Case Study: Use of Alternate Vapour Flow Media for Vapour Management Systems in New Building Construction

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AMEC Earth & Environmental
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What is Vapour Intrusion?

- Soil gas migration from subsurface to overlying and/or adjacent buildings
- Common Sources
  - Landfills
  - Service stations
  - Dry cleaning facilities
- Transport
- Preferential Pathways
Methane Properties

- CH4
- Simplest hydrocarbon (alkane)
- Gas at room temperature
- Less dense (lighter) than air
- Forms explosive mixtures with air (5 – 15% Gas)
- Colourless
- Odourless
- Simple asphyxiant
Regulatory Considerations

- City of Calgary - no written policy
- Alberta Environment – no written policy
- Calgary Health Region – internal guideline
  - Subsurface soil gas response:
    - $[\text{CH}_4] > 2\% \text{ LEL (1000 PPM)}$ - further Investigation
    - $[\text{CH}_4] > 10\% \text{ LEL (5000 PPM)}$ - mitigation
  - Indoor methane concentration response
    - $[\text{CH}_4] > 0.1\% \text{ LEL (50 PPM)}$ - further investigation
    - $[\text{CH}_4] > 1\% \text{ LEL (500 PPM)}$ - mitigation
  - Two Stage In-building Alarm System
    - Alarm # 1 > 5\% LEL (2500 PPM) - alert occupants
    - Alarm # 2 > 10\% LEL (5000 ppm) - evacuation
Case Study – Background Information

- Brownfield development in Calgary
  - industrial and commercial land use
- Site area: ~ 100 ha
- 20-30 buildings proposed
  - Area: 50,000 ft² to 150,000 ft²
- Former gravel pit backfilled with fine-grained material
- Elevated levels of methane identified in subsurface
Case Study – Mitigation

- Installation of a permeable trench along the perimeter of the site boundary
- Isolation of utility infrastructure
- Methane building management
- Methane monitoring program
Case Study - Methane Building Management

- Purpose:
  - To reduce the potential for methane gas to accumulate to harmful levels inside the buildings
Case Study - Methane Building Management

- System principles
  - Passive vapour management system that can be activated
  - Automated, continuous in-building monitoring
  - Manual monitoring
    • short term and long term
  - Emergency response plan
Case Study - Typical Vapour Management System

Concrete Slab
Fill
Geotextile
Geomembrane
Drain Rock
Perforated Pipe
Subbase
Case Study - Alternate Vapour Management System

Concrete Slab
Fill
Subbase

Geotextile
Geomembrane
Drainage Core
Drain Rock
Perforated Pipe
Case Study - Alternate Vapour Management System (cont’d)
Case Study - Alternate Vapour Management System (cont’d)
Case Study - Pilot Testing

- Purpose:
  - How effective is a synthetic drainage core at facilitating air flow beneath a building concrete slab?
  - Determine linear flow of air through a typical VMS design (40 mm drain rock)
  - Compare with two configurations of synthetic drainage core
  - Compare with typical fill material (20 mm crush)
Case Study - Pilot Testing (cont’d)

- 4 plots:
  - Dimensions: 20m x 2 m
  - Rock nests located at one end of the plots
  - Perforated pipes connected to solid pipes from rock nests, acting as risers
  - Completely enveloped in PVC to minimize short-circuiting
  - Numerous vacuum fan configurations investigated

Mock Up Plan View

![Mock Up Plan View Diagram]
Case Study - Pilot Testing: Construction Details

- Using full size equipment, as in typical building construction (i.e., bobcat, vibratory compactors)
- Measure air flow and vacuum at select locations
- Inspect synthetic drainage core material to evaluate damage from compaction loads
Pilot Test – Plot 1: Synthetic Drainage Core/Geotextile
Pilot Test – Plot 2
Synthetic Drainage Core/Geonet
Pilot Test – Plot 3
Typical Fill (20 mm Crush)
Pilot Test – Plot 4
Typical VMS/40 mm Drain Rock

- Solid Riser
- Geomembrane
- Geotextile
- Fill
- Drain Rock
- Perforated Pipe
Comparison of Plots

Exhaust Flow (m³/min)

Pressure (mm H₂O)
Comparison of Plots

Pressure (mm H₂O) vs. Linear Flow (m/min)

- Plot 1
- Plot 2
- Plot 3
- Plot 4
Conclusions - Resistance

- **Plot #4 (40 mm drain rock)**
  - Greatest flow volume with the least amount of resistance

- **Plot #1 (Synthetic drainage core/Geotextile)**
  - Approximately 3.0 to 3.5 times more resistance at the same flow rate as Plot #4

- **Plot #2 (Synthetic drainage core/Geonet)**
  - Approximately 3.5 to 4.0 times more resistance at the same flow rate as Plot #4

- **Plot #3 (20 mm crush)**
  - Resistance at orders of magnitude greater than Plot #4
Conclusions - Use as an Alternate VMS Design

- Synthetic drainage core will provide similar air flows when used in a passive VMS
- If activation of the VMS is required, larger fans would be required to ensure adequate flow beneath the building sub-slab
Cost Comparison

- Cost Variables
  - Building area
  - Building design (slab-on-grade, crawlspace)
  - Number of penetrations

- Unit Prices
  - Typical Vapour Management System
    - $7.00 - $9.00/ft²
  - Alternate Vapour Management System
    - $5.00 – $6.00/ft²

Client quoted between 20%-50% Cost Savings!!!
Example:

- ~100,000 ft² commercial building
- slab on-grade design
- Costs based on contractor quoted prices for building construction in 2008

Cost Comparison

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<table>
<thead>
<tr>
<th></th>
<th>Typical</th>
<th>Alternate</th>
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<tbody>
<tr>
<td>Dollars ($)</td>
<td>$800,000</td>
<td>$550,000</td>
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31% Savings = $250,000
Alternate Vapour Management System

Advantages

- Less materials
- Reduced labour
- Reduced schedule
- Cost effective
- Greater stability
- Reduced earthworks
## Alternate Vapour Management System

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Less materials</td>
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<td>Reduced labour</td>
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<td>Reduced schedule</td>
<td>Increased O &amp; M costs if activation required</td>
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<tr>
<td>Greater stability</td>
<td>More easily damaged during installation</td>
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Questions?

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