSQAR, 2012. Are socially responsible investors good for oil sands?. Oil Sands Question and Response, Suncor Energy Inc. October 17, 2012.

Social Funds – site has a wide range of information.

Social Investment Organization – site of the Canadian Association for Socially Responsible Investment

Socially Responsible Investing – site has a variety of information and reports.

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Oil Sands Pipelines – Beyond Gateway and Keystone – *August 4, 2011*

With all the media coverage of the Enbridge Northern Gateway Pipeline and TransCanada Keystone Pipeline expansion one could forget that there are a number of existing and proposed pipeline projects supporting oil sands development. The links below will give you a sense for some of the existing and proposed pipeline routes and the companies that operate them.

Related Links

Alberta Energy – Oil pipelines map

Canadian Energy Pipeline Association – an overview of pipelines, map of existing, proposed and under construction pipelines

Access Pipeline Inc. operates the Access Pipeline from the MEG and Devon in-situ facilities near Conklin, Alberta to Edmonton.

Enbridge Inc. operates:

- Athabasca Pipeline from Fort McMurray, Alberta to Hardisty, Alberta
- Waupisoo Pipeline from the Cheecham Terminal south of Fort McMurray to Edmonton, Alberta
- Alberta Clipper from Hardisty to Superior, Wisconsin
- Southern Lights (diluent) Project from Chicago, Illinois to Edmonton

Enbridge is also developing:

- Christina Lake Lateral from the Cenovus Christina Lake in-situ site to the Kirby lake Terminal
- Norealis Pipeline from the Husky Sunrise in-situ site to the Cheecham Terminal
- Woodland Pipeline from the Kearl Mine to the Cheecham terminal
- Wood Buffalo Pipeline from the Athabasca Terminal to the Cheecham terminal

Interpipeline Fund operates the Corridor Pipeline from the Athabasca Oil Sands Project in Fort McMurray to the Scotford Upgrader near Edmonton, and the Cold Lake Pipeline from Cold Lake, Alberta to Edmonton and Hardisty.

Kinder Morgan Canada operates the Trans Mountain Pipeline from Edmonton, to Vancouver, British Columbia.

Pembina Pipeline Corporation operates the Syncrude Pipeline and Horizon Pipeline from Fort McMurray to Edmonton.

Spectra Energy operates the Express Pipeline from Hardisty to Casper, Wyoming.

TransCanada operates the Keystone Pipeline from Hardisty to Wood River and Patoka, Illinois and Cushing, Oklahoma (see map).

Williams Companies Inc. has proposed the Boreal Pipeline from Suncor in Fort McMurray to Redwater, Alberta.

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Oil Sands Sample Bank – *September 14, 2011*

Alberta Innovates – Technology Futures provides oil sands samples to people interested in testing the materials, for example in new processes or technologies. The samples come from any one of several participating oil sands producers with no attribution to the particular source. Samples are provided in 10L or 20L pails, unhomogenized in one of three grades: low (~8% bitumen), medium (~10%), or high (~13%). The website below provides an order form and the costs for each 10L of sample.

Alberta Innovates – Technology Futures is also providing mature fine tailings samples.

Further information is available on the website below or from oilsands.samplebank@albertainnovates.ca

Related Links

Oil Sands and Mature Fine Tailings Sample Bank

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2009 NPRI Tailings and Waste Rock Data – *October 5, 2011*

In 2009, Environment Canada established new reporting requirements retroactive to 2006 for the reporting of substances disposed of in tailings and waste rock to the National Pollutant Release Inventory (NPRI). These new requirements resulted from a judicial review of the NPRI program. They require that mining and other facilities must also report the quantities and concentrations of substances disposed of in tailings and waste rock management areas.

In 2009, 94 mining and processing facilities in Canada (including 5 oil sands mines) reported their disposals to tailings and waste rock. The chart shows the amounts (in tonnes) of reported substances for the various types of mining and processing facilities in 2009; oil sands tailings comprised 9% of the total substances reported. By mass, the substances in oil sands tailings were 2% heavy metals, 60% other metals, 27% nutrients and less than 1% PAHs. However, the PAHs from oil sands mines accounted for over 90% of the PAHs in tailings reported by all facilities.

In 2009, tailings and waste rock comprised 8.5% of the total substances reported to NPRI (release of criteria contaminants to air form the largest component of the substances reported). The amounts of substances in tailings and waste rock reported from 2006 to 2009 changed very little.

Related Links

NPRI – Overview of Tailings and Waste Rock Data Reported to the NPRI for 2009

CNRL report – NPRI ID 23275

Shell Muskeg River and Jackpine report – NPRI ID 6647

Suncor report – NPRI ID 2230

Syncrude Aurora report – NPRI ID 6572

Syncrude Mildred Lake report – NPRI ID 2274

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Fort McKay First Nation Oil Sands – *November 3, 2011*

In 2004, Fort McKay First Nation received additional reserve land that contains mineable oil sands deposits. The government of Canada implemented a regulatory regime in November 2005 under the First Nations Commercial and Industrial Development Act (FNCIDA) that will allow the Fort McKay First Nation to undertake commercial development of their oil sands deposits. The Act provides the authority for the government to develop specific regulations at the request of a First Nation to enable a governance regime for resource development and environmental protection. The 2007 Fort McKay First Nation Oil Sands Regulations provide the specific governance regime for future oil sands development. The Regulations provide for the laws of Alberta to apply to any proposed oil sands development on the Fort McKay lands, with adaptations to the laws specified in the Regulations.

No applications have been made to develop these oil sands lands.

Related Links

Fort McKay First Nation

Fort McKay First Nation Celebrates Treaty Land Entitlement

Fort McKay First Nation Oil Sands Project One Step Closer To Realization

First Nations Commercial and Industrial Development Act (FNCIDA)

Backgrounder on FNCIDA

Fort McKay First Nation Oil Sands Regulations

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Fee Lots – Mineable Oil Sands on Private Land – *November 4, 2011*

There are six small rectangular blocks of land in the Fort McMurray area that are artifacts of the Dominion government's early 1900's efforts to entice exploration for the "Athabaska" bituminous sands (see map in Related Links). These Fee Lots are privately owned lands tucked in amongst the surrounding Crown land. Five of the lots are on the east side of the Athabasca River and one on the west side, stretching from just north of Fort McMurray to the Steepbank River. Originally purchased in the period from 1906 to 1910, they have been owned by Suncor Energy Inc. since 1995 (see the figure showing the December 15, 1912 survey of Fee Lot 1 for the Athabaska Oil & Ashpaltum Co.).

Besides being of historical interest, why is this important? Assuming the lands are ultimately developed for oil sands extraction, three things make the regulatory process for these Fee Lots different because the land is private (Suncor is the land owner) not Crown land.

Under Alberta's Environmental Protection and Enhancement Act and the Conservation and Reclamation Regulation the landowner and the company are given the opportunity to attend the reclamation inquiry held to determine if a reclamation certificate should be issued. For the Fee Lots, Suncor, not Alberta Sustainable Resource Development, would be invited to attend the inquiry as land owner.

Secondly, when the land is certified, it would be returned to Suncor for subsequent use or disposition.

Finally, Suncor, as land owner, would normally be given an opportunity to help shape the reclamation objectives for his/her land.

Related Links

Fee Lots map - provided courtesy of Suncor Energy Inc.

Fee Lot 1 survey map - provided courtesy of Suncor Energy Inc.

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More to Oil Grades than WTI – *November 17, 2011*

West Texas Intermediate (WTI) is the most commonly cited North American oil price and the one we see most often on the news and in the paper (WTI is quoted in US$ based at Cushing, Oklahoma). However there are also Canadian oil and bitumen grades (see the Canadian Crude Quick Reference Guide from Crude Quality Inc. for some examples). Brent Crude is also being talked about a lot these days because Brent prices have been quite a bit higher than WTI meaning Alberta could be making more money if it could get its oil and bitumen off shore.

Natural Resources Canada (NRCan), in their 2011 report Canadian Crude Oil, Natural Gas and Petroleum Products: Review of 2009 & Outlook to 2030 (page 9), noted that Edmonton Par and Western Canadian Select are benchmark crudes for the Canadian market. These crudes are priced in US$ based at the US upper mid-west market, adjusted for quality and transportation from Hardisty, Alberta or Edmonton (see National Energy Board). Synthetic Crude Oil (SCO) is a generic term for the upgraded bitumen produced from Syncrude, Suncor and Canadian Natural Resources.

As noted in the NRCan report, Western Canadian Select trades at a discount to WTI because it is a sour crude blend that requires more time and energy to refine. The spread between these prices has varied over the years, influencing the economics of oil sands developments. A wide spread between the price of bitumen and SCO helps determine the economics of upgrading bitumen in Alberta.

The Energy Resources Conservation Board's ST-3 report (Alberta Energy Resource Industries Monthly Statistics) provides price data on a $/cubic metre basis (1 cubic metre = 6.2898 barrels) for crude oil – heavy, crude oil – light & medium and for crude bitumen.

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Agricultural Species for Forested Reclamation? – *December 20, 2011*

If Alberta Environment and Water operating approvals for oil sands mines require revegetation "to target the establishment of self-sustaining, locally common boreal forest ecosystems, integrated with the surrounding area", why are barley or oats planted first? Because these species are planted as a cover crop or a nurse crop to help minimize erosion, add organic matter to the soil, and provide moisture retention and protection for planted tree and shrub seedlings. Agricultural species are used because they are readily available, easy to plant, quick to grow and only last one season. The latter feature is important to ensure the desired native species will develop.

Early oil sands reclamation efforts, especially on tailings dyke slopes, focused on establishment of a dense grass-legume mixture to prevent erosion with the intent of later planting trees. However it was soon discovered that the dense cover restricted development of trees and also provided cover for small mammals which chewed up planted trees. Cover crops provide the desired benefits without these drawbacks.

Related Links

Barley. Oregon State University Fact Sheet.

Oats. Cornell University Cover Crop Fact Sheet Series. Fact Sheet 10.

Renault, S., M. MacKinnon and C. Qualizza, 2003. Barley, a potential species for initial reclamation of saline composite tailings of oil sands. Journal of Environmental Quality 32(6): 2245-2253.

Wallace, V., n.d. Temporary grasses stabilize soil. Grounds Maintenance.

Woosaree, J. and M. Hiltz, 2011. Cover Crop Program for Tailings Sand Stabilization. Prepared for Suncor Energy Inc. by Alberta Innovates – Technology Futures.

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Range of Natural Variability – *January 5, 2012*

Alberta Environment and Water's operating approvals for oil sands mines:

- require reclamation "so that the reclaimed soils and landforms are capable of supporting self-sustaining, locally common boreal forest ecosystems, regardless of the end land use";
- require revegetation "to target the establishment of self-sustaining, locally common boreal forest ecosystems, integrated with the surrounding area"; and,
- provide guidance on the factors that should be considered when developing a mine reclamation plan.

If you have ever walked through the boreal forest you will know that it is not uniform – it is a complex and changing mixture of landforms, soils, vegetation and water bodies. Ecologists and natural resource managers use the term range of natural variability to recognize that the environment and its characteristics vary in space and time. Variations outside the expected range may indicate a problem. In a reclamation context, this problem can be fixed (for example, replanting desired species or removing undesired ones; or by increasing or decreasing water levels) or accepted by resetting the goal for an area to another acceptable goal whose normal range matches the site conditions (for example, changing the goal from a commercial forest to forested wildlife habitat).

The range of natural variability concept is important to oil sands mine reclamation for three key reasons:

- When companies create their mine reclamation plans they will base reclamation strategies on a specific goal such as an ecosite type (for example, a d3 white spruce forest). That ecosite type is defined by a number of characteristics (such as soil type, hydrologic regime, vegetation, etc.), each of which has a range of natural variability. The reclamation plan should aim to hit each of these characteristics somewhere in their range of natural variability, not target a precise number or value. It should be noted that current reclamation practices are influenced by a number of decisions about how the temporal and spatial aspects of the range of natural variability should be considered, including basing goals on:
    - a pre-disturbance survey of existing site conditions – these conditions might have been very different, and therefore the goals very different, had the survey been done at a different time. A prime example of this occurred last year when wildfires swept through the CNRL Horizon site and changed site conditions.
    - current conditions, not potential future conditions (e.g., vegetation influenced by climate change).
    - returning the range of ecosites found on the mine site rather than the range of ecosites found in the region.

- Reclamation certification requirements should be designed to recognize and accept that a range of characteristics will be evident on a reclaimed site. In reality, the ultimate character of a site is determined by the interplay of all of the individual characteristics and some characteristics are more important than others – thus reclamation outside the normal range of some parameters may still be successful but not for others.
- Once a reclaimed site is built it should be expected to perform more or less the same way as equivalent undisturbed areas in the region which will often exhibit a range of responses to various events (e.g., drought, heavy rainfall, fire).

What is evident from this is that reclamation is not like a cookbook recipe with very specific ingredient measures – it is more like grandma's recipe, a pinch of this and a dash of that. And like grandma's baking, the cookies in a batch will not all be the same and will not be the same from batch to batch. That's not good or bad, just reality.

There is considerable work going on in the Cumulative Environmental Management Association to help define the range of natural variability for "self-sustaining, locally common boreal forest ecosystems", the reclamation methods that will get us there, and the tools needed to determine if the reclamation was successful. Stay tuned as the story evolves.

Thanks to Justin Straker, Integral Ecology Group and Dr. Anne Naeth, University of Alberta for advice.

Related Links

Definitions and explanations for Range of Natural Variability (also known as range of natural variation):

- The temporal and spatial distribution of ecological processes and structures – Wong, C. and K. Iverson, 2004. Range of natural variability: Applying the concept to forest management in central British Columbia. BC Journal of Ecosystems and Management 4(1).
- The ecological conditions, and the spatial and temporal variation in these conditions, that are relatively unaffected by people, within a period of time and geographical area appropriate to an expressed goal – Landres, P.B., P. Morgan and F.J. Swanson, 1999. Overview of the Use of Natural Variability Concepts in Managing Ecological Systems. Ecological Applications 94(4): 1179-1188.
- The physical and biological conditions of ecosystems fluctuate and the degree and range in which they vary under natural conditions depends on disturbances, such as climate, fire, and flooding. Over time, plant and animal species adapt to these conditions and are able to tolerate disturbances within this range. – US National Parks Service. Bandelier National Monument.

- Ecosystems are naturally dynamic and native species have adapted to disturbance-driven fluctuations in their habitats. Therefore, the potential for survival of any given species may diminish if temporal and spatial patterns of species' habitats shift outside their natural range of variation. In other words, contemporary anthropogenic change may diminish the viability of many species adapted to past or historical conditions and processes. – McGarigal, K. Range of variability concepts. University of Massachusetts teaching materials.
- The working definition uses range of natural variability to acknowledge that "healthy" is typically a range of condition, as opposed to an absolute condition. Ecosystems are naturally dynamic within a certain range over space and time. The ecological structure and functions are influenced by the current environment as well as past environmental fluctuations and disturbances. Ecosystems are always responding to past changes, including relatively predictable daily and seasonal variation, less predictable changes in weather, and other disturbances (e.g. fire, insect outbreaks, etc.). The working definition of healthy aquatic ecosystems depicts the components of an aquatic system operating within its range of natural variation. – Alberta Water Council, 2008. Healthy aquatic ecosystems – a working definition.

Environmental Protection and Enhancement Act approval for Construction, operation and reclamation of the Joslyn North Oil Sands Processing Plant and associated Mines - See clauses 6.2.1, 6.2.2 and 6.2.8

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Monitoring Terminology – *February 13, 2012*

The recent announcement of the federal-provincial implementation plan for oil sands monitoring brings a suite of monitoring terminology to learn. A sampling of key terms is provided below:

Accuracy – The closeness of a measured or computed value to its true value.

Ambient monitoring – All forms of monitoring conducted beyond the immediate influence of a discharge source and may include sampling of sediments and living resources.

Background – An area not influenced by chemicals released from the site under evaluation or other impacts created by the activity on the site under evaluation.

Biomonitoring (Biological Monitoring) – Systematic determination of the effects on organisms as a result of changes to an ecosystem. Often done to determine the effects of a pollutant release.

Calibration – Statistical transformation of a variable to correct for scale or bias, or otherwise to impose the properties of another variable.

Confidence interval – An interval defined by two values, called confidence limits, calculated from sample data using a procedure which ensures that the unknown true value of the quantity of interest falls between such calculated values in a specified percentage of samples. Commonly, the specified percentage is 95%; the resulting confidence interval is then called a 95% confidence interval.

Contaminant – A general term referring to any chemical compound added to a receiving environment in excess of natural conditions. The term includes chemicals or effects not generally regarded as "toxic", such as nutrients, salts and colour.

Continuous monitoring – Continuous monitors take measurements continuously. One minute, five minute, and one hour averages are calculated by regularly sampling (once per second or more often) the output of the monitor.

Data quality – The totality of features and characteristics of data that bears on their ability to satisfy a given purpose.

Detection Limit – The lowest concentration at which individual measurement results for a specific analyte are statistically different from a blank (that may be zero) with a specified confidence level for a given method and representative matrix.

Fixed-station monitoring – The repeated long-term sampling or measurement of parameters at representative points for the purpose of determining environmental quality characteristics and trends (for example the WBEA air monitoring stations).

Grab sample – samples taken of a homogenous material such as water in a single vessel.

Metadata – Information that describes the content, quality, condition, and other characteristics of data.

Monitoring – A scientifically designed system of long-term, standardized measurements and systematic observations to assist in timely decision making, ensure accountability and provide the basis for evaluation and learning.

- Compliance monitoring – The monitoring of variables required for regulatory compliance.
- Effects-based monitoring – Monitoring activities undertaken to determine the status or trend of specific environmental attributes or indicators that reflect the current state of the environment.
- Investigative monitoring – Short-term monitoring of selected variables for specific purposes (e.g., test a scientific hypothesis).

Natural variability – The seasonal and long-term fluctuations of the presence, quantity, and quality of physical, hydrological, biological, or chemical attributes within a landscape or ecological unit that are not associated with human-related activities.

Nonpoint-source pollution – A contributory factor to water pollution that cannot be traced to a specific spot; for example, pollution that results from water runoff from urban areas, construction sites, agricultural and silvicultural operations, and so forth.

Passive monitoring – Passive monitors simply absorb a pollutant over a time interval that may be several weeks long. Analysis of the passive monitor will indicate an average concentration for the entire time period.

Peer review – Written, critical response provided by scientists and other technically qualified participants.

Point-source pollution – Pollution discharged through a pipe or stack or some other discrete source, for example from an industrial plant.

Precision – The closeness of repeated measurements of the same quantity.

QA/QC – Quality Assurance/Quality Control. A system of procedures, checks, audits, and corrective actions to ensure that all EPA research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

Remote Sensing – Measurement of some property of an object or surface by means other than direct contact. Usually refers to the gathering of scientific information about the earth's surface from great heights and over broad areas, using instruments mounted on aircraft or satellites.

Sample – a limited quantity of something which is intended to be similar to and represent a larger amount of that thing.

Sampling – The act of collecting a sample.

Toxic – A substance, dose or concentration that is harmful to a living organism.

Related Links

National Water Quality Monitoring Council – Glossary

OSRIN, 2010. *Glossary of Terms and Acronyms used in Oil Sands Mining, Processing and Environmental Management - December 2013 Update*. OSRIN Report No. SR-1. 123 pp.

US EPA Environmental Monitoring & Assessment Program – Glossary

Wikipedia – Environmental monitoring

Wood Buffalo Environmental Association – Glossary

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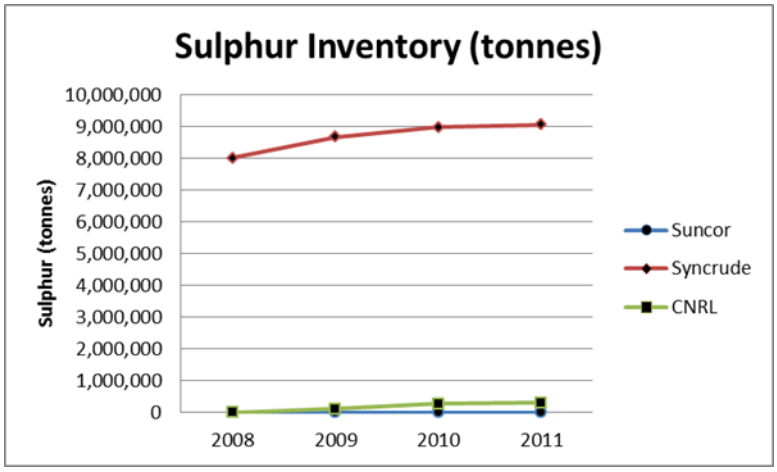
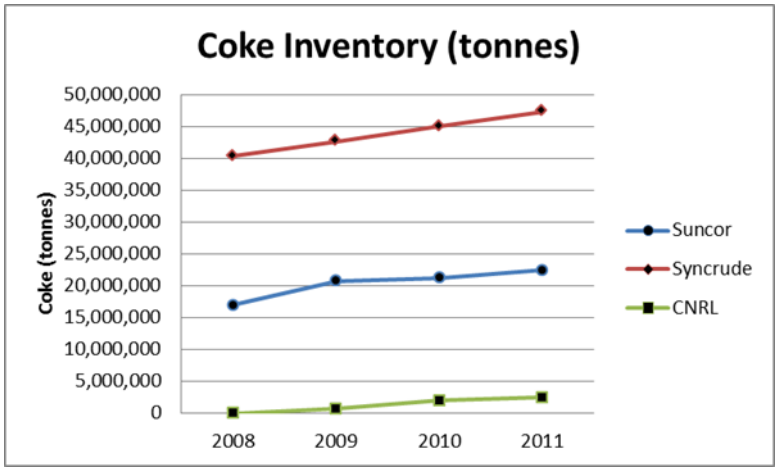
Sulphur and Coke Inventories – *June 21, 2012*

The May 9, 2012 edition of OSQAR discusses sulphur and coke, which are by-products of oil sands processing. The article gives an indication of the amounts produced and some of the uses for each by-product but doesn't indicate the amounts stored on-site.

The Alberta Energy regulator (AER) requires companies to report their production, consumption, sale and inventories of a variety of oil sands feedstock, products and by-products, including sulphur and coke. Click here to see the on-site inventories of the two by-products at the Syncrude Mildred Lake, Suncor and CNRL Horizon sites taken from the closing inventory data in the AER's 2008 to 2011 ST39 reports.

Sulphur Inventory (tonnes)				
	2008	2009	2010	2011
Suncor	2,562	1,458	1,588	1,024
Syncrude	8,007,028	8,679,124	8,979,994	9,065,912
CNRL	0	117,407	282,104	306,585
Coke Inventory (tonnes)				
	2008	2009	2010	2011
Suncor	16,984,521	20,803,196	21,305,272	22,460,826
Syncrude	40,377,356	42,757,648	45,098,113	47,437,524
CNRL	0	747,012	2,002,580	2,471,789





Some things to note when looking at the data:

- The closing inventory numbers reflect production (increases), and sale and on-site use (decreases) at the end of each calendar year
- The inventory may be in one or more visible stockpiles (the most obvious being the large sulphur blocks at Mildred Lake) or, in the case of coke, may be deposited in tailings ponds (e.g., Mildred Lake) or may be used in reclamation (e.g., Suncor)
- The Syncrude Aurora mine bitumen is processed at the Mildred Lake facility
- Shell's mines process bitumen at the Scotford refinery near Edmonton and therefore do not have these by-products stockpiled at the mine sites
- CNRL started reporting sulphur and coke volumes in 2009
- The sulphur numbers show different historical approach's taken by Syncrude and Suncor to managing sulphur

Related Links

Alberta Energy Regulator – ST39: Alberta Mineable Oil Sands Plant Statistics Monthly Supplement

Johnson, R., 2012. These mountains of sulfur growing in the oil sands are only getting bigger. Business Insider.

OSQAR (May 9, 2012) – Have you met bitumen's step-sisters?

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Fish Habitat Compensation Lakes – *July 30, 2012*

Under the federal Department of Fisheries and Oceans' no net loss policy, recent oil sands mine projects have been proposing lakes as compensation for loss of fish habitat. The Practitioners Guide to Habitat Compensation indicates that compensation should aim for greater than a 1:1 compensation ratio; recent oil sands regulatory approvals have required a ratio of 2:1 (see for example, s. 6.4.3 in Total Joslyn North Joint Review Panel Report).

Several oil sands compensation lakes have been built, are being built or are proposed, including Canadian Natural's Horizon Lake, Imperial Kearl (three lakes), Shell Jackpine, Teck Frontier, and Total Joslyn North.

Compensation lakes may be constructed in one of three ways: excavate a pit and fill with water, excavate (expand) an existing lake or stream, or dam an existing stream. It is interesting that all of these methods result in additional disturbance of boreal forest habitat.

Although the focus of this note is on compensation lakes it is worth noting that other forms of compensation are also acceptable including building new streams or enhancing existing ones. It is also important to note that, in addition to the compensation lakes which supply immediate replacement of fish habitat, current mine reclamation plans include development of over 25 pit lakes in the region that may eventually supply additional fish habitat for the region.

Definitions

Compensation for Loss – The replacement of natural habitat, increase in the productivity of existing habitat, or maintenance of fish production by artificial means in circumstances dictated by social and economic conditions, where mitigation techniques and other measures are not adequate to maintain habitats for Canada's fisheries resources.

Harmful Alteration, Disruption or Destruction (HADD) – Any change in fish habitat that reduces its capacity to support one or more life processes of fish. Prohibited by the *Fisheries Act* unless authorized by DFO under subsection 35(2) of the *Fisheries Act*.

No Net Loss – A working principle by which the Department of Fisheries and Oceans strives to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented.

Related Links

Canadian Association of Petroleum Producers – Horizon Oil Sands Compensation Lake – 2009 Steward of Excellence Recipient

Fisheries and Oceans Canada. The Department of Fisheries and Oceans Policy for the Management of Fish Habitat.

Fisheries and Oceans Canada. Practitioners Guide to Habitat Compensation.

Regional Aquatics Monitoring Program. No Net Loss of Fish Habitat.

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Diluent and Dilbit – *August 14, 2012*

Bitumen needs to be diluted so it can flow in pipelines to market; the resulting product is called dilbit. Natural gas condensate (the diluent), especially the naphtha portion, is commonly used to dilute bitumen. CRW, an Enbridge Condensate Stream, is a mix of condensate streams from a variety of sources that is a common diluent. Where there are inadequate condensate supplies shippers can use refined naphtha or synthetic crude oil (SCO – in this case the product is called synbit).

Once the dilbit is received at the upgrader/refinery the diluent can be removed and sent back for re-use. Some dilbit pipelines have a return flow pipeline devoted to shipping diluent back to the bitumen production source; for example the proposed Northern Gateway pipeline would have a 36 inch petroleum products line flowing west for export and a 20 inch condensate line flowing east. Similarly Enbridge ships condensate from Chicago through to Edmonton in the Southern Lights pipeline.

Concerns have been raised by environmental groups that dilbit is more corrosive than conventional or synthetic crude oil, thus increasing the risk of pipeline spills. A study by Alberta Innovates – Technology Futures indicated that the characteristics of dilbit are not unique and are comparable to conventional crude oils, though they did recommend further studies and separate public reporting on dilbit and conventional crude oil pipelines.

Related Links

Canadian Association of Petroleum Producers – Canadian condensate production – 1950 - 2012

Interest spurs potential for larger condensate system. airwaterland, JuneWarren Nickles, August 29, 2005.

OSQAR, 2012. Pipeline opponent claims corrode the facts. Oil Sands Question and Response, Suncor Energy Inc. October 24, 2012.

US Transportation Research Board - Study of Pipeline Transportation of Diluted Bitumen

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Heavy Oil vs. Bitumen – *August 29, 2012*

There are a variety of classification schemes for oil, most based on API gravity (the density of liquid petroleum products – measured in degrees with a high number being lighter oil and a low number being heavier). According to the Centre for Energy

- heavy oil has an API gravity of less than 22.3o; it includes some oil that will flow, however slowly, but most heavy oil requires heat or dilution to flow to a well or through a pipeline.
- bitumen (oil sand) is a solid or semi-solid petroleum that has an API gravity of less than 10o and cannot be pumped without being heated or diluted.

The *Environmental Protection and Enhancement Act* (s. 1(ss)) defines heavy oil as *a naturally occurring viscous mixture, **other than crude bitumen**, that consists mainly of hydrocarbons heavier than pentane, that may contain sulphur compounds and that in its naturally occurring state has a density of more than 920 kilograms per cubic metre*, which works out to an API of approximately 22 ^{o}.

Heavy oil can be produced using conventional cold production (with or without enhanced recovery techniques like water, solvent, and gas injection) or with heat (steam or hot water). Bitumen from wells is produced almost exclusively with heat although other processes are being field-tested (heat is also required for extraction in mining operations).

Interesting fact – heavy oil sites and thermal in-situ bitumen production sites are sometimes found in close proximity and both can require extensive well fields to extract the resource. However, under the *Environmental Protection and Enhancement Act* only thermal operations producing more than 2,000 cubic metres of bitumen or its derivatives per day require a provincial environmental impact assessment (see Schedule 1(j)).

Examples of heavy oil operations in Alberta include: Cenovus Pelican Lake, Canadian Natural Resources Pelican Lake, Murphy Oil Seal

Examples of thermal in-situ bitumen production in Alberta include: Cenovus Christina Lake and Foster Creek, Suncor Firebag and McKay River, Devon Canada Jackfish

Related Links

Alberta Energy Regulator – In-situ Performance Presentations

Alberta Energy – Oil Sands Projects

Canadian Heavy Oil Association

Centre for Energy – Energy Glossary

In-situ Oil Sands Alliance

Schlumberger – Heavy Oil Recovery Methods

Veil, J.A. and J.J. Quinn, 2008. Water issues associated with heavy oil production. Argonne National Laboratory, Environmental Science Division, Argonne, Illinois. Report No. ANL/EVS/R-08/4. 60 pp.

Wikipedia – API gravity

Wikipedia – heavy crude oil

Wikipedia – oil sands

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Early Oil Sands Characterization Work – *October 4, 2012*

With all the current media attention on oil sands developments one could easily forget that interest in the oil sands started almost a century ago. Four recent additions to the Oil Sands Environmental Management Bibliography from the Canada Department of Mines (a precursor to today's Natural Resources Canada) and the Scientific and Industrial Research Council of Alberta (a precursor to the Alberta Research Council/Alberta Innovates – Technology Futures) provide evidence of this.

Given the current issues being raised, here are some interesting quotes from the reports:

The three outstanding features presented by a consideration of the bituminous sands of northern Alberta are (Ells 1926):

1. That the deposit represents the largest known body of solid asphaltic material.
2. That the deposit is, as yet (April, 1925) commercially undeveloped.
3. That practically all asphaltic materials used in Canada are imported from foreign sources.

While, however, much of the areal geology of northern Alberta is known, there is, at the present time, very little definite information available, official or otherwise, with regard to the extent and actual value of the mineral resources of this area (Ells 1914).

… it is but reasonable that a department of the Federal Government should undertake the initial work, since the greater part of that area is held under Government reserve (Ells 1926).

The commercial development of the bituminous sands in northern Alberta concerns the province of Alberta more closely than any other part of the Dominion. For this reason it was natural that an investigation of the bituminous sands was included as a major item of the program of the Scientific and Industrial Research Council of Alberta (Clark and Blair 1927).

Up to the present time no development work has been undertaken, nor has any effort been made to "prove up" any of the outcrops of bituminous sands in the McMurray district (Ells 1914).

Work undertaken by the Mines Branch, Department of Mines, has included topographic surveys of extensive areas, examination and sampling of the principal outcrops, the mining of trial shipments, laying of demonstration pavements, and a study of methods adapted to the recovery of bitumen from the crude bituminous sands (Ells 1924).

There is a reasonable probability that conditions will eventually permit of a considerable commercial development of the Alberta deposit. Assuming this to be so, it is of importance to determine how this development can best be undertaken and an industry established on a sound economic basis (Ells 1926).

Should present conditions not favour the immediate commercial development of the deposit of bituminous sand in northern Alberta, it appears unwise to artificially stimulate such development. It is improbable that the potential value of these deposits, as a national asset, will decrease (Ells 1926).

Three main possibilities for the utilization of the bituminous sands have been considered: first, utilization of raw sands for pavements and kindred objects; second, utilization of separated bitumen in road construction; third, utilization of the bitumen as a source of petroleum products. Because of the economic conditions within the province and the many other possible sources of petroleum products, the second of these appeared to be of most immediate significance (Clark and Blair 1927).

The bituminous sands of Alberta, heretofore commonly referred to as "tar sands", … (Ells 1914).

For many years, the occurrence of so called "tar springs" or seepages of bitumen has been recognized throughout the area under discussion. The writer is familiar with upwards of 40 such springs … (Ells 1924).

Related Links

Clark, K.A. and S.M. Blair, 1927. The bituminous sands of Alberta: Part I - Occurrence, Part II - Separation of bitumen from sand, Part III - Utilization. Scientific and Industrial Research Council of Alberta, Edmonton, Alberta. Report No. 18. Various pagings.

Ells, S.C., 1914. Preliminary report on the bituminous sands of northern Alberta. Canada Department of Mines, Mines Branch, Ottawa, Ontario. Report No. 281. 92 pp. plus figures.

Ells, S.C., 1924. Bituminous sands of northern Alberta. Canada Department of Mines, Mines Branch, Ottawa, Ontario. Report No. 625. 35 pp.

Ells, S.C., 1926. Bituminous sands of northern Alberta: Occurrence and economic possibilities. Report on investigations to the end of 1924. Canada Department of Mines, Mines Branch, Ottawa, Ontario. Report No. 632. 244 pp.

Oil Sands Environmental Management Bibliography

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Not Your Old Fashioned Letters to the Editor – *October 15, 2012*

One of the benefits of the current digital news media is that we no longer have to wait a day or two for a few Letters to the Editor to appear – they are now posted online almost immediately and in significantly greater numbers. Two recent stories we added to the website provide good examples:

> Study finds little environmental impact from oil sands – 1,209 comments (as of October 15) on an October 8, 2012 Globe and Mail story reporting on a University of Waterloo water quality study funded by Suncor.
>
> Ambitious plans for oil sands would create lakes from waste – 539 comments (as of October 15) on an October 3, 2012 Globe and Mail article reporting on the release of the Cumulative Environmental Management Association's new end pit lake guidance document. Interestingly, the Edmonton Journal version of the story only has 10 comments.

Given human nature, it is no surprise that the focus of these submissions is generally a negative take on the story or the story actors. However, it is still instructive to skim through the comments, if only to get a better sense for how certain segments of the population see oil sands development, and by extension, Alberta, government and industry.

OSRIN's mandate is to provide a source of balanced information so you can develop an informed opinion about oil sands development. Therefore we encourage you to read not just the newspaper articles we provide you on a daily basis but the associated reader comments as well.

> **NOTE**: comments on the two stories mentioned in the original posting are no longer available online. See our January 25, 2013 posting on Losing Oil Sands Voices for a discussion on the loss of media content over time.

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Oil Sands Environmental Assessment Triggers – *November 16, 2012*

The recent release of the Canadian Environmental Assessment Act, 2012 and its regulations provides an opportunity to compare federal and provincial triggers for oil sands environmental assessments.

The provincial regulatory system provides a list of activities that require mandatory environmental assessment and a list of activities that are exempt from assessment (unless the Minister orders an assessment). Any other project not listed in the Regulation may require an environmental assessment if, after a screening the Director determines an environmental assessment is required, or if so ordered by the Minister.

The federal regulatory system provides a list of Physical Activities which would be subject to a screening by federal authorities; the screening may lead to a decision to require an assessment. Two other lists are provided, one for projects linked to the Canadian Nuclear Safety Commission and one to the National Energy Board. The activities under these latter two lists require a mandatory assessment.

The following table shows the different triggers for provincial and federal assessments for oil sands related projects (up to date as of October 31, 2012 according to the CEAA website). The blank sections in the Provincial column indicate projects that may be subject to a discretionary environmental assessment. This is intended to provide an overview of the rules and should not be relied upon as an exhaustive or complete review of either the provincial or federal regulatory requirements. Interested parties should follow up with the appropriate regulatory authority to confirm requirements for a specific project.

Provincial	Federal
The construction, operation or reclamation of (j) a commercial oil sands, heavy oil extraction, upgrading or processing plant producing more than 2000 cubic metres of crude bitumen or its derivatives per day;	9. The construction, operation, decommissioning and abandonment of (a) A heavy oil or oil sands processing facility with an oil production capacity of more than 10 000 m^3/d;
The construction, operation or reclamation of (i) an oil sands mine;	9. The construction, operation, decommissioning and abandonment of (b) An oil sands mine with a bitumen production capacity of more than 10 000 m^3/d
	12. The expansion of a heavy oil or oil sands processing facility that would result in an increase in oil production capacity that would exceed 5 000 m^3/d and would raise the total oil production to more than 10 000 m^3/d.

Provincial	Federal
The construction, operation or reclamation of (n) an oil refinery; (j) a commercial oil sands, heavy oil extraction, upgrading or processing plant producing more than 2000 cubic metres of crude bitumen or its derivatives per day;	13. The construction, decommissioning and abandonment, or expansion that would result in an increase in production capacity of more than 35%, of (a) an oil refinery, including a heavy oil upgrader, with a capacity of more than 10 000 m^3/d;
	13. The construction, decommissioning and abandonment, or expansion that would result in an increase in production capacity of more than 35%, of (e) a petroleum storage facility with a capacity of more than 500 000 m^3;
	14. The construction, operation, decommissioning and abandonment of (a) an oil and gas pipeline more than 75 km in length on a new right of way;
	8. The construction, operation, decommissioning and abandonment of a facility for the extraction of 200 000 m^3/a or more of ground water or an expansion of such a facility that would result in an increase in production capacity of more than 35%.
National Energy Board Projects (project must cross a provincial or national boundary; automatic environmental assessment)	
	37. The construction, operation, decommissioning and abandonment, or expansion that would result in an increase in production capacity of more than 35%, of (b) A petroleum storage facility with a capacity of more than 500 000 m^3
	38. The construction, operation, decommissioning and abandonment of (a) an oil and gas pipeline more than 75 km in length on a new right of way;

NOTE: The Regulations Designating Physical Activities were subsequently updated in October 2013; the link below contains the revised list. Notably the list no longer includes in-situ operations (s. 9(a) and 12 in the table above).

Related Links

Canadian Environmental Assessment Act, 2012 (federal)

Regulations Designating Physical Activities (federal)

Canadian Environmental Assessment Agency website

Environmental Assessment (Mandatory and Exempted Activities) Regulation (provincial)

Alberta Environment and Sustainable Resource Development Environmental Assessment website

National Energy Board – FAQs on Environmental Assessments - link no longer available

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Current and Potential Oil Sands Projects – *January 8, 2013*

The list of oil sands projects that are active, under development and proposed continues to grow at a rapid pace. There are several ways to keep track of these projects:

- Alberta Energy – Alberta's Oil Sands Projects
- Alberta Environment and Sustainable Resource Development – Environmental Assessments / EIAs
- Alberta Environment and Sustainable Resources Development – Oil Sands Information Portal
- Canadian Environmental Assessment Agency
- Alberta Energy Regulator – Scheme Approval Area Map Viewer
- Government of Alberta – Oil Sands Quarterly
- National Energy Board (NEB) – Major Applications and Projects
- Oilsands Review – Canadian Oilsands Navigator (maps, charts and project list)
- Strategy West Inc. – Canada's Oil Sands

Please let us know if there are other sources!

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Losing Oil Sands Voices – *January 25, 2013*

One of OSRIN's mandates is to provide people with unbiased information about oil sands development. One of the ways we accomplish this has been keeping you up to date on current events since April 2010 by posting reports from a variety of media sources on our What's New web page. Our original vision was that the archived stories would provide you the opportunity to track changes in the type of issues and how they are reported over time.

However, two media practices are reducing our ability to meet our original vision:

- Some media outlets are starting to charge for online access to content or are restricting the number of articles a person can read for free
- Some media outlets are not retaining archived versions of stories (if you look at the older stories in the What's New Archives you will see many articles with the note link no longer available – see this story for example). Unfortunately the most frequent media outlets you will see this note for are the Edmonton Journal and Calgary Herald, arguably the most relevant local sources for oil sands media stories. On the other hand, credit goes to the Globe and Mail, Sun Media, Fort McMurray Today, CBC News, CTV News, and several smaller newspapers for retaining stories.

Another problem hindering our ability to provide accurate historical information is URLs changing when organizations or companies revise their web sites. Examples include revisions to both the Energy Resources Conservation Board and Cumulative Environmental Management Association web site structures.

These practices reduce the diversity of views available to allow readers to develop informed opinions about oil sands issues. The reduction in diversity is further skewed because the remaining voices are often those of government, industry and ENGO's who do tend to retain historic materials (see this story for example).

All is not lost though. You can still go the old fashioned route and head to your local library to dig up the articles in the original newspaper or go to your library's website and access the older articles online. Most public and university libraries in Alberta have access to Canadian Newsstand which provides full text access to major Canadian newspapers.

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Oil Sands-Related Highlights from Budget 2013 Speech – *March 7, 2013*

The following are oil sands-related extracts from the Government's budget speech:

We can go back 20 years prior to that, to 1973, to see how events of the day would shape Alberta for the next two, three and four decades. It was 1973 when the world oil crisis sent energy prices skyrocketing—from $3 a barrel to $15 to $40 by the end of the decade. This was the boom that put Alberta's oil sands on the map, and created untold wealth and unprecedented growth in the province.

[This budget] creates an action plan to address volatile non-renewable resource revenue and the tremendous impact these revenues have on the budget.

As you will hear today, Budget 2013 is sharply focused on three priorities: … (3) Ensuring Our Resources Get to Market...that's food, technology and, especially today – oil and gas – so our resources – which belong to the people of Alberta – get the highest price possible.

We are faced with declining resource revenues – thanks, primarily, to lower energy prices; the discounted price Alberta producers get for oil in our only market – the United States; and our current inability to get our products across the ocean and to new markets.

The Bitumen Bubble means more than a $6 billion drop in resource revenue from the Budget 2012 forecast. And we expect even larger declines in the coming years. Bitumen belongs to the people of Alberta. Right now, this resource is selling for 30 per cent less than the comparable world price. That's costing us $4 billion in lost revenues this year and it's impacting our health care, education and services we all hold so dear. This is precisely why opening new markets – across Canada and around the world – has become job one for our government. Just two weeks ago, the Premier met with the National Governors Association in Washington, D.C. – her fourth trip to the U.S. capital – to build support for the Keystone XL pipeline and to share Alberta's track record as a leader in responsible energy development.

Energy continues to be a driver of Alberta's economy, and with Budget 2013, we will continue to ensure Alberta is a leader in responsible energy development. For example, approvals for all oil, gas, oil sands and coal projects will be processed though a single energy regulator. This "one-stop-shop" will enforce legislation related to our energy resources, such as land and water acts. If you break the rules, the Alberta Energy Regulator will have more tools to hold you accountable, including larger fines.

While the operating budget for Environment and Sustainable Resource Development is $516 million, it is a decrease of $22 million, but we are spending smarter with the funds we have. We are saving $2 million by creating the Integrated Resource Management Planning Division, which allocates staff from within the ministry to develop the Land-use Framework plan.

From the Capital Plan – 2013-14 Estimate

- $243M Highway 63 twinning (Grassland to Fort McMurray) but no new funding for Highway 881
- $31M Fort McMurray urban area upgrades

- $11M Fort McMurray Community Health Centre
- 15M Fort McMurray Continuing Care Centre
- $2M Northern Lights Regional Health Centre (Fort McMurray)

From the Economic Outlook – 2013-14 Estimates

- WTI (West Texas Intermediate) US$92.50
- WCS (Western Canadian Select)(Hardisty) C$68.21
- Bitumen production 2.14M bbl

Related Links

Budget 2013: Responsible Change – website

Budget 2013: Speech presented March 7, 2013 by the Honourable Doug Horner, President of Treasury Board and Minister of Finance

Budget 2013: Documents

Budget 2013: Capital Plan

Budget 2103: Economic Outlook

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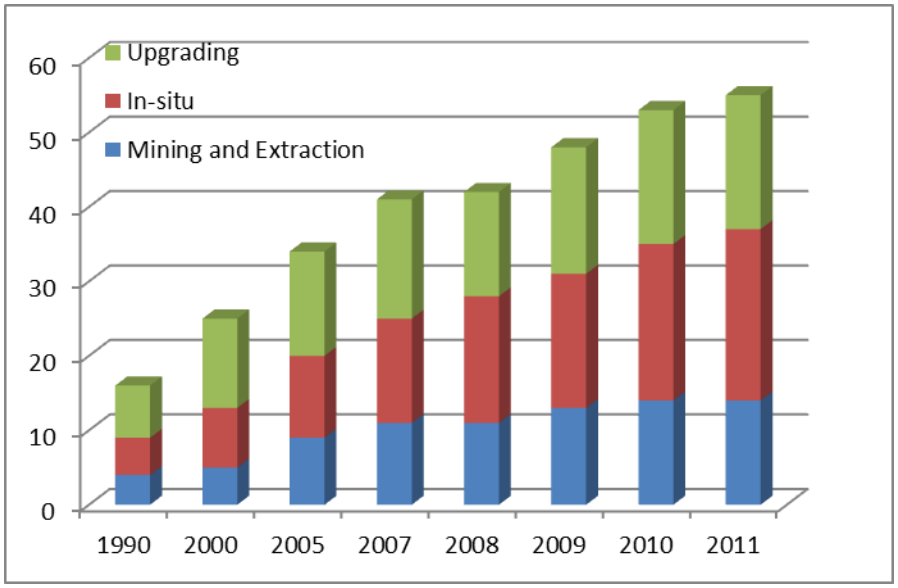
Oil Sands Contributions to National Greenhouse Gas Production – *April 22, 2013*

Although the oil sands have demonstrated significant reductions in production of greenhouse gases per barrel of production (emissions intensity) the significant increase in level of production means that overall oil sands greenhouse gas emissions have risen. Canada's submission to the UN Framework Convention on Climate Change (Government of Canada, 2013) provides figures for oil sands emissions.

Oil sands contributions from Table 2–5 GHG Emissions from All Sources (Stationary, Fugitive and Transport) for Oil and Gas, Coal Production and Non-energy Mining Sectors, Selected Years (p. 51).

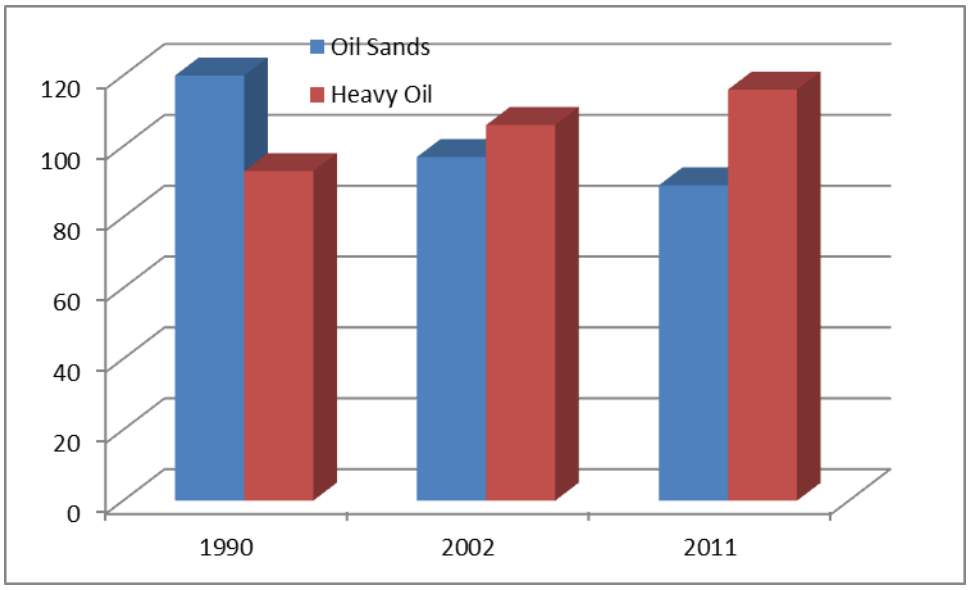
GHG Source Category GHG Emissions (Mt $CO_{2\text{-eq}}$)

Source	**1990**	**2000**	**2005**	**2007**	**2008**	**2009**	**2010**	**2011**
Total Oil Sands (Mining, Upgrading and In-Situ Extraction)	15	25	34	41	42	48	52	55
Mining and Extraction	4	5	9	11	11	13	14	14
In-situ	5	8	11	14	17	18	21	23
Upgrading	7	12	14	16	14	17	18	18



Oil sands emissions intensity (kg $CO_{2\text{-eq}}$/bbl) fell 26% from 1990 to 2011 - from Figure 2-6 Emission Intensity by Source Type for Oil and Gas (1990, 2002 and 2011)(p. 53)

Year	Oil Sands (Mining, Upgrading and In-Situ Extraction)	Conventional Heavy Oil
1990	120	93
2002	97	106
2011	89	116



The overall emission intensity from oil sands operations declined by 26% between 1990 and 2011. This reduction is due to technological innovation and equipment turnover, increased reliability across operations and the avoidance of upgrading emissions by exporting more crude bitumen. The most significant factor contributing to this overall trend has been declining rates of emissions associated with fuel combustion. For each barrel of oil produced from the oil sands, emissions associated with fuel combustion declined by approximately 24% (p. 52).

Additional points of interest

- While Canada represented only about 2% of total global GHG emissions in 2005, it is one of the highest per capita emitters, largely as a result of its size, climate (i.e., climate-driven energy demands), and resource-based economy (p. 19)
- CO_2 is the primary greenhouse gas emitted (79% of total emissions)
- Alberta was responsible for 35% of national GHGs in 2011 (p. 28)

- Oil sands 2011 emissions at 55 Mt $CO_{2\text{-eq}}$ were 7.8% of national emission levels in 2011 (702 Mt $CO_{2\text{-eq}}$; Table S-1; p.21); for context, agriculture was 10%, electricity 13% and transportation 24% (Figure S-6; p. 23).
- Oil sands emissions were 32% of the total emissions for the oil and gas sector (p. 50)
- From 1990 to 2011 bitumen and synthetic crude oil production from Canada's oil sands has increased by 393%, with most of the growth occurring from 1996 onward (p. 51); 117% just from 2002 to 2011 (p. 53)

Related Links

Alberta Environment and Sustainable Resource Development – Regulating Greenhouse Gas Emissions

Government of Canada, 2013. National Inventory Report 1990–2011: Greenhouse Gas Sources and Sinks in Canada. Part 1. Environment Canada, Pollutant Inventories and Reporting Division, Ottawa, Ontario. 227 pp.

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Common Terms Related to Aboriginal Consultation – *May 24, 2013*

The common law duty to consult is based on judicial interpretation of the obligations of the Crown (federal, provincial and territorial governments) in relation to potential or established Aboriginal or treaty rights of Aboriginal peoples, recognized and affirmed in section 35 of the *Constitution Act, 1982* (Aboriginal Affairs and Northern Development Canada 2011, Government of Alberta 2005), particularly when the actions of the Crown may result in an infringement of aboriginal or treaty rights (Government of Alberta 2005, Isaac and Knox 2004). The following terms are often used when describing the duty to consult with Aboriginal communities.

Accommodation: The goal of accommodation is to avoid, eliminate, or minimize adverse impacts on potential or established Aboriginal or treaty rights, and when this is not possible, to compensate the Aboriginal community for those adverse impacts (Aboriginal Affairs and Northern Development Canada 2011).

Adequacy: The effectiveness of the consultation in terms of process and outcomes that result in a fair assessment of impacts and a reasonable approach to addressing the impacts. Alberta's consultation guidelines provide factors that will be considered in determining the adequacy of consultation (Government of Alberta 2007). Passelac-Ross and Potes (2007) have assessed whether oil sands consultation is meeting government obligations.

Capacity: The ability of Aboriginal groups to understand the nature of the activity the Crown or proponent is contemplating and how that activity might adversely impact their potential or established Aboriginal or Treaty rights (Aboriginal Affairs and Northern Development Canada 2011).

Compensation: Where it is not possible to avoid, eliminate, or substantially reduce adverse impacts, it may be appropriate to compensate the Aboriginal group for any adverse impacts on their potential or established Aboriginal or Treaty rights. Compensation could take a variety of forms including habitat replacement; providing skills, training or employment opportunities for members of the Aboriginal group; land exchanges; impact-benefit agreements; or cash compensation (Aboriginal Affairs and Northern Development Canada 2011).

Consultation: The process of gathering information in good faith on the impacts of a specific project or decision on aboriginal or treaty rights with the intent of substantially addressing the concerns of the Aboriginal peoples (Aboriginal Affairs and Northern Development Canada 2011). Consultation with Aboriginal peoples requires specific processes tailored for and with Aboriginal peoples (Passelac-Ross and Potes 2007). The depth of consultation will depend on the nature of the infringement. Alberta's consultation guidelines provide recommended procedural steps for effective consultation (Government of Alberta 2007); the Canadian Association of Petroleum Producers provides similar guidance from an industry perspective (Canadian Association of Petroleum Producers 2006).

Cooperative Management: Arrangements made between the Province and First Nations to involve First Nations in provincial land and resource management processes (Canadian Association of Petroleum Producers 2003).

Engagement: Examples of engagement includes discussion groups and formal dialogue, sharing knowledge and seeking input on activities such as policy, legislation, program development or renewal (Aboriginal Affairs and Northern Development Canada 2011).

Free, Prior, and Informed Consent (FPIC): Broadly refers to the rights of indigenous peoples to participate in decisions affecting their lands and resources, especially as related to natural resource development (Boreal Leadership Council 2012).

Impact and Benefit Agreements: A contractual agreement between a resource developer (company) and an Aboriginal community that establishes the relationship, opportunities and understandings between the two in an effort to allow the project to proceed (Isaac and Knox 2005).

Infringement: An action of the Crown that impairs an Aboriginal right (Canadian Association of Petroleum Producers 2003).

Reconciliation: Reconciliation has two main objectives: (1) the reconciliation between the Crown and Aboriginal peoples and; (2) the reconciliation by the Crown of Aboriginal and other societal interests (Aboriginal Affairs and Northern Development Canada 2011). Consultation and accommodation play a key role in the fulfillment of these two objectives.

Traditional Territory: The geographic area identified by a First Nation to be the area of land which they and/or their ancestors traditionally occupied or used (Canadian Association of Petroleum Producers 2003).

Treaty: An agreement between government and a First Nation that defines the rights of Aboriginal peoples with respect to lands and resources over a specified area, and may also define the self-government authority of a First Nation. Treaties are final agreements that have been ratified by all parties (Canadian Association of Petroleum Producers 2003).

Treaty Right: Right protected under s. 35 of the *Constitution Act, 1982* that is held by First Nations people pursuant to a treaty (Canadian Association of Petroleum Producers 2003).

Related Links

Aboriginal Affairs and Northern Development Canada, 2011. Aboriginal Consultation and Accommodation - Updated Guidelines for Federal Officials to Fulfill the Duty to Consult - March 2011. 67 pp.

Alberta Aboriginal Relations – Aboriginal Consultation

Boreal Leadership Council, 2012. Free, prior and informed consent in Canada. Boreal Leadership Council, Ottawa, Ontario. 34 pp.

Canadian Association of Petroleum Producers, 2003. Guide for effective public involvement. Canadian Association of Petroleum Producers, Calgary, Alberta. 141 pp.

Canadian Association of Petroleum Producers, 2006. Developing effective working relationships with Aboriginal communities. Canadian Association of Petroleum Producers, Calgary, Alberta. 13 pp.

Government of Alberta, 2005. The Government of Alberta's First Nations consultation policy on land management and resource development. 7 pp.

Government of Alberta, 2007. Alberta's First Nations consultation guidelines on land management and resource development (Updated November 14, 2007). Various pagings.

Isaac, T. and A. Knox, 2005. Canadian Aboriginal Law: Creating certainty in resource development. Journal of Energy & Natural Resources Law 23(4): 427-464.

Passelac-Ross, M. and V. Potes, 2007. Consultation with aboriginal peoples in the Athabasca oil sands region: Is it meeting the Crown's legal obligations? University of Calgary, Canadian Institute of Resources Law, Calgary, Alberta. Resources 98: 1-7.

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Rail vs. Pipeline Speeds – *June 21, 2013*

While a lot of mention is made of cost and safety differentials between rail shipment of bitumen and pipeline shipment it may surprise you to learn that there is also a difference in the time it takes a given volume of bitumen to travel from source to final destination.

In addition rail shipments need less dilution therefore a given volume of shipped material contains more bitumen (Harrison 2011). Rail cars that reach their destination can also be loaded with diluent which is then backhauled to the oil sands operator (CN 2012).

Some interesting stats:

- Delivery to US Gulf Coast 8 to 10 days for rail vs. 50 days for pipeline (Meyer 2009, p. 18)
- Rail can get bitumen from Fort McMurray to the US Gulf Coast in 10 days versus 50 or 60 days via pipeline (Harrison 2011)
- It takes 40 days for crude to reach the Gulf via pipeline from the Bakken, while unit trains are roughly 90 hours each way (Credit Suisse, p. 14)
- Pipeline speeds: 5 km/hr (Canadian Energy Pipeline Association); 3.6 km/hr to 21.6 km/hr (Wikipedia (a))
- Railway speeds: 16 km/hr to 129 km/hr (US and Canada – speed depends on track type)(Wikipedia (b) and (c))

Related Links

Canadian Energy Pipeline Association. Liquids pipelines.

CN, 2012. Southern Pacific Resource Corp. completes arrangements to transport and market bitumen via CN to the U.S. Gulf Coast. CN Press Release June 27, 2012.

Credit Suisse, 2013. Entering a new era in crude logistics. Equity research report. 36 pp.

Harrison, L., 2011. Oil companies climb aboard potential alternative to pipelines. Pipeline News, July 22, 2011.

Meyer, R., 2009. Transportation solutions for oil sands production phase. IN: Transportation Innovation in Alberta Oil Sands: A summit. Van Horne Institute. PowerPoint presentation. 33 pp.

Wikipedia (a). Pipeline transport.

Wikipedia (b). Rail speed limits in the United States.

Wikipedia (c). Rail regulations in Canada.

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Oil Sands Land Disturbance vs. Well Sites

Considerable attention is paid to the extent of land disturbed by oil sands mining and the potential liability associated with the unreclaimed lands at any point in time (see for example, Lemphers et al. 2010). Recently Unger (2013) raised similar concerns for well sites in the upstream oil and gas industry. What is missing in these reviews is a comparison between the two sectors.

Alberta Environment and Sustainable Resource Development requires oil sands mining companies to provide an annual cumulative inventory of the lands that have been disturbed, reclaimed and certified and provides a breakdown of the inventory in the State of the Environment website (http://environment.alberta.ca/02863.html) as of December 31, 2011 (the data are reported in hectares). An explanation of the various categories of disturbance and reclamation that are reported is provided on the Reclamation page of the Alberta's Oil Sands website (http://oilsands.alberta.ca/reclamation.html).

Alberta Environment and Sustainable Resource Development has been tracking the number of wells drilled, abandoned and certified since 1963 (note that the data are in terms of numbers of well sites, not in hectares). These numbers are reported in the Oil and Gas Wells Reclamation website (http://environment.alberta.ca/02862.html).

Using 2012 data, and making the assumption that an individual well site will, on average, be about one hectare (1 ha) in size, a comparison between the levels of disturbance and reclamation between the two industrial sectors can be made (all data in hectares).

Sector	Total Disturbance	Currently Uncertified	Ready for Reclamation	Reclaimed	Certified
Oil Sands	84,395	84,291	372	5,042	104
Wells	393,147	239,036	52,831	?	101,280

Notes to interpret the results:

- Well data as of Mar 31, 2012 (see http://environment.alberta.ca/02862.html for historical data)
- Oil sands data as of Dec 31, 2012 (see http://environment.alberta.ca/02863.html for historical data)
- Total Disturbance:
  - wells = total number drilled
  - oil sands = sum of all reporting categories

- Currently Uncertified
  - wells = Total - Certified
  - oil sands = Total - Certified; includes 5,042 ha Reclaimed plus 1,227 ha Temporarily Reclaimed plus 1,447 ha with Soils Placed (partially reclaimed)
- Ready for Reclamation
  - wells = abandoned
  - oil sands = Ready
- Reclaimed
  - wells = unknown, however on average about 1,682 wells are certified each year (http://environment.alberta.ca/02862.html) which would imply at least 1,682 ha could be Reclaimed each year
  - oil sands = Permanently reclaimed (terrestrial and wetland)
- Certified
  - wells = Certified plus exempt (wells abandoned prior to start of reclamation legislation in 1963)
  - oil sands = Certified

Observations on the data

Well sites have disturbed more than 46 times as much land as the mineable oil sands. Human nature makes us perceive individual large disturbances (especially if they are all in one place like oil sands mines) much easier than numerous scattered small disturbances like well sites.

The upstream sector has considerably more experience getting reclamation certificates with a little less than 1,000 times as much land certified to date. As a result, the upstream sector has completed about 26% of the reclamation required based on current level of disturbance, calculated as (Certified + Reclaimed)/Total Disturbance. On the other hand, the oil sands have only completed 6% of reclamation.

There is a perception that large blocks of mined oil sands land are ready to be reclaimed that industry is not working on. The data show that there is minimal oil sands mine land ready for reclamation while the upstream sector has almost 142 times as much land ready for reclamation.

On average 14,227 wells have been drilled each year over the past 10 years (http://environment.alberta.ca/02863.html) though annual levels are highly variable; mine disturbances, on the other hand, expand in bursts with an expansion to an existing mine or start of a new mine.

Related Links

Alberta Energy Regulator – Abandoned Well Locations

Lemphers, N., S. Dyer and J. Grant, 2010. Toxic liability: How Albertans could end up paying for oil sands mine reclamation. Pembina Institute, Drayton Valley, Alberta. 56 pp. http://pubs.pembina.org/reports/toxic-liability-report.pdf

Unger, J., 2013. Reclaiming tomorrow today. Regulatory timing for abandonment and reclamation of well sites in Alberta. Environmental Law Centre, Edmonton, Alberta. 39 pp. http://elc.ab.ca/other-issues/energy/2013/reclaiming-tomorrow-today-regulatory-timing-for-abandonment-and-reclamation-of-well-sites-in-alberta.aspx

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Fort McMurray Historic Uranium Cleanup Project – *July 23, 2013*

From the 1930s to the 1960s, the Northern Transportation Route (NTR) moved pitchblende ore 2,200 km from the Port Radium Mine in the Northwest Territories to Fort McMurray. From there, the ore was shipped by rail to Ontario, where it was refined for its radium content and used for medical purposes.

In Fort McMurray ore was transferred from barge to rail. Ore was occasionally spilled during transfer operations and, in some cases, subsequently distributed over larger areas as properties were re-developed or modified.

The Low Level Radioactive Waste Management Office (LLRWMO), operated by Atomic Energy of Canada Limited (AECL) through a cost-recovery agreement with Natural Resources Canada (NRCan), directed the cleanup of these spill sites.

The Fort McMurray Historic Uranium Cleanup Project involved the removal of some 42,000 m^3 of soils contaminated with uranium ores and ore concentrates from nine properties in the City of Fort McMurray. These soils were placed into long-term management in a dedicated, locally developed and secure facility. The project ran from 1992 to 2003, involved the participation of the local community, and restored 28 ha of land to productive use, with only 1.5 ha of non-productive land devoted to the long-term management of contaminated materials. Many of these properties are in prime commercial locations, and as a consequence, have already been redeveloped into retail outlets.

Related Links

Benitez, L., J.L. Brown, D. McCauley and R.L. Zelmer, 2011. Early Progress in Building Confidence and Partnerships with Northern First Nations and Communities in Low-Level Radioactive Waste Remediation Projects in Canada. IN: WM2011 Conference, February 27-March 3, 2011, Phoenix, Arizona. 15 pp.

Geddes, B., C. Wenzel, M. Owen, M. Gardiner and J. Brown, 2011. Remediation of Canada's Historic Haul Route for Radium and Uranium Ores – The Northern Transportation Route. IN: Proceedings of the ASME 2011 14th International Conference on Environmental Remediation and Radioactive Waste Management ICEM2011, September 25-29, 2011, Reims, France. Paper ICEM2011-59303. 12 pp.

International Atomic Energy Agency, 1999. Compliance Monitoring for Remediated Sites. Annex VII: Canada – LLRMWO Experience with Post-Cleanup Site Characterisation. Report No. IAEA-TECDOC-1118. pp. 78-83.

Low Level Radioactive Waste Management Office (LLRWMO)

Natural Resources Canada

NWT Archives – Port Radium Photo Gallery – link no longer available

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The Thesis behind the Science behind Oil Sands Environmental Performance – *August 19, 2013*

The Oil Sands Environmental Management Bibliography lists 320 theses from 23 universities across Canada, as well as one each from the US, Netherlands and Denmark. The earliest thesis is from 1951 (a UofA study of Arctic grayling in the Athabaska (sic) drainage).

University theses are important bodies of work that support continuous improvement of oil sands environmental performance. In many cases the thesis is followed up with one or more publications in peer-reviewed journals. While these journal publications are often given greater importance in the scientific community, the thesis is a valuable source of data, background information and recommendations for future work.

In addition to the thesis, the knowledge and exposure gained by the students doing the work prepares them to work in industry, government or academia and contribute further to environmental management of the oil sands.

The following tables and figures provide more information on where and when the theses were done. Some observations on the data:

It is important to note that the Bibliography focuses on the mineable oil sands and environmental issues – there would be more theses from University of Calgary if we included more in-situ technology work and more from a variety of institutions if we included geological (resource delineation and characterization) and oil sands processing work.

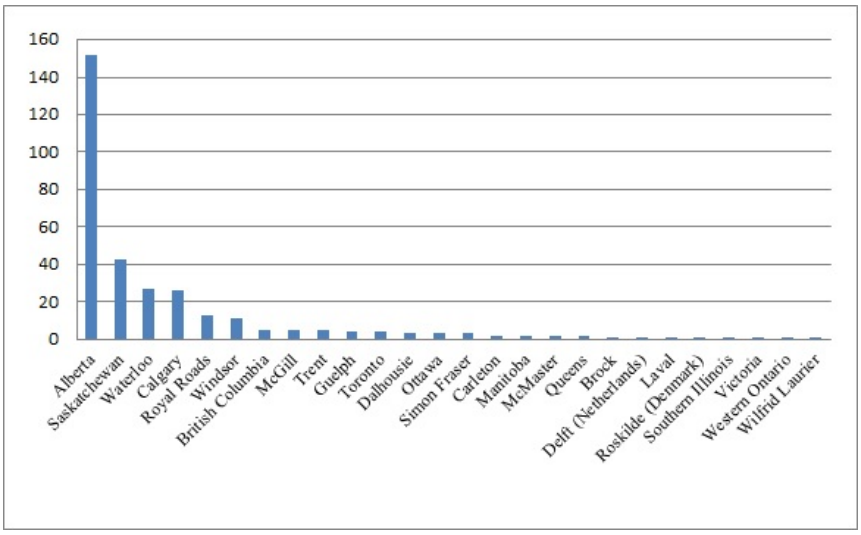
While the University of Alberta is the clear leader in producing theses it is interesting to note where in Canada other work is being done

Clearly there has been a significant increase in interest in, and opportunities for, thesis work since 2000; not surprisingly much of this work has focused on tailings

A scan of the bibliography search results shows a broad range of faculties and disciplines are involved although engineering and biology seem to dominate

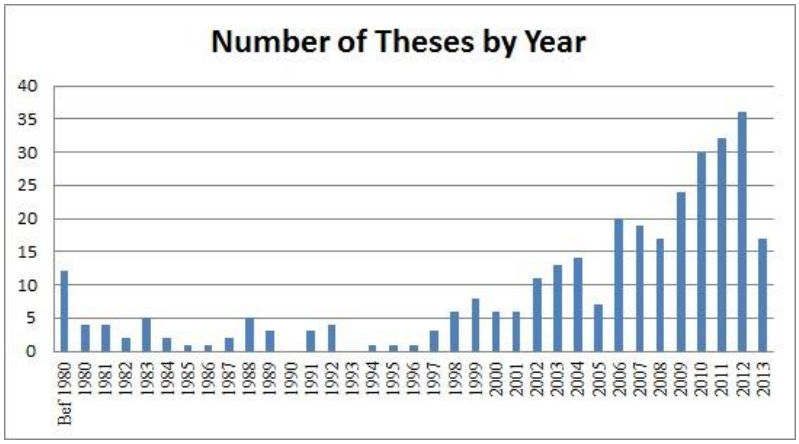
Number of Theses by University

University	Number
Alberta	152
Saskatchewan	43
Waterloo	27
Calgary	26
Royal Roads	13
Windsor	11
British Columbia, McGill, Trent	5
Guelph, Toronto	4
Dalhousie, Ottawa, Simon Fraser	3
Carleton, Manitoba, McMaster, Queens	2
Brock, Delft (Netherlands), Laval, Roskilde (Denmark), Southern Illinois, Victoria, Western Ontario, Wilfrid Laurier	1



Number of Theses by Year

Year	Number
Bef 1980	12
1980	4
1981	4
1982	2
1983	5
1984	2
1985	1
1986	1
1987	2
1988	5



1989	3
1990	0
1991	3
1992	4
1993	0
1994	1
1995	1
1996	1
1997	3
1998	6
1999	8
2000	6
2001	6
2002	11
2003	13
2004	14
2005	7
2006	20
2007	19
2008	17
2009	24
2010	30
2011	32
2012	36
2013	17

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Predicting Oil Sands Production Levels – *September 27, 2013*

Oil sands companies provide guidance on their expected production levels for the next year in their Annual Report and then report on actual levels achieved in the subsequent year's Annual Report. As the data for Syncrude and Suncor below show, prediction levels are usually not correct, and are more often than not lower than actual results. Providing a guidance range (as done by Suncor) seems to provide more chance to be right. Some reasons given in the Annual Reports for lower production levels include: longer-than-planned maintenance, unplanned maintenance, coker problems and fires.

Syncrude Production (Mbbl/year; values provided in Canadian Oil Sands Annual Reports)

Year	Guidance	Actual	% Difference
2013	110		
2012	113	104.9	-7.17
2011	110	105.3	-4.27
2010	115	107	-6.96
2009	115	102	-11.30
2008	115	106	-7.83
2007	110	111	0.91
2006[a]	99.3	91.2	-8.22
2005	83	78.1	-5.90
2004[b]	84.5	87.2	3.20
2003	85	77	-9.41
2002	86	83.8	-2.56
2001	94	81.4	-13.40

[a] NOTE: Guidance calculated based on mid-point of range (34 to 39) provided for COS portion only

[b] NOTE: Guidance calculated based on mid-point of range (82 to 87) provided

Suncor Production (in bbl/d) in Suncor Annual Reports

Year	Low Guidance	High Guidance	Actual	% Difference - Low	% Difference - High
2013	350,000	380,000			
2012	325,000	355,000	324,800	-0.06	-8.51
2011[a]	280,000	310,000	304,700	8.82	-1.71
2010	266,000	294,000	283,000	6.39	-3.74
2009	270,000	315,000	290,600	7.63	-7.75
2008	275,000	300,000	228,000	-17.09	-24.00
2007	260,000	270,000	235,600	-9.38	-12.74
2006	260,000	N/A[b]	253,800	-2.38	N/A[b]

[a] NOTE: updated in Q1 after upgrader fire

[b] NOTE: single guidance value provided instead of range

Estimates are also updated in Quarterly Reports and tend to improve as actual data from the prior quarter(s) are incorporated into the estimate; note that the range also gets tighter as certainty increases. However, as shown in the example below from Syncrude's 2012 production, even with three quarters of actual data the expected results can be different from actual.

	Production	Range
2012 Forward	113	106-117
Q1 Guidance	110	106-114
Q2 Guidance	110	106-112
Q3 Guidance	107	105-108
2012 Actual	104.9	

Why does this matter? A number of people use the forward guidance for a variety of reasons including government (to estimate royalties and taxes) and investors (to determine whether to buy, sell or short stock).

The best advice given regarding predictions can be found in the Advisory section of the Canadian Oil Sands 2012 Annual Report (p. 73):

> You are cautioned not to place undue reliance on forward-looking statements, as there can be no assurance that the plans, intentions or expectations upon which they are based will occur. By their nature, forward-looking statements involve numerous assumptions, known and unknown risks and uncertainties, both general and specific, that contribute to the possibility that the predictions, estimates, forecasts, projections and other forward looking statements will not occur. Although the Corporation believes that the expectations represented by such forward-looking statements are reasonable and reflect the current views of the Corporation, there can be no assurance that such expectations will prove to be correct.

Related Links

The following information focuses on earnings guidance (which is based in part on estimates of production)

Deloitte and Financial Executives Research Foundation, Inc., 2009. Earnings Guidance: The Current State of Play. 38 pp.

Investopedia, 2013. Earnings Guidance: Can It Accurately Predict The Future?

Ontario Securities Commission – National Policy 51-201 Disclosure Standards

Toronto Stock Exchange – Disclosure Standards for Companies Engaged in Mineral Exploration, Development & Production

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Fort McMurray or Regional Municipality of Wood Buffalo? – *October 29, 2013*

Fort McMurray is often used as short-hand for the oil sands producing area, especially the mineable oil sands. In addition, Fort McMurray is sometimes used when the more accurate term would be the Regional Municipality of Wood Buffalo.

Fort McMurray is a community (officially it is one of two *urban service areas* in Alberta – the other being Sherwood Park) within the larger Regional Municipality of Wood Buffalo (officially a *specialized municipality* in Alberta). The Regional Municipality includes a number of additional communities (hamlets) of varying sizes: Anzac, Conklin, Draper, Fort Chipewyan, Fort Fitzgerald, Fort McKay, Gregoire Lake Estates, Janvier and Saprae Creek Estates. To make things a bit more confusing the municipal seat of the Regional Municipality is Fort McMurray.

The table below shows some of the key differences between the two jurisdictions:

	Fort McMurray	Regional Municipality of Wood Buffalo
Established	1870 (as a Hudson's Bay Company trading post)	April 1, 1995 (amalgamation of City of Fort McMurray and Improvement District No. 143)
Population	72,944 (2012 regional census)	116,407 (2012 regional census)
Permanent residents	70,964	74,631
Non-permanent	1,980	41,776 (mostly in work camps)
Area	59.89 km^2	68,454 km^2

Economic data for the Regional Municipality (or more commonly Wood Buffalo / Cold Lake) is available but a breakdown for Fort McMurray is difficult to find. The estimated average household 2011 income for the Regional Municipality was $177,634 (approximately 95% higher than the national average). The median age in 2011 of both jurisdictions was approximately 31.

Related Links

Fort McMurray region (census division No. 16 – Canada)

Fort McMurray 2011 Census profile (Statistics Canada)

Harper, 2014. Municipality to pursue shadow population study. Fort McMurray Today.

Municipal census 2012

Regional Municipality of Wood Buffalo

Regional Municipality of Wood Buffalo 2011 Census profile (Statistics Canada)

Regional Municipality of Wood Buffalo economic profile 2011

Wood Buffalo Big Spirit

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Shared Infrastructure and Services – *November 15, 2013*

Although we speak most frequently about "the oil sands" (as a collective, or sometimes the mineable oil sands and in-situ separately) in reality they are managed by companies and government as individual projects. Over the years there have been suggestions that the companies could band together to develop common infrastructure and service capabilities, or that third-parties could step in and provide common services. Some of these suggestions are more farfetched than others, and some are needed today while others are longer term needs.

Examples of current shared services include:

- Work camps that provide accommodations for multiple operators
- Pipelines that serve multiple operators
- Alberta Industrial Fire Protection Association

Here are some potential shared infrastructure and services that have been suggested:

- Water sharing between mines and in-situ projects – tailings water could be used by in-situ operators for steam rather than extracting groundwater. See Godwalt, C., P. Kotecha and C. Aumann, 2010. Oil Sands Tailings Management Project. OSRIN Report No. TR-7. 64 pp. http://hdl.handle.net/10402/era.22536
- Regional water treatment plant(s) – at some point companies will need to release oil sands process-affected water to the surrounding environment. Depending on the criteria for discharge set by government water may require treatment before release. There are potential synergies of scale that would make a regional water treatment plant a logical option.
- Regional water storage – should water levels in the Athabasca River get too low and require operators to restrict water withdrawals it would be important to have backup water supplies available. One solution could be a regional storage facility that all operators fill, maintain and can withdraw from (perhaps an empty mine pit). Another might be a water supply operated by a third party – see Berzins, B. and B. Irvine, 2008. One, two. three … green light. CIM Magazine, Sept/Oct 2008. 2 pp.
- Soil sharing between mines – reclamation is more successful if salvaged soils can be immediately placed on lands ready for reclamation. Alberta Environment and Sustainable Resource Development suggested that operators should consider moving soils from Mine A to Mine B if lands are not immediately available for reclamation on Mine A. See paragraph 4, page 55 in Alberta Energy and Utilities Board and Canadian Environmental Assessment Agency, 2006. Report of the Joint Review Panel established by the Alberta Energy and Utilities Board and the Government of Canada: Albian Sands Energy Inc., application to expand the oil sands mining and processing plant facilities at the Muskeg River Mine. Alberta Energy and Utilities

Board, Calgary, Alberta and Government of Canada, Ottawa, Ontario. EUB Decision 2006-128. 116 pp.

- Regional reclamation company – regulators interest in ensuring that reclamation plans for adjacent mines are coordinated, coupled with the increasing focus on regional outcomes (for example, the Lower Athabasca Regional Plan), lead to the suggestion that a single company responsible for all reclamation could develop a more integrated plan and perhaps some cost efficiencies by better coordinating work across multiple sites. See paragraph 3, page 241 in Jones, R.K. and D. Forrest, 2010. Oil sands mining reclamation challenge dialogue - report and appendices. Oil Sands Research and Information Network, University of Alberta, School of Energy and the Environment, Edmonton, Alberta. OSRIN Report No. TR-4. 258 pp.

Related Links

Government of Alberta, Oil Sands Sustainable Development Secretariat, 2011. CRISP: Comprehensive regional infrastructure sustainability plan for the Athabasca oil sands area. Government of Alberta, Oil Sands Sustainable Development Secretariat, Edmonton, Alberta. 71 pp.

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Upgrader or Refinery? – *November 29, 2013*

Discussions of the bitumen bubble often lead to suggestions we should add more upgraders or refineries to process bitumen in Alberta instead of shipping the raw product off to others. The assumption is that we will keep more jobs and obtain higher revenues from value added products. But what's the difference between upgraders and refineries?

An upgrader is a facility that upgrades bitumen (extra heavy oil) into synthetic crude oil. Upgrader plants are typically located at oil sands mine sites (e.g., Syncrude, Suncor or CNRL Horizon). Upgraded bitumen is then sent to a refinery for further processing into final products such as into more useful products such as petroleum naphtha, gasoline, diesel fuel, asphalt base, heating oil, kerosene and liquefied petroleum gas.

Refineries that process oil sands are located in Edmonton, Fort Saskatchewan, Lloydminster and the US midwest and Gulf Coast. Refineries that handle raw bitumen combine the upgrading and refining process in one location (e.g., Shell's Scotford upgrader and refinery).

Although we usually associate upgraders with mine projects Nexen's Long Lake in-situ project also has an upgrader. To complicate things further, North West Upgrading Inc. will operate a refinery since it will produce diesel rather than synthetic crude oil.

Related Links

Alberta Energy – Upgrading and Refining

Chevron – How does an oil refinery work?

The Lloydminster Refinery and the Lloydminster Upgrader convert crude oil into useable products and feedstocks

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Remote Sensing Applications for Oil Sands – *December 13, 2013*

Remote sensing (often called earth observation) is a broad suite of methods to assist in gathering information about an object or phenomenon without making physical contact with the object. Generally we think about remote sensing in terms of satellite images and airphotos that show current state of development and changes over time – think of the impact that the first Google Earth images of the tailings ponds had. However there are other applications of the technology that are relevant to oil sands (see examples below).

Related Links

Organizations

Canada Centre for Mapping and Earth Observation (CCMEO)

Earth Observations Systems Laboratory – University of Alberta

LOOKNorth

Natural Resources Canada – Satellite Imagery and Air Photos

Remote Sensing Group – University of Lethbridge

Examples of Remote Sensing Applications in the Oil Sands

Canada Centre for Remote Sensing: Activities in Alberta's Oil Sands Region (AOSR)

Compiling a Geospatial Database of Existing Oil Sands Industrial Features for Alberta Environment

Earth Observation Technique and its Applications on Alberta Oil Sands

Hashisho, Z., C.C. Small and G. Morshed, 2012. Review of Technologies for the Characterization and Monitoring of VOCs, Reduced Sulphur Compounds and CH_4. OSRIN Report No. TR-19. 93 pp. http://hdl.handle.net/10402/era.25522

Hyperspectral Remote Sensing Research in the Oil Sands 2012-2013: Interim Progress Report

Keeping a watchful eye on wildlife - Cenovus

Morgan, T. and T. Powell, 2009. WMU 531 Aerial Moose (*Alces alces*) Survey February 2009. Alberta Sustainable Resource Development, Fort McMurray, Alberta. 25 pp.

Oil Sands Information Portal (Alberta Environment and Sustainable Resource Development)

Remote Sensing of Ore Quality

World of Change - Athabasca (NASA)

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Forestry – the Other Major Land Use – *January 16, 2014*

Forest harvest activities are conducted over an extensive area in the mineable and in-situ oil sands areas. Alberta Pacific Forest Industries Inc. (Al-Pac) for example operates a 6.8 million hectare Forest Management Agreement (FMA) area in northeastern Alberta, about 2 million hectares of which is considered commercially harvestable.

Alberta Environment and Sustainable Resource Development summarizes Forest Management Agreement holder responsibilities as follows:

> FMA holders must manage the forest on a long-term, sustained yield basis. They must also consider a broad range of forest values and social, economic and environmental factors such as watershed, environment and wildlife habitat. FMA holders take on greater responsibility and accountability for forest management planning consistent with the Government of Alberta's commitment to sustainable resource development. In addition, FMA holders are required to provide an opportunity for public consultation during the development of a Forest Management Plan for the area.

Efforts are made to coordinate the harvest activities of the forest companies with the land clearing and road development activities of the oil sands operators. Al-Pac describes Integrated Landscape Management as:

> A collaborative effort between our company and resource companies that has resulted in the construction of fewer roads, initiated research on the effects of industrial activities on forest ecosystems, assisted in the development of science-based best practices and has helped coordinate harvest operations with oil and gas activities. Al-Pac has worked with numerous energy companies to develop and plan access, harvest operations and reclamation in some areas ahead of project development. Similar plans have been generated for Steam Assisted Gravity Drainage projects to maximize operational benefits to the developers while minimizing impacts to wildlife and forest resources.

Related Links

Alberta Environment and Sustainable Resource Development – Forest Management Agreements

Alberta Environment and Sustainable Resource Development – Forest Management Map

Alberta Environment and Sustainable Resource Development – Forest Management Plans

Alberta Forest Products Association – Integrated Landscape Management: A Win-Win Solution

Al-Pac Forest Management Plan

Al-Pac Integrated Landscape Services

Al-Pac Forest Management Agreement Area

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The Mines that Weren't – *February 4, 2014*

Most of us are familiar with mines that are active or proposed or somewhere in the regulatory process (for example look here or here). But what about mines that had been proposed but never got developed?

Historical examples

Alsands

- Proponent: Alsands Project Group (Shell Canada Resources Limited, Shell Explorer Limited, Amoco Canada Petroleum Company Limited, Chevron Standard Limited, Dome Petroleum Limited, Gulf Canada Limited, Hudson's Bay Oil and Gas Company Limited, Petro-Canada)
- Location: Townships 95/96 and Ranges 9/10/11 W4
- Leases: 12, 13, 34
- Planned production: 137,000 bbl/d
- Regulatory Status: EIA completed December 1, 1978; application to ERCB December 1978; ERCB hearing June and July 1979; approved by ERCB in December 1979; site clearing begun; project halted April 30, 1982 (even with promise to take 50% ownership by Alberta government)

OSLO (Other Six Leases Operation)

- Proponent: OSLO Alberta Ltd. (Alberta Oilsands Equity, Canadian Occidental, Esso Resources Canada, Gulf Canada Resources Ltd., Pan Canadian Petroleum, Petro-Canada)
- Location: Townships 94/95, Ranges 8/9 W4
- Leases: 31
- Planned production: 77,000 bbl/d
- Regulatory Status: Pre-application environmental and other documents prepared 1985-1991; 1988 federal government promises $1.4B in grants (withdrawn 1990); EIA issues scoping document 1991; feasibility study completed December 1991; OSLO cancelled project November 1992

Solv-Ex Oilsands Co-Production

- Proponent: Solv-Ex Corporation and United Tri-Star Resources Limited (Calgary)
- Location: Townships 96/97, Ranges 10/11 W4
- Leases: 5, 52

- Proposed production: 12,000 bbl/d (plus co-production of minerals)
- Regulatory Status: EIA completed July 21, 1995, EPEA approval December 1995, project partially constructed; company filed for creditor protection in 1997

A review of the mine leases (see table below) shows some of them are now being developed by other proponents:

Now / Then	Alsands	OSLO	Solv-Ex
Shell Jackpine / Muskeg River	13		
Suncor Fort Hills			5, 52
Syncrude Aurora North	12, 34		
Syncrude Aurora South		31	

Recent example

Synenco Northern Lights Mining and Extraction Project

- Proponent: Synenco Energy Inc. (purchased in 2008 by Total E&P Canada)
- Location: Townships 98/99, Ranges 5/6/7 W4
- Leases: 15, 16 and 789
  They collectively encompass an area of approximately 186 square kilometres. These lands are the most northerly of any oil sands project proposed in the region to date.
- Proposed production: 114,500 bbl/d
- Regulatory status: EIA submitted 2006; Synenco withdrew their application in 2008

Acronyms

EIA – Environmental Impact Assessment

EPEA – *Environmental Protection and Enhancement Act*

ERCB – Energy Resources Conservation Board

OSLO – Other Six Leases Operation (also shows up in searches as Other Six Lease Operators)

Related Links

Alberta Environment and Sustainable Resource Development – Completed EIAs by Activity Type

Alberta Environment and Sustainable Resource Development – Synenco EIA

Archives Canada – Alsands Project press clippings collection

Canada.com (Edmonton Journal), April 30, 1982 – Alsands collapse could signal end of megaprojects: Lougheed

CBC Digital Archives, 1979 – Alsands seeks tax breaks for oil sands plant

JuneWarren-Nickles – Alsands files with ERCB $5.9 billion project 137, 000 B/D synthetic oil

Oil & Gas Journal – OSLO project

Oilsands Review – Project Locations map

Patrick T. McCarthy – The Solv-Ex Case

Peter McKenzie-Brown, 2013. The Way we Were

Syncrude Lease Map

The Free Library – Solv-Ex receives approval for co-production project under Alberta Oil Sands Conservation Act

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Railway Service to Fort McMurray – *February 20, 2014*

The option of shipping bitumen by rail continues to receive a lot of media attention as pipeline access is delayed. In a previous Did You Know we addressed Rail vs. Pipeline Speeds, but where exactly does the railway to the oil sands region go, who runs it, what is the history behind it, and what about the future?

Current Line

Canadian National operates the line that runs from Edmonton, past Boyle, Lac La Biche and then follows Highway 881 (passing though Conklin, Leismer, Chard, Cheecham and Anzac) up to its terminus at Lynton. A number of in-situ oil sands sites are in close proximity to the rail line.

CN reports that it would take 69 hours for a train to travel from Edmonton to Fort McMurray while the run from Fort McMurray to Edmonton takes between 78 hours and 153 hours (timing depends on the day of travel).

History

The rail line went through a series of names and owners (with associated colourful history) before being taken over by Canadian National in 2007. The line received a $135 M upgrade in 2008.

See the links below for descriptions of the Alberta and Great Waterways Railway, Northern Alberta Railways, Lakeland & Waterways Railway and Athabasca Northern Railway.

Future?

In their comprehensive regional infrastructure sustainability plan for the Athabasca oil sands area, the Alberta government explored the option of developing a new commuter rail service between Fort McMurray and the new urban growth node, servicing oil sands projects in the Surface Mineable Area.

A company called G Seven Generations has mused about a railway from Fort McMurray to Valdez, Alaska to allow oil sands to reach tidewater on its way to Asia.

PC Fort McMurray-Conklin MLA Don Scott raised the idea of bringing a high-speed train up to Fort McMurray.

The future of the railway will need to consider a number of factors, including:

- What gets shipped (dilbit, sulphur, coke (see page 19), equipment, people)
- How it is shipped – innovation in equipment
- Where is the end of the line and where should it be
- What's at the end of the line – terminals

Related Links

Athabasca Northern Railway - Wikipedia

Atlas of Alberta Railways – The Alberta and Great Waterways Railway

Atlas of Alberta Railways – The Beginnings of the Northern Alberta Railways

Atlas of Alberta Railways – 1955 Northern Alberta Railways map

Bourgonje, T. and S.A. Diercks, 2011. Rehabilitation of Canadian National Railway Track Servicing Oil Sands in Northern Alberta The Athabasca Northern Railway. 16 pp.

Cairns, J., 2012. Crude by Rail – Low Cost, Low Risk Market Access.

Cairns, M., 2013. Crude Oil by Rail: Part I and Part II - Potential for the Movement of Alberta Oil Sands Crude Oil and Related Products by Canadian Railways. pp. 412-433.

CBC News (September 27, 2012) – CN testing natural gas trains on Fort McMurray line

CN rail map (select Fort McMurray as the station)

Government of Alberta, Oil Sands Sustainable Development Secretariat, 2011. CRISP: Comprehensive regional infrastructure sustainability plan for the Athabasca oil sands area. Government of Alberta, Oil Sands Sustainable Development Secretariat, Edmonton, Alberta. 71 pp.

Lakeland & Waterways Railway

Northern Alberta Railways Company

Northern Alberta Railways – Wikipedia

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Wildfires – *March 12, 2014*

The Richardson Fire in 2011, north of Fort McMurray, was the second largest forest fire in Alberta's history at over 700,000 hectares. Fires can impact oil sands operations (through road closures or site shut-downs for safety of personnel) – see this map of historical wildfire locations relative to regional work camp locations (courtesy Brad McMurdo and Warren Rouke – Regional Municipality of Wood Buffalo and Sean MacLean – Stantec). Fires can also increase levels of particulate matter ($PM_{2.5}$) in the air, increasing health risk.

While fires are extremely destructive to the environment (trees and wildlife) they are also sources of ecological renewal – opening forest canopies to allow more light, clearing out dead brush, restarting ecological succession and providing the heat source that some seeds need to germinate (e.g., jack pine).

Government has established rules, and industry has developed practices, to prevent and control wildfires related to industrial development.

Natural Resources Canada predicts that climate change will increase the number of forest fires, with boreal forests likely to be particularly hard hit. Mountain pine beetle may increase likelihood and intensity of forest fires. Scientists and reclamation practitioners are uncertain whether reclaimed oil sands mine lands will behave similar to natural boreal forest areas following a wildfire, but have recommended practices to improve the chances of a successful recovery.

Related Links

Alberta Environment and Sustainable Resource Development – FireSmart for Industry

Alberta Environment and Sustainable Resource Development – Fort McMurray Area Update

Alberta Environment and Sustainable Resource Development – Wildfire Status

Canadian Association of Petroleum Producers – Best Management Practices: Wildfire Prevention (2008)

Edmonton Sun (July 25, 2010) – Forest fires burn near Fort McMurray

Fort McMurray Today (June 2, 2011) – Oil sands sites monitor nearby fires, incoming smoke

Global Edmonton (May 30, 2011) – Massive forest fire halts work at oil sands site

Natural Resources Canada – Fire ecology

Regional Municipality of Wood Buffalo – Wildfire update

Richardson Fire – Wikipedia

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Lots of Science and Engineering Disciplines Involved in Oil Sands – *March 24, 2014*

Monitoring and managing the impacts of oil sands development is very complex, which is why there are so many science and engineering disciplines involved. The Oil Sands Environmental Management Bibliography, a joint effort by OSRIN and the Cumulative Environmental Management Association (CEMA), has 615 peer-reviewed journal articles as of March 24, 2014.

The list of 208 journal titles below indicates the range of disciplines involved. The journals with 10 or more published articles are shown in the table; these 11 journals account for 36% of all the articles.

While it is no surprise that most of the articles are written by university researchers (452/615), quite a few are by government scientists (102/615; most of which are from the federal government – 75/102). Seventeen are by industry and the remainder (44/615) are from other sources, usually consultants or organizations.

Environmental Science & Technology	45
Chemosphere	32
Fuel	31
Canadian Journal of Soil Science	22
Environmental Pollution	17
Canadian Geotechnical Journal	16
Journal of Environmental Science and Health, Part A, Toxic/hazardous Substances & Environmental Engineering	14
Journal of Canadian Petroleum Technology	14
Environmental Toxicology and Chemistry	13
AOSTRA Journal of Research	10
Canadian Journal of Botany	10

Journal Titles

Aboriginal Policy Studies

Advances in Chemistry

Advances in Colloid and Interface Science

Advances in Water Resources

Agriculture, Ecosystems and Environment

Alberta Law Review

Analytical Chemistry

Analytical Methods

Annals of the New York Academy of Sciences

Annual Review of Plant Physiology and Plant Molecular Biology

AOSTRA Journal of Research

Applied and Environmental Microbiology

Applied Clay Science

Applied Ecology

Applied Energy

Applied Geochemistry

Applied Microbiology and Biotechnology

Applied Soil Ecology

Aquatic Biology

Aquatic Insects: International Journal of Freshwater Entomology

Aquatic Toxicology

Archives of Environmental Contamination and Toxicology

Archives of Environmental Health

Atmosphere-Ocean

Atmospheric Chemistry and Physics

Atmospheric Chemistry and Physics Discussions

Atmospheric Environment

Biological Conservation

Bioresource Technology

Biotechnology and Bioengineering

Bryologist

Canadian Chemical Processing

Canadian Field-Naturalist

Canadian Geotechnical Journal

Canadian Journal of Botany

Canadian Journal of Chemistry

Canadian Journal of Civil Engineering

Canadian Journal of Earth Sciences

Canadian Journal of Fisheries and Aquatic Sciences

Canadian Journal of Forest Research

Canadian Journal of Microbiology

Canadian Journal of Physiology and Pharmacology

Canadian Journal of Sociology

Canadian Journal of Soil Science

Canadian Journal of Zoology

Canadian Political Science Review

Canadian Public Policy

Canadian Water Resources Journal

Change

Chemosphere

CIM Magazine

Citizenship Studies

Clays and Clay Minerals

Cold Regions Science and Technology

Colloids and Surfaces A: Physicochemical and Engineering Aspects

Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology

Conservation Ecology

Desalination

Ecological Applications

Ecological Archives

Ecological Engineering

Ecological Indicators

Ecology and Society

Ecotoxicology and Environmental Safety

Energy & Fuels

Energy

Energy Fuels

Energy Law Journal

Energy Policy

Energy Procedia

Environmental and Experimental Botany

Environmental Chemistry Letters

Environmental Forensics

Environmental Geotechnics

Environmental Health Perspectives

Environmental Modelling & Software

Environmental Monitoring and Assessment

Environmental Pollution

Environmental Pollution Series A, Ecological and Biological

Environmental Research Letters

Environmental Science & Technology

Environmental Technology

Environmental Technology Letters

Environmental Toxicology

Environmental Toxicology and Chemistry

Environmental Toxicology and Water Quality

FEMS Microbiology Ecology

Forest Ecology and Management

Forest Science

Frontiers in Ecology and the Environment

Fuel

Fuel Science and Technology International

Geoforum

Geophysical Research Letters

Geoscience Canada

Geotechnical News

Ground Water

Human Organization

Hydrobiologia

Hydrological Processes

Hydrological Sciences Journal

Hydrology and Earth System Sciences

Impact Assessment and Project Appraisal

In Vitro Cellular & Development Biology. Animal

Integrated Environmental Assessments and Management

International Biodeterioration & Biodegradation

International Journal of Applied Earth Observation and Geoinformation

International Journal of Environmental Technology and Management

International Journal of Global Warming

International Journal of Mineral Processing

International Journal of Mining, Reclamation and Environment

International Journal of Technology Management and Sustainable Development

International Review of Hydrology

ISME Journal

Journal of AOAC International

Journal of Applied Ecology

Journal of Applied Microbiology

Journal of Applied Phycology

Journal of Applied Toxicology

Journal of Canadian Petroleum Technology

Journal of Chromatography A

Journal of Colloid Interface Science

Journal of Contaminant Hydrology

Journal of Environmental Assessment Policy and Management

Journal of Environmental Engineering

Journal of Environmental Engineering and Science

Journal of Environmental Informatics

Journal of Environmental Monitoring

Journal of Environmental Quality

Journal of Environmental Science and Health, Part A Toxic/hazardous Substances & Environmental Engineering

Journal of Geotechnical and Geoenvironmental Engineering

Journal of Hazardous Materials

Journal of Hydrology

Journal of Limnology

Journal of Materials Engineering and Performance

Journal of Membrane Science

Journal of Particulate Science and Technology

Journal of Petroleum Technology

Journal of Physical Chemistry A

Journal of Spatial Hydrology

Journal of Sustainable Development

Journal of Sustainable Energy Engineering

Journal of Toxicology and Environmental Health Part A

Journal of Vocational Education and Training

Journal of Wildlife Diseases

Journal of Wildlife Management

Landscape Ecology

Lichenologist

Mass Spectrometry Review

Microbial Ecology

Mining Technology

Mycologia

Mycorrhiza

Natural Resources Research

Nature

Nature Climate Change

New Forests

Northwestern Journal of International Law & Business

Organic Geochemistry

Organization

Pakistan Journal of Engineering and Applied Science

Pedosphere

Pepperdine Policy Review

Petroleum Science and Technology

Photogrammetria

Physics and Chemistry of the Earth

Pipeline & Gas Journal

Plant and Soil

Plant Propagator

PLoS ONE

Policy Options

Practice Periodical on Structural Design and Construction

Proceedings of the National Academy of Sciences

Process Safety and Environmental Protection

Project Management Journal

Rapid Communications in Mass Spectrometry

Reclamation Review

Restoration Ecology

Science

Science of The Total Environment

Separation and Purification Technology

Soil Biology and Biochemistry

Soil Science Society of America Journal

SPE Economics & Management

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy

Stochastic Environmental Research and Risk Assessment

The Canadian Geographer

The Canadian Journal of Chemical Engineering

The Energy Journal

The Journal of Canadian Petroleum Technology

The Wilson Journal of Ornithology

Toxicological & Environmental Chemistry

Toxicological Sciences

Toxicology Letters

Tree Physiology

Trees - Structure and Function

Trees

Vadose Zone Journal

Waste and Biomass Valorization

Waste Management and Research

Water Pollution Research Journal of Canada

Water Quality Research Journal of Canada

Water Research

Water Resources

Water Resources Research

Water Science & Technology

Water, Air & Soil Pollution

Wetlands

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The $100,000 Beetle – *April 16, 2014*

The headline for this Did You Know comes from a 2013 Financial Post article by Peter Foster. As eye-catching as that headline is, the 2014 article by Adam Wilmoth states that Chaparral Energy Inc. spent $6M to trap and relocate six beetles from its CO_2 pipeline route in Oklahoma.

As part of its environmental review of the revised Keystone XL route, the US Fish and Wildlife Service will require TransCanada to relocate American Burying Beetles (*Nicrophorus americanus*) from the right-of-way. Instructions for attracting the beetles include the use of dead rats that weigh 275 g to 374 g (or similar bait items if rats are not available). The beetle has been listed as an Endangered Species since 1989, and is the only one of 23 threatened species in the vicinity of the pipeline route that could be likely adversely affected.

In 2011 environmental groups launched a lawsuit against the US State Department and the Fish and Wildlife Service for allowing TransCanada to move some of the beetles from the proposed right-of-way in the Nebraska Sand Hills. Work was done under a research permit held by Dr. Wyatt Hoback, University of Nebraska Kearney prior to (anticipated) final route approval due to the small window when the beetles can be moved (August to October).

In April 2012 TransCanada filed a revised route that avoided the Sand Hills – thus avoiding prime beetle habitat. That year TransCanada also partnered with Common Ground, LLC and WLLL, LLC to create the 640 hectare American Burying Beetle Conservation Bank to provide conservation credits in Eastern Oklahoma. The conservation bank was approved by the US Fish and Wildlife Service in 2014.

Related Links

Rather than the usual ordering of information by author this information is listed chronologically to help follow the sequence of events.

Starr, P., 2011. Job-creating Keystone Pipeline affects endangered beetle, says State Dep't. cnsnews.com, September 1, 2011.

World-Herald News Service, 2011. Keystone XL pipeline has another 'bug' to work out. Norfolk Daily News, September 4, 2011.

Nunez, C., 2011. Endangered beetle lies in Keystone XL path. National Geographic Great Energy Challenge, October 3, 2011.

Schulte, G., 2011. Conservationists sue to block TransCanada pipeline. Knoxnews.com, October 5, 2011.

Song, L., 2011. Keystone XL firm moved endangered beetles before pipeline's approval. The Guardian, October 7, 2011.

Hammel, P., 2012. Burying beetle safe from pipeline for now. Kearney Hub, January 9, 2012.

Center for Biological Diversity, 2012. Newly obtained government documents suggest lawsuit to protect endangered species may delay Keystone XL Pipeline construction. News release July 31, 2012.

Laskow, S., 2012. Keystone XL's beetlemania. The American Prospect. August 8, 2012.

TransCanada, Common Ground Capital and WLLL, LLC, 2012. Keystone McAlester Conservation Area American burying beetle permittee responsible conservation plan. 29 pp.

Bain, T., 2013. UNK professor works to ensure safety of endangered burying beetle. Daily Nebraskan, April 15, 2013.

BloombergBusinessweek, 2013. TransCanada CEO on beetle along Keystone Pipeline (video). May 31, 2013.

Snyder, J., 2013. Beetle-bedeviled Keystone XL pipeline needs dead rats to let it be. Financial Post, May 31, 2013.

Wray, D., 2013. Rats needed to keep the Keystone Pipeline rolling. Houston Press, June 3, 2013.

Foster, P., 2013. Junk Science Week: Peter Foster on Keystone's $100,000-per-beetle boondoggle. Financial Post, June 11, 2013.

White, M., 2014. Keystone XL Pipeline: 4 animals and 3 habitats in its path. National Geographic Daily News, February 14, 2014.

Common Ground Capital, 2014. Endangered American Burying Beetles have new home in Oklahoma. February 24, 2014.

Wilmoth, A., 2014. New home prepared for endangered beetles. The Oklahoman, February 25, 2014.

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Who's Writing About Oil Sands? – *April 24, 2014*

While the oil sands used to be a relatively low-key, local issue in terms of media interest that is certainly no longer the case. Today one can find oil sands coverage across Canada, in the United States and in a number of other countries.

Not surprisingly pipelines have been a major focus, but issues such as greenhouse gases, proposed mines in the US (Utah and Alabama), rail transport, road shipments in the northwestern US of equipment bound for Alberta (megaloads), the European Fuel Quality Directive, and state-owned enterprises (SOEs) buying up oil sands assets have also been front and center.

The list below of jurisdictions outside of Canada that have been included in our What's New daily news feature clearly shows the extensive interest in oil sands. Some of these may surprise you!

United States

USA Today

Wall Street Journal

Washington Post

Alabama – Times Daily

Alaska – Alaska Dispatch

California – Los Angeles Times

Colorado – Coloradoan

Connecticut – Litchfield County Times

Delaware – University of Delaware – The Review

Florida – Miami Herald

Georgia – Augusta Chronicle

Idaho – Boise Weekly

Illinois – Chicago Tribune

Indiana – Journal Gazette

Iowa – Tama News-Herald

Kansas – Kansas City Star

Maine – The Forecaster

Massachusetts – Boston Globe

Michigan – The Michigan Daily

Minnesota – Duluth News Tribune

Mississippi – Sun Herald

Montana – Missoula Independent

Nebraska – Journal Star

New Hampshire – New Hampshire Union Leader

New York – New York Times

North Dakota – Bismarck Tribune

Ohio – The Blade

Oklahoma – The Oklahoman

Oregon – Oregon Live

Pennsylvania – Philadelphia JournalStar

South Dakota – Argus Leader

Texas – Dallas Observer

Utah – Salt Lake Tribune

Vermont – Vermont Public Radio

Virginia – Virginian-Pilot

Washington – Yakima Herald

Wisconsin – Wisconsin Gazette

Wyoming – Casper Star Tribune

Overseas

Australia – Sydney Morning Herald

China – China Daily

China – China Post

China – South China Morning Post

India – Business Standard

India – The Economic Times

Kazakhstan – Tengri News

Norway – The Foreigner

Oman – Oman Daily Observer

Trinidad & Tobago Guardian

UK – BBC News

UK – Herald Scotland

UK – Muslim News

UK – The Guardian

UK – Wales Online

Yemen Post

Related Articles

Holden, M., 2013. From dead ducks to Dutch disease: The vilification of Canada's oil sands in the media. Canada West Foundation, Calgary, Alberta. 15 pp.

McCarthy, S., 2012. The day the oil-sands battle went global. Globe and Mail, January 21, 2012.

OSQAR, 2011. Oil sands: local or global concern? September 28, 2011.

Paskey, J., G. Steward and A. Williams, 2013. The Alberta oil sands then and now: An investigation of the economic, environmental and social discourses across four decades. OSRIN Report No. TR-38. 108 pp.

Tarsandsworld – Global expansion of tar sands and oil shale

White, B., 2013. Social media as a green virtual sphere: Examining the Alberta oil sands and the Northern Gateway Pipeline on Twitter. Dalhousie University, Dalhousie, Nova Scotia. M.E.S. Thesis. 139 pp.

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Oil Sands Celebrities – *May 8, 2014*

Celebrity – a person who has a prominent profile and commands some degree of public fascination and influence in day-to-day media. The term is often associated with a person who is prominent in a particular field, and is easily recognized by the general public.

High profile people such as Hollywood celebrities, entertainers, media personnel, athletes, ex-politicians, business people, economists, academics and others who are influential have become associated with oil sands issues over the years, generating more publicity than might otherwise have happened. Sometimes groups of well-known people get involved or non-oil sands companies take a stand that generates media attention. Occasionally some celebrities are just dragged into the fray.

Following are some media examples of high profile people from our What's New daily news feature:

Macleans – James Cameron in Alberta's oil sands

CBC News – Examining 5 oil sands claims by Daryl Hannah

CTV News – Robert Redford slams Alberta's oil sands

Hollywood Reporter – Neve Campbell joins Alberta oil sands fight

Bloomberg – Jared Leto versus Chuck Norris: Celebrities battle over Keystone

Edmonton Journal – Seinfeld's Elaine calls project 'very, very dangerous'

Edmonton Journal – Neil Young's comments attacking oil sands, Harper government spark outrage, support

Global Edmonton – Paul Simon lends voice to B.C. group's anti-pipeline commercial

Huffington Post – Rex Murphy's oil sands speeches prompt CBC ethics review

Fort McMurray Today – Levant promotes 'oil sands pride'

Vancouver Observer – McKibben, Suzuki, Berman and Klein to lead anti-pipeline sit in

Globe and Mail – Georges Laraque wants to fight the tar sands

Fort McMurray Today – Fort Chipewyan cancers "an ongoing tragedy": O'Connor

CBC News – David Schindler – Five decades of doing science, advocating environmental policy

CBC News – Peter Lougheed opposes Keystone pipeline

Maclean's – Brian Mulroney says Canada needs foreign investment for future growth

Huffington Post – Jimmy Carter becomes first U.S. ex-President to urge Keystone rejection

Edmonton Journal – Time to 'embrace' Keystone XL: Bill Clinton

CTV News – Al Gore's oil sands comments 'over the top'

Financial Post – Warren Buffett's Suncor stake may be 'turning point' for oil sands stocks

BloombergBusinessweek – Billionaire Steyer criticizes oil export in anti-Keystone ad

Toronto Sun – Donald Trump fired up over Keystone pipeline delays

Maclean's – Rubin, oil sands, and the bitumen bubble

Homerdixon.com – The tar sands disaster

CNW – Mintz report praises Alberta's oil sands royalty system - but conventional investment tax burden is high

Guardian – Desmond Tutu tells David Cameron tar sands threaten health of the planet

Foreigner – Stavanger bishop threatens Statoil share withdrawal

Macleans – Prominent U.S. Keystone critic Robert F. Kennedy Jr. to visit oil sands

Royal Society of Canada – Environmental and health impacts of Canada's oil sands industry

Globe and Mail – Nobel laureates jump into Keystone fray

Financial Post – Nobel group expects to hear both sides before condemning oil sands

Fort McMurray Today – Oil sands undermine women and children: Nobel Peace Prize laureate

Vancouver Observer – Over 100 scientists and economists call for rejection of Keystone XL pipeline

CBC News – U.S. scientists oppose pipeline

CBC News – Churches speaking out on Northern Gateway pipeline project

CBC News – Students tell province their thoughts on the oil sands

Toronto Star – Avon plans to avoid oilsands-derived fuel

Toronto Star – Lush Cosmetics joins campaign against Enbridge oil pipeline

CTV News – Oil sands lobbyists stick with Chiquita 'boycott' claim

Related Links

Annesley, J., 2013. Celebrity opposition to Keystone XL, heavy on drama, light on facts. TransCanada guest blog.

Coutu, M., 2013. Celebrity critics add entertainment value to oil sands discussion. Vancouver Sun, October 4.

Harper, T., 2011. Celebrity protesters blur the Canadian oil sands message. Toronto Star, September 1.

Mason, G., 2013. Hollywood vs. oil sands? Not a fair fight. Globe and Mail, September 20.

OSQAR – Celebrity involvement in the energy debate: style or substance?

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Oil Sands Dinosaurs – *May 28, 2014*

Given our fascination with dinosaurs it's no surprise that when one is discovered at a mine site the news spreads rapidly.

The majority of dinosaurs unearthed in the oil sands region have come from Syncrude, though there have been two discoveries at Suncor. Finds to date include an ankylosaur, an ichthyosaur (given the scientific name *Athabascasaurus bitumineous*), a nodosaur, and a plesiosaur (the 10th fossil discovered at Syncrude;).

An elasmosaur was discovered in 2012 at the Parsons Creek interchange on Highway 63 just north of Fort McMurray.

Paleontologists from the Royal Tyrrell Museum of Paleontology have worked with Syncrude to develop a pamphlet for heavy equipment operators on what to watch for (often paler yellow materials against the darker rock).

All specimens become property of the Alberta government and many are on display at the Museum.

Note: Strictly speaking, to the experts, the majority of fossils found in the oil sands are marine reptiles, not dinosaurs (Suncor's ankylosaur being an exception).

Related Links

Alberta Venture, 2011. Energy Industry helps build the Royal Tyrrell Museum's collection. February 19.

Chandler, G., 2014. Dinosaurs in the mines. Alberta Oil, May 19.

Gordon, J., 2011. Rare dinosaur found in Canada's oil sands. Reuters Canada, March 25.

Graveland, B., 2011. Alberta oil sands yield treasure trove of ancient fossils. Globe and Mail, November 24.

InfoMine, 2011. Rare dinosaur fossil found in Alberta oil sands (video)

OSQAR, 2011. Why four year olds think we're cool. Suncor Energy, April 15.

Phys.org, 2011. Oil sands digger uncovers dinosaur. November 24.

Red Orbit, 2011. Canadian 'sands of time' hold dinosaur bones. March 26.

Suncor Energy, 2011. Discovery of Ankylosaur at Suncor Energy's Millennium Mine (video).

Syncrude, 2008. Syncrude fossil named in honour of scientist. Synergy, Issue 1, July.

Syncrude, 2010. Dinosaur discovered at Syncrude receives its name. Synergy, Issue 12, December.

Syncrude, 2011. Syncrude operator unearths rare fossil. Syncrude Canada Limited, News Release, November 24.

University of Calgary, 2008. Ancient reptile rises from Alberta oil sands: Dinosaur-era sea creature unearthed at Syncrude mine. ScienceDaily, 20 March.

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Predicting Long-term Oil Sands Production Levels – *June 13, 2014*

In a September 2013 Did You Know we discussed company projections of annual oil sands production (Predicting Oil Sands Production Levels).

The Canadian Association of Petroleum Producers, one of several organizations that predict production far into the future, recently issued a revised forecast that saw a 400,000 barrels-per-day reduction in expected production by 2030. In this article we examine the projections of the Alberta Energy Regulator (previously Energy Resources Conservation Board), Canadian Association of Petroleum Producers, National Energy Board and Canadian Energy Research Institute (CERI).

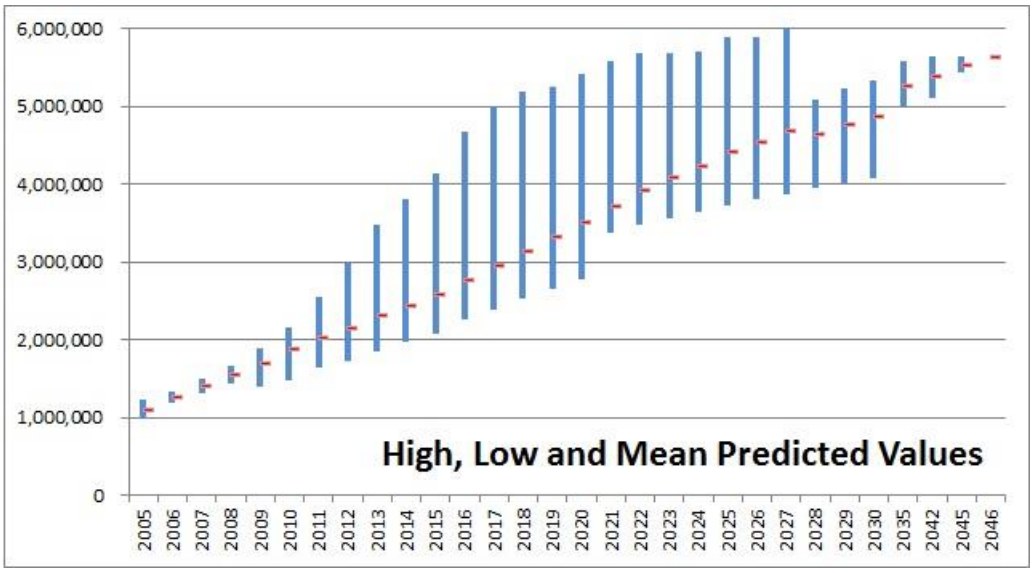
The attached table provides a summary of production predictions made starting in 2004 up to and including 2014; the predictions go out as far as 2046 but most end by 2030. Some of the organizations use various scenarios to produce multiple predictions; we used the middle-of-the-road version in this analysis. It is important (and interesting) to read the assumptions that are built into the projections – each organization uses different ones thus the different predictions.

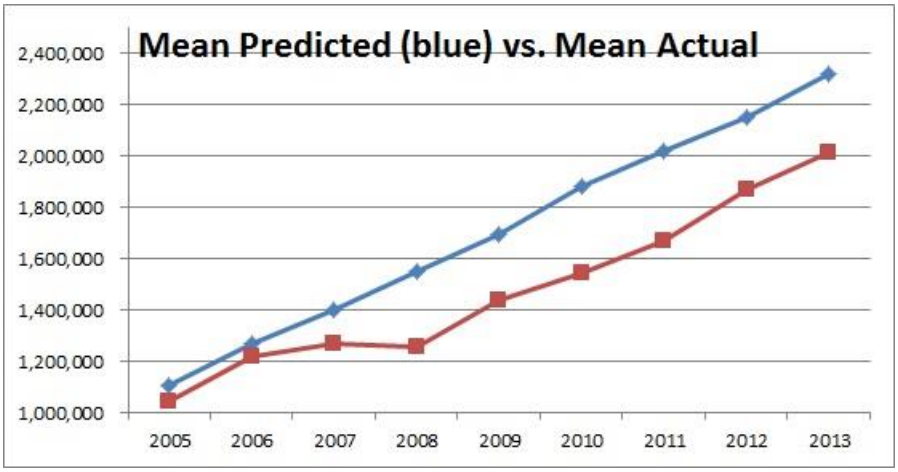
Some interesting observations on the data:

- Each organization reports slightly different data so it is not strictly correct to compare numbers between organizations (but the comparative trends are useful); this is likely in part why Actual Production values (shown in yellow highlights) vary considerably between organizations!
- It appears that predictions get better the closer they are made to actual production (see for example the 2013 predictions made from 2004 to 2011 vs. ones made in 2012 and 2013; this makes sense as the latter have more current assumptions built into the predictions
- The widest spread in predicted production occurs in 2018 at 2,652,000 barrels/day
    - low of 2,532,000 barrels/day – NEB 2009 prediction
    - high of 5,184,000 barrels/day – CERI 2006 prediction
- There are prediction data covering 2013 to 2022 from all four agencies in the 2013 reports. Looking at the average predicted production levels (barrels/day):
    - ERCB was highest (3,005,390)
    - NEB next (2,956,000);
    - then CAPP (2,768,900) and finally
    - CERI (2,637,257).
- The highest production (6,024,000 barrels/day in 2027) occurs in CERI's 2006 prediction; the lowest production that year is 3,878,000 barrels/day in the NEB's 2007 prediction

- The lack of expanding production in 2008 demonstrates the impacts of the financial crisis

The following figures show the range of predictions (high, low and mean) over the time period and the difference between predictions and actual production for the period 2005 to 2013. The second chart clearly shows that actual production is consistently below the predictions (in 2011 they were off by 347,790 barrels/day).





Related Links

The following sources were used:

Canadian Association of Petroleum Producers

2004 Canadian Crude Oil Production and Supply Forecast 2004 – 2015

2005 – Canadian Crude Oil Production and Supply Forecast 2005 - 2015

2006 – Canadian Crude Oil Production and Supply Forecast 2006 - 2020

2012 – Crude Oil Forecast, Markets & Pipelines.
http://www.strategywest.com/downloads/CAPP201206.pdf

2013 – Crude Oil Forecast, Markets & Transportation

2014 – 2014 CAPP Crude Oil Forecast, Markets & Transportation.
http://www.capp.ca/getdoc.aspx?DocId=247759&DT=NTV

Canadian Energy Research Institute

2004 – Oil Sands Supply Outlook: Potential Supply and Costs of Crude Bitumen and Synthetic Crude Oil in Canada 2003-2017

2006 – Oil Sands Industry Update: Production Outlook and Supply Costs 2006-2020

2007 – Canadian oil sands supply costs and development projects (2007-2027)

2011 – Canadian oil sands supply costs and development projects (2010-2044)

2012 – Canadian oil sands supply costs and development projects (2011-2045) plus data files

2013 – Canadian oil sands supply costs and development projects (2012-2046) plus data files

Energy Resources Conservation Board / Alberta Energy Regulator

ST98-2006 http://www.aer.ca/documents/sts/ST98/ST98-2006.pdf

ST98-2007 http://www.aer.ca/documents/sts/ST98/st98-2007.pdf

ST98-2008 http://www.aer.ca/documents/sts/ST98/st98-2008.pdf

ST98-2009 http://www.aer.ca/documents/sts/ST98/st98-2009.pdf

ST98-2010 http://www.aer.ca/documents/sts/ST98/st98_2010.pdf plus appendix

ST98-2011 http://www.aer.ca/documents/sts/ST98/st98-2011.pdf plus appendix

ST98-2012 http://www.aer.ca/documents/sts/ST98/ST98-2012.pdf plus appendix

ST98-2013 http://www.aer.ca/documents/sts/ST98/ST98-2013.pdf plus appendix

ST98-2014 http://www.aer.ca/documents/sts/ST98/ST98-2014.pdf plus appendix

National Energy Board

2006 – Canada's oil sands: Opportunities and challenges to 2015: An update

2007 – Canada's energy future: Reference case and scenarios to 2030. Appendices http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2007/nrgyftr2007ppndc-eng.pdf

2009 – 2009 Reference Case Scenario: Canadian Energy Demand and Supply to 2020. Appendices http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2009/rfrnccsscnr2009ppndc-eng.pdf

2011 – Canada's energy future 2013: Energy supply and demand projections to 2035. http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2011/nrgsppldmndprjctn2035-eng.pdf

2013 – Canada's energy future 2013: Energy supply and demand projections to 2035. Appendices http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2013/ppndcs/pxlprdctn-eng.html

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Tailings Terminology – *June 25, 2014*

It used to be that *tailings* (mineral waste from an oil sands processing plant usually deposited in a water medium) was the only technical term you needed to know to be fluent in oil sands waste management; actually back up a bit earlier and the word was *sludge*. However, an increased understanding of the complex nature of tailings, plus the advent of a multitude of treatment technologies applied to specific components of the overall tailings stream resulted in a large suite of tailings terms, accompanied by an alphabet-soup of acronyms.

The list below is compiled from sources listed in the Related Links section.

Term	Acronym	Definition
Tailings		
Cyclone Overflow Tailings	COT	A low density, fines-rich product from the overflow of hydrocycloned tailings.
Cycloned Sand Tailings Cyclone Underflow Tailings	CST CUT	A dense low-fines sandy product from the underflow of hydrocycloned tailings.
Composite / Consolidated Tailings	CT	Composite (Syncrude) or consolidated (Suncor) tailings are formed by injecting mature fine tailings from the tailings pond into the regular (whole) tailings sand stream, with a flocculant such as gypsum.
Fluid Fine Tailings	FFT	Any fluid discard from bitumen extraction facilities containing more than 1 mass per cent suspended solids and having an undrained shear strength of less than 5 kPa.
Froth Treatment Tailings	FTT	Tailings produced from the froth treatment plant. Solvents are used in the froth treatment plant thus the tailings will have residual solvent content.
Legacy Tailings		Tailings previously deposited into tailings ponds or other disposal areas (as of a certain date).
Mature Fine Tailings	MFT	Tailings that have reached a solids content of about 30% (by mass) – approximately one or two years after being deposited as fluid fine tailings.
Tailings Sand Coarse Sand Tailings	TS CST	A byproduct of oil sands extraction comprised of sands, process water, and minor amounts of fine particles and residual bitumen; oil sands with the bitumen removed.

Thin Fine Tailings	TFT	The very low density suspension of fine silts, clays, residual bitumen and water in the tailings pond after sand has settled out.
Thickened Tailings	TT	Tailings that have been significantly dewatered to a point where they will form a homogeneous non-segregated mass when deposited from the end of a pipe.
Thickener Underflow Tailings	TUT	Sedimented tailings stream (>30% solids) produced at the bottom of a thickener vessel. Thickeners use addition of chemicals to aid in flocculating the fines solids and producing water that is suitable for reuse back to the extraction process with little loss of process water temperature
Whole Tailings		Unaltered tailings that come directly from an extraction plant. Whole tailings is sometimes referred to as coarse tailings.
Tailings Water		
Oil Sands Process-Affected Water Process-Affected Water	OSPW PAW	Water that has been altered in chemical composition by activities associated with oil sands mining and/or processing; includes raw tailings water, dyke seepage, process water, and water released from tailings.
Tailings Storage		
Beach Above Water	BAW	The tailings sitting on a slope above the water line in a tailings pond or disposal area.
Beach Below Water	BBW	The tailings sitting on a slope below the water line in a tailings pond or disposal area.
Dedicated Disposal Area	DDA	An area dedicated solely to the deposition of captured fines using a technology or a suite of technologies. The material deposited each year must achieve a minimum undrained shear strength of 5 kPa within one year of deposition.

Tailings Pond External Tailings Area External Tailings Disposal Area External Tailings Facility	 ETA ETDA ETF	Man-made impoundment structures containing tailings; usually aboveground as they are constructed before mining begins but may later be placed in-pit once space is available. Tailings ponds are enclosed by dykes made with tailings and/or other mine waste materials to stringent geotechnical standards. Their function is to store solids and water and to act as a settling basin to clarify process water so it may be reused.
Tailings Management		
Accelerated Dewatering	AD	The deposition of a large volume of mature fine tailings in a dedicated cell and the subsequent use of evaporation and rim ditching to accelerate dewatering to create a final deposit of suitable density to support dry landscape reclamation.
Atmospheric Fines Drying (Shell) Tailings Reduction Operations (Suncor)	AFD TRO	Depositing tailings treated with chemicals in thin lifts and allowing the lifts to desiccate (remove moisture) by evaporative drying. Promotion of natural drying is often considered the most cost-effective means of dewatering fine-grained material.
Base Mine Lake	BML	A test site at Syncrude's Mildred Lake facility to demonstrate the effectiveness of the water-capped fine tailings disposal option.
Cross Flow Filtration	CFF	The tailings are passed across the filter membrane (tangentially) at positive pressure relative to the permeate side. A proportion of the material which is smaller than the membrane pore size passes through the membrane as permeate or filtrate; everything else is retained on the feed side of the membrane as retentate. With cross-flow filtration the tangential motion of the bulk of the fluid across the membrane causes trapped particles on the filter (cake) surface to be rubbed off. This means that a cross-flow filter can operate continuously at relatively high solids loads without blinding.

Filtered Tailings		Tailings that are processed by a technology involving mechanically dewatering by filtration (typically under pressure or vacuum). The tailings become unsaturated and are either conveyed or trucked to a disposal area.
In-line Flocculation and Thin Lift Dewatering	ILFTLD	Mature fine tailings is pumped from a tailings pond, injected with a chemical amendment to cause thickening ("in-line", i.e., in a pipe), and then deposited in thin lifts in a cell. The deposited material then dewaters through a combination of sedimentation, shear during flow down a beach, and under drainage, with additional environmental effects (drying) to increase solids content over time.
In-Line Thickened Tailings	ILTT	Injecting and mixing flocculants and coagulants into the high fines content cyclone overflow tailings (COT) in an in-line multi stage fashion to improve settling, consolidation, and strength behaviour of COT.
Non-Segregating Tailings	NST	A combination of sand and thickened tailings, (or, as a variation, from a blend of cyclone underflow, thickener underflow and mature fine tailings, using CaO and/or CO_2 as coagulants). Called non-segregating because the coarse and fine particle are intended to remain together.
Spiked Tailings	ST	Injecting mature fine tailings (as a replacement for water) into a fresh tailings stream to form a slurry with a high fines content.
Thin Lift Dewatering Thin Lift Drying	TLD	Treated tailings placed in thin lifts in a cell or on a slope to promote runoff and subsequent drying. Once dry another lift can be placed and the process repeated.
Tailings Measurement		
Sand to Fines Ratio	SFR	The mass of dry sand (>44 μm) to the mass of dry fines (<44 μm).
Solids Content		Ratio of the mass of dry solids to total mass of tailings, expressed as a percentage.

Trafficable Deposit		A deposit typically created through a process involving self-weight consolidation, drying, enhanced drainage, and/or capping with minimum undrained shear strength of 5 kPa one year after deposition. The trafficable surface layer must have a minimum undrained shear strength of 10 kPa five years after active deposition.

Related Links

BGC Engineering Inc., 2010. Oil Sands Tailings Technology Review. OSRIN Report No. TR-1. 136 pp. http://hdl.handle.net/10402/era.17555

Energy Resources Conservation Board, 2009. Directive 074: Tailings performance criteria and requirements for oil sands mining schemes. Energy Resources Conservation Board, Calgary, Alberta. 14 pp. http://www.aer.ca/documents/directives/Directive074.pdf

OSRIN, 2010. Glossary of Terms and Acronyms used in Oil Sands Mining, Processing and Environmental Management – December 2013 Update. OSRIN Report No. SR-1. 123 pp. http://hdl.handle.net/10402/era.17544

Sobkowicz, J., 2012. Oil sands tailings technology deployment roadmaps. Project Report Volume 1 - Project summary. Alberta Innovates - Energy and Environment Solutions, Edmonton, Alberta. 60 pp. plus appendices. http://www.ai-ees.ca/media/7375/1906-project_summary_report.pdf

Tailings.info – Deposition methods of tailings

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Oil Sands Mine GHG Emissions – *July 4, 2014*

In April 2013 we profiled the Oil Sands Contributions to National Greenhouse Gas Production. In this update we look at the individual company contributions.

Alberta regulates greenhouse gas (GHG) emissions of large final emitters (LFEs – those emitting more than 100,000 tonnes/year) through the Climate Change and Emissions Management Act and two regulations – the Specified Gas Emitters Regulation and the Specified Gas Reporting Regulation. Producing oil sands mines qualify as LFEs and thus report emissions.

Alberta requires facilities that emit more than 100,000 tonnes of greenhouse gases a year to reduce emissions intensity by 12 per cent, as of July 1, 2007. Companies have four choices to be in compliance:

- Make improvements to their operations
- Purchase Alberta-based offset credits
- Contribute to the Climate Change and Emissions Management Fund ($15/tonne; approximately $86M paid by all companies in 2012)
- Purchase or use Emission Performance Credits

The government produces annual reports on the emissions of LFEs (NOTE: since 2010 reporting rules changed to include facilities emitting more than 50,000 tonnes/year); the emission numbers are produced by reporting industries according to the requirements in the Specified Gas Reporting Standard. GHG emissions are reported as CO_2e (carbon dioxide equivalent) levels – the sum of CO_2 emissions plus methane (CH_4) and nitrous oxide (N_2O) and three other gases which are not common in oil sands operations (hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride).

The following table and chart show the reported emissions of oil sands mining operations from 2003 to 2011.

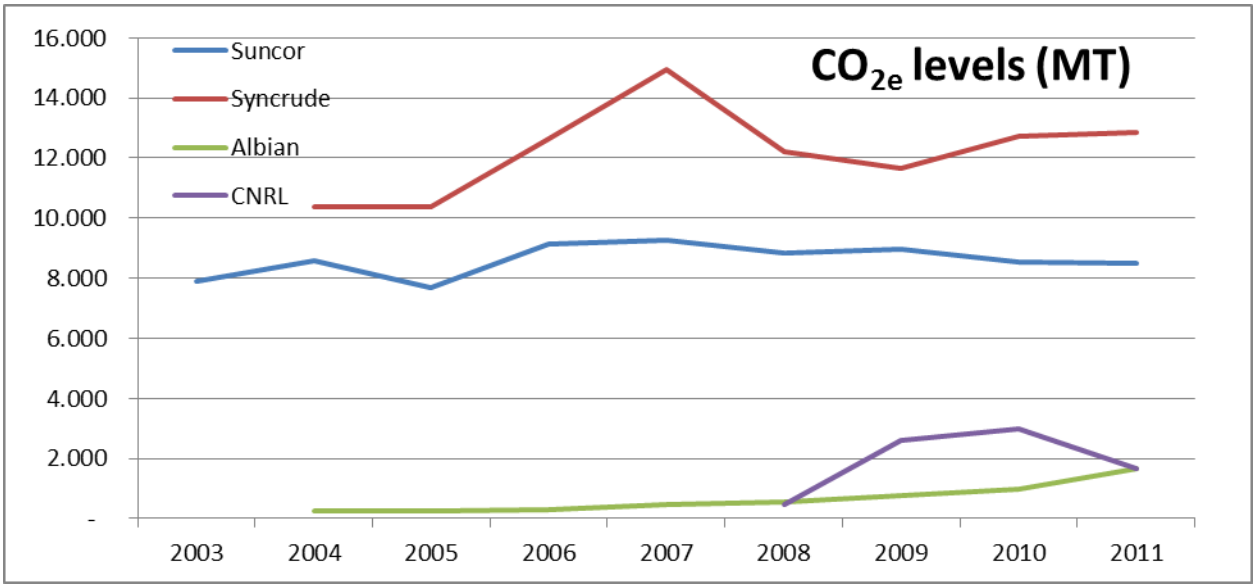
MT CO_2e/year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Suncor	7.902	8.599	7.694	9.132	9.261	8.822	8.948	8.555	8.496
Syncrude Base Mine and Aurora		10.367	10.357	12.620	14.937	12.227	11.666	12.708	12.860
Albian (Shell) Muskeg River		0.255	0.247	0.274	0.480	0.567	0.746	0.987	1.677
CNRL Horizon						0.444	2.593	2.988	1.651
TOTALS	7.902	19.221	18.298	22.026	24.678	22.060	23.953	25.238	24.685

NOTES:

MT – mega tonnes or million tonnes

Syncrude and Albian data were deemed confidential in 2003

Albian (Shell) Muskeg River values include Jackpine and Muskeg River Mine Expansion data in 2010 and 2011



Some interesting points about the emissions to note:

- In 2012, oil sands (mining, in-situ and upgrading) accounted for 22% of the province's 249 MT emissions; in 2011 oil sands emissions of 55 MT accounted for 23% of Alberta emissions (7.8% of Canada and less than 0.15% of global emissions)
- In 2011, CO_2 accounted for 96.1% of provincial emissions, methane 2.7% and N_2O 1.2%; for the oil sands mines CO_2 accounted for 93.2% of the 24,684 MT CO_2e, methane 5.5% and N_2O 1.3%; one potential source of methane is the tailings ponds
- Environment Canada (p. 20, Table 3) projects emissions from the oil and gas sector (dominated by oil sands) to increase from 160 MT in 2005 to 204 MT in 2020, the largest increase of all sectors
- Syncrude is the largest mining emitter, ranging from a low of 48.7% of reported emissions in 2009 to a high of 60.5% in 2007
- Syncrude also reports GHGs as tonnes CO_2e/barrel produced; for the years 2008 to 2012 the levels are: 0.095, 0.097, 0.102, 0.106 and 0.101
- Suncor's 2013 Report on Sustainability indicates production of 9.204 MT of CO_2e in 2012
- In their annual Oil Sands Performance Report, Shell provides data for direct (the release of specified gases from sources under the direct control of the operating facility expressed in tonnes CO_2e) and indirect (emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by

another entity) emissions from their Jackpine and Muskeg River mines. The values in the table above correspond closely, but not exactly, to the direct emissions. For 2012 the values are 1.73 MT direct and 1.21 MT indirect. For 2013 the values are 1.48 MT direct and 1.34 MT indirect.

- Syncrude paid $14M in 2012 to the Climate Change and Emissions Management Fund
- Not surprisingly, emission levels parallel production levels
- When looking at CO_2e numbers it is important to understand the methods used to calculate the numbers and what components of the operation are included; for example, Syncrude reports 2012 CO_2e levels as 12.336 MT based on Environment Canada methodology and 10.667 based on Alberta's *Specified Gas Emitters Regulation*
- In addition to mine operations, associated power plants (co-generation facilities) are also subject to the regulations; production data are available in the Oil Sands Information Portal

Related Links

Alberta Environment, 2005. Alberta Greenhouse Gas Reporting Program for 2003 – Analysis. 36 pp.

Alberta Environment, 2006. Specified Gas Reporting: Alberta's 2004 Industrial Greenhouse Gas Emissions. 32 pp.

Alberta Environment, 2007a. Alberta Environment Summary Report on 2005 Greenhouse Gas Emissions. 33 pp.

Alberta Environment, 2007b. Alberta Environment Report on 2006 Greenhouse Gas Emissions. 71 pp.

Alberta Environment, 2008. Alberta Environment Report on 2007 Greenhouse Gas Emissions. 43 pp.

Alberta Environment, 2010. Alberta Environment: Report on 2008 Greenhouse Gas Emissions. 36 pp.

Alberta Environment, 2011. Alberta Environment: Report on 2009 Greenhouse Gas Emissions. 27 pp. Data table

Alberta Environment and Sustainable Resource Development, 2012. Alberta Environment and Sustainable Resource Development: Report on 2010 Greenhouse Gas Emissions. 26 pp. Data table

Alberta Environment and Sustainable Resource Development, 2013. Alberta Environment and Sustainable Resource Development: Report on 2011 Greenhouse Gas Emissions. 27 pp. Data table

Alberta Environment and Sustainable Resource Development, 2014a. Greenhouse Gas Reporting Program

Alberta Environment and Sustainable Resource Development, 2014b. Specified Gas Reporting Standard. 15 pp.

Canada's Oil Sands Innovation Alliance, n.d. GHG roadmap.

Canadian Association of Petroleum Producers, 2012. Air emissions in Canada's oil sands.

Dyer, S., 2013. Strengthening Alberta's greenhouse gas regulations. Pembina Institute Briefing Note.

Environment Canada, 2012. Canada's emissions trends 2012. 66 pp.

Environment Canada, 2014. National Inventory Report 1990–2012: Greenhouse gas sources and sinks in Canada. Executive summary. 11 pp.

Evans, R.L. and T. Bryant, 2013. Trottier Energy Futures: Greenhouse gas emissions from the Canadian oil and gas sector. Trottier Energy Futures Project. 33 pp.

Government of Alberta, n.d. Greenhouse gases

Government of Alberta, 2004. Specified Gas Reporting Regulation. AR 251/2004. 6 pp.

Government of Alberta, 2007. Specified Gas Emitters Regulation. AR 139/2007. 24 pp.

Government of Canada, 2013. GHG emissions

Sawyer, D. and D. Beugin, 2013. Oil and gas greenhouse gas regulations: The implications of alternative proposals. International Institute for Sustainable Development Policy Brief.

Suncor Energy, 2013. Greenhouse gas emissions: The path forward

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Oil Sands Mine Costs – *July 23, 2014*

Environmental impact assessment (EIA) reports provide information on the expected costs to build and operate oil sands mines and any associated plant facilities. These figures are then used in the socio-economic assessment component of the EIA to show how the project will provide economic benefits locally, provincially and nationally through employment, purchases, taxes and royalties.

We extracted expenditure and production figures from EIAs for new projects and for expansion projects and tabulated them (see data table at end of this section) to see how they compare. The figures reported here should be taken as ballpark numbers to show gross similarities and differences between projects and over time, not exact values to be relied on. In many instances the figures had to be extrapolated (e.g., barrels per day to lifetime production) and so are subject to error. In addition, many of the reports provide rounded cost estimates (often to the nearest $1M), again resulting in errors. Some EIAs indicated whether certain cost components were included or excluded (e.g., sustaining capital) while others did not specify what was included so the costs are not directly comparable.

Finally, it is important to note that the figures here represent the estimated costs at the time of EIA submission. Actual costs are likely to vary (usually increase) for a number of reasons, including: inflation from the time the project is proposed until it is actually built, project changes resulting from the regulatory process, project changes and delays that occur during construction, and inflation over the life of the project. For example, the Imperial Kearl construction cost was estimated at $5.5B in 2005 but ended up closer to $12.9B when finally built in 2013.

With those caveats in mind, there are some interesting observations to be made about the data:

- Not surprisingly, projects with upgraders (i.e., those producing synthetic crude oil – SCO) are more expensive to build and operate than those producing bitumen on a per barrel basis; the last SCO project (CNRL Horizon) was proposed in 2002
- Recent projects are considerably more expensive to build and operate than earlier projects (e.g., $36/bbl for the 2011 Teck Frontier project vs. $20/bbl for the 2007 Shell Pierre River project and $5 for the 1996 Syncrude Aurora project). Compare these values to the Canadian Energy Research Institute estimate of current plant-gate supply costs of $71.81 for stand-alone mine (bitumen) and $107.57 for an integrated mine (SCO)
- Again, not surprisingly, converting total costs to 2013 dollars using inflation factors based on Alberta CPI data (supplied by the Alberta Energy Regulator) results in major cost increases for the earliest projects (especially 1978's Alsands project which goes from $38.8M to $125M resulting in a per barrel cost of $99.18)
- Operating costs are greater than construction costs (even though it is the latter that receive media attention), in some cases by a considerable margin; operating costs will depend to a large extent on the size and complexity of the project and its lifespan

- Expansion projects are not necessarily less costly than new projects on a per barrel basis
- Some of the EIAs reported US oil price figures (WTI) within which the project was deemed viable, or that were used in estimating future revenues – these ranged from a low of $14.88/bbl in 1978 to $40/bbl in 2006 – leaving considerable room for profit

September 26, 2014 Update – A 1962 report by the Oil and Gas Conservation Board provides capital cost estimates from both Great Canadian Oil Sands and the Board ranging from $100.7M to $111.04M to produce 11.5 M bbl/yr (depending on assumptions). Working capital estimates range from $11.4M to $15.1M. The company estimated price of synthetic crude oil delivered in Edmonton would be $2.713/bbl.

Oil and Gas Conservation Board, 1962. Supplemental report to the Lieutenant Governor in Council with respect to the application of Great Canadian Oil Sands Limited under Part VI A of the Oil and Gas Conservation Act. Oil and Gas Conservation Board, Calgary, Alberta. 48 pp. plus appendix.

Related Links

Financial Post – Energy majors in Western Canada brace for rising labour, capital costs

Financial Post – Total SA suspends $11B Joslyn oil sands mine in Alberta, lays off up to 150 staff

Globe and Mail – Oil sands firms move on cutting costs

Globe and Mail – Oil sands crippled by soaring costs, memo says

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Company	Project	EIA Year	Product	Capital Cost (Capex)($M)	Operating Cost (Opex)($M)	Total Cost ($M)	Barrels per Day (bpd)	Barrels (millions)	Total cost/ total barrels	Total Cost 2013 dollars	2013 total cost/barrel	Viability ($US)
Syncrude	Mildred Lake	1973	SCO	$410			125,000	1,141				
Alsands	Alsands	1978	SCO	$5,941	$32,868	$38,809	140,000	1,260	$31	$124,964.98	$99.18	14.88
Solv-Ex	Solv-Ex	1995	PCO	$169	$275	$444	10,529	21	$21	$674.73	$32.00	16.77
CNRL	Horizon	2002	SCO	$8,000	$32,978	$40,978	233,000	3,428	$12	$52,861.79	$15.42	18-22
Syncrude	Aurora	1996	Bitumen	$2,000	$20,000	$22,000	400,000	4,782	$5	$32,780.00	$6.86	18
Shell	Muskeg River	1997	Bitumen	$1,200	$5,640	$6,840	150,000	1,100	$6	$9,986.40	$9.08	
Suncor	Fort Hills	2001	Bitumen	$2,248	$13,080	$15,328	190,000	2,259	$7	$20,386.11	$9.02	
Shell	Jackpine - Phase 1	2002	Bitumen	$2,000	$7,200	$9,200	200,000	1,460	$6	$11,868.00	$8.13	18-20
Imperial	Kearl	2005	Bitumen	$5,500	$50,000	$55,500	300,000	4,407	$13	$66,045.00	$14.99	
Total	Joslyn North	2006	Bitumen	$1,970	$9,000	$10,970	100,000	890	$12	$12,615.50	$14.18	
Synenco	Northern Lights	2006	Bitumen	$1,700	$9,604	$11,304	114,500	1,170	$10	$12,999.60	$11.11	40
Shell	Pierre River	2007	Bitumen	$12,667	$13,090	$25,757	200,000	1,302	$20	$28,074.80	$21.56	
Teck	Frontier	2011	Bitumen	$23,000	$77,000	$100,000	277,300	2,800	$36	$103,000.00	$36.79	

Notes

Syncrude Mildred Lake - SCO plus 5,500 bpd residual fuel; $500M Capex if utility plant and pipelines included; Opex for first full year production (1977) $80M
Solv-Ex - 7-year experimental project; product is Pipelineable Crude Oil (PCO); also produce minerals (alumina, potassium sulphate and ferrous sulphate)
Alsands - Capex is $4.9B for first oil; additional Capex to get to full production
CNRL - three phases; 270,000 b/d bitumen; Opex based on mid range of costs/bbl; actual Capex reported to be $10.3B
Syncrude Aurora - 4 stages (2 North and 2 South) of 100,000 bpd each, starting in 2001, 2005, 2008 and 2015; additional $1B sustaining capital cost from 2002 to 2035
Shell Muskeg River - mid-range of Opex range $225M/yr to $300M/yr used
Suncor Fort Hills - originally filed by True North; actual Capex reported to be $2.99B
Shell Jackpine - Capex listed as "over" $2B; Opex excludes energy costs
Imperial - used mid-range of cost range provided ($4.5B to $6.5B = $13,043/bbl to $18,841); expected production 300,000 b/d but application for 345,000 b/d
Total - originally filed by Deer Creek; Capex costs increased to $2.9B in project update information in 2007
Shell Pierre River - used 2/3 of mid-range of costs for combined 300,000 bbl Pierre River and Jackpine Mine Expansion ($15B to $23B)
Teck - Opex includes sustaining capital
Viability = provided as a range within which the project makes sense or a single value used in project benefit calculations

Expansion Projects

Company	Project	EIA Year	Product	Capital Cost (Capex)($M)	Operating Cost (Opex)($M)	Total Cost ($M)	Barrels per Day (bpd)	Total Barrels (millions)	Total cost/ total barrels	Total Cost 2013 dollars	2013 total cost/barrel	Viability ($US)
Suncor	Steepbank	1996	SCO	$336	$6,400	$6,736	107,000	1,172	$6	$10,036.64	$8.57	
Suncor	Project Millennium	1998	SCO	$2,000	$7,125	$9,125	80,000	876	$10	$13,231.25	$15.10	
Suncor	North Steepbank Extension	2005	Bitumen	$350			180,000	653				28
Albian	Muskeg River Mine Expansion	2005	Bitumen	$2,280	$8,575	$10,855	120,000	2,500	$4	$12,917.45	$5.17	24-28
Shell	Jackpine Mine Expansion	2007	Bitumen	$6,333	$10,400	$16,733	100,000	3,692	$5	$18,239.30	$4.94	

Notes

Suncor North Steepbank Extension - Opex given for mine plus upgrader

Mine Closure – What Does it Mean for Oil Sands? – *August 14, 2014*

The subject of mine closure has been receiving increasing attention from planners, reclamation specialists, regulators and the public. For example:

- the 9th International Mine Closure Conference is being held in South Africa in October 2014
- Wikipedia has a closure page
- LinkedIn has a mine closure discussion group

Although complete closure of an oil sands mine or plant site is not likely for many decades, engaging stakeholders in early closure discussions and planning requires a clear, plain language, description of terminology and process(es).

See below (closure terminology section) for an overview, from a variety of documents, describing what closure is, what steps it includes and when in the life cycle of a mine it occurs. It is evident that there is no consistent definition of closure and therefore there is a need for an Alberta-specific description to allow for informed discussion between industry, regulators and stakeholders.

The Figure below is a compilation of the closure process steps from the literature translated into Alberta language (based on current legislation, policies, and past/current practices). Some things to consider when reviewing the Figure:

- This is the "lumpers" version of the process; "splitters" will want to break each hexagon into a multitude of steps, often with their own regulatory process and policies
- The Lease Cancellation box is lighter blue because it is not included in Alberta's State of the Environment indicator for oil sands mining development and reclamation, which ends at Certified. This is likely a reflection of the indicator's focus on *Environmental Protection and Enhancement Act* responsibilities, but may also reflect a view that certification implies the site is closed – the remaining step(s) are land management issues.
- The process steps are regulated under several pieces of provincial legislation, creating some potential for confusion and conflict. Creation of the Alberta Energy Regulator should help to ensure consistency of approach.

Some things to consider in developing the Alberta-specific language:

- Does closure only apply to an entire operation (e.g., the entire approval), or can a part of an operation (e.g., a landform or the mine separate from the plant) reach closure? For example, is Syncrude's S4 Dump, also called Gateway Hill, considered "closed", given that it has been certified?
- How does the concept of progressive reclamation impact closure definitions and discussions?
- Does closure terminology, or closure process, change for Suncor's fee lot (private) lands?
- What assumptions, policies or legislation exist that may get in the way of effective and timely closure (e.g., a maintenance-free end-state or removal of all water management infrastructure)?
- How would the post-closure monitoring or management (e.g., for long-term water treatment) allowed for in other jurisdictions be addressed in Alberta?

Reference

Butler, H. and G.M. Bentel, 2011. Mine relinquishment – processes and learnings. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth

International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 2: Post-Closure Monitoring and Responsibilities. pp. 3-11.

Related Links

Mine Closure Planning – OSRIN website links page

CLOSURE TERMINOLOGY

Jones (2011) notes that the Australian Commonwealth government's 2006 handbook *Mine Closure and Completion* defines a *completed mine* as one that has reached a status where mining lease ownership can be relinquished and responsibility for the land accepted by the next user.

Otto (2009) clarifies the difference between reclamation and closure as follows:

> Reclamation is the process whereby a mine's landform and ecology are altered to achieve a planned state. Closure includes actions such as the physical shutdown of the mine and the host of activities, such as final reclamation, equipment removal, community disengagement, employee severance, debt settlement, and so forth that occur when the company determines that it will no longer mine the property.

CLOSURE STEPS

Cowan et al. (2010) identify a series of mine development and closure steps (see Figure 1 in their report) which include: Closure; "Closed-out"; and, Perpetual Care.

Miningfacts.org (2012) lists a four-step mine closure process: Shut-down (production stops); Decommissioning (plant and facilities dismantled); Remediation/reclamation (site cleanup); and Post-closure (monitoring and perhaps long-term care and maintenance).

McKenna et al. (2013) list reclamation/closure as the final stage in mining. They note that this stage can include reclamation, bond release, reclamation certification and relinquishment.

Ouellet et al. (2011) list eight steps for mine closure in Quebec, the last four of which are: Carrying out rehabilitation work; Preparation of a work completion report (attested by a registered expert); Release of liability if rehabilitation work proves successful; and, Monitoring if necessary.

Umedera et al. (2011) list five reclamation phases for an Alaskan gold mine: Reclamation of construction disturbance; Reclamation concurrent with mining; Final reclamation and mine closure; Water treatment; Post-closure reclamation; and, Post-closure monitoring.

The Oil Sands Tailings Dam Committee (2014) de-licensing technical guide *focuses on the de-licensing of oil sands tailings dams in Alberta as part of the process of transitioning these structures toward final closure and reclamation certification.* The Guide identifies a series of Life Phases for a tailings facility, including: Cessation of operation; Decommissioning (Active care then Passive care); Reclamation; and, Certification. Crossley et al. (2011) identify six

stages in the life cycle of a tailings facility; the last three are: Decommissioning and Closure; Post-Closure; and, Relinquishment.

REGULATORY AND POLICY CONTEXT

Canada

Cowan et al. (2010) reviewed the policy framework for mine closure in Canada for the National Orphaned/Abandoned Mines Initiative. The following key points are relevant:

- Statutory authority for requiring closure plans is the norm.
- A clear policy on closure objectives must be in place so design for closure (or design for relinquishment) can be implemented.
- Ideally execution of a closure plan would bring to a close the need for further work however in many cases ongoing care and maintenance is required due to physical structures needing inspection and maintenance or chemical liabilities requiring management.
- Relinquishment of the mineral title back to the Crown is the final step in closing the project. However, a number of jurisdictions will not grant relinquishment if long-term treatment or maintenance is required.
- Institutional custodianship policy is fundamental to the management of sites that require some form of continuing supervision or management.

Alberta

There is no regulatory definition of *closure* in Alberta.

The *Oil Sands Conservation Rules* (Government of Alberta 1988) define *abandonment* (s. 1(2)(a.1)) as:

> the permanent dismantlement of a mining operation, an in situ operation, a mine site, an in situ operation site or a processing plant and includes any measures required to ensure that the mining operation, in situ operation, mine site, in situ operation site or processing plant is left in a permanently safe and secure condition;

Houlihan and Hale (2011) describe the factors the ERCB (now AER) considers in reviewing a company's abandonment plan:

- All economically recoverable oil sands has been recovered or conserved;
- All structures will be removed and the site left in a safe and secure, reclaimable condition;
- Monitoring demonstrates that all landforms will be left in a geotechnically stable condition; and

- The proposed abandonment plan will meet the end land use considerations, such as those for end-pit lake criteria and landform design, consistent with AENV's requirements.

Life of Mine Closure Plans are required pursuant to *Environmental Protection and Enhancement Act* (EPEA) approvals (e.g., the Total Joslyn North mine approval (s. 6.2.10 to 6.2.13) – Alberta Environment 2011). The following approval sections outline the requirements of a closure plan:

> 6.2.11 The Life of Mine Closure Plan … shall outline the most recent concepts for development and reclamation of the plant to the end of mine life.
>
> The plan shall:
>
> (a) be consistent with the values and objectives in the Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan, Alberta Sustainable Resource Development, 2002, as amended;
>
> (b) be consistent with any applicable approved regional plan under the Land Use Framework, Alberta Government, December 2008, as amended;
>
> (c) ensure that reclaimed features have natural appearances characteristic of the region;
>
> (d) be conceptual in nature and shall apply to the life of the plant and until closure;
>
> (e) describe the utility of the landscape and its ability to meet the various end land use goals and objectives; and
>
> (f) provide designs for individual landforms and for the lease landscape that will target specific end land uses.
>
> 6.2.12 The Life of Mine Closure Plan … shall address, at a minimum, the following:
>
> (a) integration of landforms, topography, vegetation, waterbodies, and watercourses with adjacent undisturbed areas within or adjacent to the plant, and mine areas adjacent to the plant;
>
> (b) geotechnical stability;
>
> (c) surface water hydrology;
>
> (d) soil salvage, stockpile, and placement, with consideration of the target ecosites, and adaptive incorporation of any guidelines prepared or provided by the Director related to reclamation material handling;
>
> (e) reclamation materials balance relative to life of mine closure reclamation requirements, indicating soil quality;
>
> (f) vegetation, with consideration of the target ecosite phases and forest productivity, including reference to spatial and temporal vegetation sourcing;

(g) forest resources considering progressive establishment of upland vegetation communities and timber productivity consistent with pre-disturbance upland communities and consistent with the Revegetation Plan …;

(h) groundwater, hydrology and hydrogeology;

(i) wetlands;

(j) end pit lakes, including adaptive incorporation of any guidelines prepared or provided by the Director related to end pit lakes;

(k) land uses including traditional land use, recreation, commercial/industrial, miscellaneous, etc.;

(l) fish and wildlife habitat as defined by validated habitat modeling (or other habitat assessment tools recommended by the Director) for key species consistent with pre-disturbance capabilities;

(m) watercourse and riparian design and development, including specific design for fish habitat; and

(n) any other information as required in writing by the Director.

The approval also requires an amendment to decommission and reclaim the plant by submitting a Decommissioning and Land Reclamation Plan (s. 6.1.1). *Decommissioning* is defined (s. 1.1.2 (p)) as:

> the dismantling and decontamination of a plant or any part of a plant undertaken subsequent to the termination or abandonment of any activity or any part of any activity regulated under the Act;

Note that *plant* is defined as both the processing plant and the associated mines (s. 1.1.2 (zz)).

Certain regulatory provisions appear to constrain how closure might be interpreted. For example:

> The provisions for return of reclamation security in the *Conservation and Reclamation Regulation* (s. 22(1) – Government of Alberta (1993)) suggest that issuance of a reclamation certificate indicates the end of responsibility:
>
> > 22(1) Where a reclamation certificate is issued in respect of all or part of specified land, the Minister may return or direct the return of all or part of the security provided, as the case may be.
>
> EPEA Section 144 (1) indicates the relationship between a surface lease and a reclamation certificate:
>
> > 144(1) Notwithstanding anything in any other Act or any surface lease or right of entry order,
> >
> > (a) no surrender of a surface lease is effective or binding on any person, and
> >
> > (b) no expropriation board shall order the termination of a right of entry order

> insofar as the surrender or termination relates to any interest of the registered owner, until a reclamation certificate has been issued in respect of the specified land affected by the surrender or termination.

The Alberta Energy Regulator's draft Directive 023 (Alberta Energy Regulator 2013) contains the following provision under s. 6.12 reclamation:

> 4) Discuss the end land-use objectives at project closure. End land-use objectives used in reclamation planning may include traditional land uses, recreation, forested ecosystem, and municipal or industrial development.

In describing Fort McKay's key reclamation concerns, Buffalo et al. (2011) note that Fort McKay believes that reclaimed sites should be self-sustaining after closure and ongoing maintenance of structures in the designs approved for mines will not be an acceptable option. This concern extends to the dykes that contain tailings and the pillars of land that contain end pit lakes. Long-term treatment of discharge waters is also a concern.

British Columbia

The BC *Mines Act* (Government of British Columbia 1996) defines a *closed mine* (s. 1) as:

> a mine at which all mining activities have ceased but in respect of which the owner, agent, manager or permittee remains responsible for compliance with this Act, the regulations, the code and that person's obligations under the permit for that mine;

A conceptual final reclamation plan for the closure or abandonment of all aspects of the mining operation, including (a) plans for the long term post-closure maintenance of facilities, and (b) proposed use and capability objectives for the land and watercourses is required (s. 10.1.4(7) of the Health, Safety and Reclamation Code for Mines in British Columbia - Ministry of Energy, Mines and Petroleum Resources 2008).

Manitoba

The *Mines and Minerals Act* (Government of Manitoba 1991) defines *closure plan* (s. 1(1)) as:

> a plan that sets out a program for protection of the environment during the life of a project and for rehabilitation of the project site upon closing of the project and that includes the provision of security to the Crown for performance of rehabilitation work;

Section 113 of the Act (Notice of intention to close mine) requires that:

> Not less than 90 days before abandoning a mine, or before closing or otherwise rendering a mine inaccessible for a period of 90 days or longer, the mineral lessee shall give the director written notice of the abandonment or closure and shall, before taking the action, submit to the director the reports, plans and statistical data required under Part 13.

The *Mine Closure Regulation* (Government of Manitoba 1999), issued under the *Mines and Minerals Act*, outlines the content of a closure plan (s. 9). The Manitoba Mine Closure Regulation 67/99 General Closure Plan Guidelines (Government of Manitoba n.d.) provide direction on matters that should be considered in planning closure.

Ontario

Pursuant to Ontario Regulation 240/00 *Mine Development and Closure under Part VII of the Act* (i.e., *Mining Act*), Ontario requires submission of a closure plan and sets out the minimum content requirements for the plan (Government of Ontario 2000).

Saskatchewan

Saskatchewan Institutional Control Program (text taken from government web site – http://economy.gov.sk.ca/Institutional_Control-Decommissioned_Mines/Mills)

In 2005, Saskatchewan initiated the formal development of an institutional control framework for the long term management of decommissioned mine and mill sites on provincial Crown land. The framework developed a formal regulatory process for long term site management when all activities had been completed and for the transfer of site responsibility back to the provincial Crown. The process provides for ensuring the health and safety of future generations, the protection of the environment, for providing closure for the mining industry and for meeting national and international standards and requirements.

In 2007, the province legislated *The Reclaimed Industrial Sites Act* (Government of Saskatchewan 2006) and *The Reclaimed Industrial Sites Regulations* (Government of Saskatchewan 2007) to establish and enforce the Institutional Control Program (ICP). The ICP implements the process for the long term monitoring and maintenance of sites when mining/milling activities have ended, remediation has been completed and approved; and the process for transfer of the site to provincial responsibility. The two primary components of the ICP are the Institutional Control Registry and the Institutional Control funds: the Monitoring and Maintenance Fund and the Unforeseen Events Fund. The Registry will maintain a formal record of closed sites, manage the funding and perform any required monitoring and maintenance work.

The Ministry of Energy and Resources has been assigned responsibility for the Institutional Control Registry. In consultation with stakeholders, the Institutional Control Program: Post Closure Management of Decommissioned Mine/Mill Properties Located on Crown Land in Saskatchewan document was created to outline the operation of the Registry and the requirements for a company to enter a site into the Registry.

The Act defines a *closed site* as (s. 2(a)):

> an industrial site at which all decommissioning, remediation and reclamation measures have been carried out and transitional-phase monitoring has been completed;

The Regulations define an *industrial site* as (s. 2(a)):

> that portion of a mine site or a mill site located on land owned by the Government of Saskatchewan that requires monitoring and possibly maintenance and includes other land owned by the Government of Saskatchewan that the site holder and the minister may agree to include;

The Regulations define *transitional-phase monitoring* as (s. 2(b)):

> the post-decommissioning and post-reclaiming monitoring program that demonstrates that an industrial site is in compliance with the decommissioning and reclamation requirements set out in *The Mineral Industry Environmental Protection Regulations*, 1996;

REFERENCES

Alberta Energy Regulator, 2013. Draft Directive 023 Oil sands project applications. Alberta Energy Regulator, Calgary, Alberta. 89 pp. http://www.aer.ca/documents/directives/DraftDirective023_20130528.pdf [Last accessed June 16, 2014].

Alberta Environment, 2011. *Environmental Protection and Enhancement Act* approval for the construction, operation and reclamation of the Joslyn North Oil Sands Processing plant and associated Mines (Leases 24, 452 and 799). Alberta Environemtn, Edmonton, Alberta. 75 pp. https://avw.alberta.ca/pdf/00228044-00-00.pdf [Last accessed June 16, 2014].

Buffalo, K., C.E. Jones, J.C. Errington and M.I.A. MacLean, 2011. Fort McKay First Nation's involvement in reclamation of Alberta's oil sands development. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 1: Mine Site Reclamation. pp. 255-261.

Butler, H. and G.M. Bentel, 2011. Mine relinquishment – processes and learnings. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 2: Post-Closure Monitoring and Responsibilities. pp. 3-11.

Cowan, W.R., W.O. Mackasey and J.G. Robertson, 2010. The policy framework in Canada for mine closure and management of long-term liabilities: A guidance document. National Orphaned/Abandoned Mines Initiative, Natural Resources Canada, Ottawa, Ontario. 123 pp. http://www.abandoned-mines.org/pdfs/PolicyFrameworkCanforMinClosureandMgmtLiabilities.pdf

Crossley, C., B. Russell, D. van Zyl and G. McKenna, 2011. Developing an operation, maintenance and surveillance manual for the post-closure management of tailings facilities. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 2: Post-Closure Monitoring and Responsibilities. pp. 219-228.

Government of Alberta, 1988. *Oil Sands Conservation Rules*. Government of Alberta, Edmonton, Alberta. Alberta Regulation 76/1988. 32 pp. http://www.qp.alberta.ca/documents/Regs/1988_076.pdf [Last accessed June 16, 2014].

Government of Alberta, 1993. *Conservation and Reclamation Regulation*. Alberta Regulation 115/1993. Government of Alberta, Edmonton, Alberta. 21 pp. http://www.qp.alberta.ca/1266.cfm?page=1993_115.cfm&leg_type=Regs&isbncln=9780779731343 [Last accessed June 16, 2014].

Government of Alberta, 2000. *Environmental Protection and Enhancement Act*. Revised Statutes of Alberta, Chapter E-12. Government of Alberta, Edmonton, Alberta. 158 pp. http://www.qp.alberta.ca/1266.cfm?page=E12.cfm&leg_type=Acts&isbncln=9780779735495 [Last accessed June 16, 2014].

Government of British Columbia, 1996. Mines Act. RSBC Chapter 293. Government of British Columbia, Victoria, British Columbia. http://www.bclaws.ca/civix/document/id/complete/statreg/96293_01#section1 [Last accessed June 16, 2014].

Government of Manitoba, n.d. Manitoba Mine Closure Regulation 67/99 General Closure Plan Guidelines. Government of Manitoba, Winnipeg, Manitoba. http://www.manitoba.ca/iem/mines/acts/closureguidelines.html#content [Last accessed June 16, 2014].

Government of Manitoba, 1991. *The Mines and Minerals Act*. C.C.S.M. c. M162. Government of Manitoba, Winnipeg, Manitoba. http://web2.gov.mb.ca/laws/statutes/ccsm/m162e.php [Last accessed June 16, 2014].

Government of Manitoba, 1999. *Mine Closure Regulation*. Regulation 67/99. Government of Manitoba, Winnipeg, Manitoba. 16 pp. http://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=67/99 [Last accessed June 16, 2014].

Government of Ontario, 2000. *Mine Development and Closure under Part VII of the Act*. Ontario Regulation 240/00. Government of Ontario, Toronto, Ontario. http://www.e-laws.gov.on.ca/DBLaws/Regs/English/000240_e.htm [Last accessed June 16, 2014].

Government of Saskatchewan, 2006. *The Reclaimed Industrial Sites Act*. Statutes of Saskatchewan, Chapter R-4.21. Government of Saskatchewan, Regina, Saskatchewan. 10 pp. http://www.qp.gov.sk.ca/documents/english/Statutes/Statutes/R4-21.pdf [Last accessed June 16, 2014].

Government of Saskatchewan, 2007. *The Reclaimed Industrial Sites Regulations*. Chapter R-4.21 Reg 1. Government of Saskatchewan, Regina, Saskatchewan. 9 pp. http://www.qp.gov.sk.ca/documents/english/Regulations/Regulations/R4-21r1.pdf [Last accessed June 16, 2014].

Houlihan, R.H. and C.E. Hale, 2011. Alberta mine reclamation and abandonment requirements. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth

International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 2: Post-Closure Monitoring and Responsibilities. pp. 13-20.

Jones, H., 2011. Three "R's" for mine closure – responsibilities, regulations and results. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 2: Post-Closure Monitoring and Responsibilities. pp. 29-38.

McKenna, G., R. An, E. Scordo and J. McGreevy, 2013. Toward effective closure planning: From progressive reclamation to sustainable mining. IN: Tailings and Mine Waste '13. Proceedings of the Seventeenth International Conference on Tailings and Mine Waste, November 3-6, Banff, Alberta. Wilson, G.W., D.C. Sego and N.A. Beier (Editors). University of Alberta Geotechnical Center, Edmonton, Alberta. pp. 615-625.

Miningfacts.org, 2012. What happens to mine sites after a mine is closed? http://www.miningfacts.org/environment/what-happens-to-mine-sites-after-a-mine-is-closed/ [Last accessed June 16, 2014].

Ministry of Energy, Mines and Petroleum Resources, 2008. Health, Safety and Reclamation Code for Mines in British Columbia. Ministry of Energy, Mines and Petroleum Resources, Victoria, British Columbia. pp. 10-1 to 10-19. http://www.empr.gov.bc.ca/Mining/HealthandSafety/Documents/HSRC2008.pdf [Last accessed June 16, 2014].

Oil Sands Tailings Dam Committee, 2014. De-licensing of oil sands tailings dams. Technical guidance document. Oil Sands Tailings Dam Committee, Edmonton, Alberta. 45 pp. http://hdl.handle.net/10402/era.38332 [Last accessed June 16, 2014].

Otto, J.M., 2009. Global trends in mine reclamation and closure regulation. IN: Mining, Society and a Sustainable World, Richards, J.P. (Editor). Springer-Verlag, Berlin. pp. 251-288.

Oullet, R., M.P. Filion, M. Edwards and G.W. Davies, 2011. Lovincourt Mine – a recent mine closure case. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 2: Post-Closure Monitoring and Responsibilities. pp. 441-450.

Umedera, M., S. McLeod, B. Farnham and S. Staley, 2011. Reclamation and mine closure plan at Pogo Mine, Alaska. IN: Mine Closure 2011. Fourie, A., M. Tibbett and A. Beersing (Eds.). Proceedings of the Sixth International Conference on Mine Closure, September 18-21, 2011, Lake Louise, Alberta. Australian Centre for Geomechanics, Nedlands, Western Australia. Volume 1: Mine Site Reclamation. pp. 513-522.

Suggested Reading

Government of Saskatchewan, 2012. 2012 Institutional Control Report (*The Reclaimed Industrial Sites Act*) for the Period April 1, 2007 – March 31, 2012. Ministry of Energy and Resources, Regina, Saskatchewan. 14 pp. http://economy.gov.sk.ca/IC2012 [Last accessed June 16, 2014].

Morgenstern, N.R., 2012. Oil sands mine closure - the end game. IN: David C. Sego Symposium, Edmonton, Alberta, April 26-27, 2012. Arenson, L.A. and N.A. Beier (Eds.). The UofA Geotechnical Centre, University of Alberta, Edmonton, Alberta. pp. 85-99.

US EPA, 2014. Closure and post-closure care requirements for municipal solid waste landfills (MSWLFs). http://www.epa.gov/osw/nonhaz/municipal/landfill/financial/mswclose.htm

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Athabasca Watershed Council – *August 27, 2014*

The Athabasca Watershed Council (AWC) is a registered not-for-profit organization formed in August 2009 to work with academia, industry, environmental groups, various levels of government, communities, and citizens to provide timely credible information about the Athabasca Watershed from Jasper to Fort Chipewyan. The AWC is a designated Watershed Planning and Advisory Council (WPAC) working in partnership with the Government of Alberta towards achieving the goals of the Water for Life strategy.

The AWC-WPAC champions scientific reports on the State of the Watershed and outreach initiatives aimed at educating communities and citizens about the watershed.

Some interesting facts from their website:

- The Athabasca River begins from the melting snow and ice of the Columbia Glacier in Jasper National Park (headwaters) and travels about 1,500 km northeast across Alberta and drains into Lake Athabasca.
- The mean annual discharge in cubic decametres (1 dam^3 = 1,000 cubic metres) at Fort McMurray is 20,860,000 dam^3
- The Athabasca watershed is approximately 159,000 square kilometres which is about 24% of Alberta.
- The Athabasca River Basin includes all or parts of 22 rural or regional municipalities and includes a city, 12 towns, and 14 Aboriginal settlements.
- There are five pulp and paper mills in the upper half of the watershed. Forestry occurs throughout the watershed, while oil sands developments dominate the lower portion of the watershed. Sand and gravel extraction is also active in the Athabasca watershed. Uranium mining on the northeast part of the watershed that extends in Saskatchewan may increase in the future. Unmanaged recreational activities are increasingly causing stress in several areas of the watershed.

Related Links

Athabasca Watershed Council

AWC Interactive Atlas

Fiera Biological Consulting, 2012. Athabasca state of the watershed report: Phase 2. Athabasca Watershed Council, Hinton, Alberta. 99 pp.

Hatfield Consultants, 2011. Athabasca Watershed Council state of the watershed report: Phase I. Athabasca Watershed Council, Hinton, Alberta. 31 pp. plus appendices.

Parlee, B., 2011. Traditional knowledge overview for the Athabasca River watershed. Athabasca Watershed Council, Hinton, Alberta. 57 pp.

Other sources

OSRIN – Athabasca River and Lake Athabasca links page

RiverWatch

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Monster Tires Supporting Oil Sands Development – *September 15, 2014*

Iconic pictures of the mineable oil sands include big trucks and people standing beside the monster tires that support them. Manufacturing companies that are able to provide the huge tires include: Bridgestone, Goodyear, Michelin, and Titan. Michelin states they invented the 63-inch tire used on the oil sands trucks, the largest in the world.

Some interesting facts about the tires:

- They weigh in at about 15,000 kg and are about 3.8 m in diameter
- There are six tires on each CAT 797B (362.8 tonne / 400 ton) dump truck
- Average lifespan is 6,000 working hours (4,000 to 8,000) and they are replaced 10 to 16 times a month
- It takes an entire 8-hour shift to produce and cure one tire
- Media reported prices range from $35,000 to $60,000 each
- Due to the tire pressure (100 psi) and the load weight a blowout can be catastrophic; analysis based on a tire for a smaller 793 truck suggested a blowout could throw a 200 lb person a mile in the air
- In 2005 an Aboriginal company started using new shredding technology to recycle the old tires; In 2014 Titan Tire Reclamation Corp leased land at Suncor to deploy pyrolysis technology to turn used tires into oil, steel and carbon black and Cutting Edge Tire Recycling of Ponoka purchased a large rubber mulch plant that can handle oil sands tires.

Given the facts above it is no wonder that monitoring wear and tear and tire pressure are key practices to get the longest life span from each tire. Another key factor in tire longevity is road maintenance and tire-oil sand interactions.

In earlier years tire supply was an issue but at least one mining equipment company reported that by 2010 the major manufacturers had caught up with demand.

Related Links

Bloomberg (2009) – Titan's giant tires falling flat in Alberta oil sands

Canada.com (2008) – Facts on the Caterpillar 797B heavy hauler

Cape Breton Post (2008) – Gigantic tires, fuel-thirsty dump trucks among biggest costs in oil sands mining

EcoWeek (2005) – New shredding process helps recycle Suncor's worn oil sands tires

Engineering and Mining Journal (2013) – Teaching tire awareness

Fort McMurray Today (2009) – Rocks – not wear and tear – greatest threat to hauler tires, say oil sands companies

Gizmag (2008) – The world's biggest production tire – the 63-inch Titan

Mining.com (2010) – Oil sands mining equipment built tough

Mining-technology.com (2008) – Longer life for tyres

Oil and Gas Product News (2013) – Big tires, big challenges

Oil Sands Discovery Centre – Facts about Alberta's oil sands and its industry (p. 18)

OTR Tires Worldwide – Causes and effects of mining tire shortages

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History of Syncrude Canada Ltd. Partnership – *September 26, 2014*

Syncrude is currently a partnership of seven companies, though the number has varied since 1965 from four to nine. Partners have changed over the years through purchases, corporate amalgamations and corporate name changes.

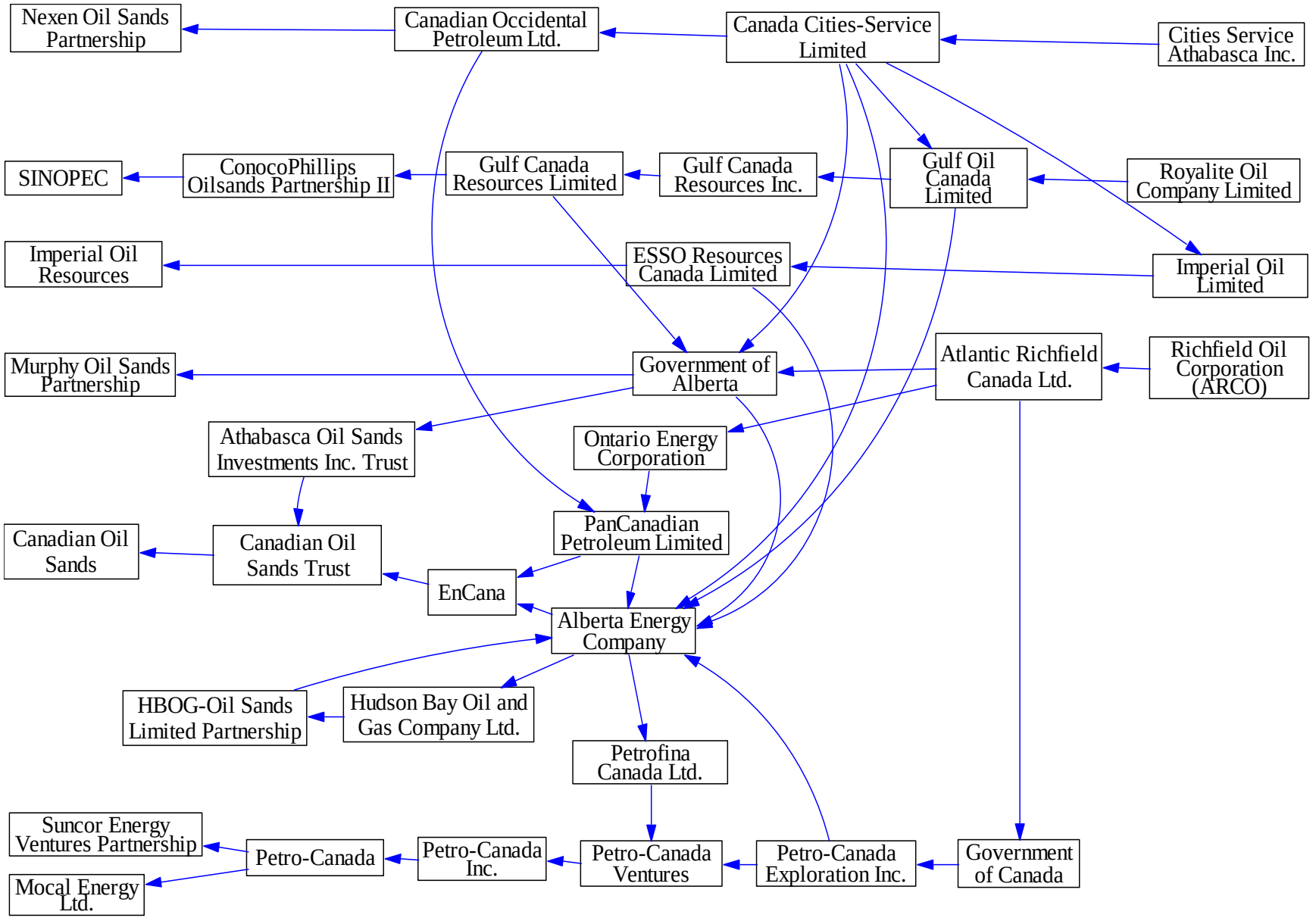
The table shows the percentage ownership over time (based on data from the sources under Related Links). The chart provides a graphical representation of the partnership changes over time – the current partners are shown on the left hand side and the original partners on the right (x-axis is not to scale). Some interesting points to note:

- Imperial (through a few names changes) is the only company to have been in the partnership since 1965
- SINOPEC is the newest partner (2010)
- Three governments owned portions of Syncrude in 1975 though purchases of the stake originally owned by Atlantic Richfield Canada Ltd.; Canada (passed on to Petro-Canada), Alberta (through the Alberta Oil Sands Equity) and Ontario (through the Ontario Energy Corporation); Alberta expanded its share in 1982 and had completely disposed of the shares by 1999
- Although Syncrude holds the environmental operating approval issued under the *Environmental Protection and Enhancement Act*, the individual partners provide the financial security required under the Act in proportion to their ownership share
- Syncrude isn't the only example of oil sands partnerships – the Jackpine, Muskeg River, Joslyn North, Fort Hills and Kearl mines all have partners

	1965	1971	1975	1976	1978	1979	1982	1984	1988	1989	1993	1999	2002	2006	2014
Canadian Oil Sands Trust												10	31.74	36.74	36.74
Athabasca Oil Sands Trust												11.74			
ConocoPhillips Oilsands Partnership II													9.03	9.03	
SINOPEC															9.03
Imperial Oil Limited	30	30	31.25	31.25											
ESSO Resources Canada Limited					31.25	25	25	25	25	25	25	25			
Imperial Oil Resources													25	25	25
Mocal Energy											5	5	5	5	5
Murphy Oil Sands Partnership											5	5	5	5	5
Nexen Oil Sands Partnership													7.23	7.23	7.23
Government of Canada			15												
Petro-Canada Exploration Inc.				15	15	12									
Petro-Canada Ventures							17								
Petro-Canada Inc.								17	17	17	12	12	12	12	
Petro-Canada															
Suncor Energy Ventures Partnership															12
Richfield Oil Corporation (ARCO)	30														
Atlantic Richfield Canada Ltd.		30													
Government of Alberta (Alberta Oil Sands Equity)			10	10	10	8	16.74	16.74	16.74	16.74	11.74				
Ontario Energy Corporation			5	5											
Royalite Oil Company Limited	10														
Gulf Oil Canada Limited		10	16.75	16.75	16.75										
Gulf Canada Resources Inc.						13.4	9.03	9.03							
Gulf Canada Resources Limited									9.03	9.03	9.03	9.03			
Cities Service Athabasca Inc.	30														
Canada Cities-Service Limited		30	22	22	22	17.6	13.23								
PanCanadian Petroleum Limited					5	4	4	4	10	10					
Pan Canadian Gas Products											10				
Alberta Energy Company Ltd.						10	10	10	10	10	10				
AEC Oil Sands Limited Partnership												5	5		
AEC Energy Company Limited												10			
Petrofina Canada Ltd.						5									
Hudson Bay Oil and Gas Company Ltd.						5	5								
HBOG-Oil Sands Limited Partnership								5	5	5	5				
Canadian Occidental Petroleum Ltd.								13.23	7.23	7.23	7.23	7.23			
TOTALS	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

NOTES:
Canadian Oil Sands Trust had a number of names, and in some years had multiple holdings; they have been combined for simplicity
Different corporate names are used at different times in various Syncrude documents, making it difficult to track changes

Changes in Syncrude Partners over Time (1965 – right; 2014 – left)



Related Links

Alberta Oil (2014) – Can Syncrude Canada maintain its legacy of social engagement in the oil sands?

Calgary Herald (April 2010) – Sinopec acquires stake in Syncrude, doubles oil sands presence

Canadian Oil Sands – History

Canadian Oil Sands – Press Release (2001) – Athabasca Oil Sands Trust and Canadian Oil Sands Trust complete merger creating Canada's largest royalty trust

Canadian Oil Sands – Press Release (2006) – Syncrude Joint Venture owners approve Management Services Agreement between Syncrude and Imperial Oil

Nexen (Wikipedia)

North of 56 – Syncrude turns 50

Oil & Gas Journal (August 1993) – Oilsands play larger role in Canadian oil production

Oilpatch History (December 1978) – Ontario to sell Syncrude interest to Pancanadian for $160 Million

Oilpatch History (March 1981) – Petrocanada acquires Petrofina Canada Inc.

Ownership and Management Agreement Amendment (March 1982)

Ownership and Management Agreement Amendment (September 1994)

Peter McKenzie-Brown, 2011 – How public money saved Syncrude – starts p. 5

Syncrude (website) – Ownership and Investors

Syncrude Canada Ltd, 1990. The Syncrude story: In our own words. Syncrude Canada Ltd., Fort McMurray, Alberta. 118 pp.

Syncrude Canada Ltd., 1995. Everything you ever wanted to know about Syncrude. Syncrude Canada Ltd., Fort McMurray, Alberta. 24 pp.

Syncrude Canada Ltd, 2000. A billion barrels for Canada: The Syncrude story. Syncrude Canada Ltd., Fort McMurray, Alberta. 182 pp.

Syncrude Canada Ltd. – 2002 Sustainability Report

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Dry Tailings – *October 14, 2014*

The Holy Grail for tailings disposal is dry tailings (or stackable tailings) which reduces water use (faster recycling back to process), water loss from storage areas (seepage), and speeds up reclamation (little or no time lost in waiting for a trafficable surface). Various terms are used to express the range in tailings water content, including fluid tailings -> thickened tailings -> paste -> filtered tailings – dry stack.

The Energy Resources Conservation Board issued Directive 074 in 2009 in an effort to: minimize and eventually eliminate long-term storage of fluid tailings in the reclamation landscape, and to create a trafficable landscape at the earliest opportunity to facilitate progressive reclamation (Energy Resources Conservation Board 2009). The Oil Sands Tailings Technology Roadmap (Sobkowicz 2012) identifies a number of tailings treatment technologies that can be used to move oil sands tailings from fluid to dry stack. However, this 2012 document is not the first to propose dry tailings technology.

In its 1962 report to the Lieutenant Governor in Council, the Oil and Gas Conservation Board (predecessor to the ERCB and now the Alberta Energy Regulator), the Board described the revised plans of Great Canadian Oil Sands Limited (now Suncor) to produce dry tailings. The text below has been extracted from the report:

> Clay, sand, water and traces of oil from the bottom of the separation cell would be pumped to rotary horizontal filters, rather than to classifiers as originally proposed. The filters would reduce the water content of the sand tailings to 6 per cent so that the tailings could be moved to the disposal area by means of conveyor belts rather than by a wet sluicing system.
>
> In the revised proposal the hydraulic system for handling solid wastes has been abandoned in favour of a belt conveyor system. The two major solid waste streams, from the rotary horizontal filters and the disc filters, would consist of dewatered sand and clay. These would be moved on 10,600 feet of 54 inch wide belt conveyors, to stacker located on the river flats south of the plant. It is anticipated by the applicant that when stacked with a slope of 30 degrees from the horizontal, the dewatered sand would form a stable pile with a "factor of safety against a slide failure of about three". With some compaction of the pile or the use of matting, the sand disposal equipment would be able to move over the tailings piles. After a period of approximately five years the conveyor system and stacker would be moved to return the sand tailings to the mined out area.
>
> Dr. R. M. Hardy (on behalf of Cities Service – now Syncrude) stated that disposing of the sand tailings as proposed by Great Canadian in the initial disposal area would constitute a public hazard in the use of the river for navigation and a hazard to operators in Lease No. 17. He estimated that as much as 10 million cubic yards of sand could suddenly move into the Athabasca River when the toe of the sand tailings pile is inundated by the river at high water. Surface erosion could wash about half a million cubic yards into the river and might also be a problem when the sand tailings are deposited in the mined out area.

> In rebuttal to Dr. Hardy's testimony, Mr. G. Reynolds (Dames & Moore on behalf of GCOS) stated that the tailings pile would be stable and that a disastrous slide would not occur under the circumstances outlined by Dr. Hardy. He agreed there would be some surface erosion but stated that it could be satisfactorily handled by constructing a dam with material cleared from the tailings pile site. Mr. Reynolds stated that the sand tailings would be quite permeable and that much of the rainfall would penetrate through the tailings pile rather than cause erosion.
>
> The Board recognizes that the toe of the sand tailings pile could become inundated during periods of high water, and that a hazard could develop. The Board believes, however, that a careful reconsideration of the limits of the disposal area and of the need for diking, compacting, the use of rip rap or the use of stabilizers as previously suggested by the applicant would prevent any of these problems arising.

The Board found that GCOS's scheme for the disposal of the solid waste of the process appear satisfactory, subject to the appropriate precautions being taken to insure stability of the tailings pile. The Board recommended the following clause (# 11) be included in the approval: Great Canadian shall carry out the solids disposal operations to the satisfaction of the Board, on lands to be approved by the Board, and in a manner that insures the stability of any tailings piles.

Of course, as we know now, this didn't happen. The behaviour of the tailings was much different than expected and an alternative system had to be employed. In a 1964 radio interview (CBC Digital Archives 1964 – at the 13 minute mark) GCOS notes the tailings will be placed in a tailings pond that will be 500 acres in size. In a 1977 review, the Alberta Research Council notes:

> A major concern still remaining with the large-scale application of hot water extraction is the production of clay slimes. Although it was recognized as far back as 1953 that extraction of surface mined oil sands by any of the processes then being considered (hot water, cold water or fluidization) would result in a massive accumulation of tailings, the problem that would be caused by the clay fraction of these tailings was not fully anticipated. It was assumed that the clay tailings would settle, much as tailings from other mining ventures, to provide recycle water, and eventually form a compact sludge which would present no major problems for abandonment and revegetation. This has not proven to be the case. Apparently as a result of the properties of the clays involved, simple settling will not produce a sludge beyond a clay to water weight ratio of about 0.24. Consequently, the GCOS settling pond is now in reality a very large storage area, with the accumulating volume of sludge requiring continuous elevation of the dyke to contain it.

Related Links

Alberta Research Council, 1977. Clay tailings from Alberta oil sands and other sources: A review. Alberta Environment, Edmonton, Alberta. 87 pp.

CBC Digital Archives, 1964. Athabasca oilsands to yield 'black gold' Radio documentary about GCOS (28 minutes).

Energy Resources Conservation Board, 2009. Directive 074: Tailings performance criteria and requirements for oil sands mining schemes. Energy Resources Conservation Board, Calgary, Alberta. 14 pp.

Oil and Gas Conservation Board, 1962. Supplemental report to the Lieutenant Governor in Council with respect to the application of Great Canadian Oil Sands Limited under Part VI A of the Oil and Gas Conservation Act. Oil and Gas Conservation Board, Calgary, Alberta. 48 pp. plus appendices.

Sobkowicz, J., 2012. Oil sands tailings technology deployment roadmaps. Project Report Volume 1 - Project summary. Alberta Innovates - Energy and Environment Solutions, Edmonton, Alberta. 60 pp. plus appendices.

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Oil Sands in Fiction – *October 30, 2014*

In 1980, Alistair MacLean wrote a novel called *Athabasca* about saboteurs attacking a tar sands mine, and concurrently the trans-Alaska pipeline. The mine, operated by a company called Sanmobil, is described as having four draglines, bucketwheels, radial stackers, conveyors and the biggest trucks in the world (this may sound familiar). The front cover shows a red and white dragline and the back cover has a photo of the author beside one of the iconic trucks. The author describes the points in the mining process that are vulnerable to sabotage.

Just fiction, right? Except that in 2012 the federal government established a counter-terror unit in Alberta to protect the oil sands (Cotter 2012), and in 2013 the MEG Energy in-situ site was evacuated due to a bomb threat (McDermott 2013), and in 2014 the RCMP issued a report warning government and industry that environmental extremists posed a "clear and present criminal threat" to the energy sector (McCarthy 2014).

Fast forward to 2008 and a novel by Clive and Dirk Cussler called *Arctic Drift* about a carbon capture and storage (CCS) project at Kitimat gone bad. Amongst other context pieces for the novel is this letter from the Prime Minister to the US President: "Because of legislation that drastically curtails greenhouse gas emissions, the Canadian government is forcing closure of the Athabasca oil sands operations". The CCS action takes place in Kitimat because, as the authors note: "The oil companies were already building a small pipeline from the oil fields to Kitimat so [the villain] convinced them to build an extra pipeline to run liquefied carbon dioxide".

Just fiction, right? And yet there are voices pushing for more stringent greenhouse gas controls (Mayeda 2014) or an end to oil sands development (CBC 2013) in the context of reducing emissions, and uncertainty at both provincial (Pratt 2014, van Loon and Mayeda 2014) and federal levels (Ljunggren 2013) about status and fate of GHG emission rules and CCS (Morgan 2014).

Related Links

Alistair MacLean, 19809. Athabasca. Collins, St. James Place, London, United Kingdom. 252 pp.

Clive Cussler and Dirk Cussler, 2008. Arctic drift. G.P. Putnam's Sons, New York, New York. 515 pp.

Bloomberg – Trudeau tries to bury father's legacy on Alberta energy Bloomberg, June 30.

CBC News – SFU's Mark Jaccard speaks out against oil sands CBC May 11.

Cotter, J., 2012. Alberta counter-terror unit set up to protect the oil sands. National Post, June 6.

Ljunggren, D., 2013. Canada continues to delay release of oil sands emission rules Financial Post, November 28.

McCarthy, S., 2014. Environmental extremism a rising threat to energy sector, RCMP warns Globe and Mail, September 14.

McDermott, V., 2013. Oil sands site evacuated after bomb threat Fort McMurray Today, July 3

Morgan, G., 2014. Jim Prentice says to wind down carbon capture fund in Alberta, new projects 'on hold'. Financial Post, October 6.

Pratt, S., 2014. Prentice refuses to beef up greenhouse gas regulations unless U.S. does. Edmonton Journal, September 25.

van Loon, J. and A. Mayeda, 2014. Alberta won't play emissions 'chicken' on Keystone, says Premier Financial Post, February 7.

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What Happens After a Mine is Suspended – *November 14, 2014*

In May, 2014 Total and Suncor announced that the Joslyn North mine project was suspended indefinitely. What does this mean in terms of environmental management and regulatory oversight of the mine site?

The Oil and Gas Conservation Act defines suspension as

> 1(1)(xx) "suspension"… means the temporary cessation of operations at a well or facility in the manner prescribed by the regulations or rules and includes any measures required to ensure that the well or facility is left in a safe and secure condition;

The Guide to the Mine Financial Security Program (MFSP – which applies to oil sands mines) defines suspension as

> The activities and operations required to ensure the safe and secure condition of a site when production activities have ceased and/or while receivership/resale of all or parts of the project takes place. This includes activities and operations to maintain the care and custody of a site while abandonment and surface reclamation activities are undertaken.

For the purposes of this Did You Know, the key components of the two definitions are: *safe and secure condition* and *activities and operations to maintain the care and custody* of the site. The level of environmental management concern associated with a suspended operation depends to a great extent on the stage of development and associated disturbance. In the case of the Joslyn North site there is relatively limited disturbance, mostly land cleared in preparation for mining, tailings pond, plant site and camp (also see photo in Lewis 2014a). The concerns would be significantly greater for sites that are further along in development – for example with water retention/management structures in place, a developed mine, plant site, and tailings ponds.

The Alberta Energy Regulator's Directive 019: Compliance Assurance spells out the tools available for ensuring environmental compliance. The Regulator's field inspectors conduct inspections of facilities such as oil sands mines.

The environmental operating requirements specified in the *Environmental Protection and Enhancement Act* (EPEA) approval, the *Water Act* approval and *Water Act* licence continue to apply to the site, including various provisions for monitoring, reporting, research and stakeholder engagement. Specific conditions that are relevant to management of a suspended site include: erosion and sedimentation control, ensuring ditches are stable, ensuring water doesn't move offsite, and protecting salvaged soil stockpiles. Provisions in other legislation such as the Weed Control Act continue to apply as well.

Total is also responsible for updating financial security for the site each year under the MFSP each year (August 2014 security amount is $24,357,491). While the extent of disturbance will not change during suspension there is potential for the nature of disturbance to change (e.g., due to erosion) and inflation will change (likely escalate) costs; these changes will need to be reflected in the security estimate.

Of note is that Total also applied in March 2013 for an expanded version of the project, indicating continued interest in eventually changing the project status from suspended to an operational mine.

Related Links

Czarnecka, M., 2014. Total disappointment: Does the shelving of Joslyn spell the end? Alberta Oil, September 8.

Lewis, J., 2014a. Total SA suspends $11B Joslyn oil sands mine in Alberta, lays off up to 150 staff. Financial Post, May 29.

Lewis, J., 2014b. Total SA seeking to upsize flagship Joslyn oil sands mine in Alberta. Financial Post, November 7.

Total – May 29, 2014 – Joslyn North Mine Update

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Zero Discharge Policy – *December 12, 2014*

One of the most frequently repeated statements in oil sands environmental management documents, presentations and discussions is "zero discharge policy". This is in reference to a widely held principle that oil sands mine operators do not discharge oil sands process-affected water off-site. Although the public interest in this policy now is mostly around water quality issues one of the early benefits of the approach was ensuring adequate water volumes for re-use in the plant. However, increases in production, coupled with improvements in water use efficiency, have resulted in the build-up of these waters on mine sites.

What follows is a collection of references from various documents from 1975 to 2014 tracking the use of the term zero discharge and identifying some of written policies that bear on the concept. You will see that while discharge (also called release) to the surrounding environment, and more explicitly the Athabasca River, is not currently allowed, it could be allowed if authorized. In other words, "zero discharge" means "not now", it doesn't mean never. What you will **not see** is a specific document called a Zero Discharge Policy because, to the best of our knowledge, there is no such document. There is a reference to a policy in the government's Facts About Water in Alberta (Government of Alberta 2010): The water in lakes and rivers within the oil sands regions will continue to be protected throughout oil sands development. The Alberta government has a zero discharge policy for all process-affected water, it must be contained on site.

A 1975 workshop summary states that "the letter of permission issued to Syncrude under the *Clean Water Act* Alberta) for the construction the Mildred Lake Plant, prohibits the disposal of process effluents in the surrounding watershed. Except intermittent mine water disposal, which is regulated by separate letters of permission, there is no disposal of effluents into the adjoining aquatic environments" (Wallace 1975). Similar restrictions remain in current oil sands operating approvals; for example, Alberta Environment (2007):

- (s. 4.2.1) The approval holder shall not release any substances from the plant to the surrounding watershed except as authorized under this approval.
- (s. 4.2.8) The approval holder shall only release industrial wastewater and industrial runoff to the Athabasca River watershed from the following locations, unless otherwise authorized in writing by the Director:

In 1986, a workshop was convened "to assess the status of collective knowledge and to co-operate/co-ordinate/set priorities for future research" related to a formal request from Syncrude "to establish discharge criteria for the treatment and release/reclamation of tailings pond water" (Baddaloo 1986). In the workshop report introduction, Syncrude notes their "Fort McMurray oil sands mining operations has been operating under the concept of zero discharge and total containment of wastewaters since start up in 1978." In the same document there are two references to Syncrude following a "zero discharge policy".

In Alberta, controlled releases of waters impacted by industrial activities are an accepted practice, and there is extensive guidance on how to apply for such a release:

- The Oil Sands Water Release Technical Working Group (1996) provides more oil sands-specific discussion on setting release limits, and lists various types of waters that could require release.
- Alberta Environment and Sustainable Resource Development's industrial release limits policy describes the principles for establishing release limits, for sectors or facilities, for various media, including water (Alberta Environment 2000).
- The government's surface water quality management framework for the lower Athabasca River states that any proposed new municipal or industrial releases would require the proponent to assess the potential effects as part of environmental impact assessments and/or applications for operating approvals under the Environmental Protection and Enhancement Act (Government of Alberta 2012).
- The Guide to Content for Industrial Approval Applications provides guidance to proponents on the information needed to assess suitability of releases to watercourses (Alberta Environment and Sustainable Resource Development 2013a – s. 5.9).

The Cumulative Environmental Management Association's end pit lakes guidance document (Hrynyshyn 2012) notes that "oil sands operators recognize that water released from a mine site into the Athabasca River is expected to be of suitable quality to support an aquatic ecosystem. It is expected by some operators that end pit lakes will provide an efficient method of improving the quality of water recovered from the mine site before release occurs". According to a 2013 Financial Post article (Weber 2013), industry and the provincial and federal governments are discussing the conditions under which discharge of treated water could occur after the end of mine life.

The current regulatory system contemplates that oil sands mines will need to discharge oil sands process-affected water to the surrounding environment:

- The standardized terms of reference for an Environmental Impact Assessment (Alberta Environment and Sustainable Resource Development 2013b) require the proponent to "describe the wastewater management strategy, including: … g) discharges to the surrounding watershed from existing and reclaimed sites, including the tailings management areas and end pit lakes and the management strategy for handling such releases.
- Similarly, the environmental operating approval requires the operator to prepare a Life of Mine Closure plan that shall address, at a minimum, the following: … (a) integration of landforms, topography, vegetation, waterbodies, and watercourses with adjacent undisturbed areas within or adjacent to the plant, and mine areas adjacent to the plant;

Recent OSRIN work shows that there is considerable interest and concern around setting release criteria and procedures for oil sands process-affected water (Oil Sands Research and Information Network 2014a,b).

Related Links

Alberta Environment, 2000. Industrial release limits policy. Alberta Environment, Environmental Sciences Division, Edmonton, Alberta. 12 pp.

Alberta Environment, 2007. Construction, operation and reclamation of the Suncor Energy Inc. Oil Sands Processing Plant and Mine. Approval No. 94-02000. Alberta Environment, Edmonton, Alberta. 104 pp.

Alberta Environment and Sustainable Resource Development, 2013a. Guide to Content for Industrial Approval Applications. Alberta Environment and Sustainable Resource Development, Edmonton, Alberta. 101 pp.

Alberta Environment and Sustainable Resource Development, 2013b. Standardized Terms of Reference - Updated January 2013. Environmental Assessment Team, Alberta Environment and Sustainable Resource Development, Edmonton, Alberta. EA Guide 2009-1. 1 p.

Baddaloo, E.G. (Ed.), 1986. Proceedings of Alberta oil sands tailings wastewater treatment technology workshop. Alberta Environment, Research Management Division, Edmonton, Alberta. Report No. RMD 86-38. 129 pp.

Government of Alberta, 2010. Facts about Water in Alberta. Alberta Environment, Edmonton, Alberta. Pub. # I/107. 66 pp.

Government of Alberta, 2012. Lower Athabasca region surface water quality management framework for the lower Athabasca River. Alberta Government, Edmonton, Alberta. 48 pp.

Hrynyshyn, J. (Editor), 2012. End pit lakes guidance document 2012. Cumulative Environmental Management Association, Fort McMurray, Alberta. CEMA Contract No. 2010-0016 RWG. 434 pp.

Oil Sands Research and Information Network, 2014a. Oil Sands Rules, Tools and Capacity: Are we Ready for Upcoming Challenges? OSRIN Report No. TR-53. 120 pp.

Oil Sands Research and Information Network, 2014b. Survey of Oil Sands Environmental Management Research and Information Needs. OSRIN Report No. TR-58. 67 pp.

Oil Sands Water Release Technical Working Group, 1996. Approaches to oil sands water releases. Alberta Environmental Protection, Edmonton, Alberta. 34 pp.

Wallace, R.R., 1975. Proceedings: Technical seminar for the Expert Advisory Group to Aquatic Fauna Committee, AOSERP. November 14, 1975. Alberta Oil Sands Environmental Research Program, Edmonton, Alberta. 82 pp.

Weber, B., 2013. Industry, governments discuss conditions for oil sands water release. Financial Post, December 16.

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LIST OF OSRIN REPORTS

OSRIN reports are available on the University of Alberta's Education & Research Archive at http://hdl.handle.net/10402/era.17209. The Technical Report (TR) series documents results of OSRIN funded projects. The Staff Reports (SR) series represent work done by OSRIN staff.

OSRIN Technical Reports – http://hdl.handle.net/10402/era.17507

BGC Engineering Inc., 2010. Oil Sands Tailings Technology Review. OSRIN Report No. TR-1. 136 pp. http://hdl.handle.net/10402/era.17555

BGC Engineering Inc., 2010. Review of Reclamation Options for Oil Sands Tailings Substrates. OSRIN Report No. TR-2. 59 pp. http://hdl.handle.net/10402/era.17547

Chapman, K.J. and S.B. Das, 2010. Survey of Albertans' Value Drivers Regarding Oil Sands Development and Reclamation. OSRIN Report TR-3. 13 pp. http://hdl.handle.net/10402/era.17584

Jones, R.K. and D. Forrest, 2010. Oil Sands Mining Reclamation Challenge Dialogue – Report and Appendices. OSRIN Report No. TR-4. 258 pp. http://hdl.handle.net/10402/era.19092

Jones, R.K. and D. Forrest, 2010. Oil Sands Mining Reclamation Challenge Dialogue – Report. OSRIN Report No. TR-4A. 18 pp. http://hdl.handle.net/10402/era.19091

James, D.R. and T. Vold, 2010. Establishing a World Class Public Information and Reporting System for Ecosystems in the Oil Sands Region – Report and Appendices. OSRIN Report No. TR-5. 189 pp. http://hdl.handle.net/10402/era.19093

James, D.R. and T. Vold, 2010. Establishing a World Class Public Information and Reporting System for Ecosystems in the Oil Sands Region – Report. OSRIN Report No. TR-5A. 31 pp. http://hdl.handle.net/10402/era.19094

Lott, E.O. and R.K. Jones, 2010. Review of Four Major Environmental Effects Monitoring Programs in the Oil Sands Region. OSRIN Report No. TR-6. 114 pp. http://hdl.handle.net/10402/65.20287

Godwalt, C., P. Kotecha and C. Aumann, 2010. Oil Sands Tailings Management Project. OSRIN Report No. TR-7. 64 pp. http://hdl.handle.net/10402/era.22536

Welham, C., 2010. Oil Sands Terrestrial Habitat and Risk Modeling for Disturbance and Reclamation – Phase I Report. OSRIN Report No. TR-8. 109 pp. http://hdl.handle.net/10402/era.22567

Schneider, T., 2011. Accounting for Environmental Liabilities under International Financial Reporting Standards. OSRIN Report TR-9. 16 pp. http://hdl.handle.net/10402/era.22741

Davies, J. and B. Eaton, 2011. Community Level Physiological Profiling for Monitoring Oil Sands Impacts. OSRIN Report No. TR-10. 44 pp. http://hdl.handle.net/10402/era.22781

Hurndall, B.J., N.R. Morgenstern, A. Kupper and J. Sobkowicz, 2011. Report and Recommendations of the Task Force on Tree and Shrub Planting on Active Oil Sands Tailings Dams. OSRIN Report No. TR-11. 15 pp. http://hdl.handle.net/10402/era.22782

Gibson, J.J., S.J. Birks, M. Moncur, Y. Yi, K. Tattrie, S. Jasechko, K. Richardson, and P. Eby, 2011. Isotopic and Geochemical Tracers for Fingerprinting Process-Affected Waters in the Oil Sands Industry: A Pilot Study. OSRIN Report No. TR-12. 109 pp. http://hdl.handle.net/10402/era.23000

Oil Sands Research and Information Network, 2011. Equivalent Land Capability Workshop Summary Notes. OSRIN Report TR-13. 83 pp. http://hdl.handle.net/10402/era.23385

Kindzierski, W., J. Jin and M. Gamal El-Din, 2011. Plain Language Explanation of Human Health Risk Assessment. OSRIN Report TR-14. 37 pp. http://hdl.handle.net/10402/era.23487

Welham, C. and B. Seely, 2011. Oil Sands Terrestrial Habitat and Risk Modelling for Disturbance and Reclamation – Phase II Report. OSRIN Report No. TR-15. 93 pp. http://hdl.handle.net/10402/era.24547

Morton Sr., M., A. Mullick, J. Nelson and W. Thornton, 2011. Factors to Consider in Estimating Oil Sands Plant Decommissioning Costs. OSRIN Report No. TR-16. 62 pp. http://hdl.handle.net/10402/era.24630

Paskey, J. and G. Steward, 2012. The Alberta Oil Sands, Journalists, and Their Sources. OSRIN Report No. TR-17. 33 pp. http://hdl.handle.net/10402/era.25266

Cruz-Martinez, L. and J.E.G. Smits, 2012. Potential to Use Animals as Monitors of Ecosystem Health in the Oil Sands Region – July 2013 Update. OSRIN Report No. TR-18. 59 pp. http://hdl.handle.net/10402/era.25417

Hashisho, Z., C.C. Small and G. Morshed, 2012. Review of Technologies for the Characterization and Monitoring of VOCs, Reduced Sulphur Compounds and CH_4. OSRIN Report No. TR-19. 93 pp. http://hdl.handle.net/10402/era.25522

Kindzierski, W., J. Jin and M. Gamal El-Din, 2012. Review of Health Effects of Naphthenic Acids: Data Gaps and Implications for Understanding Human Health Risk. OSRIN Report No. TR-20. 43 pp. http://hdl.handle.net/10402/era.26060

Zhao, B., R. Currie and H. Mian, 2012. Catalogue of Analytical Methods for Naphthenic Acids Related to Oil Sands Operations. OSRIN Report No. TR-21. 65 pp. http://hdl.handle.net/10402/era.26792

Oil Sands Research and Information Network and Canadian Environmental Assessment Agency, 2012. Summary of the Oil Sands Groundwater – Surface Water Interactions Workshop. OSRIN Report No. TR-22. 125 pp. http://hdl.handle.net/10402/era.26831

Valera, E. and C.B. Powter, 2012. Implications of Changing Environmental Requirements on Oil Sands Royalties. OSRIN Report No. TR-23. 21 pp. http://hdl.handle.net/10402/era.27344

Dixon, R., M. Maier, A. Sandilya and T. Schneider, 2012. Qualifying Environmental Trusts as Financial Security for Oil Sands Reclamation Liabilities. OSRIN Report No. TR-24. 32 pp. http://hdl.handle.net/10402/era.28305

Creasey, R., 2012. Professional Judgment in Mineable Oil Sands Reclamation Certification: Workshop Summary. OSRIN Report No. TR-25. 52 pp. http://hdl.handle.net/10402/era.28331

Alberta Innovates – Technology Futures, 2012. Investigating a Knowledge Exchange Network for the Reclamation Community. OSRIN Report No. TR-26. 42 pp. http://hdl.handle.net/10402/era.28407

Dixon, R.J., J. Kenney and A.C. Sandilya, 2012. Audit Protocol for the Mine Financial Security Program. OSRIN Report No. TR-27. 27 pp. http://hdl.handle.net/10402/era.28514

Davies, J., B. Eaton and D. Humphries, 2012. Microcosm Evaluation of Community Level Physiological Profiling in Oil Sands Process Affected Water. OSRIN Report No. TR-28. 33 pp. http://hdl.handle.net/10402/era.29322

Thibault, B., 2012. Assessing Corporate Certification as Impetus for Accurate Reporting in Self-Reported Financial Estimates Underlying Alberta's Mine Financial Security Program. OSRIN Report No. TR-29. 37 pp. http://hdl.handle.net/10402/era.29361

Pyper, M.P., C.B. Powter and T. Vinge, 2013. Summary of Resiliency of Reclaimed Boreal Forest Landscapes Seminar. OSRIN Report No. TR-30. 131 pp. http://hdl.handle.net/10402/era.30360

Pyper, M. and T. Vinge, 2013. A Visual Guide to Handling Woody Materials for Forested Land Reclamation. OSRIN Report No. TR-31. 10 pp. http://hdl.handle.net/10402/era.30381

Mian, H., N. Fassina, A. Mukherjee, A. Fair and C.B. Powter, 2013. Summary of 2013 Tailings Technology Development and Commercialization Workshop. OSRIN Report No. TR-32. 69 pp. http://hdl.handle.net/10402/era.31012

Howlett, M. and J. Craft, 2013. Application of Federal Legislation to Alberta's Mineable Oil Sands. OSRIN Report No. TR-33. 94 pp. http://hdl.handle.net/10402/era.31627

Welham, C., 2013. Factors Affecting Ecological Resilience of Reclaimed Oil Sands Uplands. OSRIN Report No. TR-34. 44 pp. http://hdl.handle.net/10402/era.31714

Naeth, M.A., S.R. Wilkinson, D.D. Mackenzie, H.A. Archibald and C.B. Powter, 2013. Potential of LFH Mineral Soil Mixes for Land Reclamation in Alberta. OSRIN Report No. TR-35. 64 pp. http://hdl.handle.net/10402/era.31855

Welham, C. and B. Seely, 2013. Oil Sands Terrestrial Habitat and Risk Modelling for Disturbance and Reclamation: The Impact of Climate Change on Tree Regeneration and Productivity – Phase III Report. OSRIN Report No. TR-36. 65 pp. http://hdl.handle.net/10402/era.31900

Eaton, B., T. Muhly, J. Fisher and S-L. Chai, 2013. Potential Impacts of Beaver on Oil Sands Reclamation Success – an Analysis of Available Literature. OSRIN Report No. TR-37. 65 pp. http://hdl.handle.net/10402/era.32764

Paskey, J., G. Steward and A. Williams, 2013. The Alberta Oil Sands Then and Now: An Investigation of the Economic, Environmental and Social Discourses Across Four Decades. OSRIN Report No. TR-38. 108 pp. http://hdl.handle.net/10402/era.32845

Watson, B.M. and G. Putz, 2013. Preliminary Watershed Hydrology Model for Reclaimed Oil Sands Sites. OSRIN Report No. TR-39. 193 pp. http://hdl.handle.net/10402/era.34250

Birks, S.J., Y. Yi, S. Cho, J.J. Gibson and R. Hazewinkel, 2013. Characterizing the Organic Composition of Snow and Surface Water in the Athabasca Region. OSRIN Report No. TR-40. 62 pp. http://hdl.handle.net/10402/era.36643

De Corby, R.G., 2013. Development of Silicon-Based Optofluidic Sensors for Oil Sands Environmental Monitoring. OSRIN Report No. TR-41. 19 pp. http://hdl.handle.net/10402/era.36936

Iqbal, M., T.K. Purkait, J.G.C. Veinot and G.G. Goss, 2013. Benign-by-Design: Synthesis of Engineered Silicon Nanoparticles and their Application to Oil Sands Water Contaminant Remediation. OSRIN Report No. TR-42. 30 pp. http://hdl.handle.net/10402/era.37308

Oil Sands Research and Information Network, 2013. Future of Shrubs in Oil Sands Reclamation Workshop. OSRIN Report No. TR-43. 71 pp. http://hdl.handle.net/10402/era.37440

Smreciu, A., K. Gould and S. Wood, 2013. Boreal Plant Species for Reclamation of Athabasca Oil Sands Disturbances – Updated December 2014. OSRIN Report No. TR-44. 23 pp. plus appendices. http://hdl.handle.net/10402/era.37533

Pereira, A.S. and J.W. Martin, 2014. On-Line Solid Phase Extraction – HPLC – Orbitrap Mass Spectrometry for Screening and Quantifying Targeted and Non-Targeted Analytes in Oil Sands Process-Affected Water and Natural Waters in the Athabasca Oil Sands Region. OSRIN Report No. TR-45. 33 pp. http://hdl.handle.net/10402/era.37793

Liang, J., F. Tumpa, L.P. Estrada, M. Gamal El-Din and Y. Liu, 2014. Ozone-Assisted Settling of Diluted Oil Sands Mature Fine Tailings: A Mechanistic Study. OSRIN Report No. TR-46. 43 pp. http://hdl.handle.net/10402/era.38226

Rochdi, N., J. Zhang, K. Staenz, X. Yang, D. Rolfson, J. Banting, C. King and R. Doherty, 2014. Monitoring Procedures for Wellsite, In-Situ Oil Sands and Coal Mine Reclamation in Alberta. OSRIN Report No. TR-47. 156 pp. http://hdl.handle.net/10402/era.38742

Taheriazad, L., C. Portillo-Quintero and G.A. Sanchez-Azofeifa, 2014. Application of Wireless Sensor Networks (WSNs) to Oil Sands Environmental Monitoring. OSRIN Report No. TR-48. 51 pp. http://hdl.handle.net/10402/era.38858

Marey, H.S., Z. Hashisho and L. Fu, 2014. Satellite Remote Sensing of Air Quality in the Oil Sands Region. OSRIN Report No. TR-49. 104 pp. http://hdl.handle.net/10402/era.38882

Li, C., A. Singh, N. Klamerth, K. McPhedran, P. Chelme-Ayala, M. Belosevic and M. Gamal El-Din, 2014. Synthesis of Toxicological Behavior of Oil Sands Process-Affected Water Constituents. OSRIN Report No. TR-50. 101 pp. http://hdl.handle.net/10402/era.39659

Jiang, Y. and Y. Liu, 2014. Application of Forward Osmosis Membrane Technology for Oil Sands Process-Affected Water Desalination. OSRIN Report No. TR-51. 27 pp. http://hdl.handle.net/10402/era.39855

Zhu, L., M. Yu, L. Delgado Chávez, A. Ulrich and T. Yu, 2014. Review of Bioreactor Designs Applicable to Oil Sands Process-Affected Water Treatment. OSRIN Report No. TR-52. 39 pp. http://hdl.handle.net/10402/era.39903

Oil Sands Research and Information Network, 2014. Oil Sands Rules, Tools and Capacity: Are we Ready for Upcoming Challenges? OSRIN Report No. TR-53. 120 pp. http://hdl.handle.net/10402/era.39985

Iqbal, M., T.K. Purkait, M. Aghajamali, L. Hadidi, J.G.C. Veinot, G.G. Goss and M. Gamal El-Din, 2014. Hybrid Aerogel SiNP Membranes for Photocatalytic Remediation of Oil Sands Process Water. OSRIN Report No. TR-54. 29 pp. http://hdl.handle.net/10402/era.40004

Schoonmaker, A., J-M. Sobze, E. Fraser, E. Marenholtz, A. Smreciu, C.B. Powter and M. Mckenzie, 2014. Alternative Native Boreal Seed and Plant Delivery Systems for Oil Sands Reclamation. OSRIN Report No. TR-55. 61 pp. http://hdl.handle.net/10402/era.40099

Aguilar, M., E. Glucksman, D. Bass and J.B. Dacks, 2014. Next Generation Sequencing of Protists as a Measure of Microbial Community in Oil Sands Tailings Ponds: Amplicon Versus Metagenomic Approaches. OSRIN Report No. TR-56. 24 pp. http://hdl.handle.net/10402/era.40100

Alessi, D.S., M.S. Alam and M.C. Kohler, 2014. Designer Biochar-Coke Mixtures to Remove Naphthenic Acids from Oil Sands Process-Affected Water (OSPW). OSRIN Report No. TR-57. 38 pp. http://hdl.handle.net/10402/era.40122

Oil Sands Research and Information Network, 2014. Survey of Oil Sands Environmental Management Research and Information Needs. OSRIN Report No. TR-58. 67 pp. http://hdl.handle.net/10402/era.40128

Huang, Q., H. Wang and M.A. Lewis, 2014. Development of a Toxin-Mediated Predator-Prey Model Applicable to Aquatic Environments in the Athabasca Oil Sands Region. OSRIN Report No. TR-59. 59 pp. http://hdl.handle.net/10402/era.40140

Currie, R., S. Bansal, I. Khan and H. Mian, 2014. An Investigation of the Methylene Blue Titration Method for Clay Activity of Oil Sands Samples. OSRIN Report No. TR-60. 50 pp. http://hdl.handle.net/10402/era.40164

Welham, C., 2014. Risk and Uncertainty in Oil Sands Upland Reclamation: Best Management Practices within the Context of Climate Change. OSRIN Report No. TR-61. 26 pp. http://hdl.handle.net/10402/era.40171

Mahdavi, H., H. Mian, S. Hepperle and Z. Burkus, 2014. Standard Operating Procedures for Analysis of Naphthenic Acids from Oil Sands Process-Affected Water. OSRIN Report No. TR-62. 67 pp. http://hdl.handle.net/10402/era.40181

McPhedran, K., M.S. Islam and M. Gamal El-Din, 2014. Development of a Novel Engineered Bioprocess for Oil Sands Process-Affected Water and Tailings Fines/Bitumen/Water Separation. OSRIN Report No. TR-63. 28 pp. http://hdl.handle.net/10402/era.40190

OSRIN Videos – http://hdl.handle.net/10402/era.29304

Rooney Productions, 2012. Assessment Methods for Oil Sands Reclamation Marshes. OSRIN Video No. V-1. 20 minutes. Also available on the University of Alberta You Tube Channel (recommended approach).

Rooney Productions, 2012. Assessment Methods for Oil Sands Reclamation Marshes. OSRIN Video No. V-1. Nine-part mobile device version. Also available on the University of Alberta You Tube Channel (link to Part 1 - recommended approach).

OSRIN Staff Reports – http://hdl.handle.net/10402/era.19095

OSRIN, 2010. Glossary of Terms and Acronyms used in Oil Sands Mining, Processing and Environmental Management – December 2013 Update. OSRIN Report No. SR-1. 123 pp. http://hdl.handle.net/10402/era.17544

OSRIN, 2010. OSRIN Writer's Style Guide – November 2013 Update. OSRIN Report No. SR-2. 29 pp. http://hdl.handle.net/10402/era.17545

OSRIN, 2010. OSRIN Annual Report: 2009/2010. OSRIN Report No. SR-3. 27 pp. http://hdl.handle.net/10402/era.17546

OSRIN, 2010. Guide to OSRIN Research Grants and Services Agreements - June 2011 Update. OSRIN Report No. SR-4. 21 pp. http://hdl.handle.net/10402/era.17558

OSRIN, 2011. Summary of OSRIN Projects – October 2014 Update. OSRIN Report No. SR-5. 113 pp. http://hdl.handle.net/10402/era.20529

OSRIN, 2011. OSRIN Annual Report: 2010/11. OSRIN Report No. SR-6. 34 pp. http://hdl.handle.net/10402/era.23032

OSRIN, 2011. OSRIN's Design and Implementation Strategy. OSRIN Report No. SR-7. 10 pp. http://hdl.handle.net/10402/era.23574

OSRIN, 2012. OSRIN Annual Report: 2011/12. OSRIN Report No. SR-8. 25 pp. http://hdl.handle.net/10402/era.26715

OSRIN, 2013. OSRIN Annual Report: 2012/13. OSRIN Report No. SR-9. 56 pp. http://hdl.handle.net/10402/era.31211

OSRIN, 2014. OSRIN Annual Report: 2013/14. OSRIN Report No. SR-10. 66 pp. http://hdl.handle.net/10402/era.38508