IN-SITU BIOLOGICAL PERCOLATING SYSTEM
FOR THE TREATMENT OF
HYDROCARBON IMPACTED GROUNDWATER

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Outline

- Site History
- Geology/Contaminant Situation
- Remediation System
- BPS Design
- BPS Installation
- BPS Performance Data
Site Location

NEW YORK IS BIG...

BIGGAR
SASKATCHEWAN

BUT THIS IS BIGGAR

BIGGAR MUSEUM & GALLERY
PAST & PRESENTS
GIFT SHOP
105 3rd AVE WEST
Former Roundhouse (locomotive maintenance activities)

CN’s main above ground fuel storage tanks from 1960’s to 1980’s

Now a poultry rearing operation

Phase I & II investigations between 1997 to 2001
Geology/Contaminant Situation

- more than 24 m of clayey silt (till) with alternating beds of sand, silt and gravel.
- water table between 15 and 18 m belowground surface.
- hydraulic conductivity of $1.6 \times 10^{-5}$ m/s.
- approximately 500,000 liters of light non-aqueous phase liquid (LNAPL) in the form of diesel fuel is present in the subsurface over an area of 16,000 m$^2$.
- Groundwater recovered on-site for livestock watering
- Dissolved BTEX groundwater plume migrating toward property boundary
Assessment of Remedial Options

- Two insitu remediation options were considered
  - Conventional pumping
  - Vacuum Enhanced Recovery (VER)
- Pilot Testing in 2002 determined that both technologies were feasible but higher recovery rates were predicted for the VER option
- A VER System was installed in 2003/2004
VER System Components

- 40 Hp Liquid ring vacuum pump
- Inlet manifold air/water and diesel
- Air/liquid separator
- Settling Tank
- Oil/water separator
- Air compressor
- Diesel AST
- Biological Percolating System
VER System Installation

Non winterized system
7 months/year
A BPS was selected as the preferred effluent treatment and became operational in May 2004. The advantages of biofiltration are:

- Less expensive than treating effluent water with activated carbon;
- Reduced energy and maintenance costs; and
- Ideal for remote locations and provides a “close loop” operating system.
BPS Installation
Percolating Filter System For Treatment of Extracted Vapours and Water
Cumulated Product Volume Versus Time

Total Volume Accumulated in 2004 and 2005 is 98,322 Litres
## VER Performance

<table>
<thead>
<tr>
<th>Year</th>
<th>Vapour (L)</th>
<th>Aqueous (L)</th>
<th>Product (L)</th>
<th>Total (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>666</td>
<td>24.9</td>
<td>69,065</td>
<td>69,756</td>
</tr>
<tr>
<td>2005</td>
<td>413</td>
<td>44.8</td>
<td>28,089</td>
<td>28,566</td>
</tr>
<tr>
<td>Total</td>
<td>1079</td>
<td>69.7</td>
<td>97,154</td>
<td>98,322</td>
</tr>
</tbody>
</table>
BPS Performance

Benzene, Toluene and Ethylbenzene Influent and Effluent Concentrations

Date (dd/mm/yr)

Concentration (ug/L)

- Benzene (W1)
- Benzene (W2)
- Toluene (W1)
- Toluene (W2)
- Ethylbenzene (W1)
- Ethylbenzene (W2)

W1 - influent
W2 - effluent
Total Petroleum Hydrocarbon Influent and Effluent Concentrations

BPS Performance

- TPH (W1)
- TPH (W2)

Date (dd/mm/yr):
- May-04
- Jul-04
- Sep-04
- Nov-04
- Jan-05
- Mar-05
- May-05
- Jul-05
- Sep-05

Concentration (mg/L)
Nutrient Concentrations

Nitrate and Nitrite Influent and Effluent Concentrations

Date (dd/mm/yr)

Concentration (mg/L)

May-05 | Jun-05 | Jul-05 | Aug-05 | Sep-05
--- | --- | --- | --- | ---
Nitrate (W1) | Nitrate (W2) | Nitrite (W1) | Nitrite (W2)

July 2005 had the highest concentration of Nitrate (W1) at approximately 10 mg/L. Nitrate (W2) and Nitrite (W1) concentrations were very low, while Nitrite (W2) had a slight increase.
Iron and Manganese Concentrations

<table>
<thead>
<tr>
<th>Date</th>
<th>Iron (W1)</th>
<th>Iron (W2)</th>
<th>Manganese (W1)</th>
<th>Manganese (W2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-May-05</td>
<td>0.006</td>
<td>0.142</td>
<td>0.629</td>
<td>0.255</td>
</tr>
<tr>
<td>6-Jul-05</td>
<td>0.078</td>
<td>0.272</td>
<td>0.522</td>
<td>0.122</td>
</tr>
<tr>
<td>17-Aug-05</td>
<td>0.07</td>
<td>0.27</td>
<td>0.522</td>
<td>0.122</td>
</tr>
<tr>
<td>21-Sep-05</td>
<td>0.08</td>
<td>0.27</td>
<td>0.522</td>
<td>0.122</td>
</tr>
</tbody>
</table>

Iron and Manganese Influent and Effluent Concentrations

- **Iron (W1)**
- **Iron (W2)**
- **Manganese (W1)**
- **Manganese (W2)**

![Bar chart showing concentrations over time](chart.png)
Biological Oxygen Demand Concentrations

Date (dd/mm/yr)

1-May-05
1-Jun-05
1-Jul-05
1-Aug-05
1-Sep-05

Concentration (mg/L)

0
50
100
150
200

BOD (W1)
BOD (W2)
Conclusions

- The VER system continued to recover approximately 10,000 litres per month in 2004 and 5000 litres per month in 2005 of diesel from the subsurface during the operating period.
- Approximately 85% of the recovered diesel was sold locally as heating fuel.
- The results for the 2004/2005 operating period showed that the treatment level of the BPS steadily improved over a six month operating period as biomass grew and acclimatized in the filter matrix.
- Chemical concentrations of pH, conductivity, alkalinity, total dissolved solids, sulphate, chloride, sodium, calcium, potassium did not change during treatment.
- Nitrate/Nitrite concentration were reduced.
Conclusions

- Iron concentrations increased, manganese concentration decreased
- Results in 2004/2005 demonstrated an average 80% mass removal of dissolved hydrocarbons by the BPS and suggests that a fully acclimatized BPS is capable of meeting the potable groundwater or groundwater ingestion guidelines for benzene, toluene, xylenes and petroleum hydrocarbon fractions at this Site.
- Ethylbenzene potable guideline was not achieved
- BPS has offered a cost effective treatment option for this Site