2015 PERFORMANCE UPDATE: PROJECT HIGHLIGHTS
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Our Vision: To enable responsible and sustainable growth of Canada’s oil sands while delivering accelerated improvement in environmental performance through collaborative action and innovation.

Canada’s Oil Sands Innovation Alliance (COSIA) is an alliance of oil sands producers focused on accelerating the pace of improvement in environmental performance in Canada’s oil sands through collaborative action and innovation.

The alliance was launched March 1, 2012, when representatives of 13 companies came together in Calgary, Alberta to sign the COSIA charter, signifying their agreement with COSIA’s vision, their support of our alliance’s beliefs and their pledge to uphold the commitments put forward in the charter.

We bring together leading thinkers from industry, government, academia and the wider public to improve measurement, accountability and environmental performance in the oil sands in four priority areas. These four Environmental Priority Areas (EPAs) are tailings, water, land and greenhouse gases.

We accomplish this through a continued focus on collaboration and transparent exchange, by setting environmental performance goals and by reporting publicly on progress towards these goals. Progress towards these goals will be achieved by breaking down barriers to innovation, and by identifying, developing and applying solutions-oriented innovation to the most pressing oil sands environmental challenges.

COSIA has 13 members representing almost 90 per cent of the oil sands production in Canada. COSIA member companies have signed COSIA’s Charter and support the Alliance’s vision.

These companies, by becoming part of COSIA, share experience and intellectual property with other member companies. Through the sharing of innovation and application of these technologies, members accelerate the pace of environmental performance improvement.

COSIA brings companies together to share innovation and intellectual property related to COSIA’s Environmental Priority Areas. Sharing is done in a manner that values and protects corporate technologies, but still provides access for the COSIA companies who can apply and build on these technologies to accelerate environmental performance improvement in their operations.

To date, COSIA member companies have shared 814 distinct technologies and innovations that cost nearly $1.3 billion to develop. These numbers are increasing as the alliance matures and expands. Through this sharing of innovation and application of new technologies, members can accelerate the pace of environmental performance improvements.
FOREWORD

Welcome. I’m delighted to be able to share with you some of the work COSIA companies have been leading in 2015. This selection of projects includes work that started in 2015, as well as other projects that were ongoing and completed this year. I trust you’ll find the work our members are doing as exciting and innovative as I do.

In 2015, with the significantly lower price of oil, the COSIA sharing model has become even more important today than ever before. The COSIA model is built on the concept of leverage. Through COSIA our members share environmental knowledge, best practices and technology. Through this sharing or leverage, duplication can be eliminated and more technology development and testing can be conducted at lower cost.

“The technologies our members develop have the potential to be applied in other sectors around the world to solve common challenges”

However, to gain as much value out of our sharing model as possible we need to continually look at ways to expand what I like to call our collaborative global ecosystem, made up of the brightest people and progressive organizations developing solutions to the environmental challenges that lie at the heart of the oil sands sector and many others. The technologies our members develop have the potential to be applied in other sectors around the world to solve common challenges. In order to do this our members believe it is important to share the work they are doing and the areas in which they are doing it.

In 2015 COSIA members have:
- started 37 new projects worth $23 million;
- completed 60 projects, many of which are delivering real environmental benefits; and
- shared 65 technologies costing $101 million to develop.

This hard work has resulted in COSIA members sharing a total of 814 distinct technologies and innovations that cost just under $1.3 billion to develop.

If you’re an innovator, I hope that this snapshot of some of the work our members are doing inspires you to go to cosia.ca/challenges and find out more about how to partner with COSIA companies to help drive accelerated improvement in environmental performance through collaborative action and innovation.

DAN WICKLUM
Environmental Priority Area

Land

We will strive to be world leaders in land management, restoring the land we disturb and preserving biodiversity of plants and animals.
APPLYING NATURAL ANALOGUES TO CONSTRUCTING AND ASSESSING LONG-TERM HYDROLOGIC RESPONSE OF OIL SANDS RECLAIMED LANDSCAPES

PROJECT DESCRIPTION

Syncrude and Canadian Natural are supporting studies to determine the distribution and limits of water use within reconstructed landscapes by examining the hydrological processes controlling the flux and storage of water in natural analogue landscapes. Through the examination of large-scale wildfire disturbance at the Utikuma Region Study Area (URSA), the project tests the role of soil type/depth, vegetation (i.e., wetland – forestland hydrologic units (HUs)) and geology (i.e., equivalent material storage and transmission, or hydrologic response areas (HRAs)), and their interactions with climate cycles, on the timing and location of water and chemical storage and connectivity at the local and landscape scale. Specific objectives are to determine:

- Whether boreal plains ecosystems (wetlands – forestlands) develop and interact to minimize overall water use or develop to maximize productivity;
- How water use vs. productivity varies with succession (or development) of wetland and forestland ecosystems; and
- The role of organic (peat) depth vs. local (soils) and regional (HRA-connectivity) geology on the successional trajectory of natural and constructed wetlands and forestlands.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- These findings can be used to develop landscape design criteria at both the local and lease scale to promote long-term resilience of constructed ecosystems.
- The findings can also aid in the assessment of available source water within constructed landscapes for the maintenance and function of end-pit lakes.
- It will provide information on the types of landforms (HRA) created with existing material storage and the limitations this imposes on existing capping capabilities to direct ecosystem function.

OPPORTUNITY AREA: EFFECTIVE RECLAMATION

LEAD COMPANY: Syncrude
OTHER PARTICIPANTS: Canadian Natural

BUSINESS BENEFITS

- Research will provide information to further aid in the success of reclamation.
- Potentially accelerate the pace of reclamation and enhance public confidence in our operations.
CRITERIA TO ASSESS – STP WETLANDS COMPLEX

PROJECT DESCRIPTION

In March 2005, Suncor received approval to construct a tailings storage facility for the Millennium Mine project in the upper portion of the McLean Creek watershed. The construction of the tailings pond required the alteration of fish habitat. A compensation plan was developed that included a new diversion channel to the McLean Creek watershed and a dispersed-flow wetlands system (the STP Wetlands Complex) to mitigate fish-habitat losses. Fisheries and Oceans Canada (DFO) specified that monitoring in the area must take place to compare the development of the constructed wetlands condition/function to natural wetlands over time, and ensure the constructed wetland conforms to regional norms and meets DFO expectations. The monitoring program includes the assessment of:

- hydrologic conditions;
- water quality;
- sediment quality;
- benthic invertebrate communities;
- vegetation; and
- plankton communities.

Additional monitoring has also been conducted on two other mature wetland systems to compare against the wetland complex.

The Criteria to Assess the Ecological Function of the STP Wetlands Complex and Diversion Channel report provides an outline of the performance indicators and success criteria to determine when the ecological function of the STP Wetlands Complex has conformed to regional norms. The data gathered will help determine the success of constructed wetlands. Project monitoring is ongoing in 2015 and monitoring may continue until criteria is met.

OPPORTUNITY AREA: EFFECTIVE RECLAMATION

LEAD COMPANY: Suncor

BUSINESS BENEFITS

- The study will fill a gap in Alberta Monitoring programs by establishing guidelines for the monitoring of created wetlands to address or minimize effects of development. This will specifically establish guidelines for setting performance standards and success criteria for the STP Wetlands Complex.
- Once performance standards and success criteria are met, and the DFO is satisfied with conditions, monitoring will no longer be required, resulting in a cost savings.
- Suncor-funded, the company has regulatory requirements to meet the DFO ED-04-3045 Authorization.
PROJECT DESCRIPTION

The Fisheries Sustainable Habitat (FiSH) Committee’s focus is on coordinating and improving the efficiency and effectiveness of monitoring related to Fisheries Act Authorizations, as well as the construction of fisheries compensation habitat in the oil sands region. The FiSH committee originated from the requirement that the industry needed to validate the Habitat Suitability Indices (HSI) models used to account for habitat losses from different oil sands developments. Industry Canada, along with Fisheries and Oceans Canada (DFO), agreed that the collection of information to assess the original HSI models from 2008 would be more consistent and cost-effective. Through collaboration, the FiSH Committee enhances the value of regulatory compliance requirements by moving towards a more integrated compliance monitoring program.

Key priorities include:
- compiling existing data and identifying gaps to reduce redundancies, allowing for collaboration to better coordinate integrated monitoring;
- planning amongst different development projects;
- developing improved sampling techniques;
- refining regional habitat models;
- optimizing compensation lake design and sustainable habitat solutions; and

This work provides additional certainty to impacts and compensation requirements.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

Through the sharing of knowledge, resources and project-specific experience, the FiSH Committee has the potential to:
- promote and foster continued improvement of efficient and effective methods for fish-habitat and compensation development;
- promote and enhance fish population assessment; and
- enhance fish-habitat quantification.

OPPORTUNITY AREA: EFFECTIVE RECLAMATION

LEAD COMPANY: Suncor
OTHER PARTICIPANTS: Shell, Total, Teck and Canadian Natural

BUSINESS BENEFITS

- Cost savings by harmonizing and streamlining research program development (HSI model validation), data collection (pre-disturbance fish habitat inventory) and reporting by avoiding duplication and inconsistencies.
- A forum allowing for knowledge and information sharing of fish and fish-habitat impacts, together with regular discussion and engagement with other industry members and government - resulting in consistency on discussions and decisions.
- Up to a 50 to 75 per cent reduction in project cost (approximately $700,000 in total) for pre-disturbance and model validation project work.
- The current project (HSI model validation for streams) is in its final year of data collection with analysis and report writing due in 2016.
PROJECT DESCRIPTION

Geoscientist Matt Lindsay will help Canada’s oil sands industry make sustainable mine closure decisions through a new industrial research chair (IRC) funded by the Natural Sciences and Engineering Research Council (NSERC) and Syncrude.

This IRC in Mine Closure Geochemistry aims to develop a more comprehensive understanding of the geochemical characteristics and evolution of oil sands mine wastes and associated waters within closure landscapes.

An interdisciplinary field and laboratory research program was developed to examine interactions among chemical, biological and physical processes within these landscapes, and therefore, to build a more integrated understanding of influences on water chemistry. This research focuses strongly on understanding relationships between biogeochemical cycling of carbon, iron and sulfur, hydrogeological processes and the release, transport and attenuation of dissolved constituents. Particular emphasis is being placed on examining these processes at environmental interfaces including grain margins and material boundaries.

This IRC research program is principally focused on centrifuge cake and petroleum coke deposits and on examining the geochemical implications of interactions between these and other materials under potential closure scenarios.

Initial field studies are examining spatial and temporal variability in the biogeochemical characteristics of existing cake and coke deposits.

POTENTIAL/ACTIONAL ENVIRONMENTAL BENEFITS

- Lindsay and his team will study by-products of oil sands mining and processing — such as sand, treated fluid fine tailings and petroleum coke — and analyze changes to these materials after they are used to form reclaimed landscapes.

Research on both materials will address four principal objectives over a five-year period:

- define the geochemical characteristics of existing waste deposits;
- identify processes and conditions controlling water quality;
- constrain geochemical implications of potential closure scenarios; and
- develop conceptual models of the geochemical evolution of closure landscapes.
PROJECT DESCRIPTION

Boreal swamps are the most poorly understood wetland type in Canada. The landscapes and ecosystems within which swamps have formed have not yet been studied to the degree required to inform reclamation. There is also little to no guidance for the reconstruction of swamps.

In response, a three-year study has been designed to monitor three natural conifer swamps in the oil sands region to improve understanding on the vegetation, hydrology, soils and landform elements. The study will help address the information gaps that are most critical for informing the development of reclamation practices for swamp wetlands.

In 2014 and 2015, site investigations and selections were completed using geographic information system data, high-resolution aerial photography and on-the-ground verification.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Improve the understanding and ability to re-establish a common wetland type.
- Increase biodiversity in reclamation.

BUSINESS BENEFITS

- Provide significant cost savings through potential partnerships.
**PROJECT DESCRIPTION**

Creating a robust dataset that will support reclamation certification by regulators is a constant challenge for oil sands companies. Defining reclamation success traditionally often depends on physically measuring indicators such as tree height, vegetation composition and soil moisture that are repeatedly monitored over the course of decades. As such, there is a need for oil sands operators to utilize new technologies to become more effective at monitoring and measuring success across large reclamation areas.

Unmanned Aerial Vehicles (UAV) use cameras and sensors to collect high-resolution data, then geospatially analyzes it to measure vegetation success in natural and reclamation areas. UAVs can be used for various types of environmental monitoring including land-clearing, tree-height and reclamation-material surveys.

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- Allows many reclamation areas to be monitored more frequently and for less cost.

- Increases available data, allowing more opportunity to do comparative analysis and identify trends:
  - Minimizes the need to physically observe and collect samples.
  - Lowers the health, safety, security and environment (HSSE) risk compared to a conventional ground survey, such as slips, trips and falls walking through woodlands, shrubs and uneven ground.
  - Enables personnel to spend more time planning, assessing and analyzing data.

- Findings from a pilot project using a UAV to capture high-resolution digital images and digital elevation data to determine soil stockpile volumes indicate that UAV results were within 5 per cent of the ground survey. The intent is that this technique can be altered to measure reclamation success.

**BUSINESS BENEFITS**

- The use of UAV technology offers potential to reduce cost, reduce safety risk and increase the efficiency of reclamation monitoring by enabling many small areas to be measured more frequently, but with less physical interaction and, therefore, less risk of physical injury.

**OPPORTUNITY AREA: EFFECTIVE RECLAMATION**

**LEAD COMPANY:** Shell

**OTHER PARTICIPANTS:** PrecisionHawk

- Where using a full-size aircraft is cost and efficiency-prohibitive, the UAV units are easily deployed, low-cost, accurate and easy to use once appropriate training has been completed. The carbon footprint of UAVs is less than that of manned aircraft.

- In some situations, a UAV is probably the only alternative to collect data from an otherwise inaccessible or hazardous environment.

- Shell is evaluating the technology for robustness and reliability and will contribute its knowledge to the other COSIA members. This minimizes the investment each operator needs to do in order to evaluate the technology for their own use.
PROJECT DESCRIPTION

Oil and gas exploration activities over the past 40 years have resulted in fragmentation in the boreal forest as corridors were cut to accommodate seismic exploration and access routes for exploration drilling. A common barrier to restoring this land is that it’s often inaccessible because the ground is too spongy and wet. Conventional equipment will sink in those conditions and can only be used in winter, when the ground is frozen.

This JIP explores using alternative, low ground-pressure amphibious equipment to perform habitat restoration activities in the muskeg of northern Alberta in non-frozen conditions, where conventional equipment can’t access the wet areas. Amphibious vehicles can operate on dry land, muskeg and even water. They’re equipped with an extra-large undercarriage that is filled with air, similar to pontoons, that allows them to safely navigate the muddy marshy and swampy terrain of boreal forest at any time of the year, not just when the ground is frozen. Due to their low pressure footprint, they typically don’t compress the soil and are much less likely to leave ruts or get stuck in the mud.

The project will focus on completing a desktop evaluation of potential equipment and a site test of multiple candidates’ equipment and technology, as well as quantifying the potential gains of using amphibious equipment.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

● Restoring older seismic lines to their natural state will improve caribou habitat by making it more difficult for wolves to hunt caribou

BUSINESS BENEFITS

● Potentially restoring larger areas at a faster rate for less cost than during the short winter season

OPPORTUNITY AREA: EFFECTIVE RESTORATION

LEAD COMPANY: Cenovus Energy
OTHER PARTICIPANTS: Devon and ConocoPhillips
## PROJECT DESCRIPTION

COSIA and non-COSIA organizations have conducted multiple projects that investigate and trial techniques to restore linear disturbance features in caribou habitat.

This EPA-led study compiles information from these projects, including location and scale, planning approaches, treatments, monitoring and results.

### POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Illustrates significant volume of work already done by industry to address habitat issue.
- Best-practice examples are based on biological science and land-management principles.
- Tool to engage and grow restoration efforts among COSIA companies and other industries.

## OPPORTUNITY AREA: EFFECTIVE RESTORATION

### LEAD COMPANY: COSIA

### OTHER PARTICIPANTS: Canadian Natural, Cenovus, ConocoPhillips, Devon, Imperial, Nexen, Shell, Suncor, Statoil, Total, Alberta Biodiversity Monitoring Institute, Alberta Environment & Parks, Alberta Innovates – Energy and Environment Solutions, Alberta-Pacific, Golder Associates, MEG Energy, TransCanada Pipelines and the University of Alberta

### BUSINESS BENEFITS

- Provides recommendations to COSIA and other organizations that are already moving forward with ‘common planning’ as an example.
- Strongly illustrates COSIA principles of collaboration with other organizations and industries to find solutions.
- Creates a strong base of work to engage and inform provincial and federal policy makers.
- Reduces costs through sharing of best practices.
Within the Cold Lake and East Side Athabasca caribou ranges (geographic area), a group of companies representing the natural resource sectors (i.e., oil sands, pipeline and forestry) have come together to coordinate research, habitat restoration, effectiveness monitoring and integrated land management to contribute to recovery of boreal woodland caribou, while maintaining an economically viable resource industry. This multi-sectoral collaboration provides access to the landscape scale that’s needed to achieve impactful solutions.

**LEAD COMPANY:** Devon

**OTHER PARTICIPANTS:** Canadian Natural, Cenovus, Imperial, Alberta Biodiversity Monitoring Institute, Alberta-Pacific Forest Industries, MEG Energy, TransCanada Pipelines, Alberta Environment & Parks, Alberta Innovates Technology Futures and the University of Alberta

**BUSINESS BENEFITS**

- Recognizing efficiencies and reducing costs.
- Demonstrating commitment to regulatory agencies by proactively working on solutions to a complex issue.
- Gaining social licence to support research and implementation of other caribou-conservation levers (e.g. population augmentation).

Improving caribou habitat by:

- Restoring disturbed areas by priority across large habitat areas within the geographic area;
- Monitoring wildlife responses to habitat restoration;
- Maximizing area restored and minimizing future disturbance in the geographic area; and
- Conducting scientific research on caribou ecology and on caribou-predator-landscape relationships.
**PROJECT DESCRIPTION**

Teck’s Cardinal River Operations (CRO) is a steelmaking coal mine located in the Rocky Mountains near Hinton, AB. CRO is also home to the healthiest bighorn sheep population in North America — numbering approximately 950. The Rockies are known for its bighorn population with large bodies, good lamb-to-ewe ratios and high density and numbers. The reclaimed Luscar pit, a former mining area at CRO, provides excellent year-round habitat for bighorn sheep, including terrain that helps protect the animals from predators and provides shelter for giving birth, as well as high-quality forage and saltlicks for nutrition.

Since the 1980s, Teck has helped transfer close to 400 bighorn sheep from CRO to various jurisdictions throughout North America to help rebuild depleted herds. In February 2012, for example, working in conjunction with Alberta Sustainable Resource Development and Nebraska Fish and Wildlife, Teck facilitated the collection and transfer of 41 bighorn sheep to the state. Nebraska’s bighorn sheep population began to decline in the late 1800s due to loss of habitat, unregulated hunting and disease. Efforts to rebuild the population began in the late 1970s and continue to this day.

Alfalfa hay was used to attract the sheep, and a large net was used to safely capture them. Approximately 60 volunteers, veterinarians and wildlife biologists safely collected and prepared the sheep for transfer. The animals were blindfolded to help keep them calm, and GPS collars were affixed so Nebraska Fish & Wildlife could monitor them upon release.

Once collected, the sheep were examined at the capture site and loaded onto trailers by Canadian Food and Inspection Agency veterinarians. To ensure their safety, the animals’ vital signs were monitored by veterinarians throughout the 48-hour, 2,000-kilometre journey. Upon arrival in Nebraska, the bighorn sheep were released into the wild near the town of Harrison to start a new herd and to help repopulate the bighorn range throughout the state.

Teck has contributed learnings from this program related to mine-reclamation and biodiversity preservation to COSIA.

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**OPPORTUNITY AREA:**  
**SPECIES OF MANAGEMENT CONCERN**

**LEAD COMPANY:** Teck

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- A healthy bighorn sheep population at CRO enabled Teck to help rebuild a depleted herd in Nebraska.
PROJECT DESCRIPTION

The Wild Watch website and application (app) was created to make it easier for Cenovus staff to record wildlife sightings at and around its operations. This helps staff to better understand wildlife movements and behaviour, so that awareness and protection efforts can be improved. The smartphone app is now the most popular tool to record wildlife observations at or near Cenovus’s operations.

In 2013, Cenovus teamed up with the Mistakis Institute at Mount Royal University to develop the app and website iwildwatch.ca. Mistakis is a non-profit organization dedicated to wildlife management and conservation. The program is now in its second year of operation. Cenovus has collected more than 2,000 wildlife reports and improvements to the website and app have been made.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- The Wild Watch Program helps companies understand what animal species exist near project sites and where adjustments can be made to the way operations are managed in animal habitats in northern Alberta.

- The app also has an alert system. Safety and environment staff receive an automatic alert if an animal sighting is recorded that could pose a risk to field workers, such as a bear near a worksite or a moose on a road. Workers nearby are then warned of the risk.

BUSINESS BENEFITS

- Before the Wild Watch app and website were created, staff had to use hard-copy forms to report animal sightings at or near operations. They now have the option of using the smartphone app. About 55 per cent of all recorded wildlife observations are now being submitted through the app, with 30 per cent using the mapping tool on the website and 15 per cent using hard-copy forms.

- The technology has been shared with other COSIA members, and as a result, Shell Canada staff are also using the program to track wildlife at some of that company’s sites.

LEAD COMPANY: Cenovus

OPPORTUNITY AREA: SPECIES OF MANAGEMENT CONCERN
Environmental Priority Area

Water

We will strive to be world leaders in water management, producing Canadian energy with no adverse impact on water.
PROJECT DESCRIPTION

Approximately 80 to 85 per cent of water used for oil sands extraction in mining operations is recycled. The remaining proportion of ‘make-up’ water is made up of the Athabasca River and its tributaries, precipitation (rainwater/snow melt) captured on operators’ leases and groundwater. The groundwater includes sources upstream of the mining face, sometimes known as mine depressurization water. Variable concentrations of salts are present in mine depressurization water and river water depending on source quality, all of which are used in oil sands operations.

COSIA members are conducting a feasibility study to understand the unique issues from the effects of changes in natural groundwater movement from mine depressurization activity, as well as options to effectively manage the associated salts on mine sites. Technologies include reverse osmosis, evaporator, crystalliser, saltmaker and thermionic technologies.

Results of this study will be evaluated through the remainder of 2015.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Anticipated that learnings from the study will provide an understanding of practical, efficient options for water management of salts on mine sites.

BUSINESS BENEFITS

- By understanding and applying effective water management options for high-saline mine depressurization water, operators will improve the reliability and efficiency of process equipment through reduced potential for corrosion from salts.
PROJECT DESCRIPTION

All closure landscapes in oil sands mining are designed to include pit lakes, which must be an ecologically sustainable component in the final reclaimed landscape. This includes receiving surface and groundwater from surrounding landscapes and safely discharging water to the downstream environment. Pit lakes can be used as a method for passive water treatment and sequestering Mature Fine Tailings (MFT) as they settle.

The Demonstration Pit Lakes Research Facility project envisions a demonstration-scale facility on a mine site in northern Alberta, used to study demonstration lakes and ponds of various sizes and depths, with different contents, vegetation treatments and drainage approaches.

The Demonstration Pit Lake Research Facility project complements both Syncrude’s Base Mine Lake program and the Pit Lake Design Guide developed by the Cumulative Environmental Management Association (CEMA), and will address knowledge gaps.

OPPORTUNITY AREA: PIT LAKES

LEAD COMPANY: Shell
OTHER PARTICIPANTS: Canadian Natural, Imperial, Suncor, Syncrude and Teck

BUSINESS BENEFITS

- COSIA’s approach to coordinated pit lake research alleviates the need for all involved operators to individually carry out extensive research programs.

- This collaborative research approach is saving time and tens of millions of dollars.

- It helps close key knowledge gaps and provide a basis for design for viable pit lakes.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Provide operators with research on design criteria and operating parameters for their intended pit lakes, applicable to a range of design and operational strategies.

- Demonstrate the design criteria to create viable water-capped tailings as a passive closure solution.
The Instrumentation & Controls Working Group is a forum for in situ operators to:

- share technologies currently in use or in development;
- identify priorities and gaps in the instrumentation & controls space; and
- develop best practices and scope Joint Industry Projects (JIP) to help close any gaps.

It’s expected that improved instrumentation and controls will contribute to improved efficiency and environmental performance. The initial focus area for this group relates to water, specifically online water analyzers.

Equipment comparison and shared learnings via a database and workshops.
SOFT SENSORS – PRIMROSE THERMAL IN SITU OPERATIONS

PROJECT DESCRIPTION

Building on successful research conducted in 2014 by Suncor and the University of Alberta (U of A), Canadian Natural is testing technology to increase the efficiency of Once-Through Steam Generators (OTSG) at the Primrose North in situ facility.

Most OTSGs operate at 75 to 80-per cent steam quality (percentage of water converted to steam). The rest becomes “blowdown”, which is a mix of water, salt and other solids. Increasing steam quality has been a challenge because, when more water is converted to steam, scale builds up on boiler tubes, increasing the risk of damage or failure.

Soft sensors (also known as virtual, inferential, proxy or surrogate sensors) work by using information from hardware instruments in other areas to calculate conditions in areas where instrumentation is not successful in real time (i.e. in an OTSG). Information from soft sensors is used to apply corrective actions so steam quality can be controlled in a tighter range with reduced variation in the amount of fuel used.

Suncor’s research into soft sensors for use in its OTSGs was successful but Canadian Natural’s OTSGs at Primrose are slightly different, requiring a modified algorithm. In Q3 2014, Canadian Natural worked with the U of A on a feasibility study for applying the technology at its Primrose operations. That is being followed by development of a soft sensor model for its Primrose OTSGs, so preliminary testing can take place (Q3 and Q4 2015). The next step will be in Q1 2016, when soft sensors will be implemented in the control system for selected OTSGs at Primrose for commercial evaluation.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- The initial feasibility study with the U of A and Canadian Natural’s OTG data indicated that Canadian Natural could improve steam quality by up to two-per cent, resulting in environmental benefits and enhanced oil recovery efficiency including:
  - an eight-per cent reduction in boiler blowdown.
  - up to a one-per cent drop in greenhouse gas emissions.
  - a two-per cent increase in oil production.

- This is a good example of using the COSIA model to leverage the work of other members. CNRL’s own work with soft sensors will be shared allowing other companies to use the information to further improve the technology and modify it as needed for their own operations.

LEAD COMPANY: Canadian Natural
OTHER PARTICIPANTS: University of Alberta and Suncor

BUSINESS BENEFITS

- Soft sensor technology can be implemented quickly and at a low cost. With the enhanced efficiencies, the technology could be paid for within a couple of months.

- Canadian Natural had confidence to pursue this technology, based on information Suncor shared from its own soft sensor project. Partnering with the University of Alberta on the feasibility study was a benefit that made sense based on the school’s previous experience working with Suncor.

- Successful implementation of this technology will contribute significantly to cost efficiency at Canadian Natural’s Primrose operations, as increased production is among its benefits.
AERIAL DEPOSITION STUDY

PROJECT DESCRIPTION

Aerial emissions of polycyclic aromatic hydrocarbons (PAHs) and metals to the environment can occur from a number of sources, including industrial activities like resource extraction and refining, residential and commercial heating, or the natural emissions that occur during a forest fire. Various models have been developed in the past few decades to simulate the aerial deposition and fate of PAHs and metals to the environment.

In 2014, COSIA summarized and evaluated current research with regards to aerial deposition and the efficacy of existing models to accurately predict levels of PAHs and metals appearing in snowpack runoff in the Alberta Oil Sands Region. The objective of the Aerial Deposition Study is to improve the prediction accuracy of aerially deposited metals and PAH concentrations in the snowpack, and how this relates to concentrations being received in the aquatic environment by refining the existing PAH and metal models. At the conclusion of the study, expected at the end of 2015, this project will have developed a standard protocol for snow sampling working in conjunction with Environment Canada and Alberta Environment; and improved predictability in aerial deposition modelling.

OPPORTUNITY AREA:
REGIONAL WATER RESOURCE MANAGEMENT

LEAD COMPANY: Teck
OTHER PARTICIPANTS: Shell, Imperial, Suncor, Syncrude, Total and Canadian Natural

BUSINESS BENEFITS

- More predictable and accurate modelling could decrease the cost associated with future developments, thereby reducing the risk associated with project development.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Improved predictability of aerial deposition modelling will enable industry to more effectively identify potential effects of oil sands development on water quality and implement plans for mitigation, as appropriate.
- The study will help identify gaps in modelling research.
- The study may help to determine the sources of the PAHs and metals deposited in the snowpack.

STATUS OF PROJECT

- The first phase of the study is due to be completed at the end of 2015. COSIA will continue to evaluate the need for further research and monitoring in specific areas; as well as using new sampling methodology and techniques for better analysis of geographical data, as necessary.
The Best Practices Working Group (WG) aims to bring together oil sands companies with in situ operations to share practices and technologies and accelerate the dissemination of practices, knowledge and information. The resulting improvement in operations and reliability will enable improved environmental performance.

The fundamental premise of the Best Practices WG is that improvements to operational reliability relate to improved environmental performance. Each year, the WG identifies common problem areas across member companies with in situ operations to share operational improvements that have been implemented at the various in situ facilities. The WG also acts as a venue for companies to ask for support from other companies with immediate pressing issues. In 2015, the WG focused on sharing company experiences with boiler feedwater chemical additives, as well as operational actions associated with off-spec boiler feedwater.

The WG organizes annual forums to allow direct interaction between personnel from the various COSIA companies to discuss water-related issues. The 2015 forum will consist of a series of presentations, as well as workshops to discuss produced water cooler operation, water treatment equipment operation and generating high-quality steam with existing equipment.

**Potential/Actual Environmental Benefits**

- Identify operational and/or technology improvements to existing facilities that can be implemented relatively quickly and will incrementally improve environmental performance. Recently shared topics include:
  - Increasing steam quality to increase steam volume output while decreasing greenhouse gas intensity;
  - Improved evaporator cleaning to increase heat-transfer efficiency;
  - Slop oil treating to minimize the amount of waste trucked off site; and
  - Operational learnings related to using brackish water.

- All operational reliability improvements can be directly related to environmental benefits.

**Business Benefits**

- Leveraging operational experience across entire industry for immediate troubleshooting.
- Increasing steam quality and steam volume output using existing equipment.
- Using a chemical additive to reduce plugging of lime slurry lines, leading to more reliable water plant operations.

**Opportunity Area:** Sharing Best Practices

**Lead Company:** ConocoPhillips

**Other Participants:** BP, Canadian Natural, Cenovus, Devon, Imperial, Nexen, Shell, Statoil and Suncor
PROJECT DESCRIPTION

This project seeks to test viability of a titanium oxide-coated ceramic membrane as a water-treatment technology for use in recovering hot/warm water from bitumen production processes.

Presently in oil sands mining and in situ production, water recovered from production processes is treated before being used/reused in bitumen extraction or steam generation.

This membrane has the potential to treat water to ‘release quality’ standard and, as such, could minimize or eliminate pre-treatment before water is used in mining.

For in-situ, ‘produced water’, which is cooled to 85°C, then treated before being sent to boilers for steam generation, could potentially be treated at the temperature it comes out of the production header, (~200 °C). This would allow it then to be put directly into steam generation without significant additional heating.

In both cases, this increases the water available for reuse and decreases GHGs associated with heating.

The project has two main components: optimizing application of membrane coating to achieve consistent performance; and a de-risking pilot to test the membrane using different types of water, measuring optimal pressures as well as fouling rates/frequency and assessing potential recovery options.

OPPORTUNITY AREA:
SITE-WIDE WATER MANAGEMENT

LEAD COMPANY: Shell
OTHER PARTICIPANTS: Alberta Innovates – Energy and Environment Solutions

BUSINESS BENEFITS

- Potentially reduced capital expenditures (CAPEX) and operating expenditure (OPEX) costs associated with:
  - reduced natural gas usage (less heating of water); and
  - reduced capital required for water treatment (fewer processing steps).

- This technology could be useful or informative to future research on effective water treatment as part of ongoing water-management strategies.

- The membrane could eventually go to the Water Technology Development Centre (WTDC) for further testing once the WTDC is completed; further leveraging the value of COSIA collaboration.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Treats water to a high quality, therefore available for a range of uses.
- Increases water available for recycle and reuse.
- Decreased GHGs associated with heating water.
SAGD operators target efficient reuse of produced water to optimize steam generation and improve energy efficiency. Condensed steam pumped to the surface in the extraction process is separated from the bitumen (de-oiling), then is treated further to allow for reuse in steam generation. Operators are currently aiming to reduce overall process chemicals, energy and water inputs, and also reduce new Central Processing Facility (CPF) capital expenditures, operating expenses and plot plan to improve environmental performance.

In 2015, Devon Energy, GE and Suncor developed a new collaborative Joint Industry Project (JIP) at Suncor’s MacKay River facility, the GE Gen3 Research and Development project. In this project, technologies will be tested to enable treating and reusing the water more consistently, which translates to being more operationally efficient. The JIP is a multi-year technology program focused on developing produced water-treatment technologies for SAGD boiler-feed water applications.

The JIP was signed in April 2015 and the completion of the program is planned for Q2 2020.

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

It is anticipated that the technology and learnings have the potential to:

- Improve plant reliability.
- Exceed water recycle regulatory directives.
- Reduce water and waste disposal.

**BUSINESS BENEFITS**

- Shared pilot costs among multiple partners have contributed to the development of water treatment technologies for boiler feed water applications. If the technology proves successful, there is the potential for a reduction in capital costs for CPFs.
PROJECT DESCRIPTION

COSIA has initiated a study to understand the factors that contribute to water quality in the Athabasca River and its tributaries.

The project has been designed to assess the impact of natural and non-natural (i.e., anthropogenic) inputs on the Athabasca River and how it affects the aquatic ecosystem within the river and on downstream users. The study will consider the significance of the underlain bituminous sand in the river and within the river banks. Understanding how anthropogenic emissions are influencing this ecosystem must be balanced by an understanding of how natural emissions influence the same system. In the case of the Lower Athabasca, only very recent attention has been paid to natural inputs to the river.

Stakeholders are interested in knowing whether oil sands surface-mining actively contributes to significant contamination of the Athabasca River or its tributaries. A better understanding of natural and anthropogenic sources of bitumen-derived organics is required to assess any potential impacts.

POTENTIAL/ACTIONAL ENVIRONMENTAL BENEFITS

- Provide an understanding, to the general public, on the impact of anthropogenic water use and contaminant emissions on the Athabasca River and its tributaries.
- Assist government and industry in striking a balance between economic development, social well-being and environmental management and protection.

BUSINESS BENEFITS

- There are potential cost savings to industry by not storing natural waters on oils sands leases.

OPPORTUNITY AREA:
WATER TREATMENT PERFORMANCE

LEAD COMPANY: Syncrude
OTHER PARTICIPANTS: Shell, Canadian Natural, Teck, Total, Suncor and Alberta Innovates – Energy and Environment Solutions
Environmental Priority Area

Tailings

We will strive to transform tailings from waste into a resource that speeds land and water reclamation.
PROJECT DESCRIPTION

Syncrude has initiated a field pilot program to understand subaqueous deposition methods that minimize composite tailings (CT) segregation. The project has been designed to assess the benefit of reducing CT discharge energy when placing CT in deposits under water. The study will assess the significance of the discharge velocities, and the performance of various equipment configurations, as they relate to the degree of segregation. Minimizing segregation reduces the fines released back to the fluid column, thereby minimizing the amount of fine fluid tailings (FFT) that require reprocessing, further handling or long-term storage.

A significant component of this field program will be to enhance current deposit characterization practices—including sample collection, correlation with geophysical data and deposit-modelling practices—for non-cohesive tailings deposits.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- The study will help provide industry with the basis for decision making on equipment selection and deposition methods for subaqueous tailings deposition.

- The study will also provide further understanding and ability to accurately characterize tailings deposits.

BUSINESS BENEFITS

- Success in meeting the Tailing’s Management Framework in managing legacy fine tails.

- Provide public confidence that the industry is effectively managing composite tailings.
### PROJECT DESCRIPTION

The members of COSIA’s Tailings EPA are continuing to fund collaborative research in the areas of tailings dewatering and rheology at Carleton University through the NSERC Collaborative Research Development (CRD) program.

Through this program, graduate students, under the direction of Primary Investigator Dr. Paul Simms, have been conducting collaborative research with industry in the field of tailings management. This means that in addition to providing $100,000 in funding for four years, the members of COSIA’s Tailings EPA interact directly with program participants. This provides industry with insight into the body of research being conducted through the CRD, while also providing participants with improved understanding of the challenges facing the oil sands industry, specifically in the area of tailings management.

The Tailings EPA has provided large support in the form of:
- field data for use in research, including samples, numerical data and opportunities for students to engage in field work;
- opportunities to participate in technology meetings held by individual member companies;
- an annual update workshop with members of the Tailings EPA to help provide direction for future research; and
- the University of Alberta’s NSERC Industrial Research Chair, Dr. Ward Wilson – also funded by COSIA – is also a Co-Primary Investigator for the CRD program, allowing both universities to work collaboratively on research.

According to Simms, CRD programs are focused on developing research deliverables in the form of presentable research, something program has already delivered on. They gave a number of presentations on work being conducted through the program at the 2015 Oil Sands Tailings conference.

### OPPORTUNITY AREA: ENHANCED DEPOSIT DENSIFICATION (FINES)

#### LEAD COMPANY: COSIA

#### OTHER PARTICIPANTS: Canadian Natural, Imperial, Shell, Suncor, Syncrude and Teck

#### POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Comprehensive research to aid in the development of technologies that enhance the sustainability of oil sands operations.

#### BUSINESS BENEFITS

- Ensure research being conducted in the field of tailings is tailored to industry needs.
- Direct input from industry ensures programs adapt to economic, operational and regulatory changes so that research results remain relevant.
PROJECT DESCRIPTION

Syncrude has initiated a field pilot program to understand the long-term consolidation behaviours of fine fluid tailings (FFT) centrifuge cake.

The project involved the installation of 10 columns, 10 metres tall by three metres in diameter. The columns have been filled with centrifuge cake under a variety of capping and drainage scenarios and have been instrumented to monitor their geotechnical performance. The geotechnical information gathered will be used to better predict performance trajectories of commercial scale deposits. The consolidation columns are commercial analogues for a variety of deep cohesive deposits. Understanding the performance trajectories of the columns will enable long-term planning to schedule deposit events that will ensure final landform objectives are met at commercial scale.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Provide industry with the basis for decision-making as to cake placement, capping and drainage-management options to create targeted landforms.
- Provides a reasonably scaled deposit to gain confidence in tailings management that substantially reduces environmental footprint and improves cost-efficiency.
- Provide insight into cohesive deposit performance variables that, in turn, may initiate new fundamental geotechnical research work.

BUSINESS BENEFITS

- Confidence in meeting closure and reclamation plans and final landform objectives.
- Increasing the state of knowledge in the area of cohesive deposit consolidation in oil sands.

OPPORTUNITY AREA: ENHANCED DEPOSIT DENSIFICATION (FINES)

LEAD COMPANY: Syncrude
The test facility consists of eight steel casings, each about three metres in diameter and 11 metres deep. Each will be filled with fluid tailings treated with varying amendments.

The facility will:

- expand understanding of scale-up impacts currently being done at lab-pilot scale;
- evaluate longer-term tailings deposit behaviour at stress states approaching those at commercial scale; and
- provide opportunities to evaluate tailings deposit drainage, capping and other post placement activities scenarios.

**OPPORTUNITY AREA:**

**ENHANCED DEPOSIT DENSIFICATION (FINES)**

**LEAD COMPANY:** Shell

**OTHER PARTICIPANTS:** Suncor

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**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- Accelerate development of tailings reclamation consolidation technologies will help increase the pace with which land usage for tailings can be reduced.
- Provide a better understanding of longer-term tailings behaviour and its impact on progressing reclamation of treated tailings.

**BUSINESS BENEFITS**

- Contribute to the evaluation of various fluid fine tailings treatment technologies for input into business plans.
- This project leveraged technical expertise from Syncrude for design, instrumentation and construction of the test facility and costs were shared with Suncor to expand the testing program by two casings.
- Collaboration between Suncor and Shell and other COSIA Tailings EPA members.
- An ability to build on knowledge shared by Syncrude was critical for reducing the cost of the project and achieving implementation within one year.
PROJECT DESCRIPTION

The members of COSIA’s Tailings EPA are continuing to fund academic research in the field of oil sands tailings geotechnique at the University of Alberta (U of A) through the Natural Sciences & Engineering Research Council (NSERC)/COSIA Industrial Research Chair (IRC).

Through this program, graduate students, under the direction of IRC Dr. Ward Wilson, have been conducting collaborative research with industry in the field of tailings. This means that in addition to providing almost $500,000 in funding, the members of COSIA’s Tailings EPA interact directly with program participants. This provides industry with insight into the body of knowledge arising from the IRC, while also providing participants with improved understanding of the challenges facing the oil sands industry, specifically in the area of tailings management.

The Tailings EPA has organized a number of engagements to facilitate this collaboration including:

- three research update meetings between the U of A IRC participants and senior management and technical representatives from COSIA;
- a Research Advisory Committee was commissioned in 2015, consisting of COSIA members and Alberta Innovates – Energy and Environment Solutions representatives to provide direction on research conducted through the programs;
- member companies, including Shell and Suncor have facilitated field work programs at their operations and provided the researchers with tailings samples for use in experiments; and
- the IRC also works collaboratively with Carlton University’s NSERC Collaborative Research Development program – also funded by COSIA – which allows members of both programs to benefit from the work being done at each institution.

COSIA has enjoyed the interaction with the U of A and will continue to strive to support the success of the program through hands on engagement and access to oil sands sites, technical staff, and data as necessary to move this research forward.

OPPORTUNITY AREA:
ENHANCED DEPOSIT DENSIFICATION (COARSE & FINES)

LEAD COMPANY: COSIA
OTHER PARTICIPANTS: Canadian Natural, Imperial, Shell, Suncor, Syncrude and Teck

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS
- Comprehensive research to aid in the development of technologies that enhance the sustainability of oil sands operations.

BUSINESS BENEFITS
- Ensure research being conducted in the field of tailings is tailored to industry needs.
- Direct input from industry ensures programs adapt to economic, operational and regulatory changes so that research results remain relevant.
PROJECT DESCRIPTION

More efficient Fluid Fine Tailings (FFT) mixing and disposal systems requires a thorough understanding of how FFT flows in a number of states (primarily in a liquid state, but also as ‘soft solids’ or solids under conditions in which they respond with plastic flow) – an area of study known as Rheology.

The flow properties of FFT vary significantly with solids concentration, particle size and size distribution, pH, ionic strength, shear history and age. This makes obtaining FFT samples that perform consistently under experimental conditions difficult. As a consequence, comparing the outcomes of experiments that use variable deposits is problematic.

This study focused on better understanding the flow properties of FFT to develop a model fluid that exhibits the salient rheological behavior of industrial FFT samples. Advanced rheological methodologies combined with Doppler ultrasound velocity profile measurement techniques were used to build this understanding.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- This study resulted in developing more effective and efficient FFT mixing, transportation and disposal methods.
- It will also help with increased pace of tailings remediation.

BUSINESS BENEFITS

- Greater understanding of the rheological behavior of FFT may assist in designing more cost effective transport systems by providing data for accurate determination of pump capacities and power requirements for mixing.
- Utilizing this model could not only reduce the cost associated with sampling and shipping of the FFT material, but also ensure the repeatability of the material properties and better characterization of the samples.
- The existence of such a model for FFT makes research in this area more accessible on a global scale, helping to accelerate technological advancements.

OPPORTUNITY AREA:
WATER-SOLIDS SEPARATION PROCESSES

LEAD COMPANY: Shell,
OTHER PARTICIPANTS: Imperial, Suncor, Syncrude, Teck and Coanda Research & Development Corporation
PROJECT DESCRIPTION

The Applied Process Innovation Centre (APIC) is a 3,600-square-foot research facility at Canadian Natural’s Horizon Oil Sands site, operational as of June 2015. It was created to provide a dedicated and protected workspace to investigate methodologies to enhance the effectiveness and efficiency of Horizon Oil Sands operations, and the operations of our COSIA partners. In 2015, all research at the APIC is related to tailings management, facilitating Canadian Natural’s seamless shift from whole tailings to non-segregating tailings (NST).

The APIC provides a common location from which Canadian Natural’s continuous improvement and technology groups can work closely with process employees, and where test equipment and materials required for current and future research can be stored for quick access.

The facility was designed and equipped to be capable of performing an extensive variety of tailings tests and programs including: analysis of mixing systems, evaporation and drying analysis, production of bench scale testing quantities of NST and thickened tailings. Various measurements can be performed quickly and effectively with fast turnaround of results and subsequent decisions.

Findings from research conducted at the APIC will directly shape the future of Horizon, both operationally and from a capital-investment perspective. The research from this facility is also key for the oil sands industry as a whole. As a COSIA partner, all research findings will be shared with member companies.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

○ The APIC began operating in June 2015 so ‘actual’ benefits have not been realized yet. Current research related to tailings management is expected to yield results that reduce environmental impact (i.e. smaller tailings pond footprint, reduction in greenhouse gases, improved process water recycling, etc.) and enhance process efficiency (lowering operating costs).

○ Canadian Natural may expand research in the APIC beyond tailings management in future years, investigating enhancements in other process areas.

BUSINESS BENEFITS

○ The APIC is where Canadian Natural will perform much of its research and testing going forward, and it’s a facility where our staff can easily collaborate on research projects with representatives from other COSIA member companies, academia and government.

○ This facility will yield new methods and technologies that will have a positive impact on cost efficiency and environmental performance at Horizon Oil Sands (and, in turn, at the operations of fellow COSIA members).

○ Canadian Natural is already a leading investor in research and development, and this facility further enhances our ability to perform certain types of research.

LEAD COMPANY: Canadian Natural

OPPORTUNITY AREA: WATER-SOLIDS SEPARATION PROCESSES (FINES & COARSE)

APPLIED PROCESS INNOVATION CENTRE - HORIZON OIL SANDS
The in-line flocculation test platform is focused on the design, fabrication and construction of a flocculation skid for testing of in-line dynamic mixing, flocculation and dewatering in a commercial setting.

A primary objective for the unit is to test the control scheme under commercial conditions. The skid will be portable, so it can be moved to various operating sites, with potential site-specific modifications such as tie-ins.

The platform is designed to be portable so it can be integrated into existing tailings treatment systems for testing at the different sites. The portable platform will allow for the evaluation of control systems and instrumentation performance, as well as the impact of the pipeline flow on material degradation.

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- More efficient and better performing fluid fine tailings and legacy mature fine tailings treatment.
- Could help reduce storage space required for fluid fine tailings prior to treatment.

**BUSINESS BENEFITS**

- The project is an expansion of several COSIA JIPs on flocculation and mixing from 2013 and 2014.
- Expertise and experience from Shell’s atmospheric fines drying (AFD) and Suncor’s Tailings Reduction Operations (TRO) brought in Teck as the major financial contributor to develop the testing platform.
- Potential cost savings could be realized from reduced storage and transportation volume requirement for tailings.
- Sharing technical expertise will reduce engineering and fabrication costs as well as minimize risk and duplication of effort.
- Expediting maturation of the technology by testing at multiple sites.
Environmental Priority Area

Greenhouse Gases

We will strive to produce our oil with lower Greenhouse Gas emissions than other sources of oil.
Previous CO₂ capture technology scans conducted by Total E&P Canada Ltd. and the COSIA GHG EPA identified several early-stage promising technologies with the potential to capture CO₂ at significantly lower costs compared to the current state-of-the-art technologies.

Using the data from the technology scans, Suncor, along with other COSIA members, will plan to undertake a study in order to further identify, screen and quantitatively rank shortlisted emerging CO₂ capture technologies for CO₂ capture from oil sands operations.

To significantly exceed current technology performance and minimize the economic barriers to large-scale CO₂ capture and ultimately reduce emissions from oil sands operations.

The cost of CO₂ capture is significant for oil sands operations. Evaluating and sharing the research on promising CO₂ capture technologies in a collaborative manner expedites the potential for further innovation specifically focused on oil sands applications. By sharing their technology scan on promising CO₂ capture technologies, Total E&P Canada and the COSIA GHG EPA have enabled other COSIA members such as Suncor and Canadian Natural to use the prior research which may expedite the evaluation of the most promising CO₂ capture technologies that could drive industry towards significantly lower capture costs for oil sands operations.

Shared knowledge from the contributed technology scans reduces COSIA member companies’ time and financial investments by providing a baseline on the most promising CO₂ capture technologies to be applied to future JIPs.

The technology scans executed and contributed by the COSIA GHG EPA and Total E&P Canada have been important in helping to identify and prioritize the most promising technologies and will likely expedite Suncor and Canadian Natural’s work to further evaluate potential opportunities for CO₂ capture from oil sands operations.
**PROJECT DESCRIPTION**

In 2015, COSIA’s GHG EPA members are in the final stages in a study of CO₂ conversion technologies that could be used in the oil sands.

The conversion of waste carbon has the potential to be transformational by leveraging technologies that reduce the net CO₂ emissions from an operating facility while creating value-added products such as chemicals, fuels and solids. Few CO₂ conversion technologies are currently at the research and development stage, with limited commercial deployment.

This study is designed to understand the current state of knowledge across a wide range of CO₂ conversion technology classes, with a specific focus on their applicability to the oil sands. Critical gaps and technical challenges in the different classes of CO₂ conversion technologies have been identified. Currently, the technology classification includes organic chemical conversions, bio conversion, fuels and solid products/mineralization.

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- Successful CO₂ conversion technologies can be a game-changer in reducing carbon footprint while generating revenue. In particular, technologies in dry reforming, bio processing and electrolysis classes.

**BUSINESS BENEFITS**

- The study could lead to the formation of a JIP to advance CO₂ conversion technologies or identification of potential applications of specific technology in a commercial application.

**OPPORTUNITY AREA:**

**CARBON CAPTURE, STORAGE & CONVERSION**

**LEAD COMPANY:** Canadian Natural  
**OTHER PARTICIPANTS:** BP, CenovusPhillips, Devon, Imperial, Nexen, Teck, Total, Shell and Suncor
PROJECT DESCRIPTION

The NRG COSIA Carbon XPRIZE challenges the world to reimagine what we can do with CO₂ emissions by inventing the development of technologies that convert CO₂ emissions into valuable products.

The competition launched on September 29, 2015, and will operate over four and a half years. It is structured as a two-track prize, with one track focused on testing technologies at a coal power plant and one track focused on testing technologies at a natural gas facility. The total prize purse is US$20 million. Following a nine-month team recruitment phase, two US$2.5-million milestone purses will be shared equally among up to five finalists in each track at the end of Round 2. Two US$2.5-million grand-prize purses will be awarded to the winner in each track at the end of Round 3.

The winning team(s) will convert the most CO₂ into products with the highest net value.

The prize is managed by the XPRIZE Foundation, an American non-profit known for addressing challenges that appear to be unsolvable or have no clear path toward a solution.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

● Developing technologies to convert CO₂ emissions from oil sands operations into valuable, useful products.

● Accelerating CO₂ reuse technology development by attracting more resources (intellectual and financial) to solve the problem caused by excess CO₂.

BUSINESS BENEFITS

● Open Innovation: first-hand exposure to how open innovation can work to help tackle challenges in the energy sector. This type of collaboration across borders (both geographical and sectoral) will become more integral to research and development efforts in the future.

● Accelerate CO₂ technology development from low technology readiness to commercial-ready.
QUEST CARBON CAPTURE AND STORAGE (CCS)

PROJECT DESCRIPTION

Quest is a carbon capture and storage (CCS) facility integrated with the Scotford Upgrader, which upgrades bitumen from the Shell Albian Sands mining and extraction facility.

Quest captures CO₂ from the upgrader’s hydrogen-manufacturing process, compressing and transporting it via pipeline to an injection well. There it is injected more than two kilometres underground into the Basal Cambrian Sands, a saline aquifer, where it will remain permanently stored.

Quest is designed to capture and store roughly 1 million tonnes of CO₂ annually, equivalent to the emissions from about 250,000 cars.

The project was approved in 2012, constructed in 2013 to 2014, and has successfully completed its commercial injection tests as required by government funding agreements.

Quest is the first application of CCS in an oil sands operation and is an important demonstration of CCS in an industrial operation. The project features a robust measurement, monitoring and verification program (MMV) for managing the subsurface storage, earning Quest the world’s first certificate of fitness for safe underground storage of CO₂ from Det Norske Veritas (DNV). The MMV program will also involve collaboration with the U.S. Department of Energy to explore novel technologies.

An official opening will be celebrated in November 2015.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Capturing roughly 1 million tonnes of CO₂ annually and permanently storing it underground, equivalent to the emissions from about 250,000 cars.

BUSINESS BENEFITS

- Through innovative funding agreements with the Alberta and Canadian governments, Shell is sharing the knowledge and lessons learned from building Quest, including its experiences with subsurface development and stakeholder engagement, two areas that have been critical to the project’s success.

- Through this sharing, CCS projects worldwide can be implemented with the benefit of the lessons learned to help reduce costs and implementation time and overcome potential regulatory or stakeholder hurdles.

OPPORTUNITY AREA: CARBON CAPTURE, STORAGE & CONVERSION

LEAD COMPANY: Shell

OTHER PARTICIPANTS: Chevron, Marathon, Government of Alberta and Natural Resources Canada (NRCan)

Aerial view of the Quest unit at the Shell Scotford Upgrader.

Two employees in the Quest unit at the Shell Scotford Upgrader.
PROJECT DESCRIPTION

This study looks at using de-carbonized natural gas for steam generation, which would eliminate CO₂ emissions. Carbon can be removed from natural gas in the form of a fine powder called “carbon black.” It can be stored as a solid for future use or sold to the tire, ink or pigment industries.

Solid carbon is ready to be stored, while CO₂ emissions have to be captured, purified, compressed, transported and injected into the ground. Storing solid carbon has fewer stakeholder, environmental and regulatory issues than storing CO₂ in underground reservoirs or saline aquifers. As well, CO₂ stored in saline aquifers will unlikely be available for future recovery and use.

Removing carbon from natural gas requires energy input, such as thermal or an electrical plasma discharge. There would be energy savings from de-carbonizing natural gas. The issue is whether there is a net avoidance compared to natural gas combustion followed by carbon capture and storage.

A technology vendor has run a small pilot in New Brunswick to show that the technology works. The study will be completed at the end of October 2015.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- For the same amount of steam generation, net CO₂ emission would be reduced from 50 to 65 per cent if natural gas is de-carbonized prior to combustion for steam generation.

BUSINESS BENEFITS

- Part of the deliverable is to estimate the CO₂ avoidance cost which will be compared with the Alberta CO₂ compliance cost of $30 a tonne starting in 2017.

- The revenue from selling carbon black would be part of the avoidance cost estimate. It would offset the cost of de-carbonizing natural gas to reduce CO₂ emission from SAGD steam generation.

OPPORTUNITY AREA: LOW CARBON HEAT & POWER

LEAD COMPANY: Cenovus

OTHER PARTICIPANTS: Alberta Innovates Technology Futures, BP, Canadian Natural, ConocoPhillips, Devon, Imperial, Nexen, Shell, Teck, Total and Suncor

Natural gas de-carbonization schematic
PROJECT DESCRIPTION

Cenovus and its partners are exploring a Molten Carbonate Fuel Cell (MCFC) technology that combines capturing CO₂ emissions with generating low GHG-intensive electricity. MCFCs are a commercial technology for electricity generation, converting natural gas to electricity, electrochemically. They’ve been used in commercial power generation since the 1990s.

In a SAGD application, the MCFC can be directly connected to the flue gas of a once-through steam generator (OTSG). The CO₂ can be separated from the flue gas, and power is simultaneously produced. The separated CO₂ can be further purified, compressed and shipped to storage sites or used for enhanced oil recovery. With this technology, the normally costly process of separating CO₂ from the exhaust stream is offset by the sale of the electricity generated by the fuel cell.

The JIP participants are funding a preliminary front end engineering design (FEED) that will estimate the installed cost of a 200-kilowatt (kW) pilot project at the University of Calgary’s 14-megawatt (MW) Combined Heat and Power plant (CHP Plant). The pilot is designed to capture approximately 5 to 10 tonnes of CO₂ per day from a slipstream of the CHP Plant. It will use a 200-kW MCFC to concentrate the diluted CO₂ from the CHP Plant flue gas while generating approximately 200-kW net electricity for export.

This COSIA JIP is the first to design and assess the installed cost of a sizeable pilot for this new application in an operating environment. It’s a first and critical step to scale this technology up to a deployable and mature stage. Currently, the project is close to finalizing design and will be starting the cost estimates.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Combining MCFCs and OTSGs to cogenenate steam and electricity at in situ facilities will produce significantly lower GHG intensive steam and electricity at the same time as CO₂ is captured. It’s an alternative to the conventional process of co-generating steam and electricity by gas turbine and heat-recovery steam generators (HRSG).

- The technology would capture CO₂ emissions from gas-fired boilers and provide cost-effective CO₂ reductions.

- The co-generation of low GHG-intensive electricity for export to the Alberta grid will reduce its GHG intensity and help to reduce GHG emission from other Alberta industries and commercial and residential sectors.

OPPORTUNITY AREA: LOW CARBON HEAT & POWER

LEAD COMPANY: Cenovus
OTHER PARTICIPANTS: Devon, Shell and Alberta Innovates – Energy and Environment Solutions

BUSINESS BENEFITS

- Using MCFC technology to capture CO₂ from natural gas-fired process units (boilers and combined heat and power generators) can lower CO₂ avoidance costs to about $30 a tonne of CO₂ when the technology is mature. Conventional post-combustion capture (PCC) using 30 per cent monoethanolamine (MEA) was estimated to cost $270 a tonne using similar assumptions.

- The revenue from selling electricity to the power grid will offset some or all CO₂ capture costs.

- Having a close-to-zero GHG-intensive electricity output will earn credits, further offsetting the CO₂ capture costs.