Soil or water? Resource or waste?

Bridging Dichotomous Approaches to Manage Oil Sands Waste and Reclaim Landscapes

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Water - Energy

- Water is the universal solvent
- Essential to life, industry, economy. USEPA main focus
- Water management is one of the most important yet poorly addressed problems
- Technical ability to manage water is available
- Public perceptions is not consistent with available solutions and with energy reliance
Water Perspectives
Global Water Market

- Large global industry
- Protection of water resources and sustainable use is a major public concern
- Water is critical to the continued development of unconventional resources
- Unconventional resources are key to North American energy security
- Produced water expected to grow 32% by 2025 (Clark & Veil 2009)
A Different Perspective on Water

- A majority of electricity is generated by thermal processes that require water.

- The US average is about 2.1 m$^3$ per Gj, in Canada the estimate is 20x higher.
  - A 60 W bulb consumes 11 to 24 m$^3$ per year
  - Electricity use consumes 100 m$^3$ per person/yr
  - Energy use consumes 630 m$^3$ per person/yr

- Water use consumes energy
  - California uses 8% of its total electricity to convey water$^1$; 19% on its use cycle$^2$
Water Supply & Use

• Oil and gas sector:
  • A small user of water relative to other segments
  • A large recipient of attention and regulatory scrutiny

• Industry’s water management and overall environmental performance impacts public perception & in turn regulatory agenda

• Regulations continue to tighten on industry & limit access

• Industry has an opportunity to show leadership through action
Water Consumption & Energy

Figure III-4
Life-cycle Water Use of Various Energy Sources

- Oil Sands Mining
- Oil Sands In-situ
- Conventional Oil
- Enhanced Oil Recovery
- Corn Ethanol
- Soy Biodiesel
- Coal-to-liquids
- Gas-to-liquids
- Hydroelectricity
- Electricity from Nuclear Power
- Electricity from Coal

1 gigajoule = 29 liters of gasoline (7.6 gallons)

Water or Solids?

How do we turn this?

Into this?

Source: Syncrude and Alberta Government
A Space Issue

Square kilometres

- solid tailings
- tailings water
- reclaimed

2007 Surface Mineable Projects Disturbance and Reclamation

2007 Landcover
- project areas

Land Cover 1
- disturbed
- reclaimed

Government of Alberta Environment

Square kilometres


August 2000

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Solids Out of Water
Solids Out of Water – No Slam Dunk

Figure 6.8 Relative volumes of mineral solid and water in MFT

Source: Devenny 2009
Solids Out of Water – No Slam Dunk

$50$/dry tonne?

$30$/dry tonne?

$60$/dry tonne?

\[ \text{FFT(vol)} = \text{Legacy} + \text{New Production} - \sum \text{Treatment options} \]
Is The Recycle Concept Hurting Water Management?
Water Efficiency Regulations

- **US**
  - Executive Order 13423 requires 2% reduction in use intensity per year to 2016
  - Energy Independence & Security Act requires water efficiency BMPs be implemented
  - Executive Order 13514 extends 13423 to broader water use (e.g. landscaping) and reduction out to 2020
  - Application of Environmental Flow Maintenance in water licensing applications

- **Canada**
  - National Action Plan to Encourage Municipal Water Use Efficiency
  - Application of Environmental Flow Maintenance in water licensing applications (DFO process to evaluate HADD)

- **Alberta**
  - Water Act = Procedures for allocating water includes IFN (licenses), Basin restrictions (regulations) determined from a number of factors
Alberta: What is “Best use”

• Strong focus on recycling:
• Could this be alternative use, or
• Returning water to the hydrologic cycle?
• Alternative Use:
  • One users waste may be another users (relatively) clean water
  • OSLI is leading an initiative to examine the potential for maximizing water reuse
• Discharge in safe manner:
  • Discharge criteria for slow and managed release of non-toxic water
Mine Tailings Example
Tailings Water Chemistry

e.g. MFT pore water and MFT pond water

- TDS
- Na
- HCO3
- Cl
- SO4
- Ca
- Mg
- CO3
- Fe
- pH
- Phenols

Log(ppm)
Water Will Return from Tailings

• Tailings need to be reclaimed

• 70% of volume will be released as water

• Industry needs to be committed to water treatment

• Waiting to deal with water issue has several consequences:
  • By 2025 the volume of water will have grown to 900 million m$^3$
  • If the Tailings Framework accomplishes its objectives there may be as much as 2.5 billion m$^3$ of water that needs an alternate use or a return to the environment
  • As water is recycled the concentration of solutes that are difficult to treat increases
The Water Treatment Problem

- 2.5 B m\(^3\) water contains 0.1 to 1 B Kg each of Na, SO\(_4\), and Cl

- To remain below the draft Athabasca Water Management Framework this water would require over 100 years of dilution, or

- The dilution scenario would require 200 to 500 km\(^2\) of pit lakes and still require >40 years of retention time

- Cheap methods of treatment and / or disposal are required:
  - Planning reclamation features for dilution and retention in aquifers with similar chemistry
  - Treatment and disposal
Understanding Other Potential Uses

Supply Demand Curve

Source: OSLI
HYWARE System

H₂O In

Softened H₂O

Portable RO Unit (optional)

Centrate Re-Cycle

Dry Solids Out
# Haynesville Water

<table>
<thead>
<tr>
<th>Flowback Water</th>
<th>Raw Water In</th>
<th>Product Water</th>
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<tbody>
<tr>
<td>Total Hardness (ppm)</td>
<td>10,200</td>
<td>40</td>
</tr>
<tr>
<td>Calcium (ppm)</td>
<td>3,780</td>
<td>16</td>
</tr>
<tr>
<td>Barium (ppm)</td>
<td>1,050</td>
<td>1</td>
</tr>
<tr>
<td>Strontium (ppm)</td>
<td>72</td>
<td>1</td>
</tr>
<tr>
<td>Magnesium (ppm)</td>
<td>178</td>
<td>ND</td>
</tr>
<tr>
<td>Iron (ppm)</td>
<td>93</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Solids Management

- Oil Sands Mine Fine Tailings Solids are > 44 µm
- About 340 Kt of fines/day, enough to fill a city block (150 m square) 3 m deep every day
- Can be used in reclamation features
Fluid Fine Tailings Inventory and Bitumen Production

- Total Volume Growth to 2.4 Mbb/d (Mm3 MFT)
- Dir 074 Applications + Projected growth (Mm3)
- Total Bitumen Projected (Mbbl/d)

**Legend:**
- Red line: Total Volume Growth to 2.4 Mbb/d (Mm3 MFT)
- Black line: Dir 074 Applications + Projected growth (Mm3)
- Green line: Total Bitumen Projected (Mbbl/d)
True Cost of Not Managing the Back End

- Tervita remediating Sherridon Mine
- Whole lake water treatment
- Stable hydrology
- Passive wetland treatment
- Appropriate boreal features
Intractable Problems = Expensive Solutions

Kam Kotia
- 6 MT of tailings, water and soil treated
Putting Waste Solids to Good Use But There is More to Consider...

Source: Syncrude via Alberta Government
What Chemical Loads Are Expected?

- Sustainable? Hydrology
- Wetland treatment?

Set success criteria:
- Stream concentration
- Watershed load
- Without this there is no evaluation of cost = no planning to offset
Developing Planning Tools From A Waste Perspective

• Planning from production to reclamation
  • Material balance
  • Energy balance
  • Financial balance

• Get away from reacting to the waste we generate, manage the material balance
  • Are there opportunities in production to generate easier to treat waste?
Filling Active Pits?

Extraction

- Thickening for energy recovery

Water Treatment

- In Situ
- Recycle
- Release

Fines Management System (Pond)

- Thickened, Centrifuged, Dried - DDA

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Leadership In Watershed Reclamation

• Building industry best practices

• Developing knowledge systems to ensure success
  • Front to back
  • Integrated projects

• Developing experience for oilsands using past experience in mine reclamation

• Experience in reclamation using mining AND other sectors (e.g. forestry)
Conclusion

• The world view on aqueous waste needs to expand to its full energy, waste life-cycle

• Regulations that facilitate transfer of water among best uses should be examined

• Waste water and waste solids must be managed together

• Opportunities that generate more benign waste (but may reduce recycling of water) need a broader life-cycle assessment

• Passive treatment options can be promoted if well planned before the waste is generated
Questions or comments?

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