Technology Deployment Roadmap and Action Plan of “End-to-End” Solutions for Oil Sands Tailings
Alberta Innovates – Energy and Environment Solutions (AI-EES)

Who we are?
One of four Alberta Innovates corporations
Technology arm of the Alberta Government in energy and environment

What we do?
Position Alberta for the future in energy and environment:
• Identify, evaluate, select technologies and partners
• Invest in research & technology with industry & international collaborators
AI-EES Strategic Priorities

**STRATEGIC AREAS**

**Energy Technologies**
- HC Recovery & Processing
- Clean Carbon & Coal
- Unconventional Gas

**Renewable & Emerging Resources**
- Renewable Energy
- Emerging Resources

**Environmental Management**
- Carbon Capture & Storage
- Oil Sands Tailings & Water
- Enhanced Ecology

**Water Resources**
- Water Security - Risk and Safety
- Watershed & Ecosystem
- Efficiency of Water Use
AI-EES: Energy Technologies

- HC Recovery & Processing
- Clean Carbon & Coal
- Unconventional Gas

Decreasing fresh water use
Decreasing GHG emissions

- CCS
- In situ and Mining
- Non-aqueous Extraction
- Energy Efficiency refining, mining
- SAGD, CSS
- Steam-solvent
- Energy Efficiency SAGD, CSS
- Electrical heating
- Combustion
- Current
- 5 - 10 years
- 10 - 20 years
- Surface Mining
- Best-in-class SAGD
- SAGD, CSS
- Combustion
- Energy Efficiency
AI-EES: Renewable & Emerging Resources

- Renewable Energy
- Emerging Resources
AI-EES:
Water Resources

- Water Security - Risk and Safety
- Watershed & Ecosystem
- Efficiency of Water Use
AI-EES: Environmental Management

- Carbon Capture & Storage
- Oil Sands Tailings & Water
- Enhanced Ecology

Carbon Capture and Storage (CCS)

Oil Sands Tailings + Water Management

Enhanced Ecology
Technology Deployment Roadmap and Action Plan of “End-to-End” Solutions for Oil Sands Tailings
**Project objectives**

- A technology deployment roadmap and action plan for regulators, industry and Albertans
- Meets the needs and expectations of stakeholders – including the *Tailings Management Framework and Directive 074*
- The roadmap will:
  1. achieve more timely deployment of end-to-end tailings technologies
  2. provide strategic direction to government and industry for funding of near term commercial-scale demonstrations and longer term development R&D
  3. help to ensure information sharing and technology transfer between industry partners
  4. provide a collaborative protocol for on-going assessment of new tailings technologies
The Collaboration

Alberta Innovates Energy and Environment Solutions

Government of Alberta Energy

Government of Alberta Environment

ERCB Energy Resources Conservation Board

Natural Resources Canada
Getting Started

AI-EES Led:

- Consultation with OSTC and Government
- RFP Process
- 4 Components
  - Technology Descriptions
  - Criteria Development
  - Technology Evaluation
  - Roadmaps

Contractor
Submitted by: The Consortium of Tailing Management Consultants (“CTMC”)
Oil sands are excavated at Suncor mine. Roll crushers at Syncrude Aurora. A Froth Treatment Plant at CNRL. A Tailings Pond.
Conventional tailings:
- typically at 40 to 50% solids (sand, fines, water, bitumen)
- discharged from an open pipe to a tailings dike (a long dam)

Tailings segregates:
- the sand drops out forming a low angle sandy beach
- the fines and excess water flow further down the beach into the tailings pond
• The “wet area” of the tailings pond includes a clear water zone
  – typically has a solids content of <0.5%
• The fines settle slowly, forming first thin fine tailings (TFT)
  – 5 to 20% solids (mostly fines)
• After several months, the rate of settlement / densification markedly slows, forming mature fine tailings (MFT)
  – 25 to 40% solids (>90% fines) – remainder is water (some bitumen)
Component 1: Background & Existing Technologies

• Four Tasks:
  – Data gathering
  – Summarize current state of knowledge
  – Describe current state of practice
  – Identify and describe all known tailings management technologies
Current state of knowledge

Master Technology List Summary Histogram: Courtesy CTMC, 2012

101 unique Technologies Reviewed
Component 2: Develop Evaluation Criteria

• Three Tasks:
  – Identify Reclamation Objectives
  – Identify Evaluation Criteria
  – Identify Constraints and Opportunities
Component 3: Technology Assessment / Evaluation

• Five Tasks:
  – Develop evaluation methodology
  – Initial evaluation of all technologies
  – Internal review by multi-disciplinary experts
  – More in-depth technology evaluation
  – Develop strategies for possible roadmap pathway
### Component 2/3 Criteria and Evaluation Process Development

#### Environmental Aspects

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#### Economic Aspects

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</table>
Component 2/3 Criteria and Evaluation Process Development

Graphical representation of performance
Big + Green = Good
Component 4: Develop Roadmaps of Selected Technologies

• Three Tasks:
  – Develop roadmaps for selected technology Suites
  – Identify gaps and synergies within and among technology suites
  – Issue final report
General Comments

• The collaboration has been extremely positive
  – Non-partisan technical collaboration among companies and regulators that does not normally take place

• The project **Team** to identify technologies to define future tailings work (individual company and collaborative)

• Intention of OSTC and AI-EES to use the final report as **the** strategic plan for future field demonstrations, supporting R&D and on-going technology screening

• All about near term deployment, longer term development and on-going screening
Why is the treatment of Tailings a water issue?

- 10 barrels of water needed for extraction of each barrel of bitumen
- Surface Mining Oil sands producers recycle about 80% of water
- Between 2 – 4 barrels of fresh “make-up” water are imported for every barrel produced
- About 1.5 barrels of MFT are created for every barrel of bitumen produced
- At 70% water = 1 barrel of water stranded in MFT for every barrel of bitumen produced
Put another way ...

- 10 barrels of water needed for the extraction of each barrel of bitumen.
- With about 800 million m3 of MFT currently held in tailings ponds, that equates to 3.5 billion barrels of water stranded and unavailable for recycle.
- 3.5 billion barrels of water would be enough to extract 350 million barrels of bitumen.
  That’s a 150,000 bpd mine operating for about 6 years.
Tailings Release

Water Treatment:

Suncor Tailings Reduction Operation (TRO), from: http://www.edmontonjournal.com/

Centrifuged MFT at Syncrude, from: http://www.womp-int.com
Goal: make process affected water acceptable for reuse as recycle water within the extraction plant or for discharge to the environment.

• Main issues for recycle: solids concentration (fines) and elevated salinity (typically sodium and magnesium chloride and sulphate salts)
  – Chemical disruption of the extraction process

• Main issues for disposal to the environment: pH, metals (Arsenic, lead, cadmium) and organics (naphthenic acids and Polycyclic Aromatic Hydrocarbons)
  – Acute and chronic toxicity affects on natural biota

• 42 Water treatment related technologies were evaluated
## WATER TREATMENT TECHNOLOGIES EVALUATION TABLE FOR PROCESS-AFFECTED WATERS

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<tr>
<th>Target Component</th>
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<tr>
<td>Suspended Solids</td>
<td>Used for free oil removal</td>
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<tr>
<td>Total Organic Carbon (TOC)</td>
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<td>Hydrocarbons</td>
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<td>Dissolved Air Flotation</td>
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<tr>
<td>Induced Air Flotation</td>
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<tr>
<td>Activated Sludge</td>
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<td>Aeration</td>
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<td>Nitrification</td>
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<td>Anaerobic Digestion</td>
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<td>Attached Growth/Fixed-film Water</td>
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<tr>
<td>Metal Removal by Micro Algae</td>
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</table>

### AFFECTED WATERS

- Solids
- Acidity
- Acute Toxicity
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Nutrients (N/H/NO3/P/etc.)

**Note:** Table entries are placeholders and need to be completed based on specific process-affected waters.
Closing Comments

• There is no doubt that tailings ponds are essential to a surface mining oil sands operation
  – To ensure maximum recycle of process water needs

• There is a lot of water stranded in the MFT

• The make-up and chemistry of the tailings in the ponds can be changed to produce useable water for either recycle or discharge back to the environment

• The Project is all about identifying the technologies that can make tailings ponds and the water they contain more process effective
  – acceptable for reuse as recycle water within the extraction plant or for discharge to the environment
www.ai-ees.ca