Ex-Situ Soil Washing – Achieving Effective Mass Reduction for Organic Contaminant in Soil via the use of a Co solvent/Surfactant Process
Presentation summary

- About our Expertise, Products and Services
- Project Inception and Description
- Bench scale Treatability Study Results
- Geological & Contaminant Consideration
- Scale up and Equipment Validation
- Case Study Presentation and Economical Evaluation
About our Expertise, Products and Services

- **Training and Education**: technical transfer session, health and safety training;
- **Consulting and Technology Site Assessment**: technology support and selection (chemical oxidation, co solvent-surfactant soil washing and enhanced bioremediation);
- **Products supply, logistic and storage**: nutrients, bacterial preparations strains, oxidants, catalysts, oxygen and hydrogen release compounds, co solvent-surfactant blends
- **Laboratory Services and Analysis**: Groundwater Parameter Analysis, Tracer Study, Soil and Groundwater Oxidant Demand Evaluation (SOD), Bench Scale Treatability testing.
Organic Contaminants (Petroleum hydrocarbon, PCB, Dioxin, Furans, etc.) are entrapped as pure product (free phase) or at high concentration in various soil matrix.

Highly contaminated soils are bringing challenges for an effective low cost remediation.

Soil Washing using co-solvent and/or surfactant offers the benefit to treat effectively and economically these high contaminant concentration that allow for soil to be re-used or dispose at a lower cost.
Bench scale Treatability Study Protocol

- Laboratory Protocol
  - Fully mixed system of the impacted soil with the co-solvent-surfactant mix at a soil:liquid volume ratio of 1:2
  - Typical system mixing time 30 minutes
  - Liquid:solid separation step followed by liquid:contaminant separation and co-solvent-surfactant blend re-use.

- Notes:
  1- Recuperation and re-use of 99.5 % of the co-solvent-surfactant mix after separation of the contaminant.
  2- Wash cycle can be repeated if contaminant removal is insufficient.
### Bench scale Results

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Soil type</th>
<th>Initial Soil contaminant concentration (mg/kg)</th>
<th>Treated Soil contaminant concentration (mg/kg)</th>
<th>Number of wash cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH C10-C50</td>
<td>Silty-Sand</td>
<td>F2 – 32000</td>
<td>F2 - 840</td>
<td>2 wash</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3 – 24000</td>
<td>F3 – 840</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F4 – 6300</td>
<td>F4 - 1400</td>
<td></td>
</tr>
<tr>
<td>PCB</td>
<td>Clay</td>
<td>640</td>
<td>46</td>
<td>2 wash</td>
</tr>
<tr>
<td>Invert Oil Based Drilling Fluid</td>
<td>Shale</td>
<td>120 000 mg/kg (12 %)</td>
<td>6400 mg/kg</td>
<td>1 wash</td>
</tr>
</tbody>
</table>
Geological & Contaminant Consideration

- The washing process is NOT influenced by the geology where the contaminant is entrapped.
- The choice of co-solvent-surfactant mix that are available make for applicability to a large array of organic contaminants.
- Addition of wash cycles allow to reach low contaminant concentration.
- Contaminant can be re-used or destroyed once separated from the soil.
- Additional treatment (chemical oxidation, bioremediation, etc.) can be applied to the treated soil to polish contaminant removal if desired.
Scale up and Equipment Validation

- A 4 step full scale portable process was designed and build:

1. Feed hopper where soils are mechanically added.
2. The wash tank/auger where the co-solvent-surfactant mix interacts with the soil
3. The co-solvent-surfactant mix recovery system
4. The soil dryer
Scale up and Equipment Validation
Scale up and Equipment Validation
Scale up and Equipment Validation
Case Study Presentation and Economical Evaluation

- **Work Description:**

  Full scale testing done on the treatability of invert based drill cuttings resulting from drilling operations that utilize ‘invert’ or oil-based drilling fluids.
Case Study Presentation and Economical Evaluation

- Cutting Description:
  Drill cuttings originate from drilling operations that use invert as a base fluid to lubricate the drill bit and move cuttings up the well bore to surface. This type of operation is carried out by many oil and gas operators around Western Canada. The wells in this area typically produce 100m$^3$ to 300m$^3$ or 160 to 480 tonnes of hazardous wastes (cuttings), which are sent to a local, Secure oilfield landfill. The hydrocarbon content of the drilled cuttings is usually between 15-50% prior to any fluid recovery or stabilization processes on site.
Case Study Presentation and Economical Evaluation

- Treatment Goal and Benefit
  Removing the hydrocarbons from the cuttings to a state where the total hydrocarbon (BTEX, HEPH, LEPH, PAH) will be less than 1%.
Environmental, health and safety benefits:

- Significant reduction in greenhouse gas emissions due to a 30-40% volume reduction of wastes entering a landfill.
- Safer roads with less trucks on roads and highways
- Minimize the frequency or potential for spills
- No need for wood waste to be transported to wellsites for stabilization of material during transport
- Recovery of all base fluid from waste streams previously lost to landfill.
- Landfill cells can be open longer and will require less expansion
- Less drilling fluids needed to be transferred to site from recovery and reuse
- Near elimination of liquids (water or hydrocarbons) entering the landfill
- Reduction or limitation of liability associated with hazardous wastes in landfills
Case Study Presentation and Economical Evaluation

- Treatment Results
  - Cutting waste treated had an original average 20% wet weight of hydrocarbons (using a retort analysis) after undergoing a high-gravity shaker. Treatment was able to reduce these hydrocarbon levels to the below levels:
# Economical Evaluation

<table>
<thead>
<tr>
<th>Standard Operating Practice (Stabilized using Track-hoe &amp; Sawdust)</th>
<th>“Normal” Cuttings Volume is 200m³ (538 tons) 350 tons cuttings (with an SG of 2.0) 50 tons OBM (with an SG of .99) {Plus} 138 tons of sawdust (6 walking floors)</th>
<th>Treatment &amp; Recovery (Treated by Cutting Edge Systems)</th>
</tr>
</thead>
<tbody>
<tr>
<td>538</td>
<td>Total tonnage hauled to land fill</td>
<td>109</td>
</tr>
<tr>
<td>$55,000</td>
<td>OBM lost to cuttings &amp; fines</td>
<td>$11,000</td>
</tr>
<tr>
<td>$14,148</td>
<td>Sawdust consumed (@ $2,358 per load)</td>
<td>$4,716</td>
</tr>
<tr>
<td>$57,600</td>
<td>Rental cost of Stabilization method @ $1,200 (hoe)</td>
<td>$0</td>
</tr>
<tr>
<td>$0</td>
<td>Rental cost of Treatment System @ $1,800 (CES)</td>
<td>$86,400</td>
</tr>
<tr>
<td>$0</td>
<td>Rental cost of Generator &amp; Shale Sloops (CES)</td>
<td>$28,800</td>
</tr>
<tr>
<td>$1,440</td>
<td>Fuel Cost @ $.74/litre</td>
<td>$20,000</td>
</tr>
<tr>
<td>$4,800</td>
<td>Transport of equipment to/from site</td>
<td>$4,800</td>
</tr>
<tr>
<td>$31,602</td>
<td>Transport of “Contaminated Cuttings” from site to a secure landfill @ $58.74/ton</td>
<td>$6,320</td>
</tr>
<tr>
<td>$0</td>
<td>Recovered OBM sent back to tank farm</td>
<td>$44,000</td>
</tr>
<tr>
<td><strong>Others?</strong></td>
<td><strong>END COST COMPARISON</strong></td>
<td><strong>$118,036</strong></td>
</tr>
</tbody>
</table>

**Total Cost Comparison:**

- **538:** Total tonnage hauled to landfill
- **$55,000:** OBM lost to cuttings & fines
- **$14,148:** Sawdust consumed
- **$57,600:** Rental cost of Stabilization method
- **$0:** Rental cost of Treatment System
- **$1,440:** Fuel Cost
- **$4,800:** Transport of equipment
- **$31,602:** Transport of contaminated cuttings
- **$0:** Recovered OBM sent back to tank farm

**Others?**

**Total Cost:** $164,590

**Total Savings:** $118,036
Acknowledgement

- Cutting Edge System

Thank you for your attention!

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