COSIA CHALLENGE

Mobilizing the world's minds and resources to improve environmental performance.

Approaching Zero Land Disturbance Exploration

SOLUTION DESCRIPTION:

Technologies and techniques that will allow for subsurface geology profiling without the need to clear surface vegetation.

UPDATED: June 29, 2017

All projects are evaluated and actioned as they are received.

CHALLENGE SPONSOR:

COSIA's **Land EPA** is sponsoring this challenge.

Our aspiration is to be world leaders in land management, restoring the land and preserving biodiversity of plants and animals.

COSIA has four Environmental Priority Areas (EPAs): Water, Land, Tailings, and Greenhouse Gases (GHGs).

For more information on this COSIA Challenge please visit **www.cosia.ca/challenges**

Canada's Oil Sands Innovation Alliance (COSIA) accelerates the pace of environmental performance improvement in Canada's oil sands through collaborative action and innovation. COSIA members represent more than 90 per cent of oil sands production.

COSIA Challenges are one way we articulate an actionable innovation need, bringing global innovation capacity to bear on global environmental challenges. We bring together innovators and leading thinkers from industry, government, academia and the wider public to identify and advance new transformative technologies.

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WHAT TO SUBMIT TO COSIA

COSIA requires sufficient non-confidential, non-proprietary information to properly evaluate the technology.

Some items that will be especially important to present in your submission are:

- Concept and basic unit operations
- Technical justification for the approach (e.g. laboratory batch or continuous experiments; pilot or demo plants; process modeling; literature precedent)
- Describe quantities and qualities of utilities and consumables that are required
- Energy inputs – quantity and type(s)
- Capital and operating cost estimates if available based on described capacity targets
- 3rd party verified comparison of your proposed technology against an MEA baseline. 3rd party verifiers should be reputable, independent engineering companies if possible
- Basis of cost estimation, including estimation scope, contingency, etc.
- IP status of your proposed technology
- What operating environment restrictions might your technology face:
  - Explosive atmospheres
  - Severe weather
  - Power fluctuations

FUNDING, FINANCIALS, AND INTELLECTUAL PROPERTY

COSIA Members are committed to identifying emerging technologies and funding the development of the technologies to the point of commercialization, while protecting the Intellectual Property (IP) rights of the owner of the technology.

COSIA Members have funded over 400 projects to date, totaling over $1 billion.

Successful proposals can receive funding from COSIA members to develop and demonstrate the technology in an oil sands application. Multiple technologies may be funded, at the discretion of the Members.

HOW TO SUBMIT TO COSIA

Submit a summary of your solution through COSIA's Environmental Technology Assessment Portal (E-TAP) at:
http://www.cosia.ca/initiatives/etap

Please note: ETAP is a staged submission process. The initial submission requires only a brief description and limited technical information. Upon review by COSIA, additional information may be requested. Instructions for submission are provided on the ETAP site.

All information provided is non-confidential.
COSIA will respond to all submissions.

DETAILED SOLUTION DESCRIPTION

The COSIA Land Environmental Priority Area (EPA) has identified an opportunity to eliminate tree clearing associated with exploration across the boreal forest and in particular within the oil sands region of northern Alberta, Canada.

The successful technique, technology or approach:

- will be applicable for two-dimensional and three-dimensional subsurface geologic profiling;
- will not require removal of any pre-existing vegetation - in particular trees - orl result in any other vegetation-reduction clearing beyond current practices.

BACKGROUND

One of the challenges for resource development companies in the Canadian Oil Sands is the surface footprint associated with oil sands projects. Of the 142,200 km^2 of land that oil sands underlie in northern Alberta, a small portion has been mined (i.e. <1% or 895 km^2 in 2013).

The majority of the oil reserves are deep underground (>75m). Approximately 97% of the oil sands that will be recovered will be by in situ recovery methods. While in situ projects require very little surface land disturbance - only 15 to 25 per cent of the land compared to 100 per cent for mining - these projects still have an impact on the boreal forest.

For example, the roads and seismic exploration lines associated with in situ projects contribute to forest fragmentation, which has contributed to the decline of threatened Woodland Caribou (*Rangifer tarandus caribou*) – or boreal caribou – in Alberta,. About 30% of the land disturbed at in situ projects results from current exploration methods and regulations.

As a responsible industry alliance, we strive for reductions in the surface footprint required for resource development. As an example, COSIA has a Land Performance Goal focused on increasing land-use efficiency and reducing the operating footprint intensity of in situ developments. (For more information see http://www.cosia.ca/initiatives/land/land-performance-goals).

To help us accomplish our goal COSIA for reducing our commercial footprint, this challenge is aimed at finding ways to significantly reduce the impact of our exploration activities. Exploration accounts for about 50 per cent of the environmental impact resulting from in situ projects

CHALLENGE GOAL

The goal of the challenge is to:

- Investigate alternative exploration techniques that would help lead us towards zero land disturbance for in situ projects.

Today's Approach to In Situ Exploration

Successful resource recovery requires detailed information about the location and quality of the oil resources under the ground. Seismic and oil sands exploration well drilling are the exploration methods used to evaluate oil sands reserves.

However, seismic lines create travel corridors for wildlife, providing line of sight visibility for predators (e.g. wolves, bears, etc.) to track prey such as deer, moose and boreal caribou. (To learn more about how COSIA is accelerating seismic line recovery see: http://www.cosia.ca/initiatives/land/caribou-habitat-restoration)

Exploration well drilling is most often done to collect sediment cores and, ultimately to delineate a potential resource. This includes developing access routes or roads for heavy equipment and clearing-up to one hectare of area for each exploration well (Figure 1).

Seismic exploration involves the production and analysis of underground sound waves to generate a computer model of subsurface geological structures. Corridors are cleared for access through the boreal forest and truck-mounted drilling equipment is used to drill a series of shallow holes (shot holes), at defined locations (Figure 2). Dynamic charges are placed in the holes and then detonated to generate seismic sound waves.

By analyzing the time it takes for seismic waves to return to the surface, a geophysicist can map subsurface formations and anomalies and predict where oil may be trapped. As the charges are sequentially exploded, the sound waves are reflected by subsurface geological formations and recorded at the surface using portable recording equipment called geophones.

Alternatively, seismic data can be obtained using vibration waves instead of dynamite. This is called vibroseis. It involves using a truck-mounted device that injects low frequency vibrations into the earth.

Historically, seismic exploration would leave cleared gaps in the forest up to eight metres wide for lengths that could stretch many kilometres. Technology enhancement and adoption have seen low impact seismic become the preferred form of exploration in the oil sands region. This challenge is an extension of the evolution towards smaller clearings, with an ultimate goal of eliminating our exploration footprint and assisting with the reduction of forest fragmentation.

Two-dimensional (2D) seismic exploration occurs along a single line on the ground, producing a picture akin to a slide through the earth beneath that line. Three-dimensional (3D) seismic surveys have shot holes and geophones laid out in a grid system, resulting in multi-directional reflections that are recorded at the receiver geophone, creating a 3D image of the subsurface.

In some cases, seismic programs are repeated, over the same area, known as four-dimensional (4D) seismic, to monitor changes in the subsurface over time. The time between repeated programs varies from company to company (e.g. every six months to every three years). Basically, the 4D seismic approach is used for surveillance, to examine reservoir depletion and changes after a production well is installed and producing oil.

In terms of project phases, exploration occurs throughout the life of a project to support the following activities:

- Deposit extent and commercial viability – systematic grid of core holes and 2D seismic exploration gathers coarse geological data used to delineate deposits;
- Production Pad Design and Well Placement – 3D models of the deposit are produced to aid in production pad and horizontal well placement; and
- Reserve Depletion – 4D seismic monitors changes in the deposit over time after a production well(s) is developed.

Figure 1:Oil Sands Exploration (OSE) pads, the result of winter exploration well drilling, are typically one hectare in size. Un-reclaimed (left) and newly reclaimed OSE pads (right).

Figure 2 - (left) Equipment clearing corridors for low-impact seismic exploration and (right) an aerial view of 2D seismic exploration.

Exploration approaches do not always result in development. Industry practice, and regulatory minimum (see next section for more detail), is to drill at least eight wells per section (see Appendix B for definition) and shoot 3D seismic to delineate the geological formation (i.e. McMurray Formation) for development (or alternatively, to drill at least 16 wells per section without seismic).

Generally, for each section that is developed there will be one or more sections that are explored but deemed uneconomic to develop. In this case, there are typically less than four wells per section and 3D seismic may also have been acquired.

For more detail on current exploration activities see Appendix B.

Today's Regulatory Requirements

Existing regulatory requirements require oil sands companies using in situ methods to explore oil sands reserves using particular techniques and well densities. See: The *Oil Sands Tenure Regulation, 2010* (http://www.qp.alberta.ca/documents/Regs/2010_196.pdf) and the *Oil Sands Tenure Regulation, 2010 – Interim Approach Update Memo* (http://www.energy.alberta.ca/OilSands/pdfs/IB_2012-04.pdf).

For more information see the Alberta Energy Regulator's (AER) Draft Directive 023 (http://www.aer.ca/documents/directives/DraftDirective023_20130528.pdf).

For example, the *Draft Directive 023: Oil Sands Project Applications* indicates that the "Energy Resources Conservation Board (ERCB) now known as the Alberta Energy Regulator (AER) expects applicants to have obtained an adequate amount of resource delineation to support their application.

The project area must be delineated adequately so that the applicant can demonstrate there is potentially recoverable bitumen within each section. To achieve this, applicants have to drill at least one well per section in each of the sections in the project area. A section is a legal land description term with a measurement of roughly 1.61km X 1.61km (Appendix A).

COSIA is looking for exploration solutions beyond current and regulatory-approved exploration approaches. We encourage innovators not to limit their approaches to today's regulations if they have potentially better solutions to current exploration practices.

Performance Metrics and a Multi-Disciplinary Team Approach

COSIA convened a multi-disciplinary technical committee in 2016 to draft this COSIA Land Challenge seeking solutions for improving exploration footprint intensity and supporting boreal caribou conservation efforts. The technical committee is composed of multi-industry members with diverse backgrounds, including expertise in biology, geology, geophysics, reclamation, regulatory, stakeholder engagement, innovation and industry collaboration.

The technical committee is responsible for ensuring that potential solutions address the range of needs across an individual company and industry. They have developed a list of performance metrics that proposed solutions must meet or exceed. For more information, see Table 1.

Table 1 – A list and description of the performance metrics that will be used to guide: (a) innovators in proposal development; and (b) COSIA during proposal evaluation and awarding of the winner(s).

Focus Area	Performance Target	Base Case	Description
Disturbance Footprint	• Goal of zero disturbance for exploration activities • Proposals outlining ≥50% reduction from base case will be considered	Average disturbance area per section is 33 ha	Today's technology standards and regulatory requirements for adequate reservoir delineation (e.g. core hole drilling and 3D seismic) result in ~50% of a project's overall disturbance (i.e. trees harvested; ~25% of total area) being caused by exploration activities in the oil sands region. Therefore, on average, any given section (1x1 sq. mi/259 ha) will have ~33 ha disturbed by exploration. COSIA is looking for innovative solutions that will result in a "step-change" or significant reductions in tree harvesting during resource exploration. See Appendix B for more detail. *Note: Disturbance area will vary from company-to-company due to numerous factors (e.g. depth of reservoir). An estimated regional average is used as the base case.*
Reservoir Data Needs	• Must obtain the following data: (a) lithology; and (b) oil, water and gas saturation.	Significant sections of the boreal forest are harvested to obtain an assortment of geobody data	Today, seismic and core hole drilling techniques provide a range of data that ultimately enables reservoir exploration and delineation, and production planning. New technology needs to continue collecting information that supports examination of the geobody and attributes of the geobody, including distribution of bitumen saturation and cut-offs and structural subsurface features (e.g. cap rock and disposal zones). The new method(s) must produce reliable and consistent data, which can be applied over the same geographical area numerous times, while significantly reducing boreal forest disturbance (see above).
Safety	• New technology does not result in any increased risks to people safety	Top priority	The oil sands industry's top priority is people safety. New technology must not result in any increased risks to people safety. Risks will be evaluated and mitigated prior to commercial implementation

APPROACHES NOT OF INTEREST

Approaches that do not produce an equal or greater than resolution and quality that can be obtained from existing "low impact" seismic and core hole drilling will not be considered. Profiling results will need to meet or exceed the quality and resolution that is currently obtained from today's practices.

POTENTIAL SOLUTION PROVIDERS

Responses to this Challenge are welcome from anyone including:

- COSIA Member employees;
- COSIA Associate Members;
- Companies (small, medium, or large);
- Academic researchers;
- Research institutes;
- Consultants;
- Venture capitalists; and
- Entrepreneurs or inventors

COSIA encourages potential solution providers to partner with others, where the partnership will lead to a more complete and comprehensive solution.

ADDITIONAL INFORMATION

Seismic, electromagnetic, gravity or other technologies or methods that will result in zero land disturbance may be considered.

APPENDIX A – WHAT IS A SECTION?

The province of Alberta, Canada, manages its land using an Alberta Township Survey (ATS) system, where any parcel of land can be located by a legal land description, referencing a given section, township, range and meridian (Figure 3). The ATS is a grid network dividing the province into equal-sized parcels of land.

Land is identified as being west of one of three meridians, 4th, 5th or 6th (110°, 114°, 118° west longitude, respectively). These meridians are six-mile-wide columns called ranges. Ranges are numbered consecutively from east to west, starting at Range 1 west of each meridian.

Townships are six-mile-wide rows that intersect ranges and are numbered from Township 1 (at the Montana, USA border) to Township 126 at the Northwest Territories (NWT), Canada border. Township is also described as the six-by-six mile square formed between a given range and township. Townships are divided even further into 36 sections with each section measuring one-by-one mile.

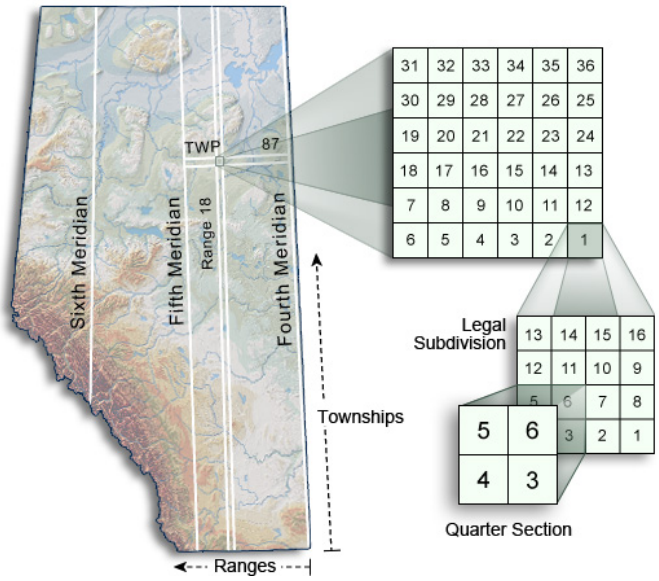

Figure 3 – The Alberta Township Survey system divides the province into equal-sized parcels of land. This image illustrates the legal description of a particular parcel of land, called 1 – 87 – 18 – W4 (Section-Township-Range-Meridian)- modified from http://aep.alberta.ca/recreation-public-use/recreation-on-agricultural-public-land/alberta-township-survey-system.aspx)

APPENDIX B – A THEORECTICAL SECTION IMPACTED BY OIL SANDS EXPLORATION

The image below illustrates an average and theoretical oil sands in situ exploration footprint, referred to as "Section A". It is based on a "reasonable average" from an in situ footprint model developed by the Sustainable Ecosystem Working Group (SEWG) of the Cumulative Environmental Management Association (CEMA) using 2006 footprint data from eight oil sands operators (Silvatech Group, 2009).

According to the 2006 average, 66/259ha of a given section will be disturbed. Of the 66ha that is disturbed, 33ha will be disturbed as a result of exploration activities. Exploration footprint is divided between exploration pads developed by core hole drilling (6ha), winter roads (1ha) and seismic exploration (27ha). *Note: Disturbance area will vary from company-to-company due to numerous factors (e.g. the depth of reservoir, age of operator and year production commenced). Also, if the same exercise was repeated today, the average exploration footprint would likely be less than the 2006 reasonable average, since low-impact exploration is now widely used across the industry.*

If the collected exploration data identifies that the reservoir underlying this is an economically viable reservoir, then the operator will develop and submit a D23 application to the Alberta Energy Regulator. If approved, the company will construct production well pad infrastructure over the area, effectively doubling the exploration footprint from 33ha to 66ha.

Features	Regional Average Area (ha)	Regional Average Area (%)
OSE pads	5.6	17
Winter Roads	0.9	3
2D & 3D Seismic	26.8	80
OSE Development	**33.4**	**50.6** (of total disturbance
Total In Situ Disturbance	**66**	**25.4** (of total section)
Total Area of Section	***259***	***100***