Post Closure Care Project for Florida Landfills

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Introduction

Aim: To develop a performance based methodology that can be used as a decision making tool to reduce the post closure care (PCC) period of Florida landfills.

This project is funded by State University System of Florida, Hinkley Center for Solid and Hazardous Waste Management.

The data for Davie Landfill are provided by Broward County Waste and Recycling Services Solid Waste Operations Division.

The partners
PCC Period Assessment Tasks

Identification of Case Study Landfills

Analysis of Land Use Data

Analysis of Performance Data
- Leachate
- Groundwater
- Landfill Gas
- Cap

Analysis Monitoring and Care Requirements

Analysis of environmental risks

Identification of potential human health and environmental threats
Vista View Park (Davie Landfill)  
Broward/FL

December 1987 - Landfill was officially closed

July 2003 - Vista View Park was opened to the public
Design Features

Cap Feature

A two-foot thick, compacted, limerock cover
A total of 31,969 tons of limerock were used as landfill cover material

Leachate Collection System, LCS

The south mound (trash landfill) is unlined
The north mound (sanitary landfill) is lined and made up of 14 cells
Leachate to City of Sunrise wastewater treatment plant.

Gas collection

33 gas extraction wells
collected gases eliminate through an enclosed flare

Surface water

All surface water runoff is channeled to borrow lakes

Ground water

There are 22 G.W monitoring well. Sampled semiannually

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Methods used for PCC assessment

First step
- Field based approach (quality and quantity data evaluation)
  - Leachate
  - Groundwater
  - Landfill Gas
- Knowledge based parametric assessment

Second step
Evaluation of the risk analysis,
Leachate Quantity

Available data are from 1990 to 2008
Monthly Total Leachate vs Total Rainfall

![Graph showing monthly total leachate vs total rainfall]
Leachate Quantity Prediction with time series analysis

Time Series Decomposition Plot for Leachate
Multiplicative Model

Variable
- Actual
- Fits
- Trend
- Forecasts

Accuracy Measures
MAPE 57
MAD 57980
MSD 6264293439

Leachate gal/month

Month
Leachate Quality

- Total 49 parameters monitoring
- Available data April 2001-April 2008
- 26 parameters non detected (always below detection limit)
- 8 parameters always above MCL
- 10 parameters below MCL

<table>
<thead>
<tr>
<th>Below MCL</th>
<th>Above MCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>Chloride</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>Bicarbonate</td>
</tr>
<tr>
<td>cis-1,2-Dichloroethylene</td>
<td>Sodium</td>
</tr>
<tr>
<td>Dichlorodifluoromethane</td>
<td>Ammonium as N</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>Iron</td>
</tr>
<tr>
<td>Methyl-tert-butyl ether (MTBE)</td>
<td>Benzene</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>Vinyl Chloride</td>
</tr>
<tr>
<td>Toluene</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>Xylenes</td>
<td></td>
</tr>
<tr>
<td>Total BTEX</td>
<td></td>
</tr>
</tbody>
</table>
Chloride and Sodium Trend and Forecast

**Chloride mg/L**

- **MAPE**: 7.72
- **MAD**: 67.46
- **MSD**: 6150.42

**Time Series Decomposition Plot for Chloride**

MCL will be reached in 2021

**Sodium ug/L**

- **MAPE**: 2.31233E+01
- **MAD**: 2.39774E+05
- **MSD**: 7.58125E+10

**Time Series Decomposition Plot for Sodium**

MCL will be reached in 2011
Ammonia and Benzene Trend and Forecast

Time Series Decomposition Plot for Ammonia
Multiplicative Model

MAPE 971
MAD 699
MSD 902979

Ammonia
Projections indicate decrease
Observations indicate steady trend

Time Series Decomposition Plot for Benzene
Multiplicative Model

MAPE 12.0964
MAD 0.3909
MSD 0.2045

Benzene
Projections indicate decrease
Observations indicate steady trend
Vinyl Chloride and TDS Trend and Forecast

MCL will be reached in 2012
Iron and Bicarbonate Trend and Forecast

Iron and Bicarbonate have increasing trend
Recommendations for Leachate Monitoring

- Significantly reduce or stop the monitoring frequency for non detected parameters
- Reduce monitoring frequency for parameters below MCL limits
- Continue monitoring parameters above MCL limits
- Refine projections of parameters above MCL limits as more data became available
Landfill Gas Projections

- Data available from 2004-2008
- No graphical prediction for Total LFG and Current LFG to calculation of remaining LFG
- Use LANDGEM to find closest numbers for real LFG/year and CH4 quantity
**Comparison LANDGEM and Real Data**

- Run the LANDGEM for closest value for the real data
- $k$: **0.21** 1/year
- $L_o$: **22** m3/MG
- Methane content **45%**

<table>
<thead>
<tr>
<th>Years</th>
<th>Real Data LFG m3/year</th>
<th>CH4 m3/year</th>
<th>LANDGEM LFG m3/year</th>
<th>CH4 m3/year</th>
<th>% Difference</th>
<th>CH4 %Difference</th>
<th>LFG %Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>370232.5</td>
<td>166098.8</td>
<td>380454.1</td>
<td>171204.3</td>
<td>3</td>
<td>2.7</td>
<td></td>
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<tr>
<td>2005</td>
<td>314018.2</td>
<td>139673.8</td>
<td>308390.1</td>
<td>138775.5</td>
<td>0.6</td>
<td>1.8</td>
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</tr>
<tr>
<td>2006</td>
<td>188392.5</td>
<td>96618.44</td>
<td>249976.1</td>
<td>112489.3</td>
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<tr>
<td>2007</td>
<td>218121.6</td>
<td>91035.01</td>
<td>202626.7</td>
<td>91182.03</td>
<td>0.2</td>
<td>7.6</td>
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</table>
**LFG Results**

- Total gas values calculated from Landgem model.
- Model estimates total LFG and current LFG, remaining LFG is 0.5%
- After the year 2032 total LFG projected to be below 1000 m3/year
Groundwater Monitoring

- There are 22 GW monitoring wells.
- The monitoring frequency is biannual. (April and September).
- Total 53 parameter are monitored.
- Available data are from April 2001 to April 2008.
- 35 parameters organic compounds
- 11 parameters inorganic compounds.
- 32 parameters non detected parameters
- 5 parameters above MCL limits
- 11 parameters below MCL limits (however, public health concern)

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<tr>
<td>1,4-Dichlorobenzene</td>
<td>Sodium</td>
</tr>
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<td>Iron</td>
</tr>
<tr>
<td>1,2-Dichloroethylene</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>Methyl Chloride</td>
<td>Ammonium as N</td>
</tr>
<tr>
<td>Xylenes</td>
<td>Vinyl Chloride</td>
</tr>
<tr>
<td>Methyl-tert-butyl ether (MTBE)</td>
<td>Coliform</td>
</tr>
<tr>
<td>Arsenic</td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td></td>
</tr>
</tbody>
</table>
Detection Frequency of Contaminants of Concern from 22 GW monitoring wells, monitored biannually

<table>
<thead>
<tr>
<th>Compound</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorobenzene</td>
<td>60</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>23</td>
</tr>
<tr>
<td>Methyl chloride</td>
<td>6</td>
</tr>
<tr>
<td>Methyl tert-Butyl Ether</td>
<td>9</td>
</tr>
<tr>
<td>Xylene</td>
<td>1</td>
</tr>
<tr>
<td>Vinyl Chloride</td>
<td>10</td>
</tr>
<tr>
<td>cis-1,2-Dichloroethylene</td>
<td>3</td>
</tr>
<tr>
<td>Ammonia as N</td>
<td>330</td>
</tr>
<tr>
<td>Arsenic</td>
<td>3</td>
</tr>
<tr>
<td>Cadmium</td>
<td>1</td>
</tr>
<tr>
<td>Chromium</td>
<td>6</td>
</tr>
<tr>
<td>Iron</td>
<td>330</td>
</tr>
<tr>
<td>Sodium</td>
<td>330</td>
</tr>
<tr>
<td>Zinc</td>
<td>105</td>
</tr>
<tr>
<td>Dissolved Solid</td>
<td>330</td>
</tr>
<tr>
<td>Coliform</td>
<td>68</td>
</tr>
<tr>
<td>Turbidity</td>
<td>330</td>
</tr>
</tbody>
</table>

![Frequency Chart](image-url)
Most Frequently Detected Parameters for each well always above MCL

- Iron
- Ammonia as N
- TDS
- Sodium
- Turbidity

Monitored in all GW wells
Parameters below MCL for each well - Organics

GW 3-38
- Chlorobenzene
- 1,4-Dichlorobenzene
- Methyl chloride
- Methyl tert-Butyl Ether
- Xylene

GW 3-58
- Chlorobenzene
- 1,4-Dichlorobenzene
- Methyl chloride
- Methyl tert-Butyl Ether

GW 22-34
- Methyl chloride
- Methyl tert-Butyl Ether

GW 7-37
- Chlorobenzene

GW 7-59
- Chlorobenzene
- 1,4-Dichlorobenzene
- Methyl chloride
- Methyl tert-Butyl Ether

GW 22-34
- Methyl chloride
- Methyl tert-Butyl Ether

GW 8-35, 59, 72
- No organics

GW 7-84
- Methyl tert-Butyl Ether

GW 21-35, 62, 85
- No organics

GW 9-93
- Chlorobenzene
- 1,4-Dichlorobenzene
- Methyl chloride
- Vinyl Chloride

GW 21-35, 62, 85
- Chlorobenzene
- 1,4-Dichlorobenzene
- Methyl chloride
- Vinyl Chloride
- cis-1,2-Dichloroethylene

GW 9-93
- Chlorobenzene
- 1,4-Dichlorobenzene
- Methyl chloride

GW 11-31
- Methyl chloride

GW 11-57
- Chlorobenzene
- Vinyl Chloride

GW 11-75
- Chlorobenzene
- Methyl chloride
Vinyl Chloride

Observations indicate steady trend

Vinyl Cl ug/L

y = -7E-05x + 4.734
R² = 0.05

Years

Vinyl Cl MW11-100
Parameters below MCL for each well - Metals

GW 3-38  GW 3-58  GW 3-110  GW 22-34  GW 22-60  GW 22-60
Chromium  Chromium  Zinc  Zinc  Zinc

GW 7-37  GW 7-59  GW 7-84  GW 8-35  GW 8-59  GW 8-72
Zinc  Zinc  Zinc  Zinc  Zinc  Zinc

GW 21-35  GW 21-62  GW 21-85  GW 9-93  GW 9-93  GW 9-93
Arsenic  Cadmium  Zinc  Zinc  Zinc  Zinc

GW 11-31  GW 11-57  GW 11-75  GW 11-100
Arsenic  Chromium  Zinc  Zinc  Zinc  Zinc  Zinc  Zinc
Recommendations for GW Monitoring

- Significantly reduce or stop the monitoring frequency for non detected parameters
- Reduce monitoring frequency for
  - Methyl chloride
  - Methyl tert-Butyl Ether
  - Xylene
  - 1,2-Dichloroethylene
  - Chromium
- Continue monitoring parameters for above MCL limits and
  - Chlorobenzene
  - 1,4-Dichlorobenzene
  - Vinyl Chloride
  - Cadmium
  - Arsenic
  - Zinc
- Refine projections of parameters above MCL limits as more data became available
Anticipated Outcome

The outcome of the project will be a PCC period guidance document incorporating risk assessment for Florida landfills.
Thank you