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NC Vasuki and John Baker

Evaluation of Long-Term Monitoring  
Data from Full-Scale MSW Landfills with  
Leachate Recirculation



# Test Facilities

- DSWA, Central Solid Waste Management Center, Sandtown, DE
  - 27-acre Landfill Cells (Area A/B)
  - 1-acre Test Cells
    - Cell 1 – Leachate Recirculation
    - Cell 2 – Non-Recirculation (Control)

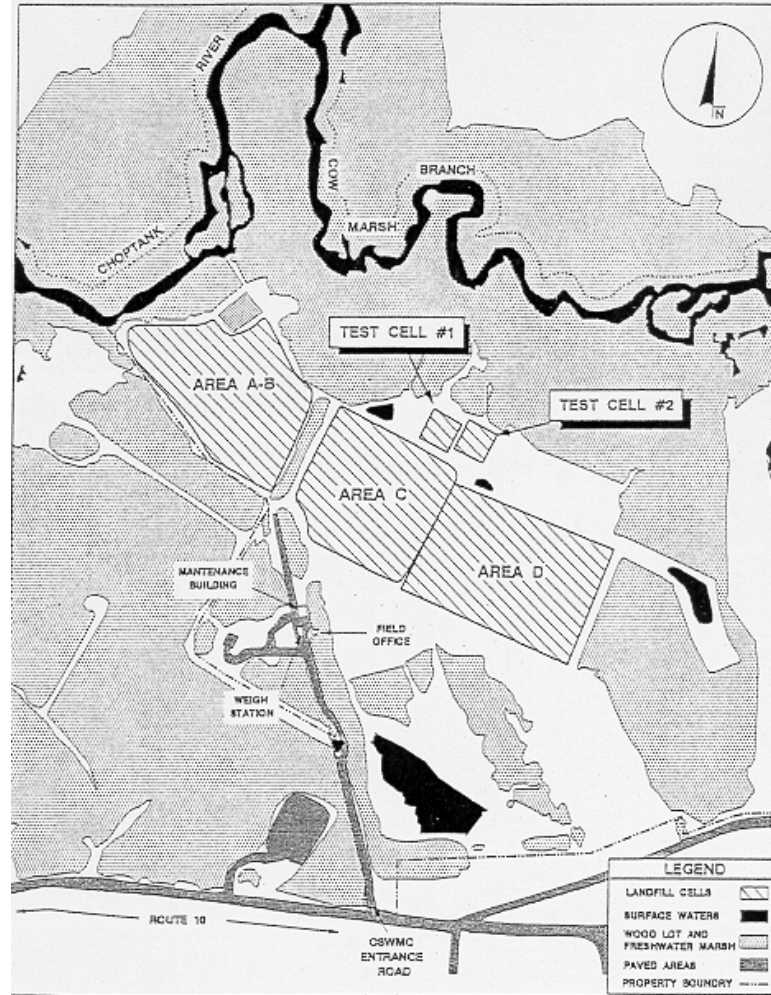
# Evaluations

- Leachate Quality
- Landfill Gas Generation
- Landfill Settlement
  
- Area A/B – compare to stability criteria
- Test Cells – comparative study

# Location of Test Site



# Site Plan



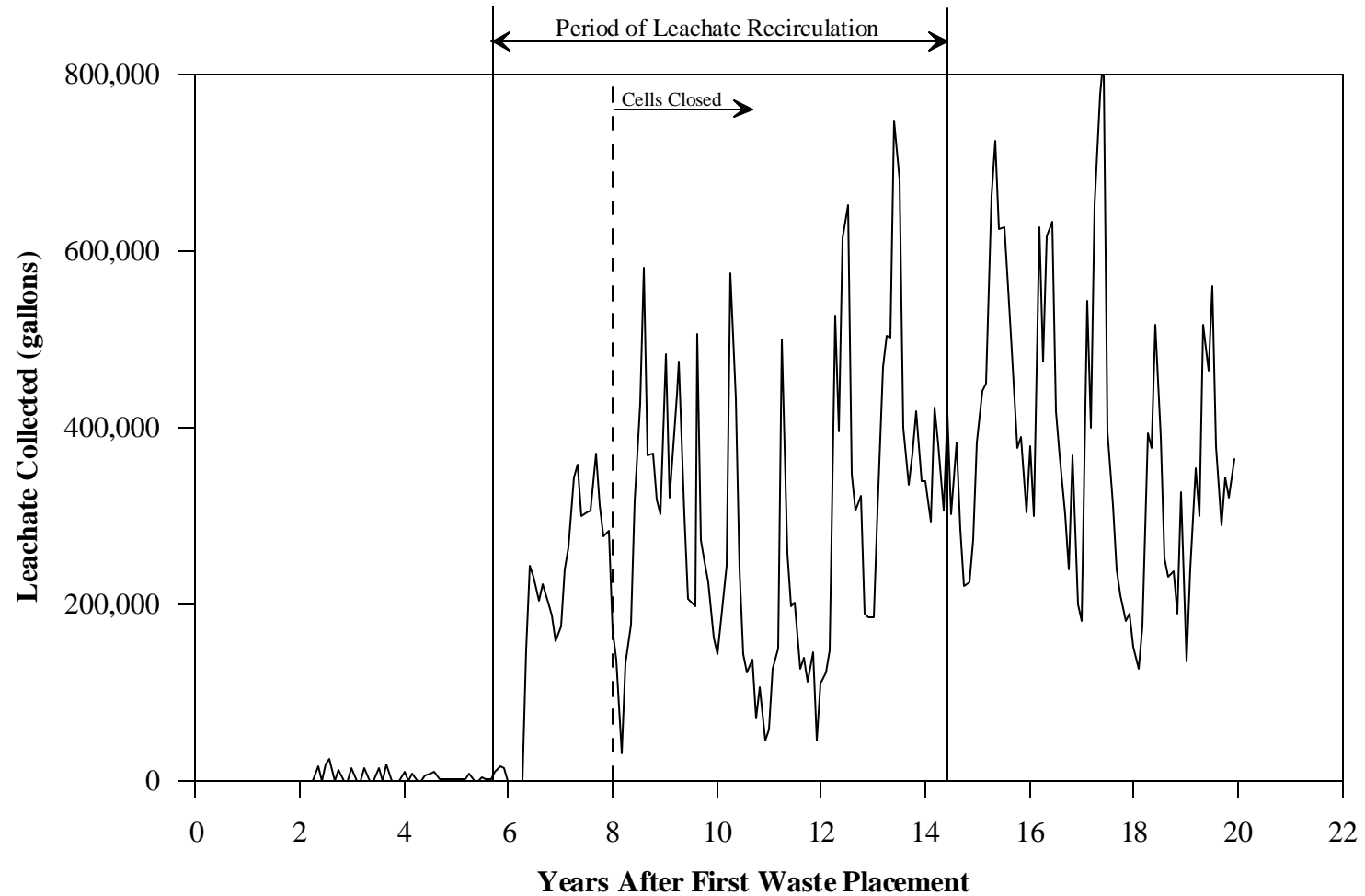


Area A/B

# Overview of Leachate Recirculation at Area A/B

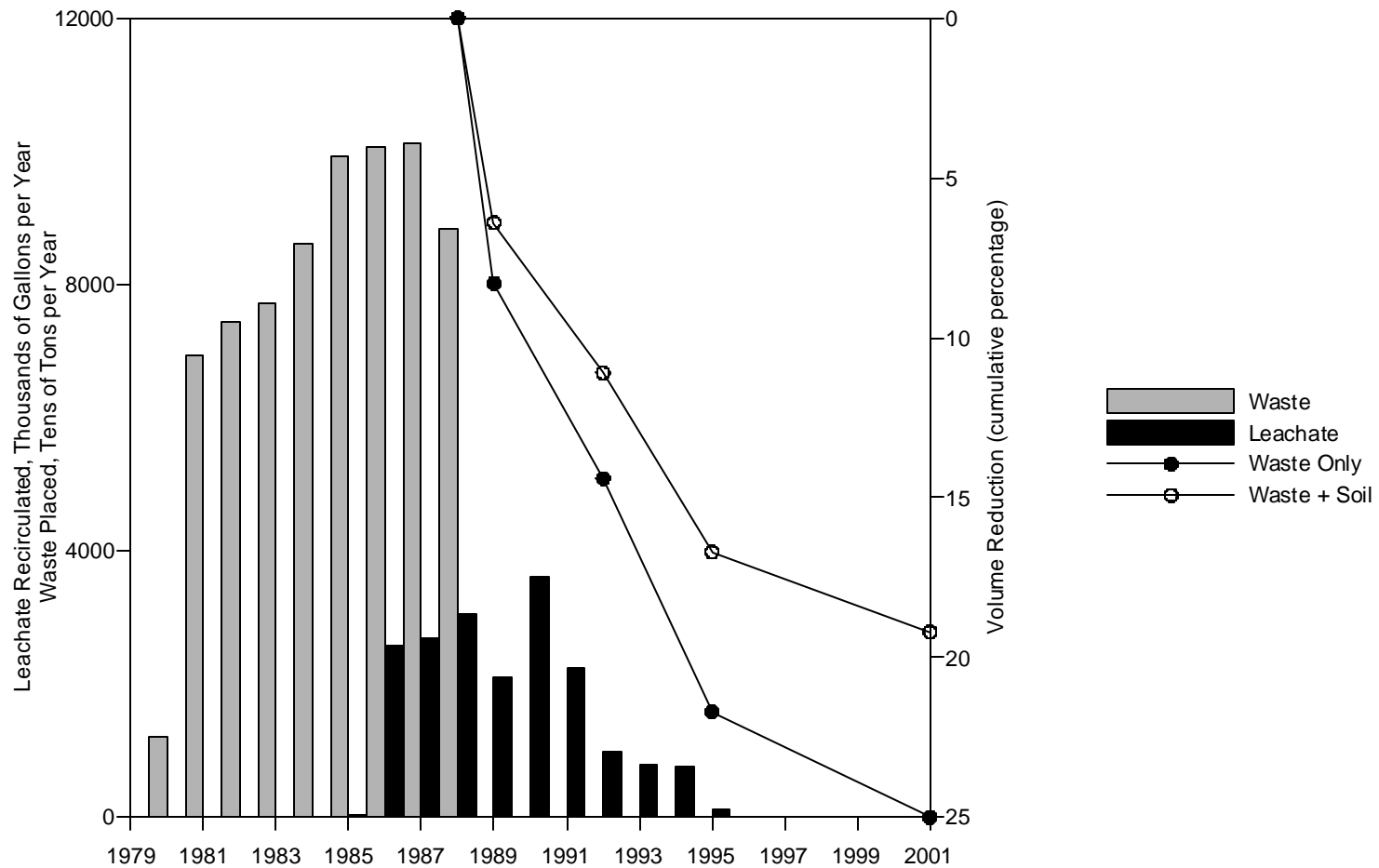
- Area A constructed in 1980 (9 acres); Area B constructed in 1982 (18 acres)
- Landfill closed in 1988. Volume details:
  - Waste disposed: 708,000 tons (approx. 1.30 million cubic yards)
  - Daily-Intermediate-Final cover: 389,000 cubic yards
  - Total Leachate Recirculated : 19 million gallons (15 gal/cy = 75 liters/m<sup>3</sup>)
- Leachate recirculated by vertical wells, leach fields, and spray irrigation.  
Application 1986 - 1995.

# Area A/B – Leachate Flow

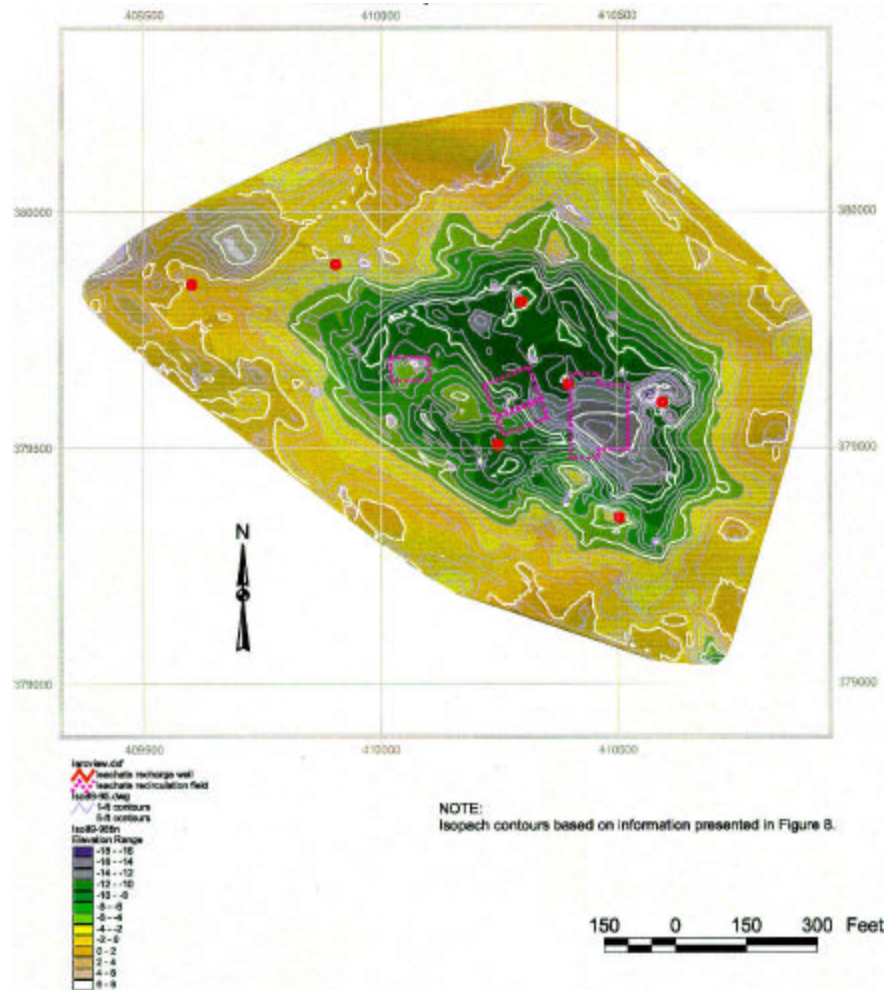




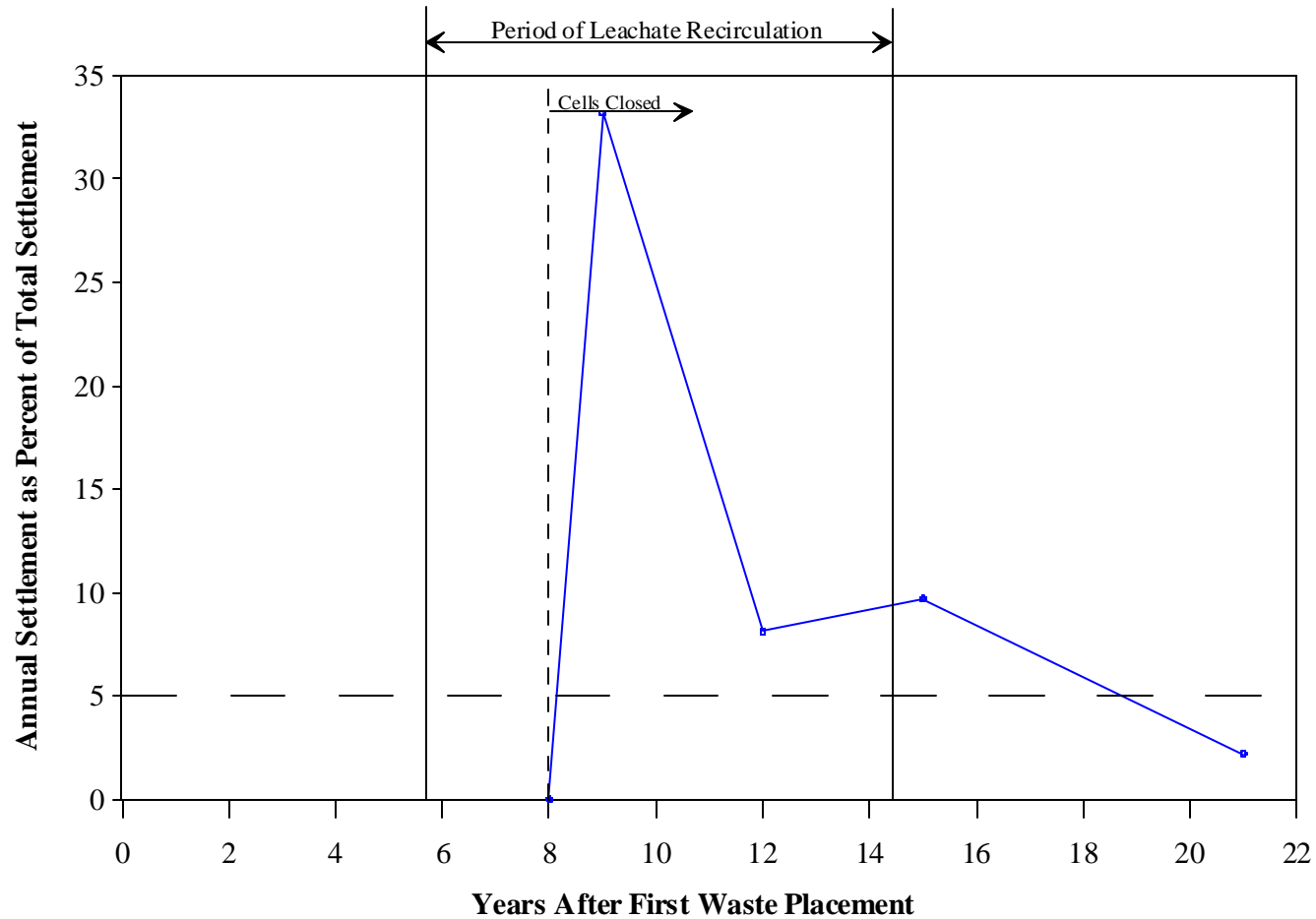
# Area A/B – Waste Placement and Leachate Recirculation



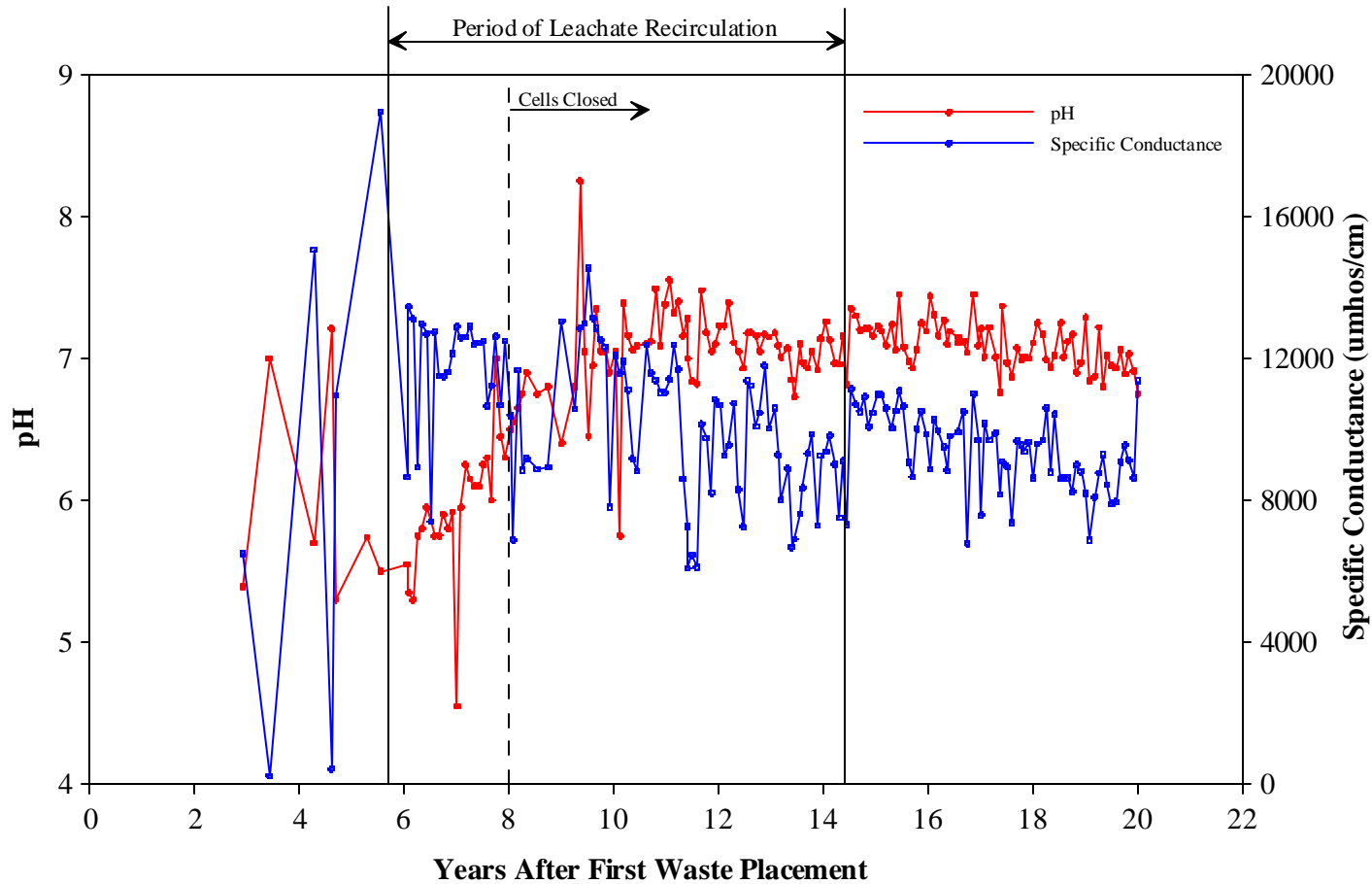
# Area A/B - Settlement Isopach



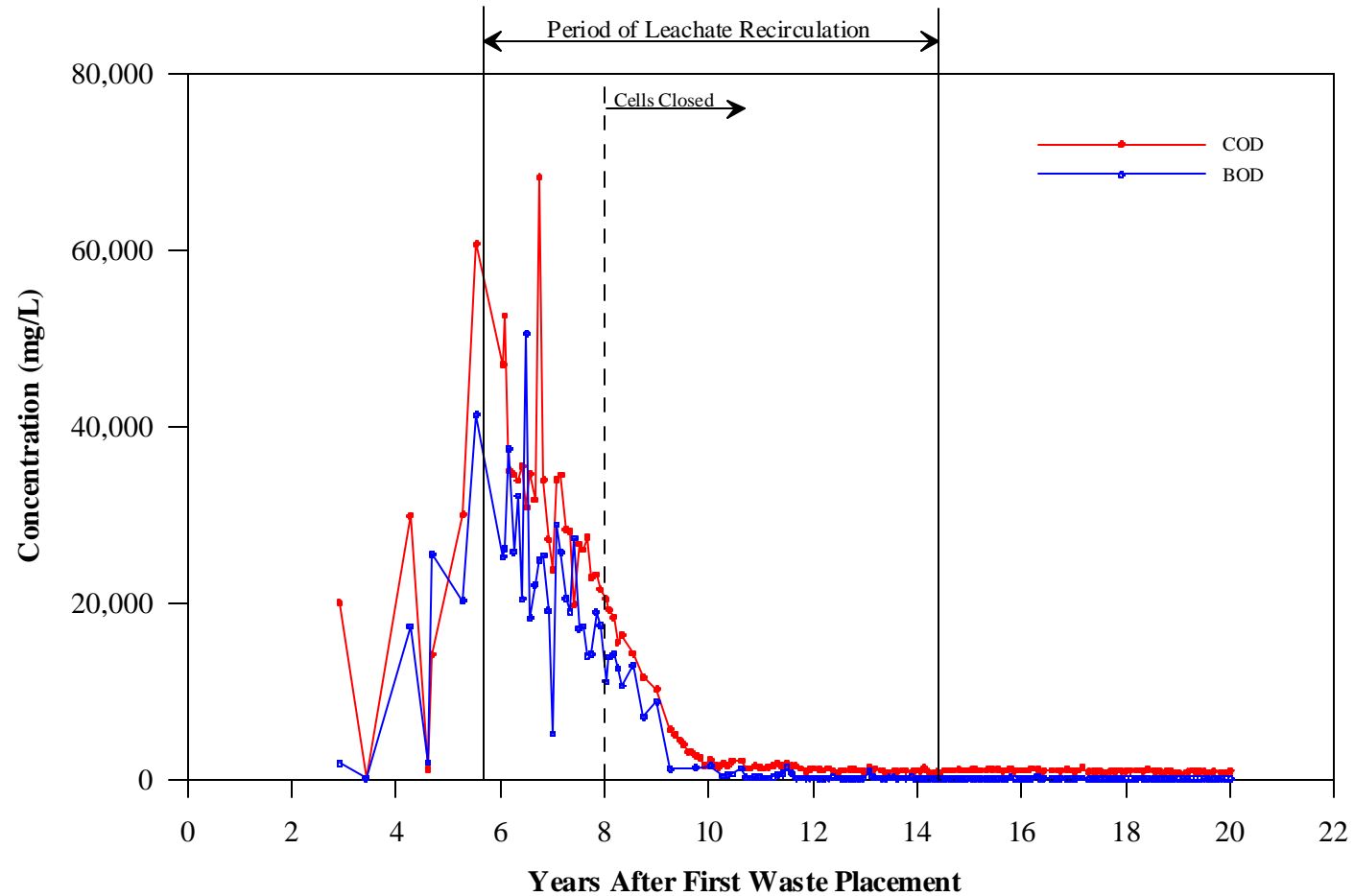
# Area A/B - Settlement



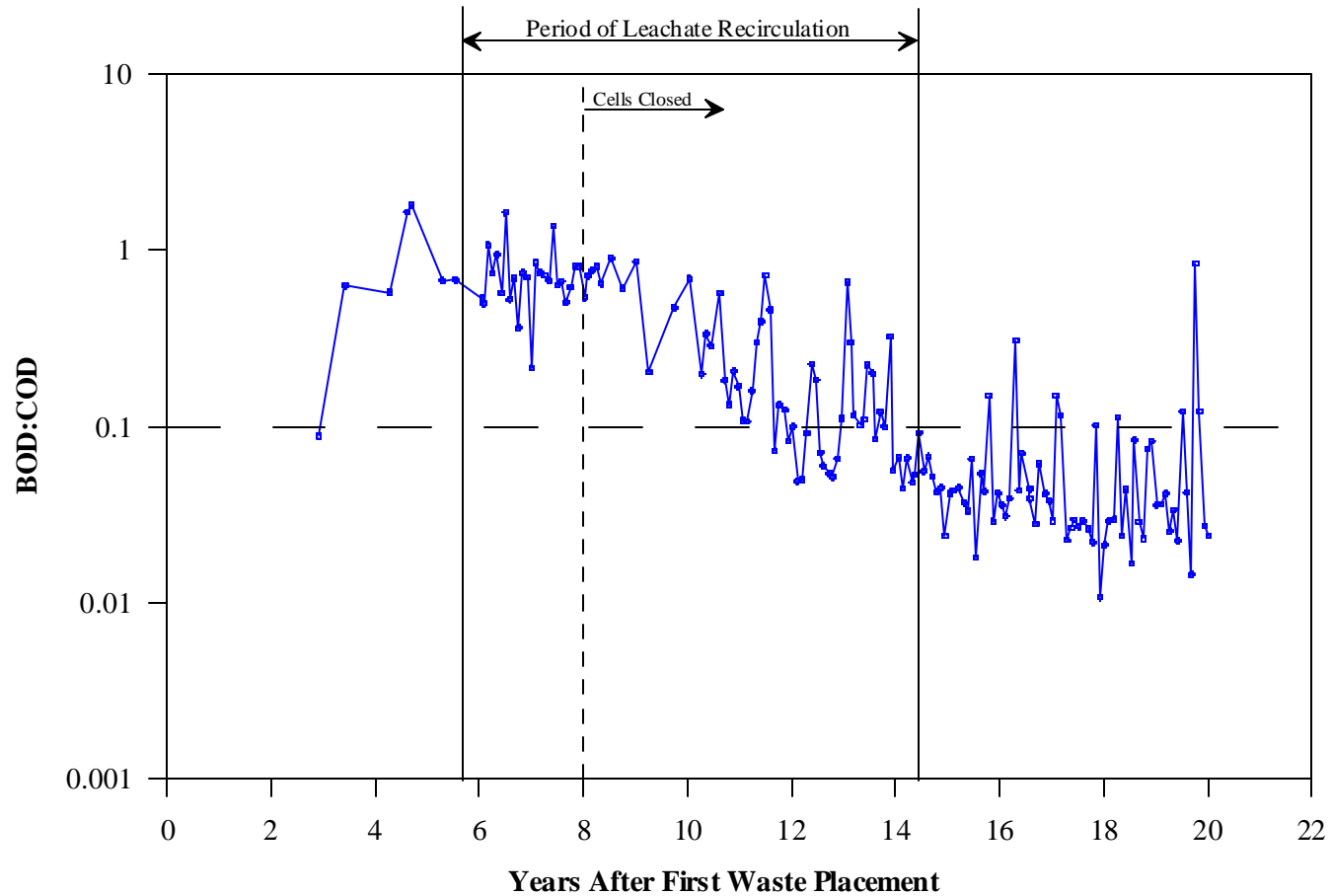
# Area A/B - pH & Conductivity



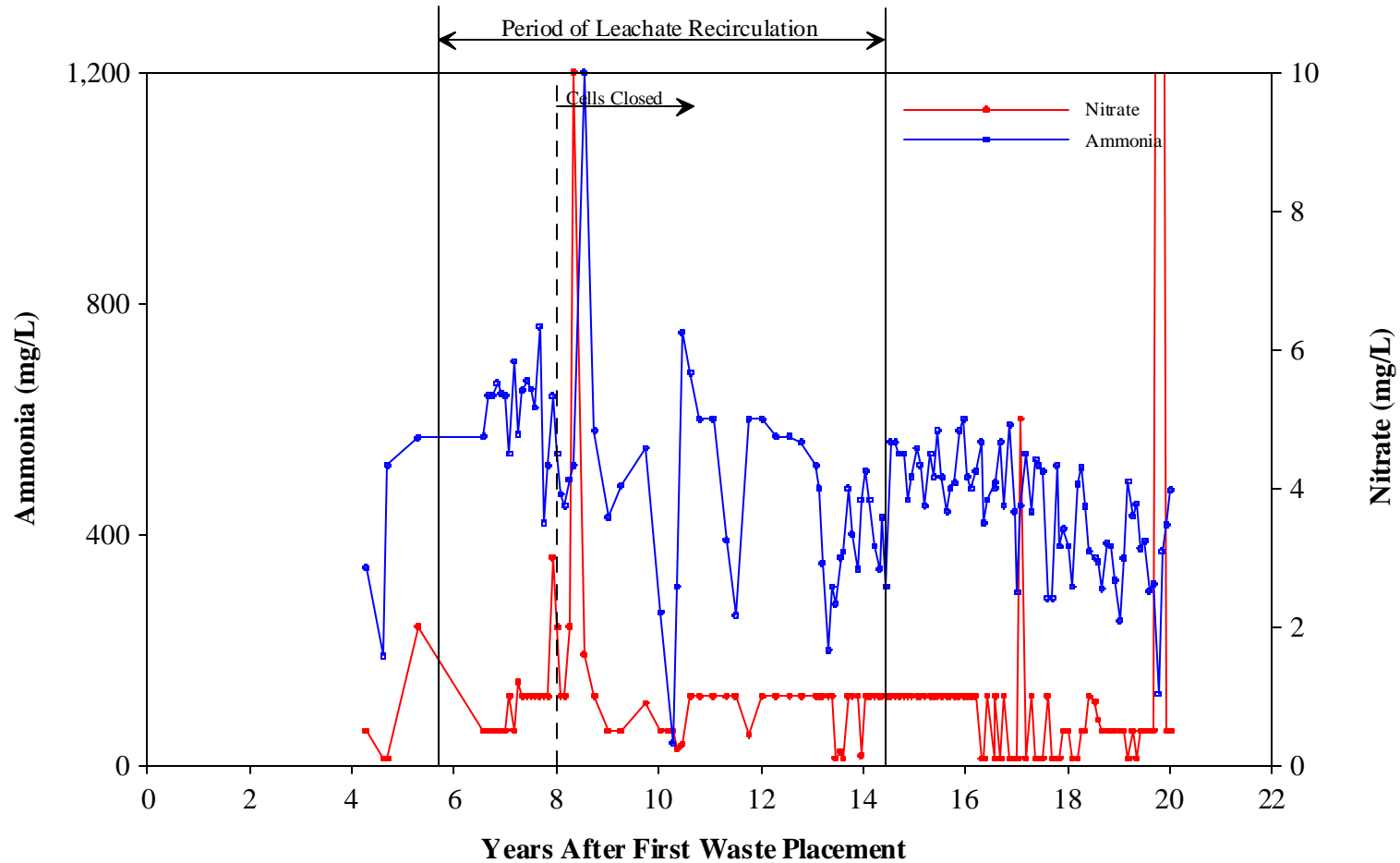
# Area A/B – COD & BOD



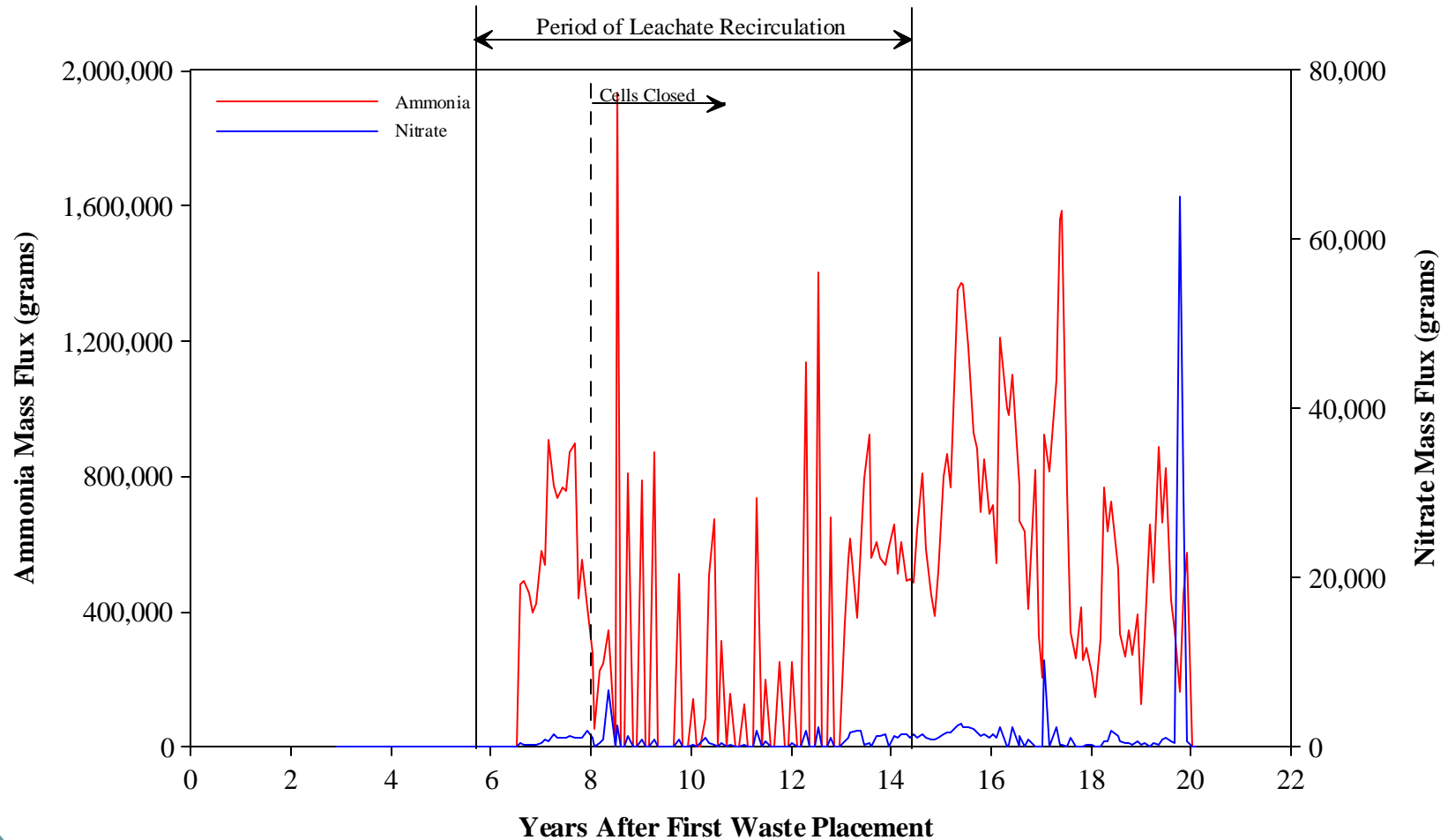
# Area A/B – BOD:COD Ratio



# Area A/B – Ammonia & Nitrate



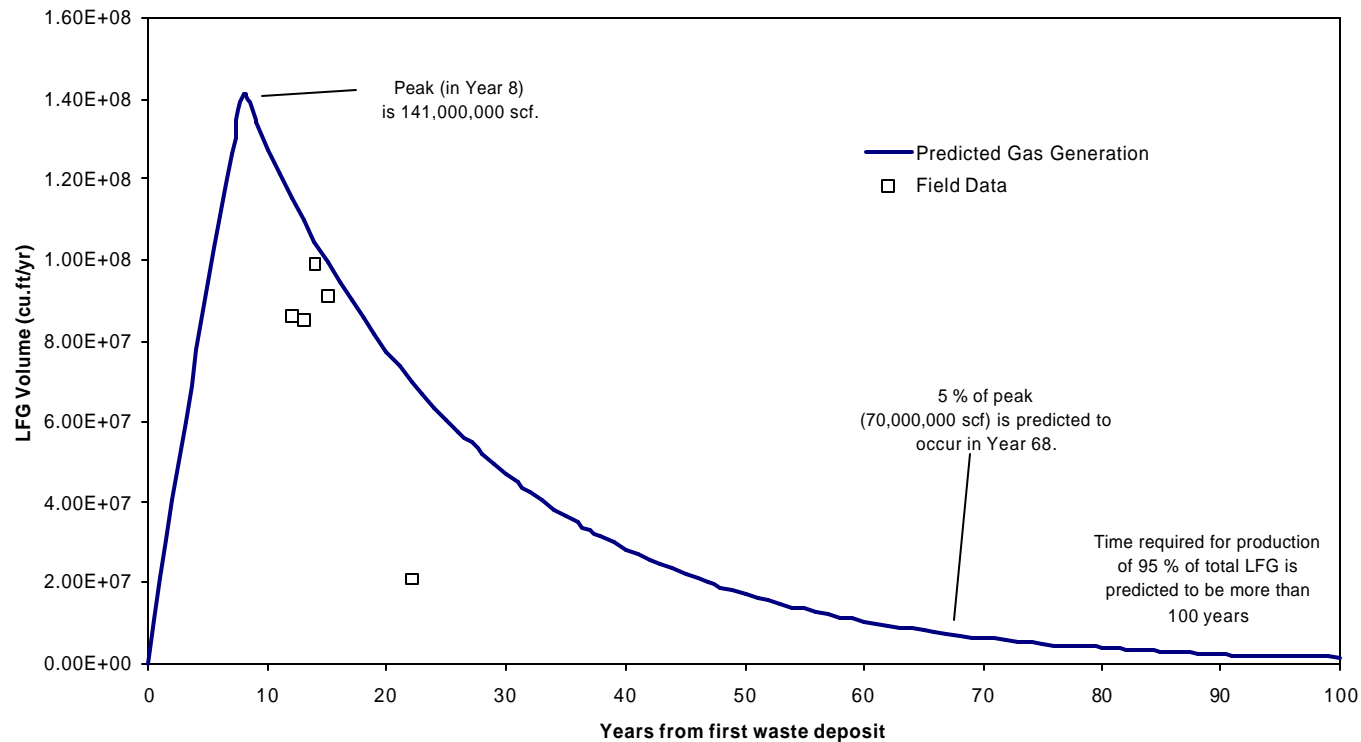
# Area A/B – Ammonia & Nitrate





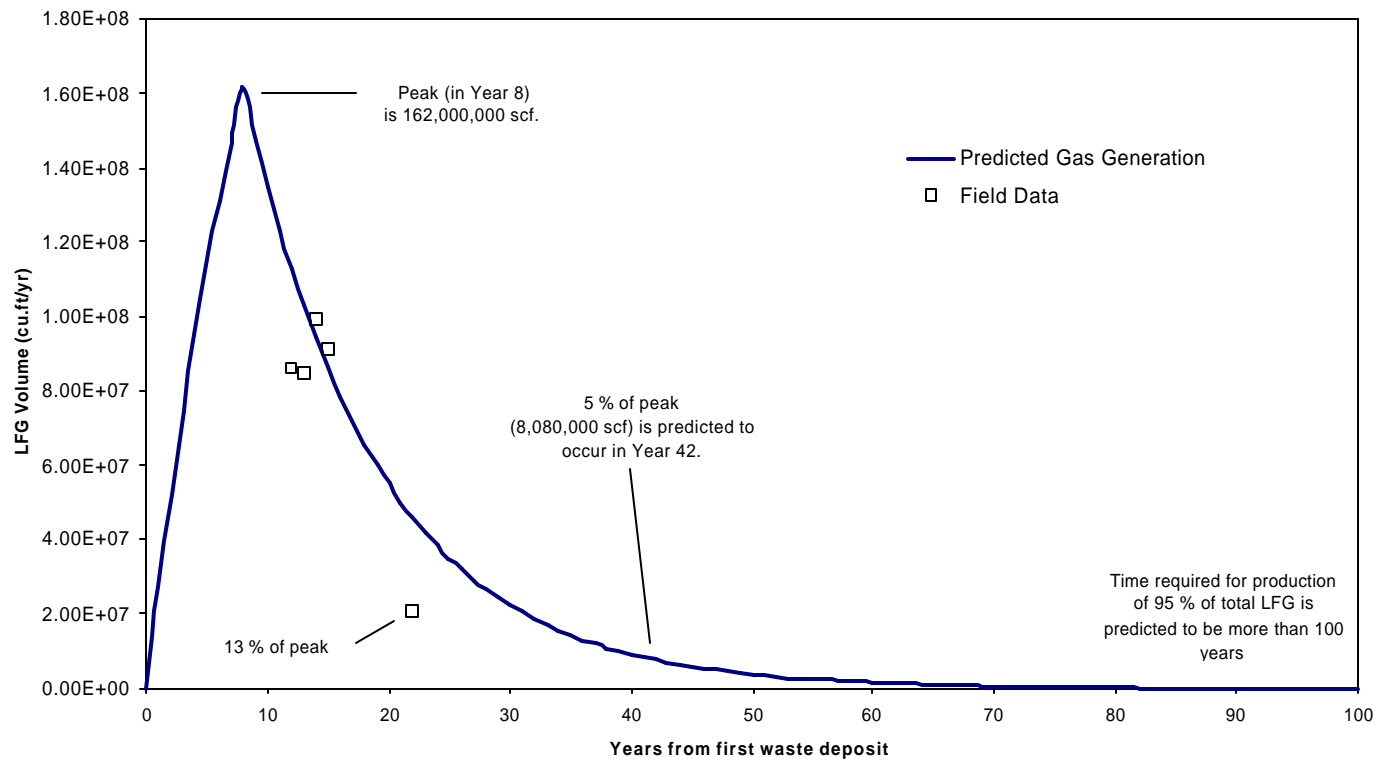
# Area A/B – Gas Generation (1)

Landfill Gas Generation ( $L_0 = 2.72 \text{ ft}^3/\text{lb}$ ,  $k = 0.05/\text{yr}$ )  
NSPS default values for  $L_0$  and  $k$



# Area A/B – Gas Generation (2)

**Landfill Gas Generation ( $L_0 = 2.0 \text{ ft}^3/\text{lb}$ ,  $k = 0.09/\text{yr}$ )**  
 $L_0$  from E-PLUS model,  $k$  closer to suggested values for bioreactors



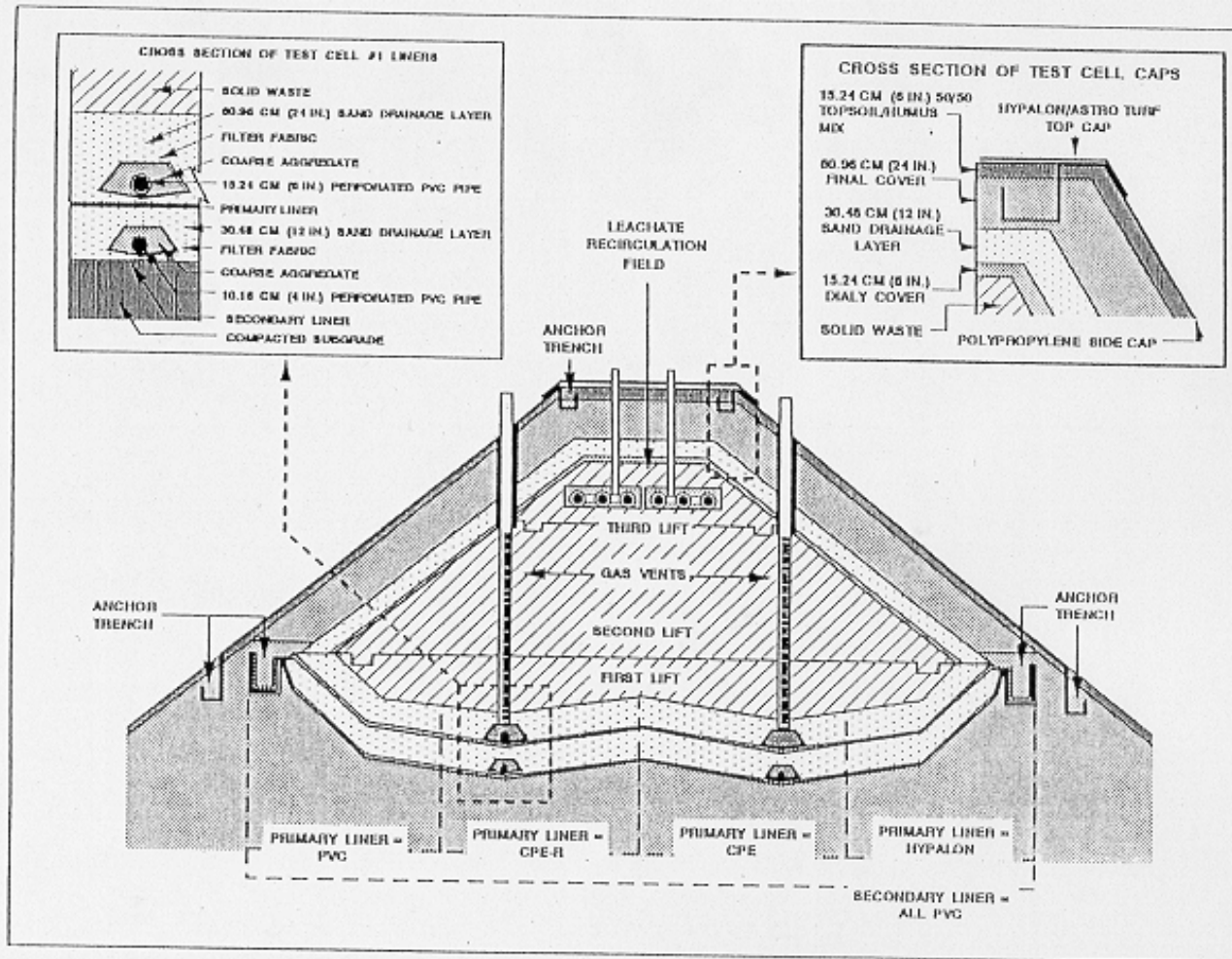
# Area A/B – Conclusions

- Leachate quality data compare favorably to published values for leachate from old landfills
  - No reducing trend for ammonia
  - Mass flux not reducing due to cap conditions
- LFG data indicates that generation is reducing and low
  - Nowhere near proposed stability criteria
- Rate of settlement is slowing and currently meets stability criterion

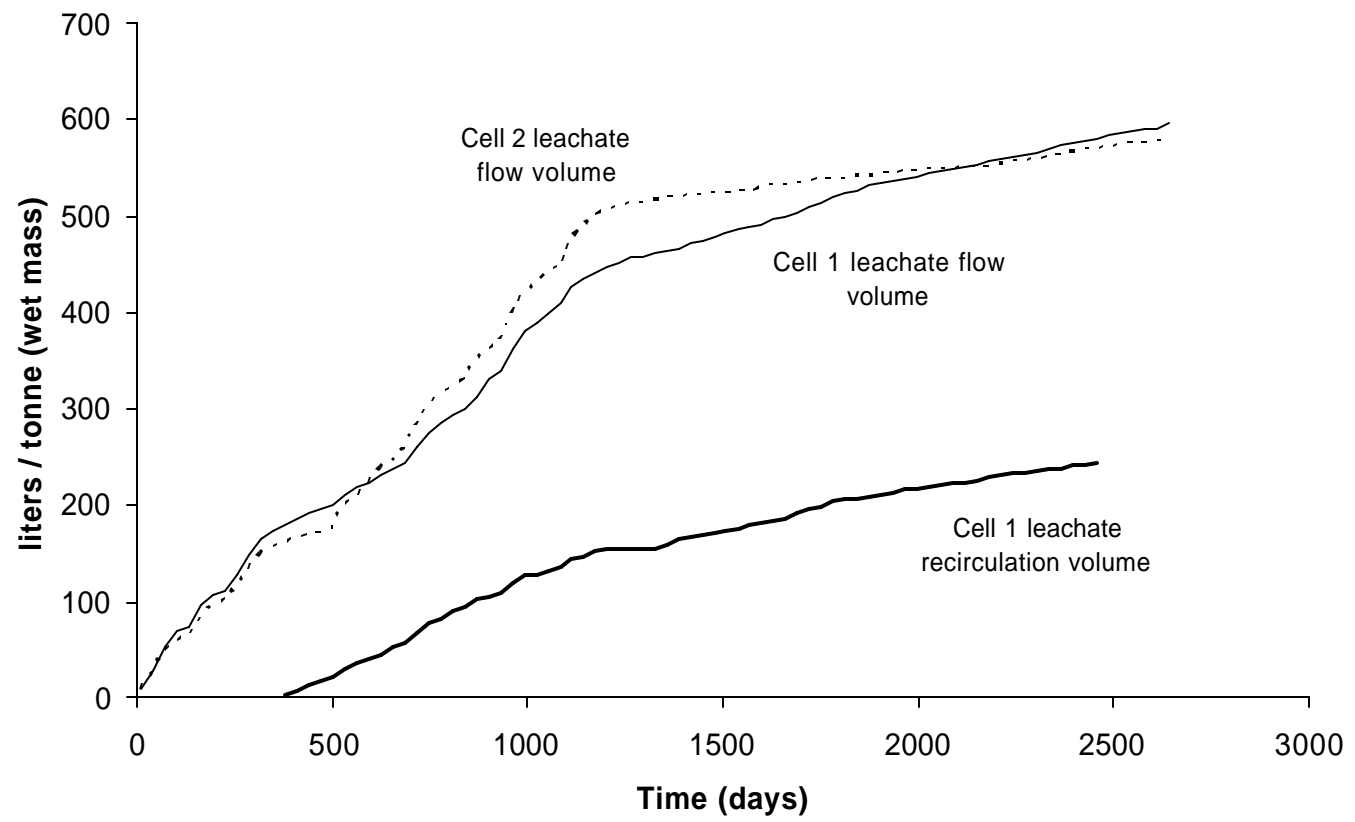


# Test Cells

# Test Cells – Cross Section



# Test Cells – Cumulative Leachate Flow Volumes

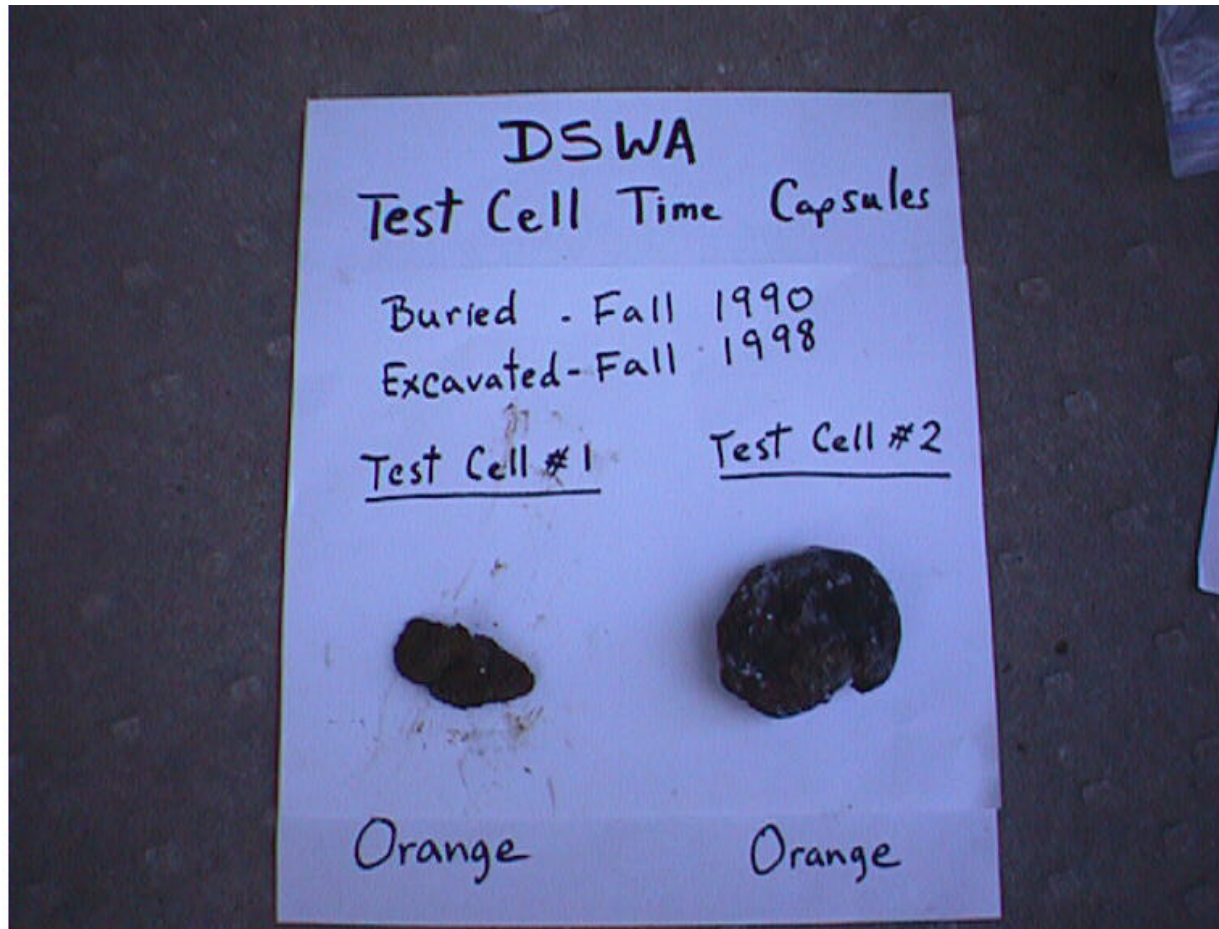


# Test Cells – Chicken Legs



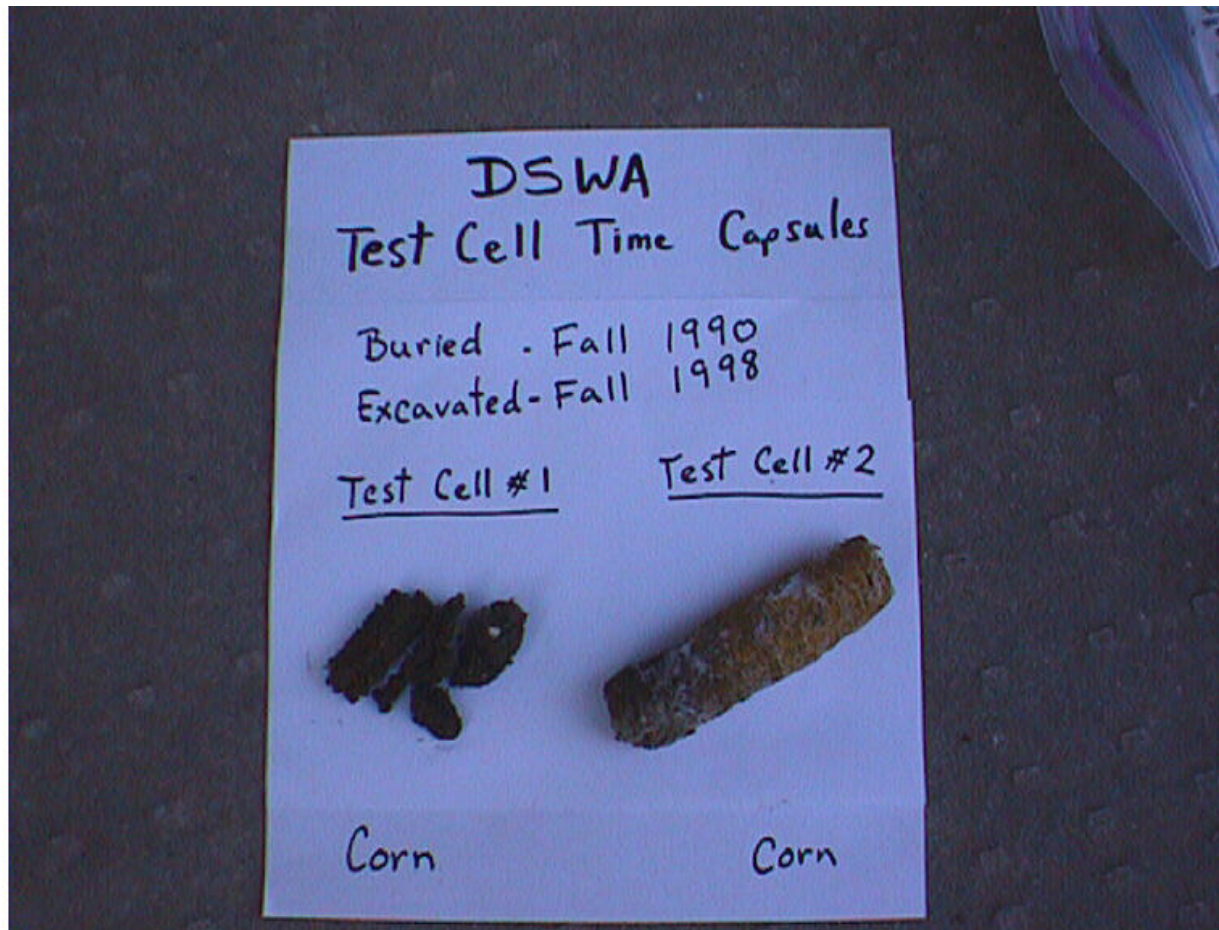


# Test Cells - Oranges

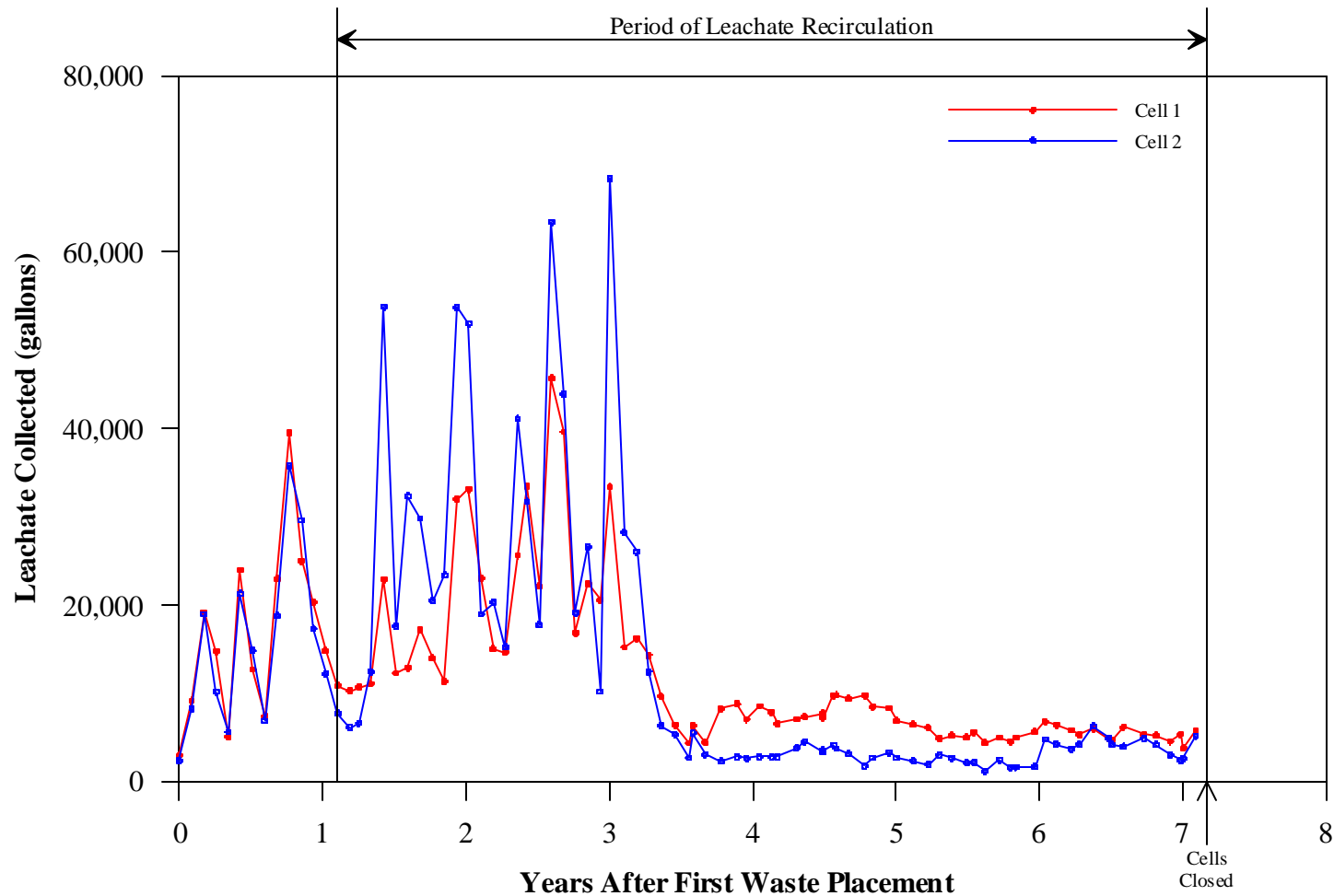




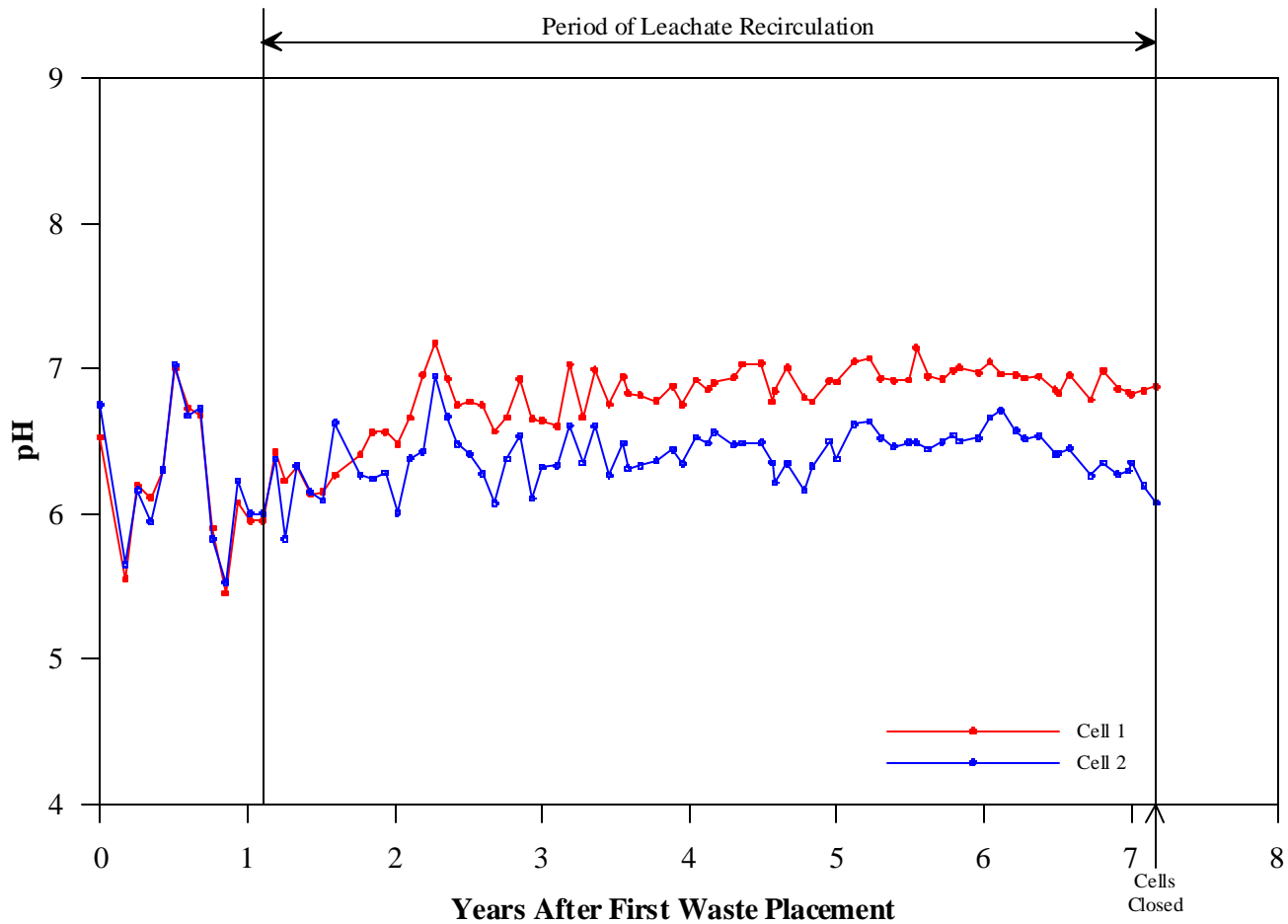
# Test Cells – Corn Cobs



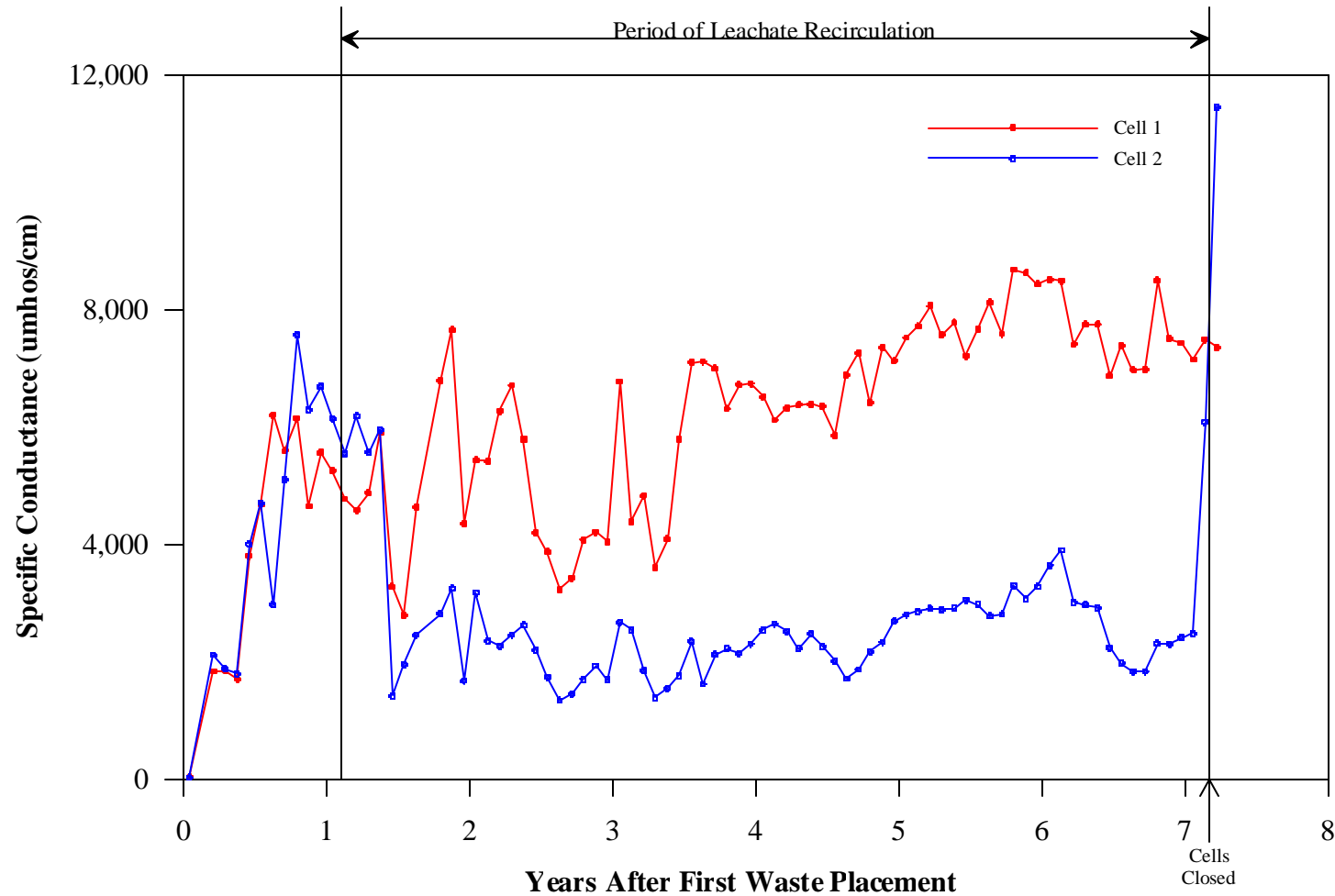
# Test Cells – Leachate Flow



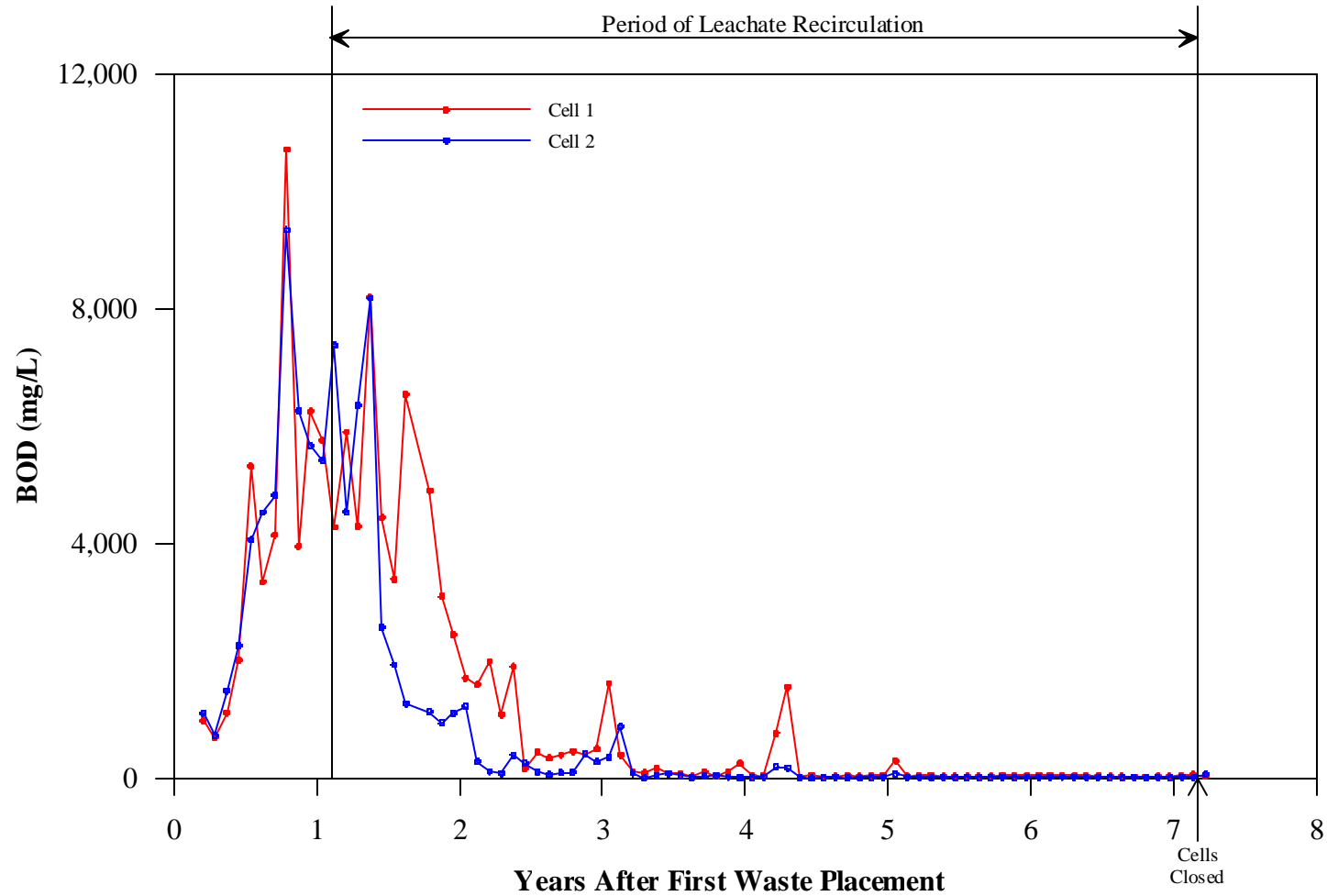
# Test Cells - pH



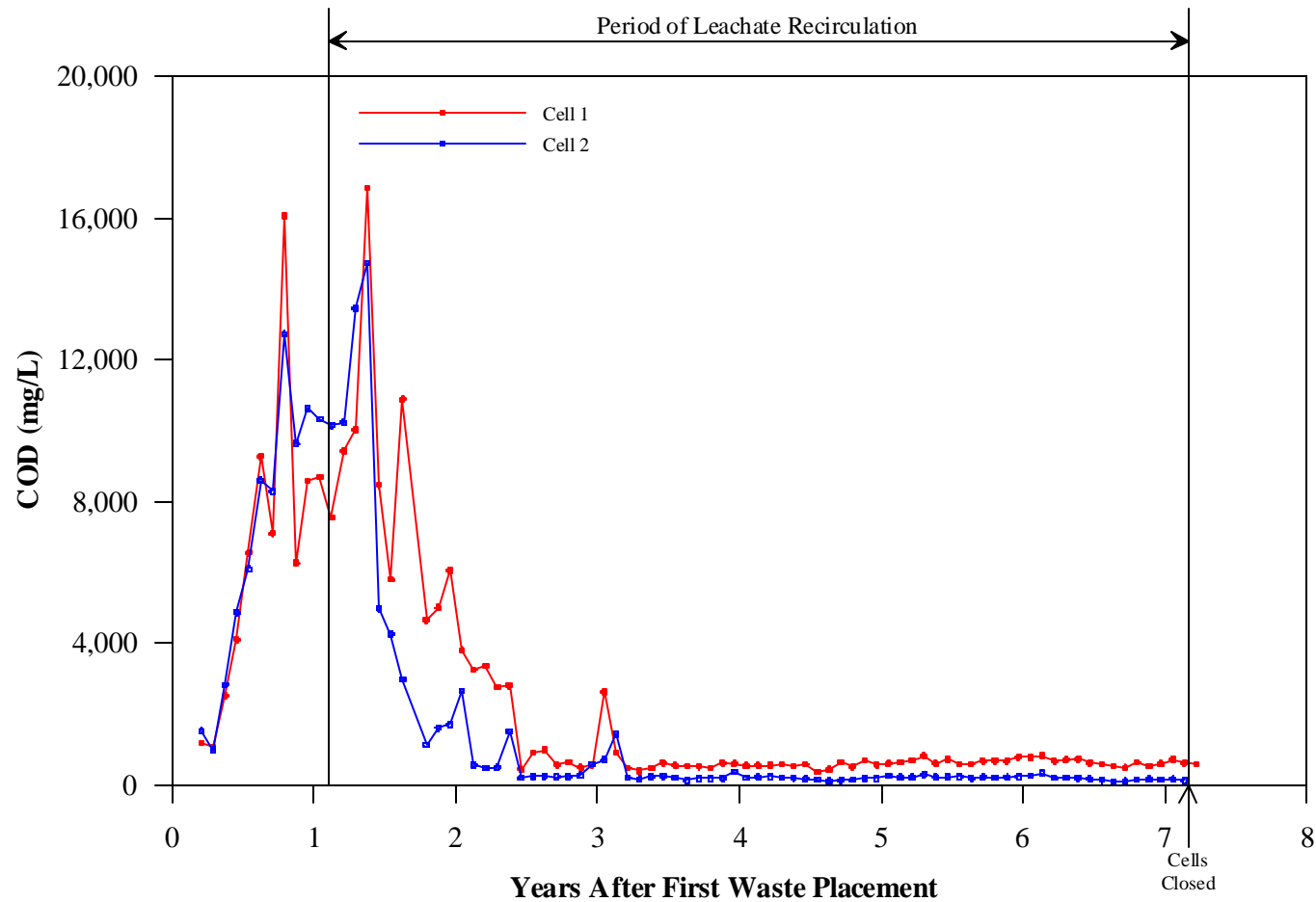
# Test Cells - Conductivity



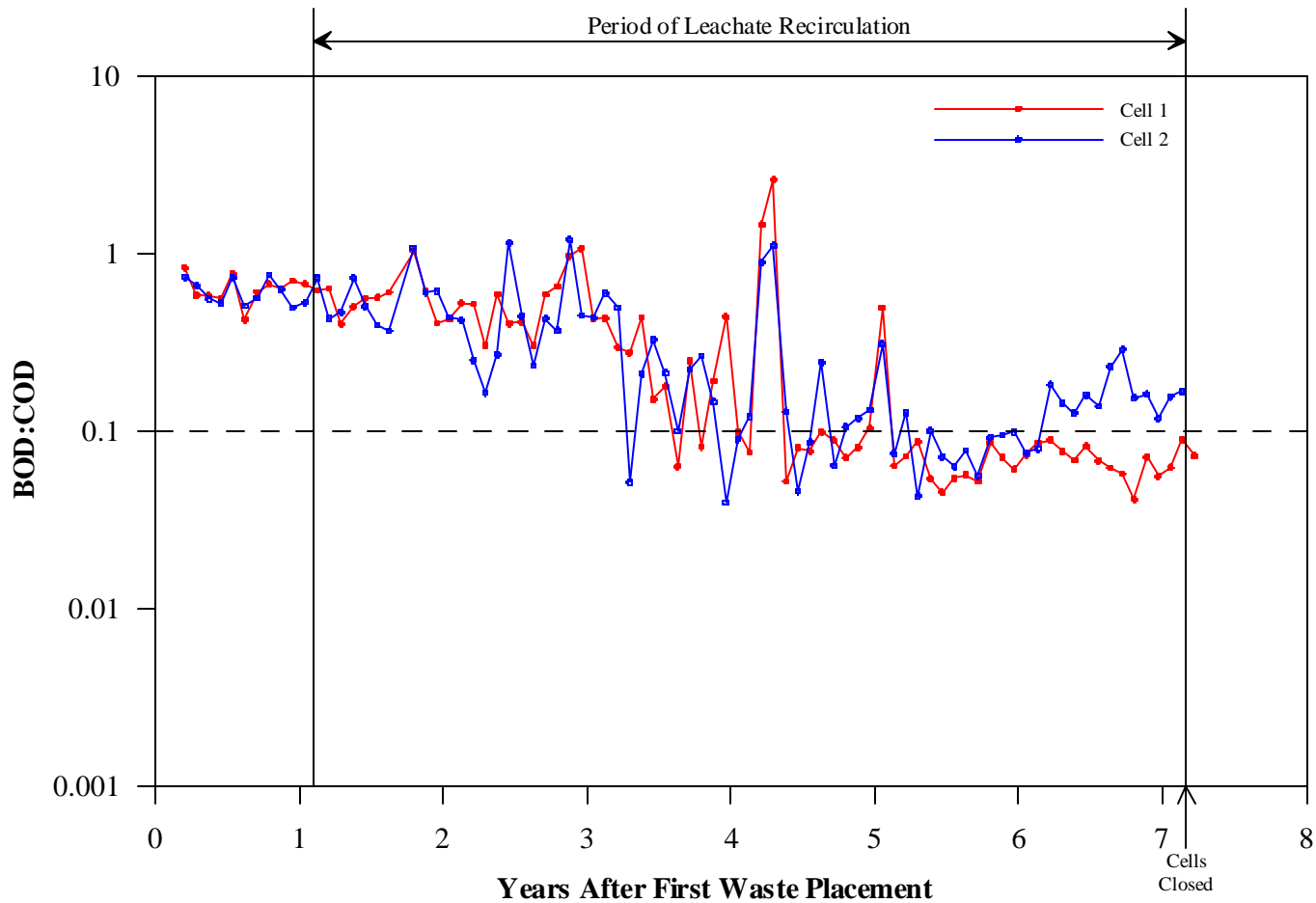
# Test Cells - BOD



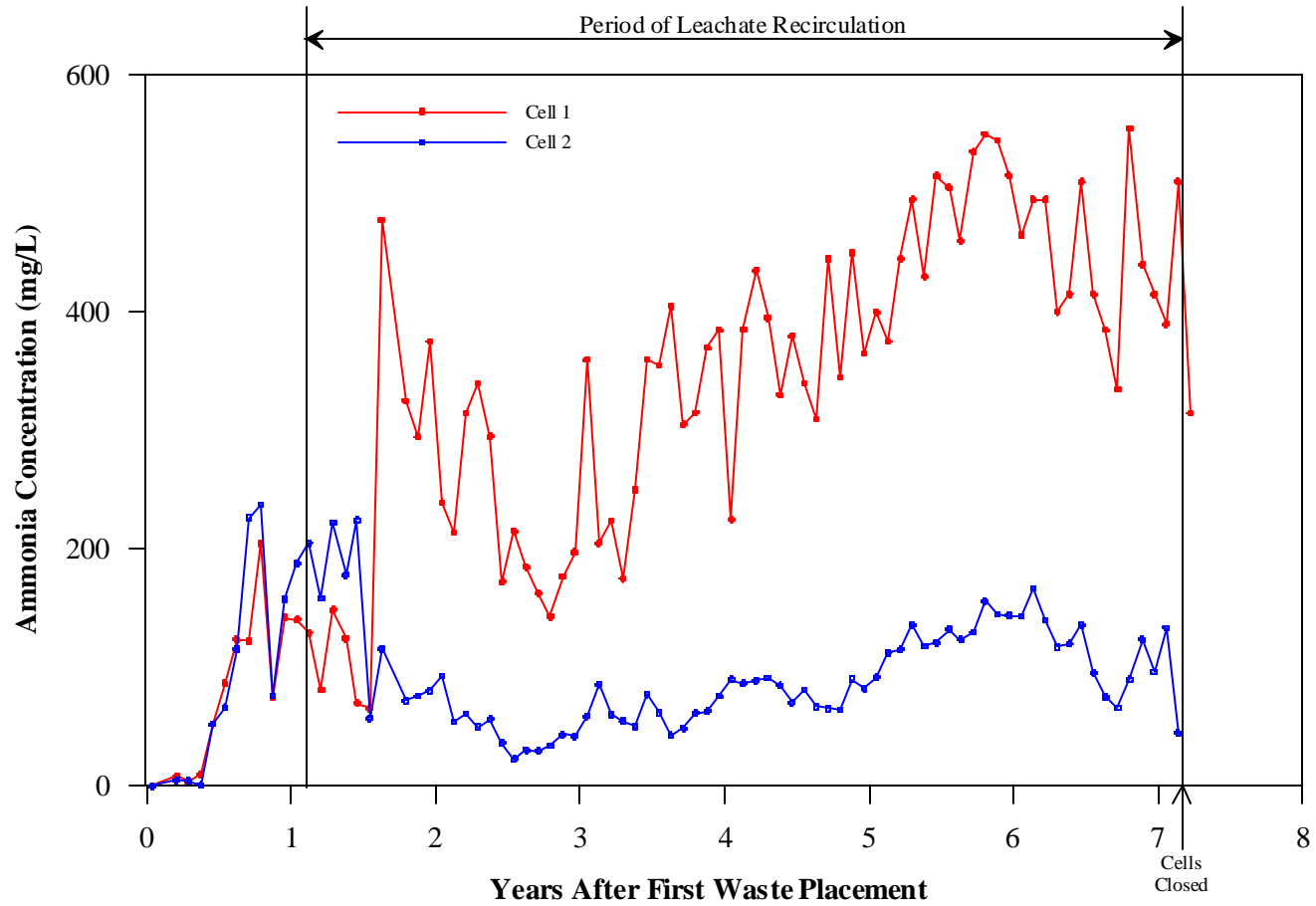
# Test Cells - COD



# Test Cells – BOD:COD Ratio

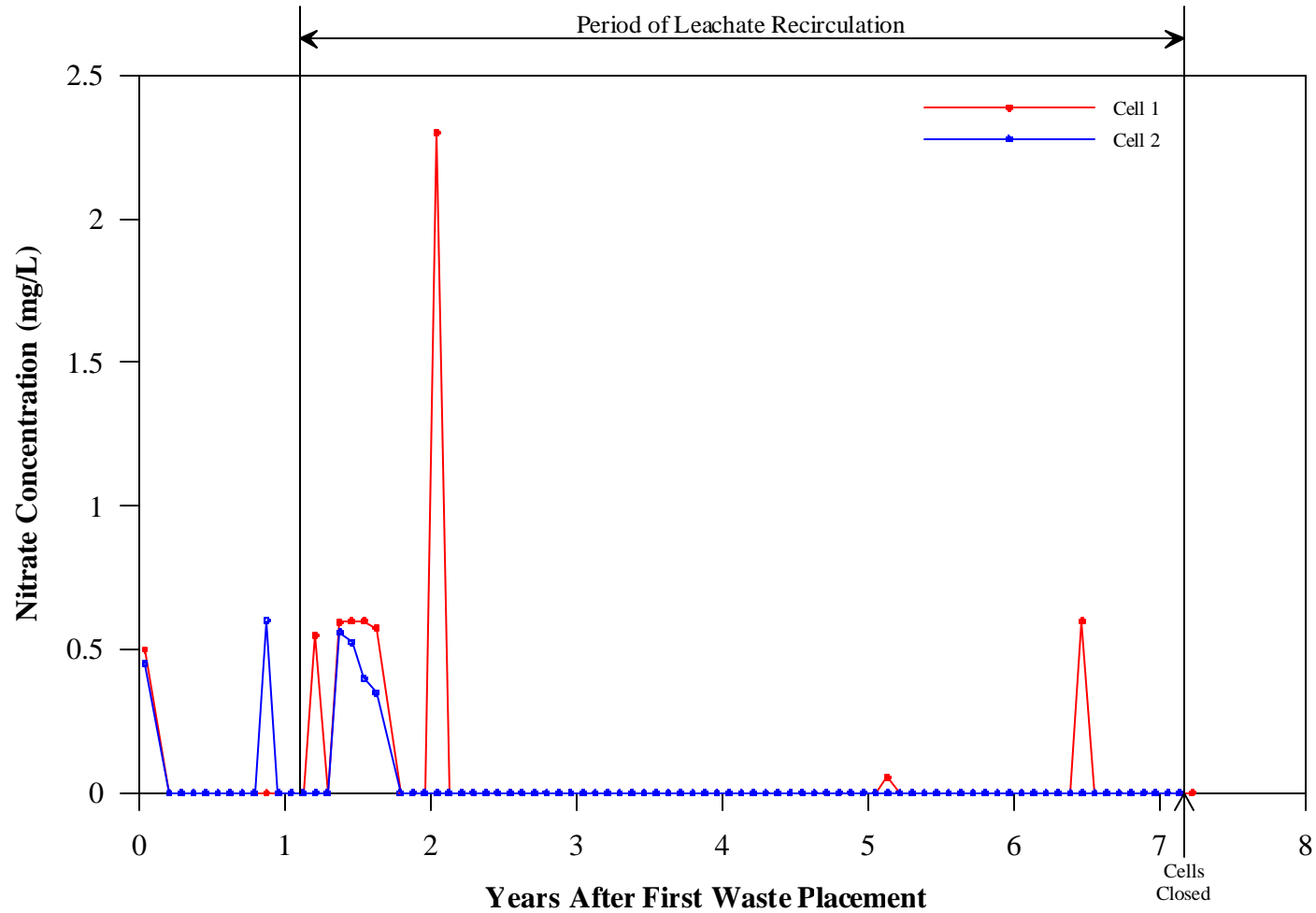


# Test Cells - Ammonia

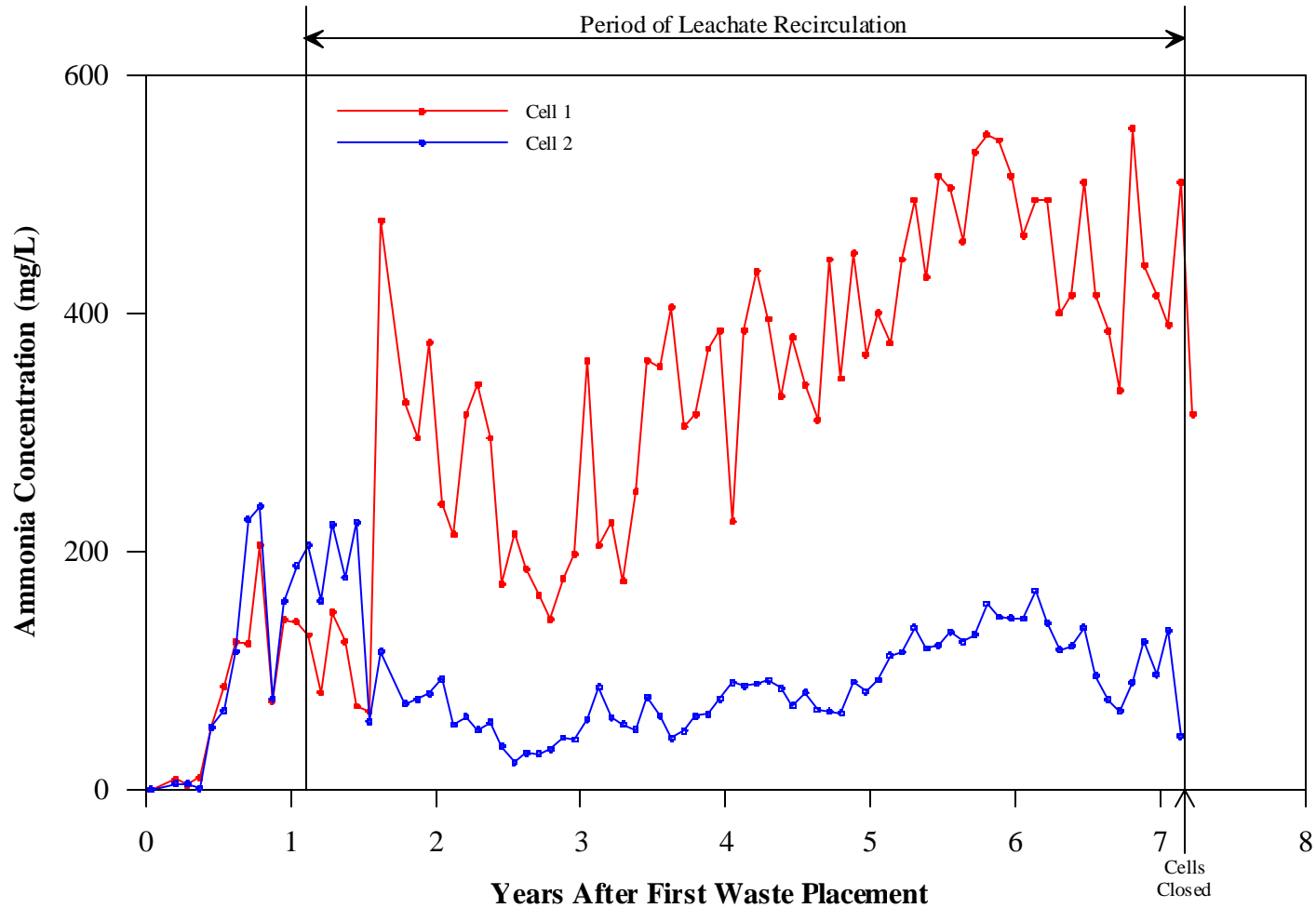




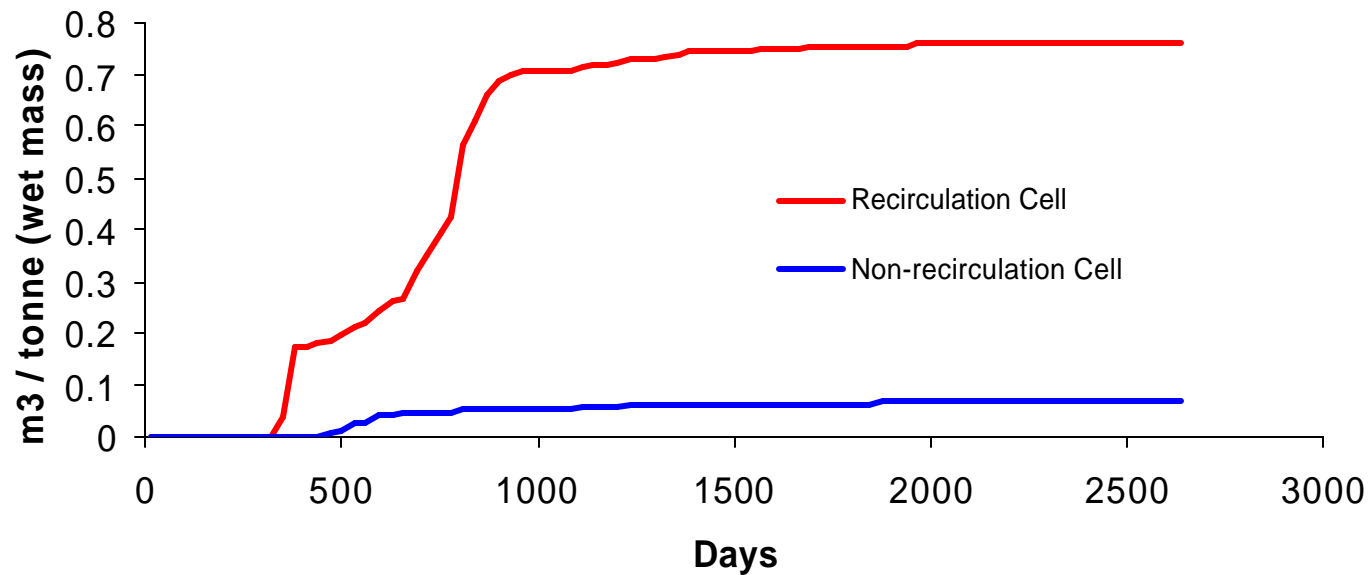
# Test Cells - Nitrate



# Test Cells - Ammonia



# Test Cells – Cumulative Gas Production Volumes



# Test Cells – Conclusions

- Time capsule study demonstrated significant differences in state of waste degradation
- Leachate quality data was not significantly different between the cells (except ammonia)
  - No reducing trend for ammonia
  - pH, BOD/COD slightly better in Cell 1
- LFG generation was 10x greater in Cell 1
  - Overall generation very low in both cells
  - Nowhere near proposed stability criteria
- Efficiency of recirculation in Cell 1 was poor
  - Preferential flow

# Suggestions for Further Research

- Hard to meet many proposed stability criteria directly
  - Need to look at mass flux of contaminants such as ammonia in leachate rather than concentrations
  - Long-term control/reduction of leachate flow will be important
  - Move towards a risk-based or performance-based approach
- Investigation of preferential flow mechanisms in full-scale leachate recirculation landfills
  - How to minimize?

# Thank-you

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# Area A/B – Leachate Quality

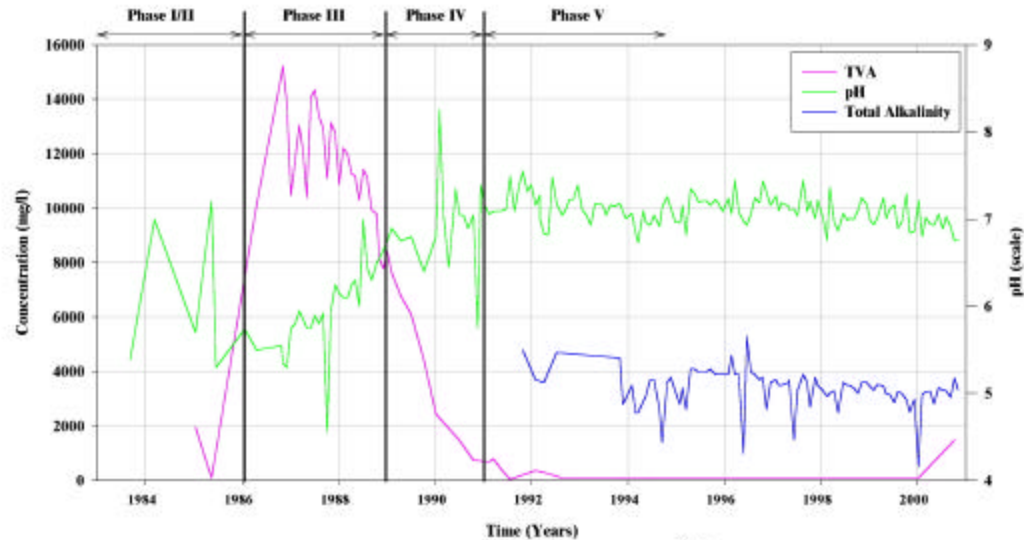
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Figure 4

## LEACHATE QUALITY SUMMARY, TVA, pH, AND TOTAL ALKALINITY

Evaluation of Historical Data at Leachate Recirculating Landfills  
Area A/B Disposal Cells, Central Solid Waste Management Center

Sandtown, Delaware



Note:  
Phase designation references the phases of waste degradation presented in Figure 2, after Pohlund and Harper, 1986.

# Area A/B – Leachate Quality

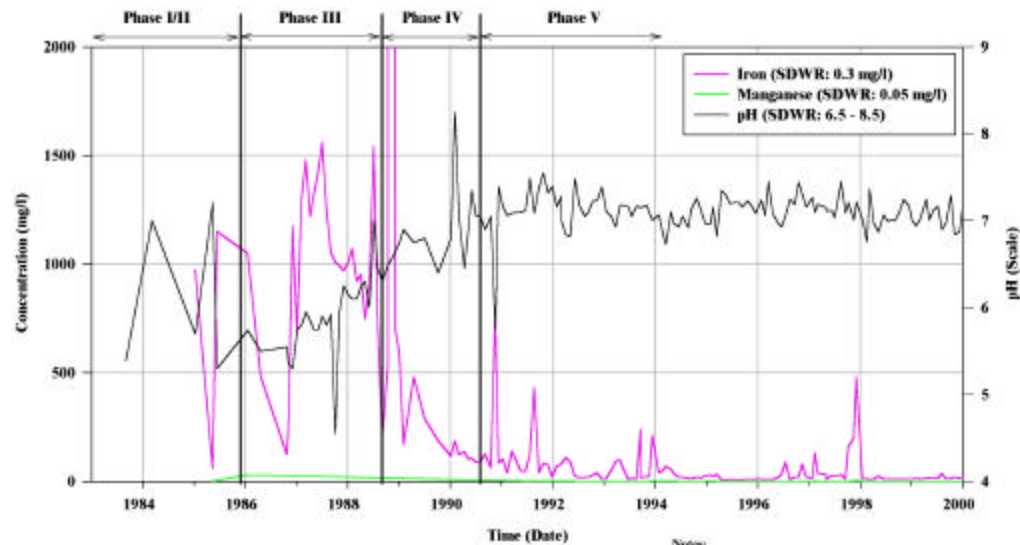
Figure 10

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## LEACHATE QUALITY SUMMARY, IRON, MANGANESE, AND pH

Evaluation of Historical Data at Leachate Recirculating Landfills  
Area A/B Disposal Cells, Central Solid Waste Management Center

Sandtown, Delaware



Notes:

1. Phase designation references the phases of waste degradation presented in Figure 7, after Pothland and Harper, 1986.
2. SDWR: Secondary Drinking Water Regulation.

MR14-08LEACHATE.DATL.NR



# Area A/B – Leachate Quality

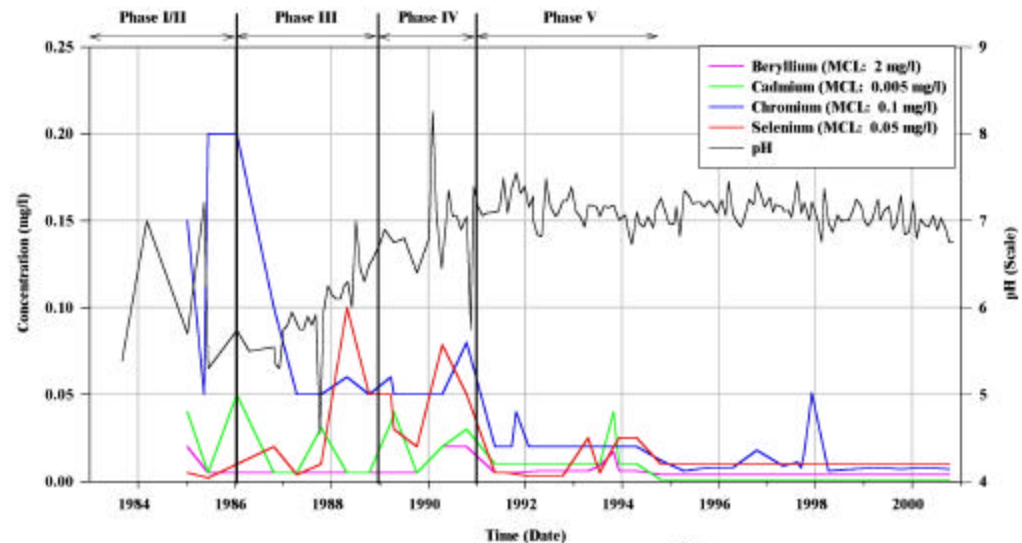
Figure 9

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## LEACHATE QUALITY SUMMARY, BERYLLIUM, CADMIUM, CHROMIUM, SELENIUM, AND pH

Evaluation of Historical Data at Leachate Recirculating Landfills  
Area A/B Disposal Cells, Central Solid Waste Management Center

Sandtown, Delaware



Note:  
Phase designation references the phases of waste  
degradation presented in Figure 2, after Poldoski and Harper, 1986.



# Area A/B – Leachate Quality

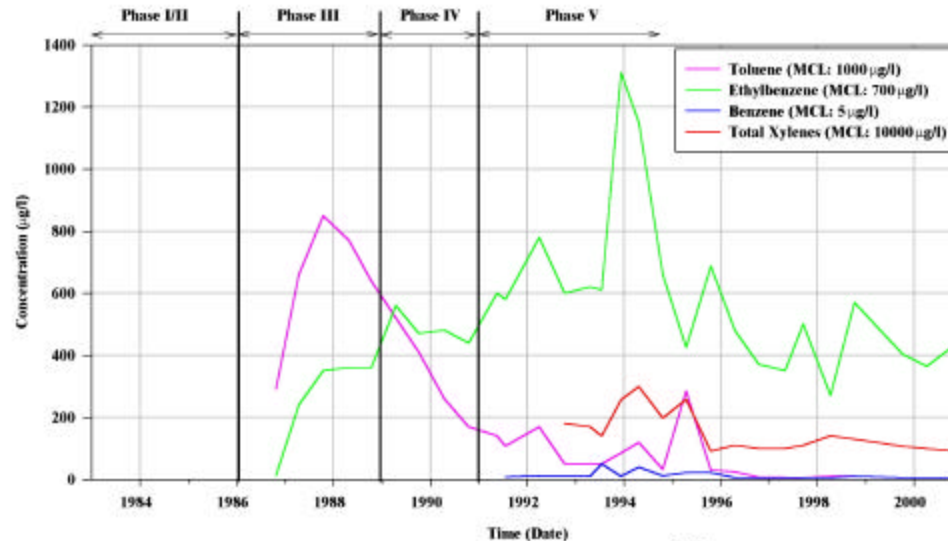
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Figure 13

## LEACHATE QUALITY SUMMARY, BTEX

Evaluation of Historical Data at Leachate Recirculating Landfills  
Area A/B Disposal Cells, Central Solid Waste Management Center

Sandtown, Delaware



Note:  
Phase designation references the phases of waste  
degradation presented in Figure 2, after Peltard and Harper, 1986.