Innovative Approach to Landfill Gas Collection and Control

PRESENTED BY

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Business Development Manager East

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Presented By:
SWANA & WRANS
Solid Waste Association of North America
Waste Resource Association of North America
Atlantic Canada Chapter
Nova Scotia
1 – Purpose of LFG collection and basic considerations

2 – Traditional Horizontal LFG collection during operation

3 – Geosynthetic approach

4 – Greenhouse gas & Cost savings

5 – Comparative study

6 – Conclusion / Questions
1 – Purpose of LFG collection and basic considerations

- Control emissions
- Control odors
- Collect fuel for:
  - Electric generation
  - Direct use applications
- Regulatory requirement
1 – Purpose of LFG collection and basic considerations

Traditional LFG collection

Wellheads
2 – Traditional Horizontal LFG collection during operation

Typical Collection trench

- **Nonwoven Geotextile** (optional on trench sides and bottom)
- **Aggregate**
- **152-mm Ø Perforated HDPE Pipe**
- **Waste/Cover Soil**
- **Waste**

**Dimensions:**
- **0.45 m** (3 to 6 ft)
- **0.9 m** (3 ft)
- **15 to 30 m** (50 to 65 ft)
- **9 to 12 m** (30 to 40 ft)
2 – Traditional Horizontal LFG collection during operation

Collection trench construction
3 – Geosynthetic approach

Tubular drainage geocomposite
- PP mini-pipes
- Geotextile layers
3 – Geosynthetic approach

Tubular drainage geocomposite
3 – Geosynthetic approach

Positive connection to the manifold: *Quick Connect System*

- Airtight connection
- Vacuum
3 – Geosynthetic approach

Long term behavior
- No geotextile intrusion
- No creep in compression

Head loss calculation
- Lymphea software

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**Hydraulic Transmissivity of Draintube LFG4 D25 under 50,000 psf**

<table>
<thead>
<tr>
<th>Hydraulic Transmissivity (m²/s)</th>
<th>Time (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0E-01</td>
<td>0</td>
</tr>
<tr>
<td>1.0E-02</td>
<td>200</td>
</tr>
<tr>
<td>1.0E-03</td>
<td>400</td>
</tr>
<tr>
<td>1.0E-04</td>
<td>600</td>
</tr>
<tr>
<td>1.0E-05</td>
<td>800</td>
</tr>
<tr>
<td>1.0E-06</td>
<td>1000</td>
</tr>
</tbody>
</table>

Test conditions:
- 85mm sand
- Draintube geomembrane 60 mil
- 25mm sand
- 50,000 psf

**Draintube LFG4 D25 - Head Loss per 100’**

<table>
<thead>
<tr>
<th>Flow Rate (cfm)</th>
<th>Head Loss (in. w.c.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>5</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>0.4</td>
</tr>
<tr>
<td>15</td>
<td>0.6</td>
</tr>
<tr>
<td>20</td>
<td>0.8</td>
</tr>
<tr>
<td>25</td>
<td>1.0</td>
</tr>
<tr>
<td>30</td>
<td>1.2</td>
</tr>
<tr>
<td>35</td>
<td>1.4</td>
</tr>
</tbody>
</table>

- LFG
  - 45% CH₄ + 55% CO₂
  - Specific mass (oz/in³): 8.13 x 10⁻⁴
  - Dynamic viscosity (lbm/in·s): 8.7 x 10⁻⁴
## 4 – Greenhouse gas & Cost savings

### Innovative Approach to Landfill Gas Collection and Control

**Reduction by 70% of Greenhouse gas emissions**

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
<th>Emission (eq.CO₂)</th>
<th>Emission reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal LFG collection</td>
<td>Traditional solution 0.9m x 1m trench with gravel material + 150mm collector pipe</td>
<td>54.5 kg (CO₂ / lm)</td>
<td>70 %</td>
</tr>
<tr>
<td>Geocomposite solution</td>
<td>DRAINTUBE Geocomposite only</td>
<td>17 kg (CO₂ / lm)</td>
<td></td>
</tr>
</tbody>
</table>

### Excavation Work

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit</th>
<th>Kg CO₂ eq./m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil density</td>
<td>1.5</td>
<td>tons/m³</td>
</tr>
<tr>
<td>Trench height</td>
<td>1.0</td>
<td>meters</td>
</tr>
<tr>
<td>Trench width</td>
<td>0.9</td>
<td>meters</td>
</tr>
<tr>
<td>Soil extraction for 1 lm</td>
<td>1.35</td>
<td>tons</td>
</tr>
</tbody>
</table>

### Soil Extraction Using Machinery

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Im of trench per day</td>
<td>70</td>
</tr>
<tr>
<td>Tons of soil extracted per hour</td>
<td>13.5</td>
</tr>
<tr>
<td>Hours of work for 1 lm</td>
<td>0.1</td>
</tr>
<tr>
<td>Fuel consumption per hour</td>
<td>45</td>
</tr>
<tr>
<td>Fuel consumption for 1 lm</td>
<td>41</td>
</tr>
</tbody>
</table>

**Emission (eq.CO₂)**

- Horizontal LFG collection: 70%
- Geocomposite solution: 0.05

**Costs**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost per lm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour costs per hour</td>
<td>$30</td>
</tr>
<tr>
<td>Number of workers</td>
<td>2</td>
</tr>
<tr>
<td>Dollars for services per 1 lm</td>
<td>$6</td>
</tr>
</tbody>
</table>

**CO2 to Landfill (lmxkg)**

<table>
<thead>
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<th>Description</th>
<th>Cost per lm</th>
</tr>
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<tbody>
<tr>
<td>Labour costs per hour</td>
<td>$30</td>
</tr>
<tr>
<td>Number of workers</td>
<td>3</td>
</tr>
<tr>
<td>Dollars for services per 1 lm</td>
<td>$9</td>
</tr>
</tbody>
</table>

**Total Co2**

- Horizontal LFG collection: 11.78
- Geocomposite solution: 0.22

**Total Co2**

- Emission: 15.92

**Transport to the site**

- Distance to worksite: 1500 kims one way
- Transport of products: 5.4 tons kims

**Application of the product on site using machinery**

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<th>Cost per lm</th>
</tr>
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<tr>
<td>Labour costs per hour</td>
<td>$30</td>
</tr>
<tr>
<td>Number of workers</td>
<td>3</td>
</tr>
<tr>
<td>Dollars for services per 1 lm</td>
<td>$9</td>
</tr>
</tbody>
</table>

**Application of gravel using site machinery**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost per lm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour costs per hour</td>
<td>$38</td>
</tr>
<tr>
<td>Number of workers</td>
<td>2</td>
</tr>
<tr>
<td>Dollars for services per 1 lm</td>
<td>$7.2</td>
</tr>
</tbody>
</table>

**Collector Pipe**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost per lm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight per lm</td>
<td>$143</td>
</tr>
</tbody>
</table>

**Total Co2**

- Horizontal LFG collection: 54.67

**Conclusion**

Reduction by 70% of Greenhouse gas emissions
4 – Greenhouse gas & Cost savings

Costs estimation for a 60 meter (200 ft) long trench

Traditional horizontal trench:
- Excavation and construction ~ $7,500
- Lost airspace ~50 m³ @ $75/ m³ = $3,800
- Totaling ~$11,300 for 60 meters

Total cost ~$190 per meter

Horizontal Tubular Drainage geocomposite:
- Material and installation ~ $3,600
- Excavation and construction - $0
- Lost airspace - $0
- Totaling ~$3,600 for 60 meters

Total cost ~$60 per meter

Reduction of the costs by 70%
5 – Comparative study

- Cedar Hill Landfill, WA
- Study conducted by Toraj Ghofrani, PE
5 – Comparative study

- 3 types of Horizontal LFG collectors:
  - “Conventional perforation”: 150 mm diameter HDPE pipe with six 13 mm perforations, 60° apart, and 150 mm on center
  - “Alternative perforation”: 150 mm diameter HDPE pipe with one 3 mm perforation, rotating 90°, and 900 mm on center
  - “Minitube Blanket”: DRAINTUBE 500P LFG4 D25 with 4 PP mini-pipes 25mm diameter with two 1 mm perforations per valley, 180° apart, rotated 90°
5 – Comparative study

- Pipe Perforations vs Landfill Gas Flow (Q) & Vacuum Zone of Influence (ZOI)

<table>
<thead>
<tr>
<th>Lots of Large Pipe Perforations</th>
<th>Fewer Smaller Pipe Perforations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q High</td>
<td>Q Low</td>
</tr>
<tr>
<td>ZOI</td>
<td>ZOI</td>
</tr>
</tbody>
</table>
5 – Comparative study

- 215 m long trench
- From September 2015 to March 2016
- Sum of perforated areas:
  - Conventional perforation: 1 m²
  - Alternative perforation: 0.001 m²
  - Minitube Blanket: 0.4 m²

![Diagram of Landfill Gas Collection and Control System]
5 – Comparative study

Innovative Approach to Landfill Gas Collection and Control
5 – Comparative study

Innovative Approach to Landfill Gas Collection and Control
5 – Comparative study

Vacuum Dissipation Along Perforated Section of Each Landfill Gas Collector Design

- Conventional Perforation
- Alternative Perforation
- Minitube Blanket

Inside Trench Along Perforated Pipe Section

Vacuum (inches of Water Column) vs. Distance Away From Vacuum Source in Feet

Distance: 50 to 700 feet
Vacuum: 0 to 5 inches
5 – Comparative study

Comparative Landfill Gas Flow Rates

- Conventional Perforation Design
- Alternative Perforation Design
- Minitube Blanket Design

Flow Rate (SCFM) vs. Elapsed Time in Days
5 – Comparative study

Comparative Landfill Gas CH₄ Concentrations

- Conventional Perforation Design
- Alternative Perforation Design
- Minitube Blanket Design

Elapsed Time in Days

% CH₄

Target
5 – Comparative study

Comparative LFG Heating Content Collected

- Conventional Perforation Design
- Alternative Perforation Design
- Minitube Blanket Design

Elapsed Time in Days

[Graph showing comparative heating content collected over time for different designs.]
6 – Conclusion / Questions

- Minitube Blanket is successful in preserving the vacuum loss for further reach of Zone of Influence (ZOI) and the flow rate
- Minitube Blanket allowed for similar peak collection rate of heating content (165 MMBTU/day) as compared with the Conventional LFG collector (173 MMBTU/day)
- Corrugated polypropylene pipes of the Minitube Blanket have a better behavior towards long term landfill settlement
- Cost saving on Cedar Hill:
  - Minitube Blanket is about 15% cheaper than conventional trench
  - 80+ kms of about 0.6 m x 1.2 m rock filled trench and piping systems = 53,500 m³ of lost landfill airspace
  - If Minitube Blanket used for the 80 kms LFG collectors, more than $7,000,000 financial gain (tipping fees of $130/ton)
6 – Conclusion / Questions

THANK YOU!