Waste Management's Experience with ACAP and Phytoremediation

John Baker- Director New Technologies

WASTE MANAGEMENT

WM's ACAP and Phytoremediation Projects

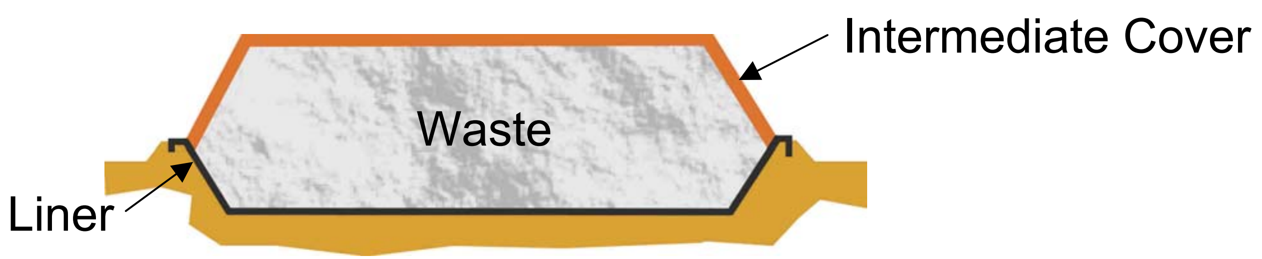
- Co-funded 2 ACAP projects- Altamont, CA and Douglas Co. LF, NB
- Numerous ET caps in Sub D, Closed, and NPL sites in CO, PA, TX, OK, FL
- Poplar Trees for Groundwater Control and Riparian Buffer
- Wetlands for leachate and stormwater treatment/mitigation

ITRC Team-ACAP Guidance

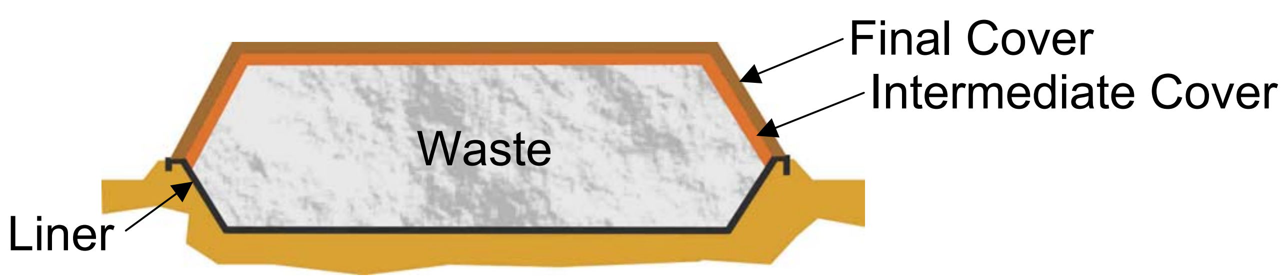
- Alternate Cap includes evaluation of landfill unit and allows controlled infiltration to the degree owner wants to manage
- Evaluate leachate generation rates and quality
- Evaluate existing/potential for groundwater contamination

LCRS OPERATION STAGES

Initial Period of Operation



Active Period of Operation



Post-Closure Period

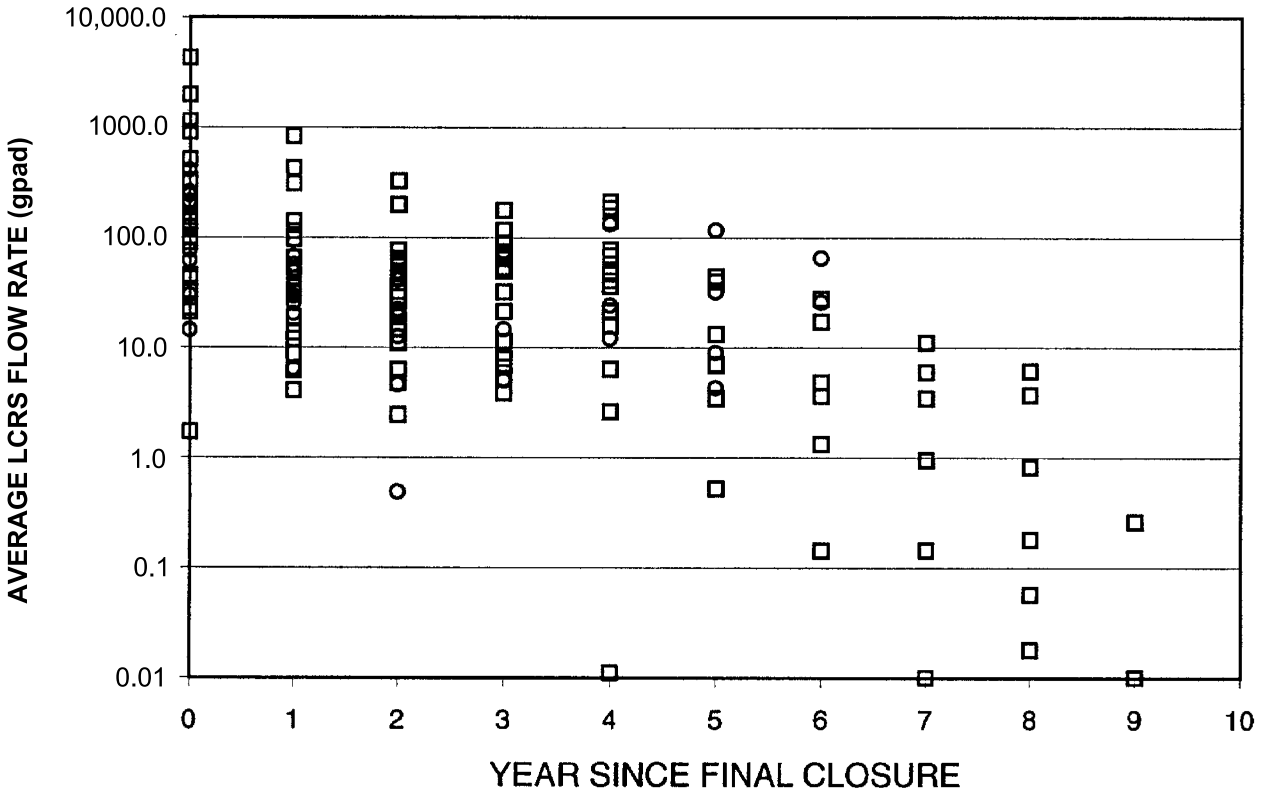
MSW LEACHATE GENERATION RATES (gal/acre/day)

	NE	SE	W
Initial period of operation	105 - 3,990 (1,000)	148 - 4,370 (1,000)	-
Active period of operation	4 - 1,770 (350)	30 - 1,090 (290)	5 - 10 (8)
Post-closure period	5 - 68 (40)	-	-

Notes: Rates represent range of total monthly flow average over entire period of interest. Values in ( ) represent average (mean) flow for all facilities in the data set.

WM WASTE MANAGEMENT

4. LEAKAGE THROUGH LANDFILL COVER SYSTEMS



Average LCRS flow rates (lhd) after closure for eleven MSW cells (shown as circles)and 22 HSW cells (shown as squares)

Note: gpad = gal/acre/day

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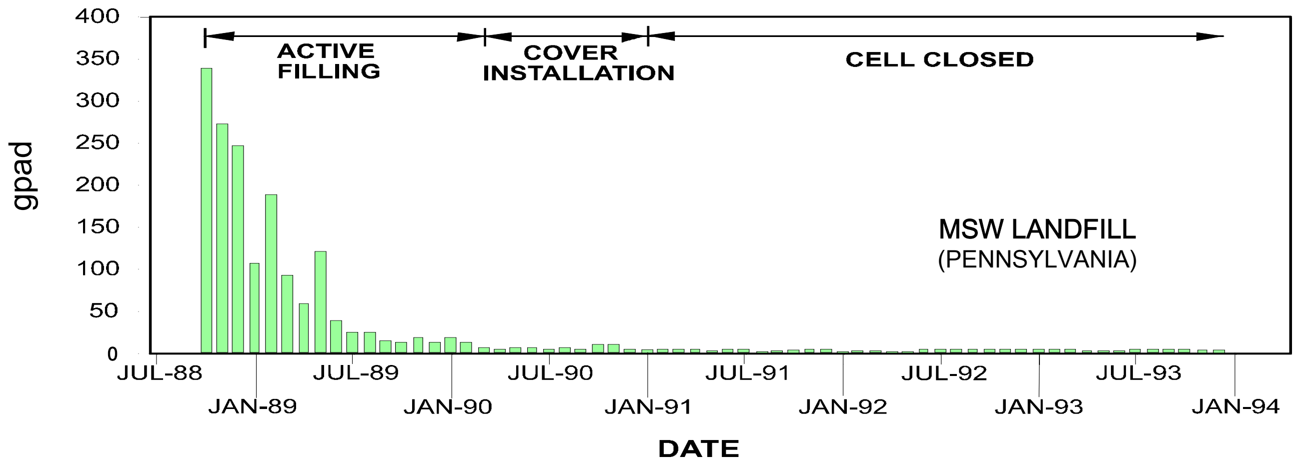
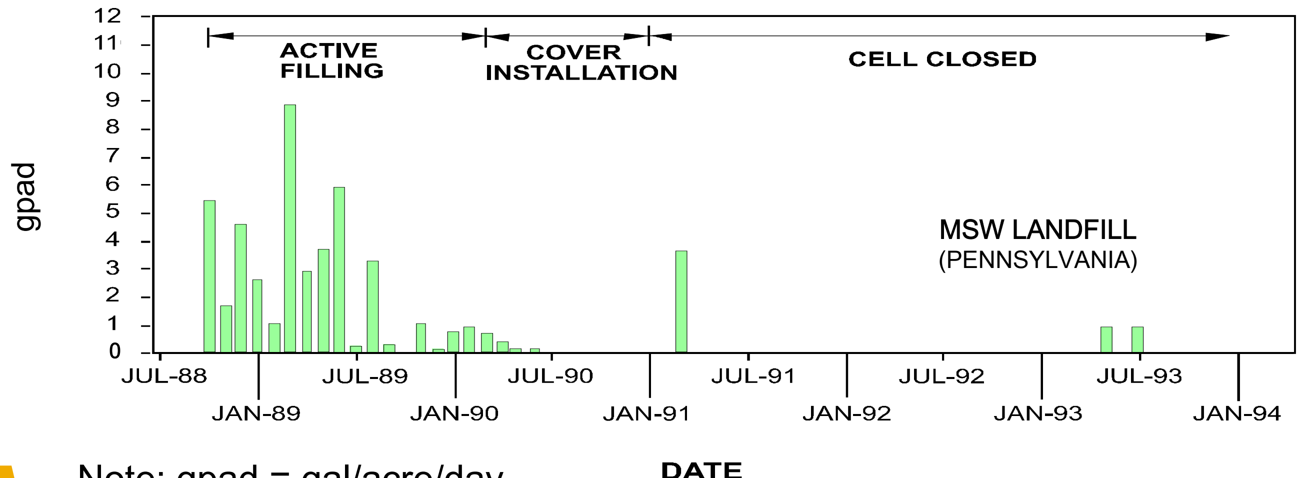
SAMPLE LCRS AND LDS FLOW RATES

LCRS



LDS



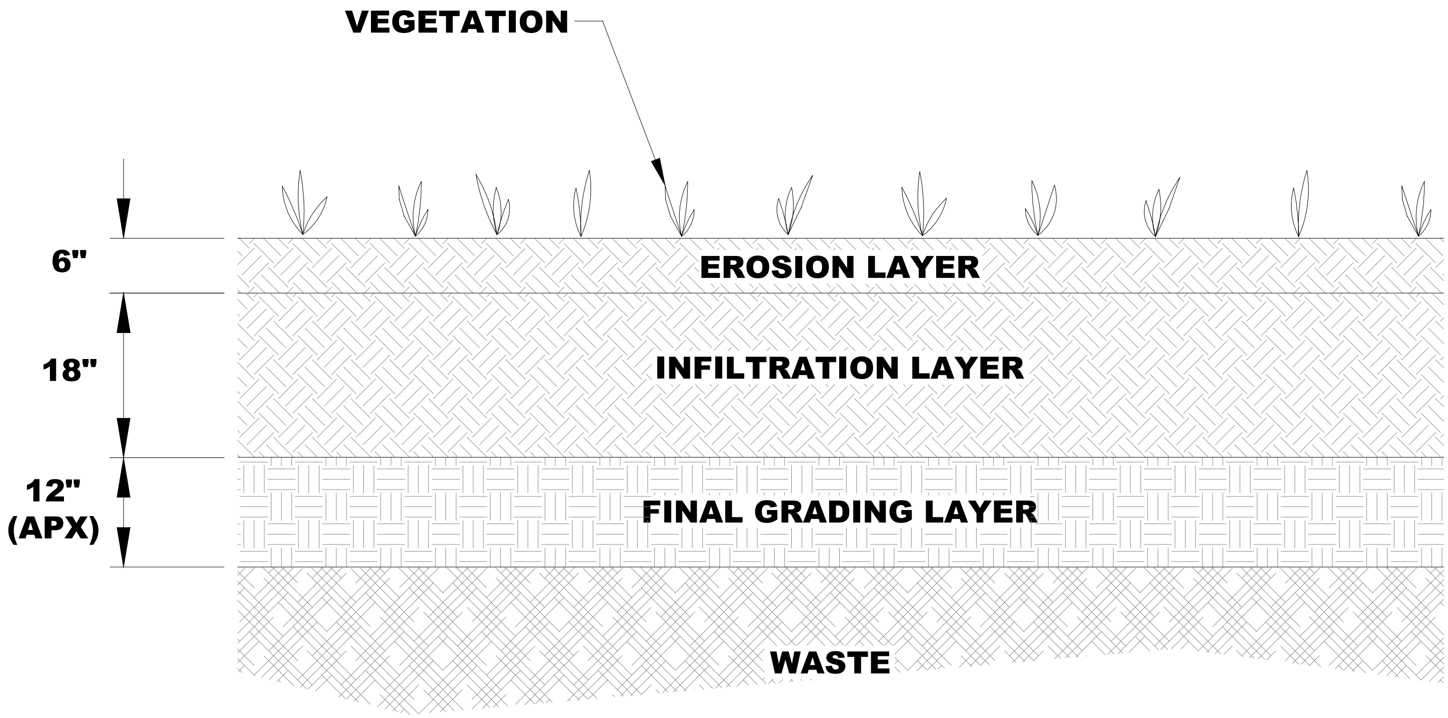
Note: gpad = gal/acre/day

WASTE MANAGEMENT

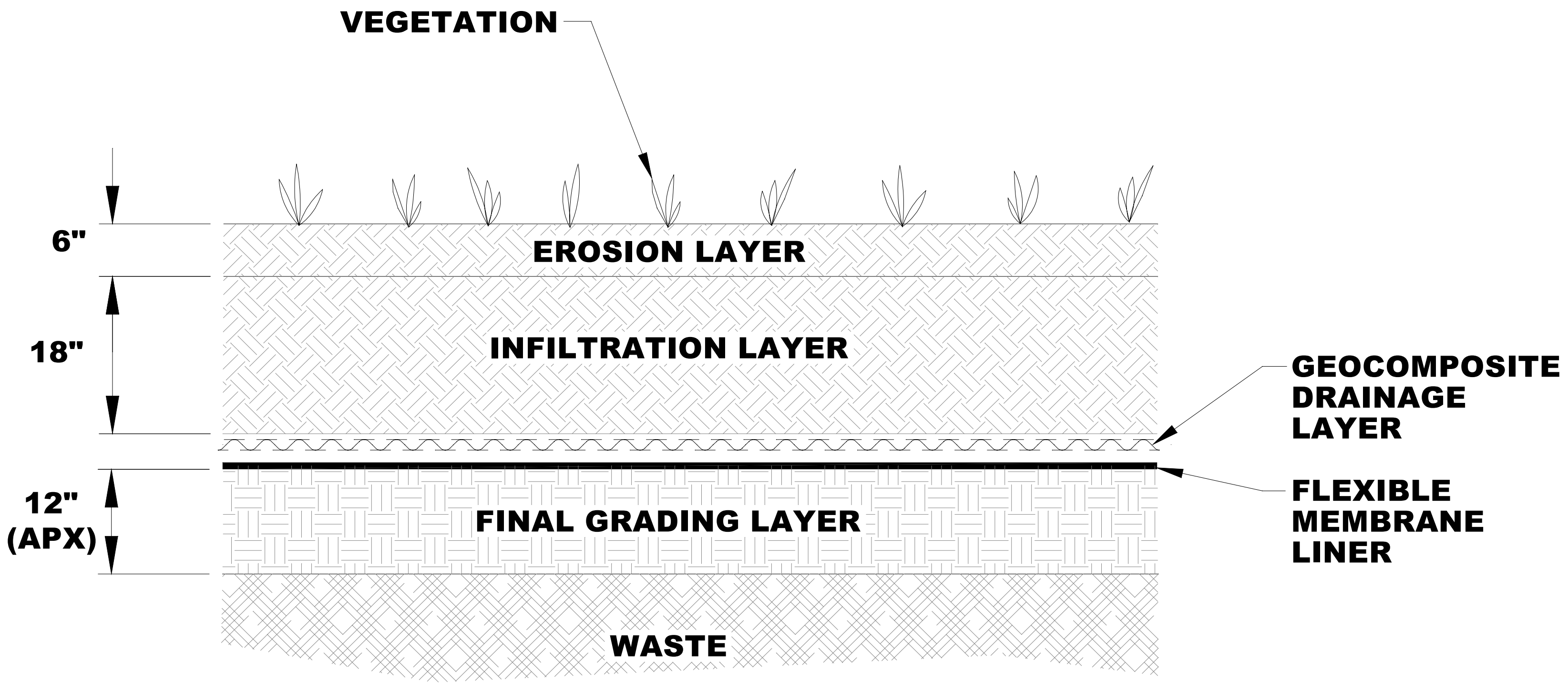
GEOSYNTEC CONSULTANTS

WM's Bioreactor Program

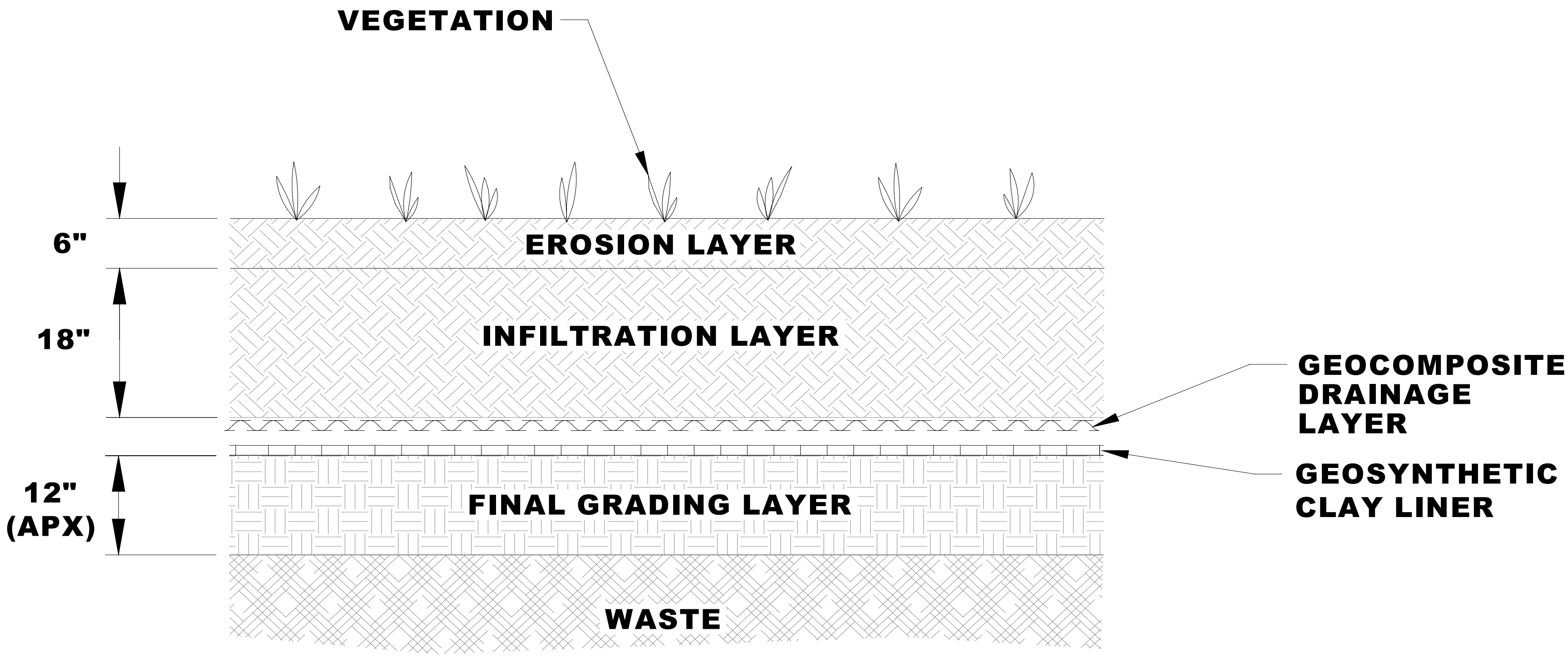
- Alternate Interim Cover/Cap Needs
- Allows controlled moisture introduction while controlling odor and gas emissions
- Handles substantial settlement
- Cost-effective to remove to capture airspace



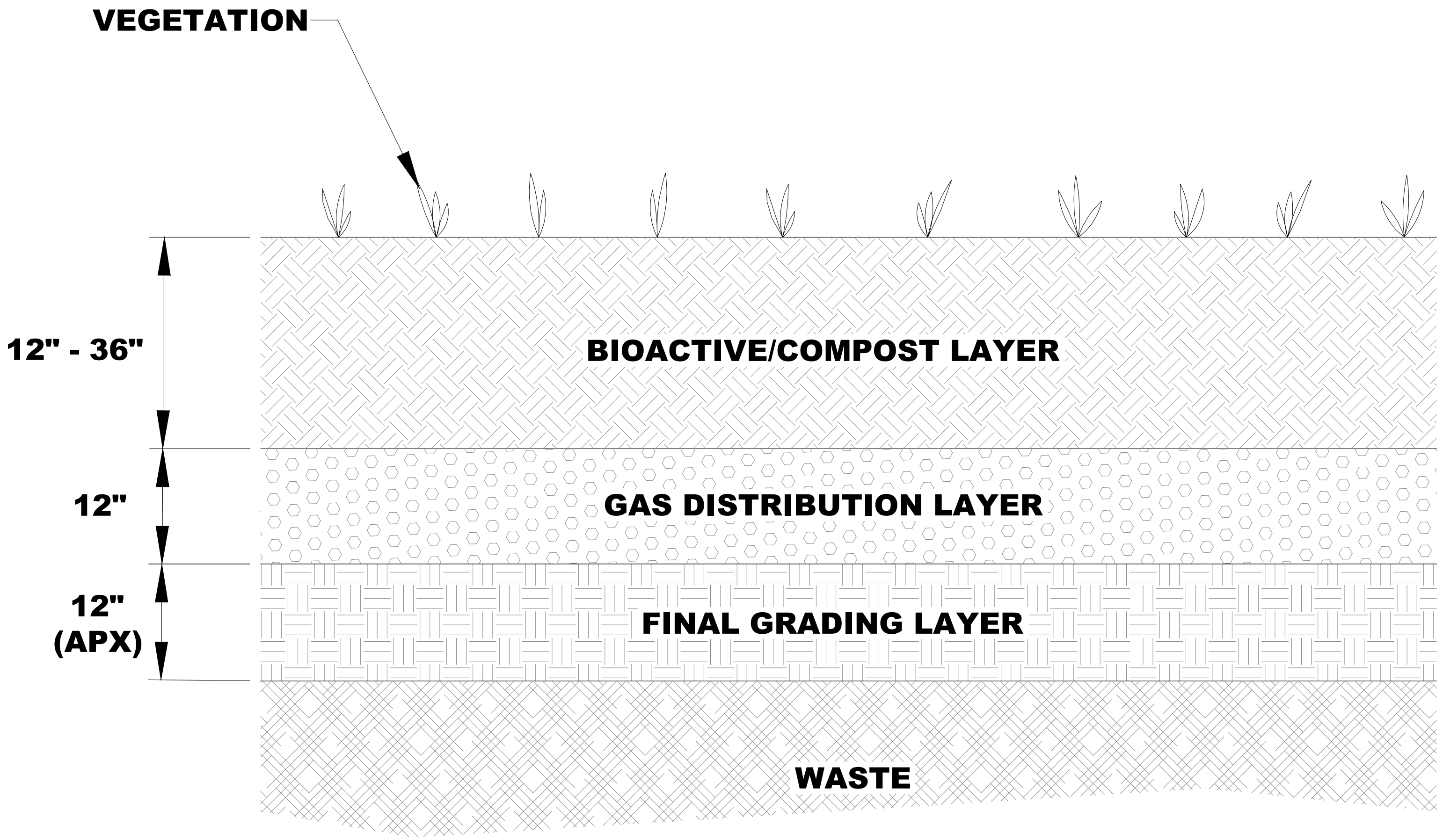
SUBTITLE-D PRESCRIPTIVE CAP



GEOMEMBRANE CAP

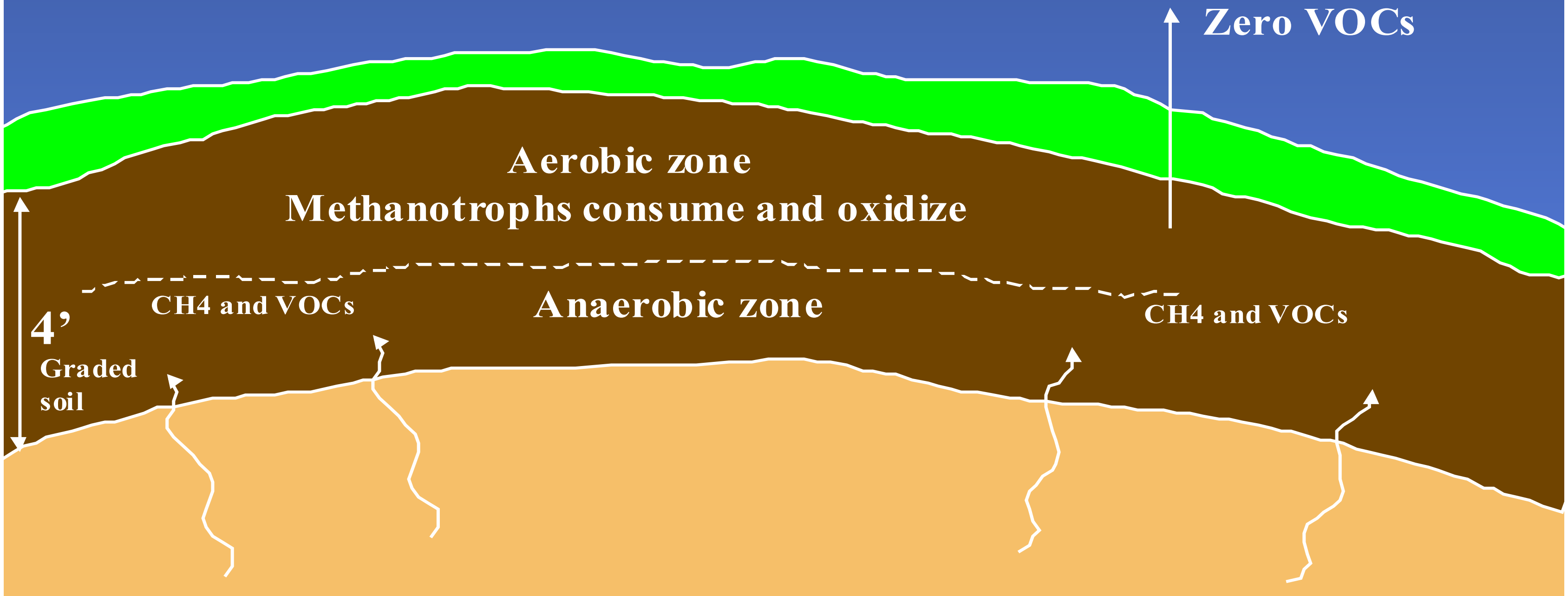


GEOSYNTHETIC CLAY CAP

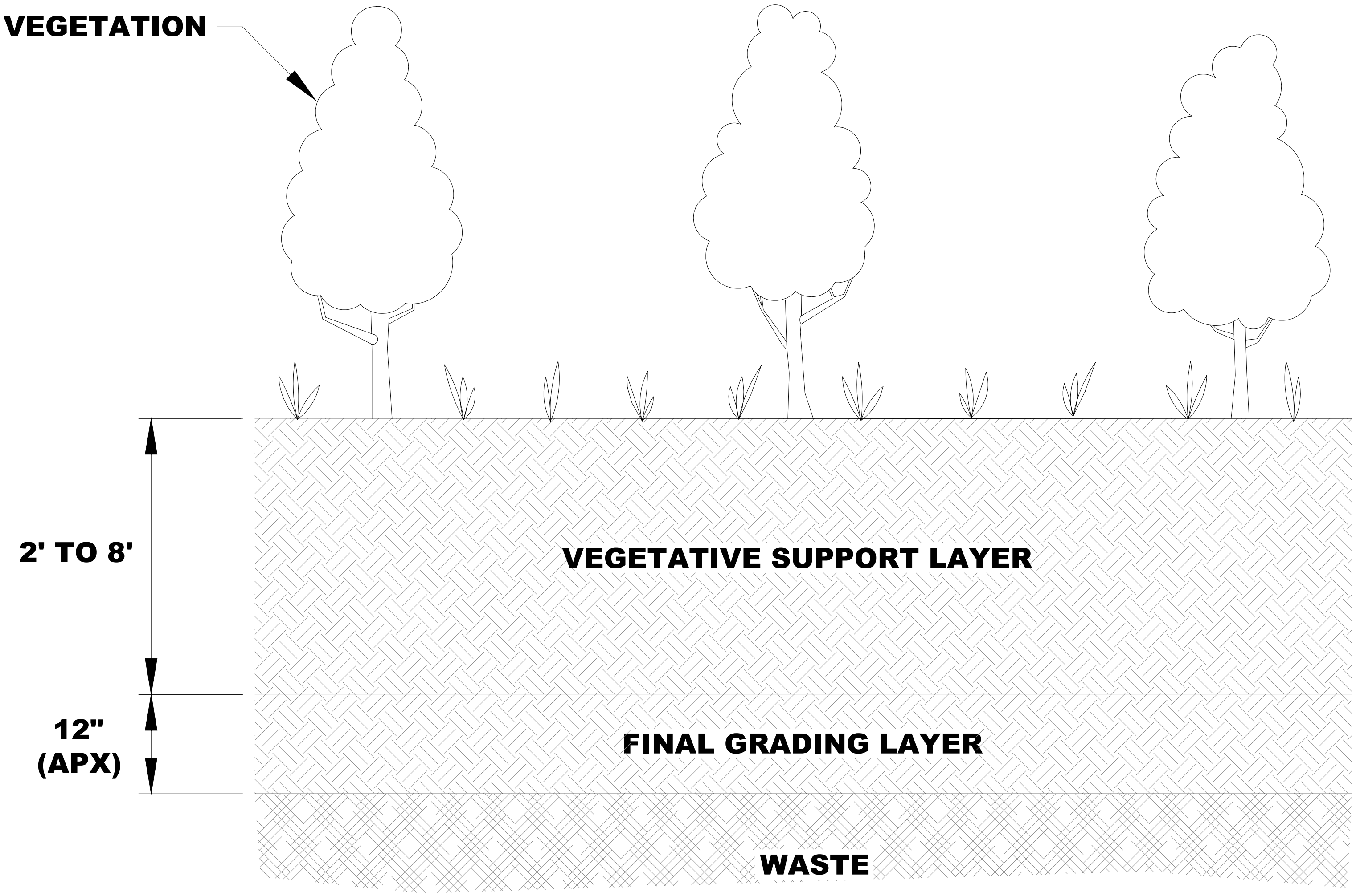


BIOACTIVE CAP

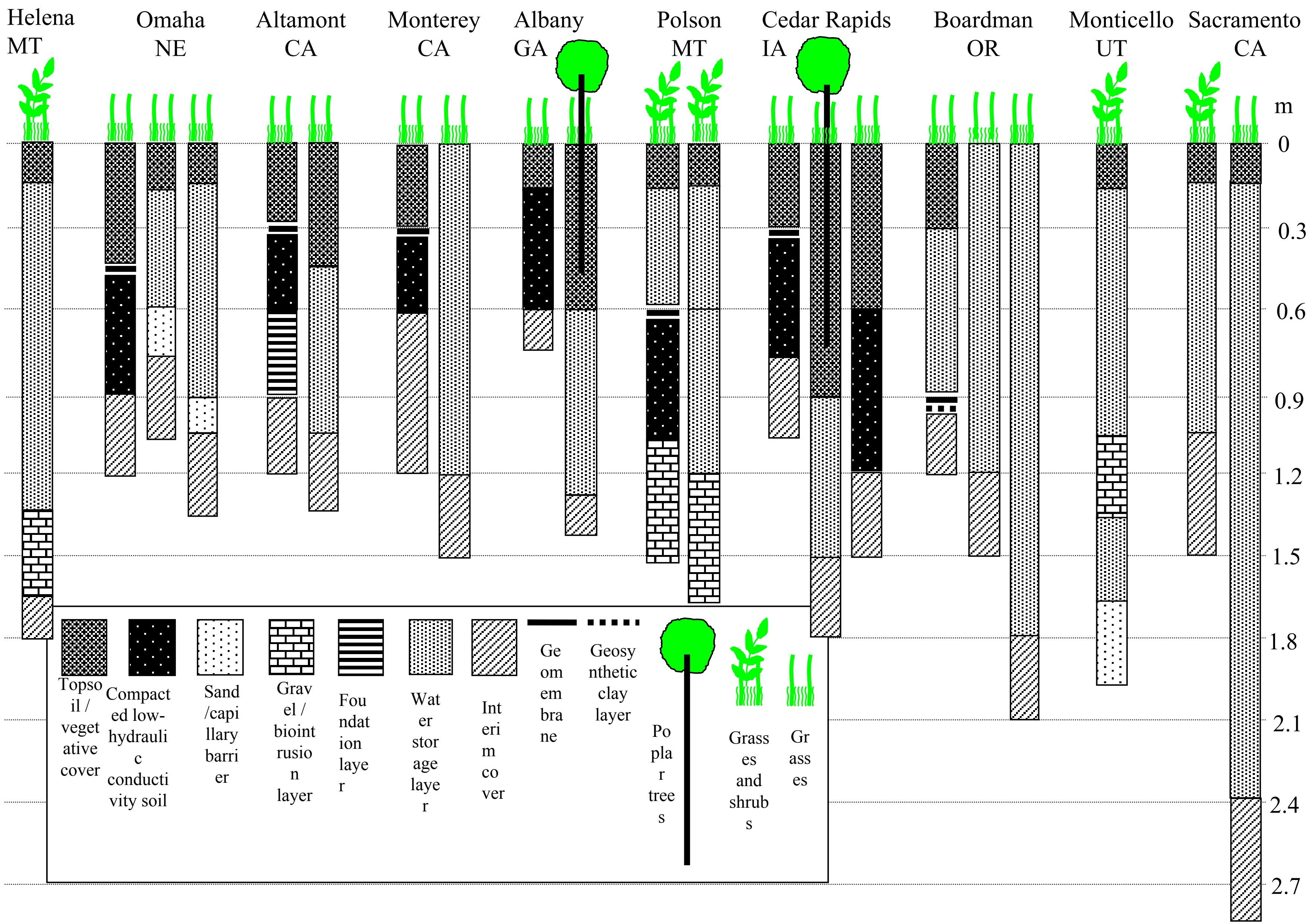
“Bio”- cap



Argonne Labs - Dr. Jean Bogner
Measured this effect at several landfills



EVAPOTRANSPIRATIVE CAP



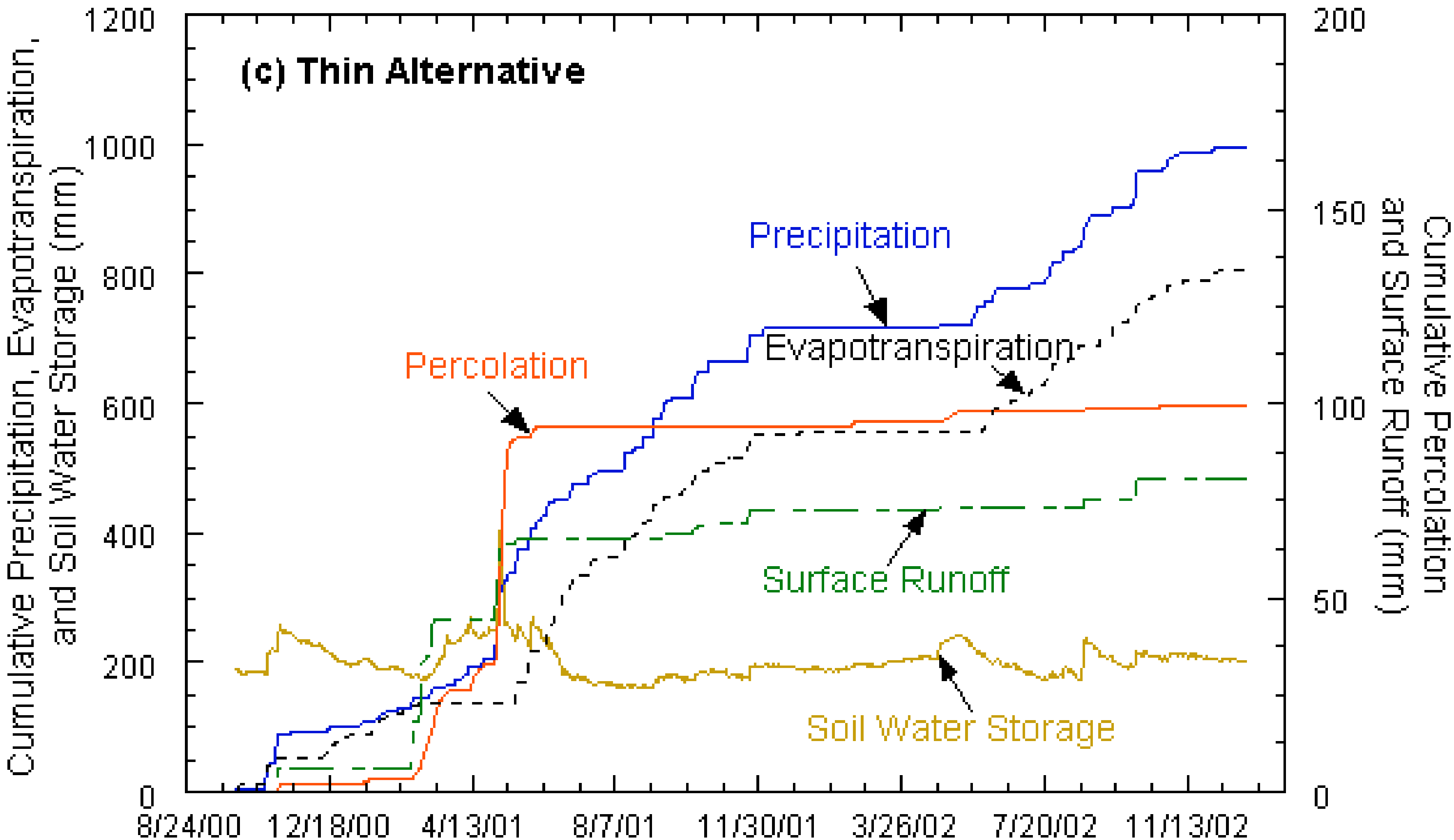
Helena MT
Omaha NE
Altamont CA
Monterey CA
Albany GA
Polson MT
Cedar Rapids IA
Boardman OR
Monticello UT
Sacramento CA
m
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
Topsoil / vegetative cover
Compacted low-hydraulic conductivity soil
Sand/capillary barrier
Gravel / biointrusion layer
Foundation layer
Water storage layer
Interim cover
Geomembrane
Geosynthetic clay layer
Poplar trees
Grasses and shrubs
Grasses

DCLF ACAP

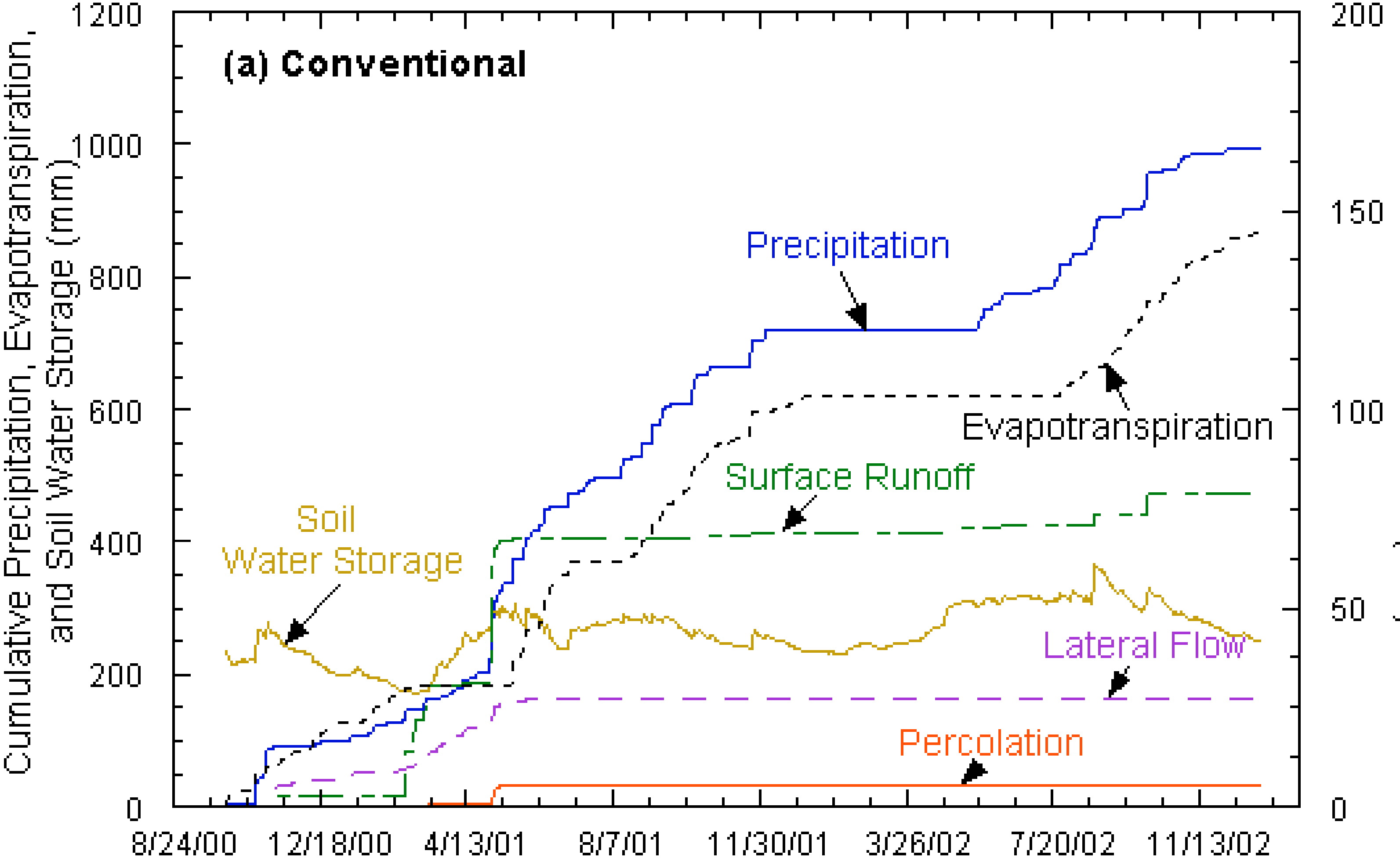
- ACAP Alternative #2 permited
- L4=150mm topsoil and vegetation
- L3=760mm silty clay
- L1 =150mm sand as capillary break
- Thinner ACAP continues testing

Performance Criteria

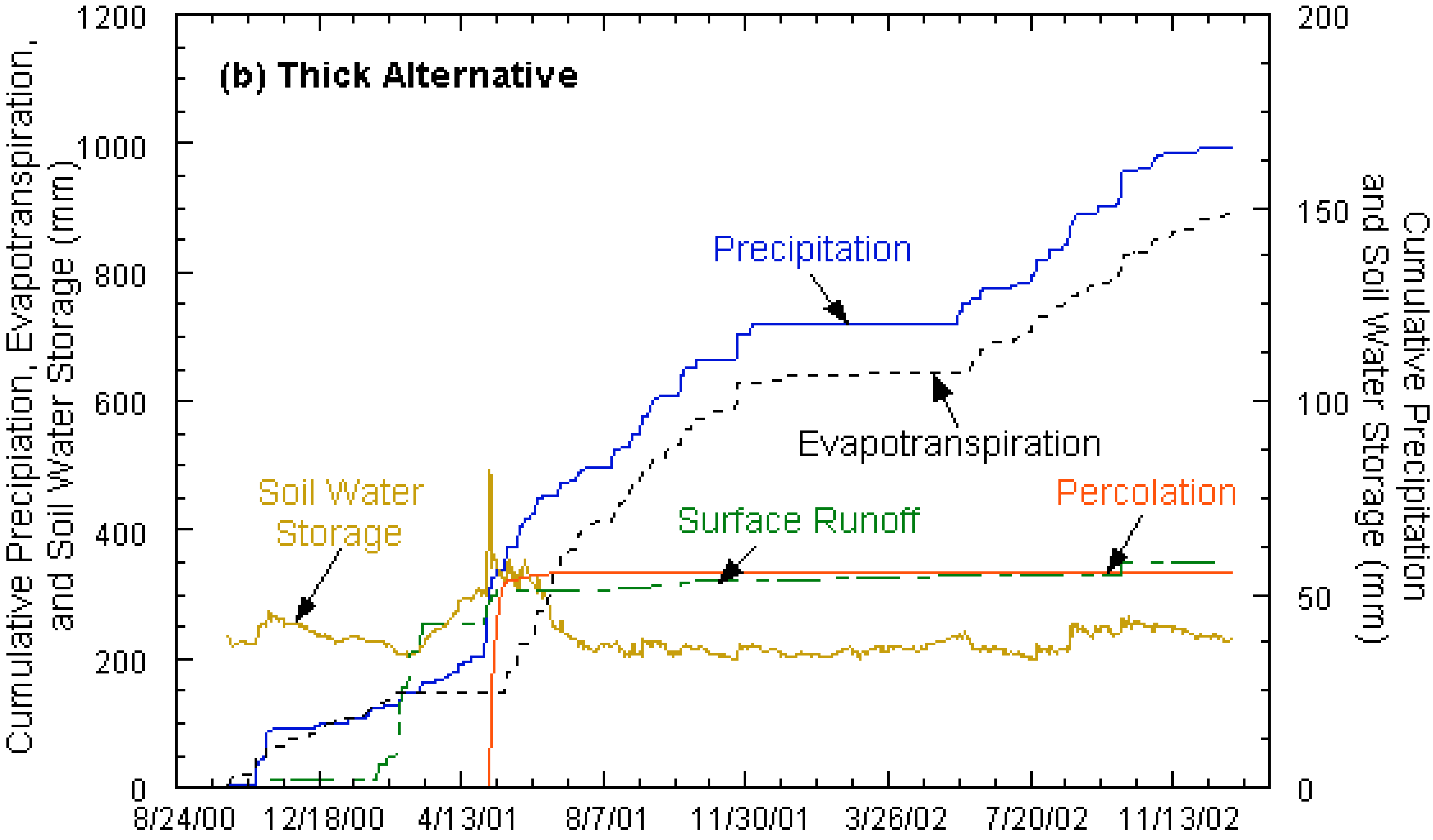
- Meet 3mm infiltration to demonstrate equivalency
- "0" infiltration observed after plants grew
- Altamont LF ACAP has less than 1.5mm infiltration mostly due to short circuiting during intense storm



(c) Thin Alternative
Cumulative Precipitation, Evapotranspiration, and Soil Water Storage (mm)
Cumulative Percolation and Surface Runoff (mm)
1200
1000
800
600
400
200
0
200
150
100
50
0
Precipitation
Evapotranspiration
Percolation
Surface Runoff
Soil Water Storage
8/24/00
12/18/00
4/13/01
8/7/01
11/30/01
3/26/02
7/20/02
11/13/02

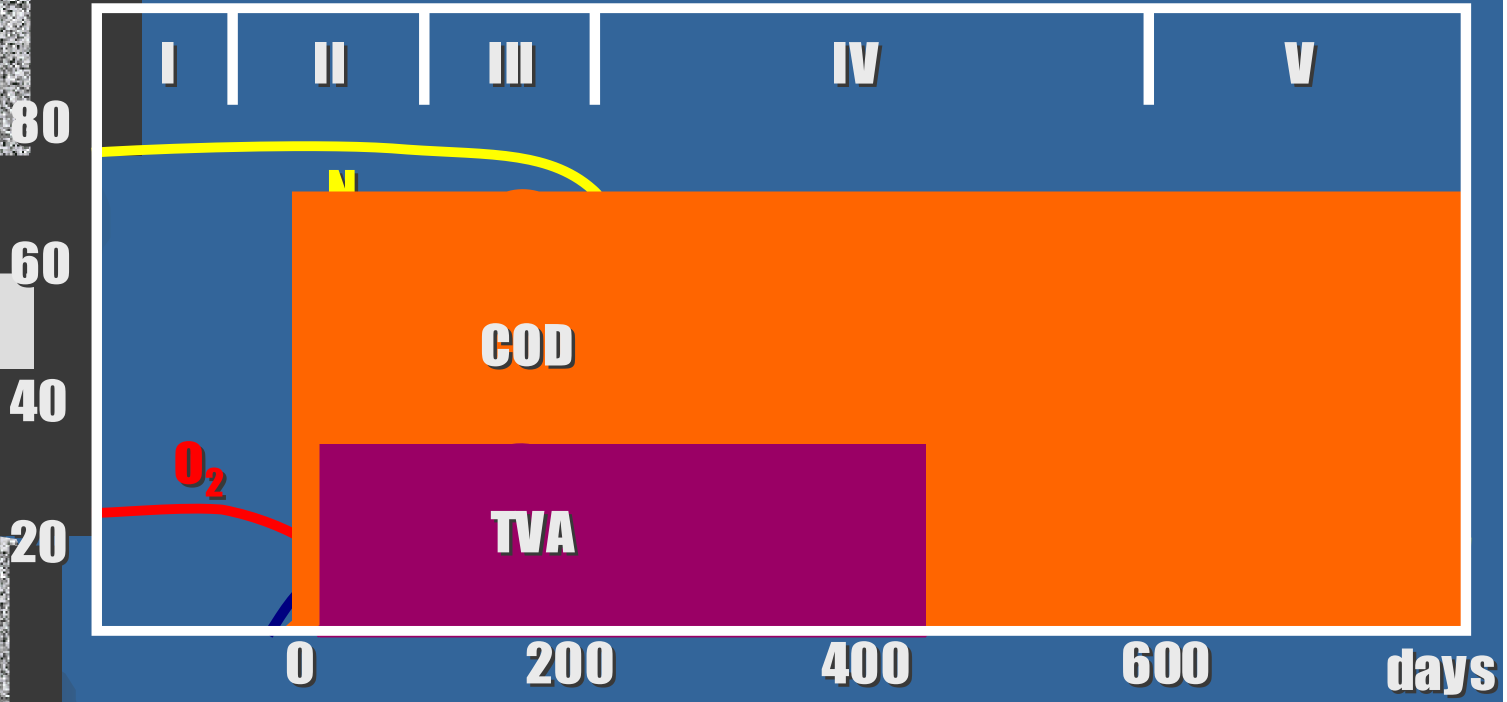


(a) Conventional
Cumulative Precipitation, Evapotranspiration, and Soil Water Storage (mm)
Cumulative Percolation, Lateral Flow, and Surface Runoff (mm)
1200
1000
800
600
400
200
0
200
150
100
50
0
8/24/00
12/18/00
4/13/01
8/7/01
11/30/01
3/26/02
7/20/02
11/13/02
Precipitation
Evapotranspiration
Surface Runoff
Soil
Water Storage
Lateral Flow
Percolation



(b) Thick Alternative
Cumulative Precipiation, Evapotranspiration, and Soil Water Storage (mm)
Cumulative Precipitation and Soil Water Storage (mm)
1200
1000
800
600
400
200
0
200
150
100
50
0
8/24/00
12/18/00
4/13/01
8/7/01
11/30/01
3/26/02
7/20/02
11/13/02
Precipitation
Evapotranspiration
Soil Water Storage
Surface Runoff
Percolation

Stabilization Profile



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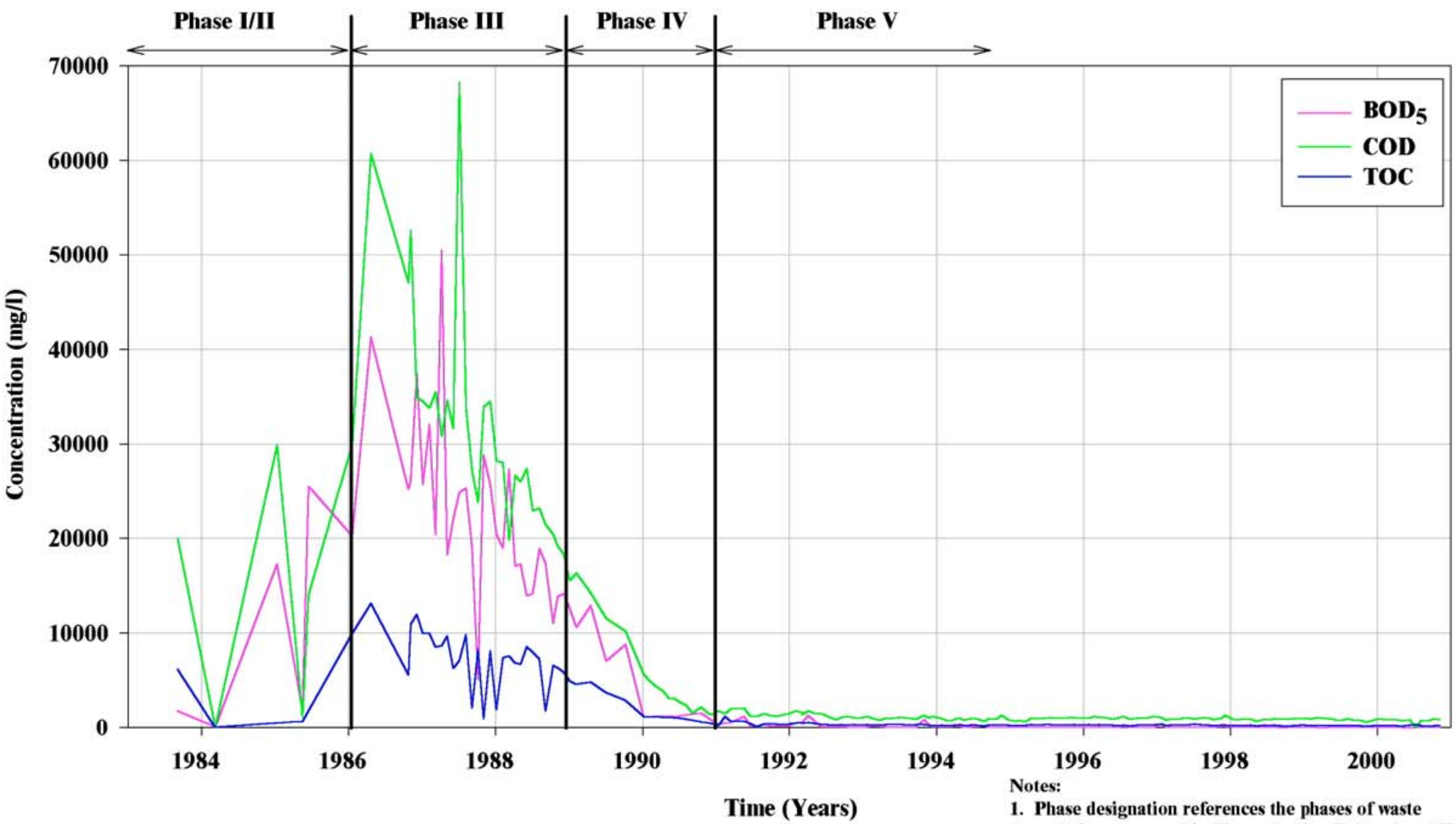
WASTE MANAGEMENT

Figure 3

LEACHATE QUALITY SUMMARY, BOD_5, COD, AND TOC

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

Sandtown, Delaware



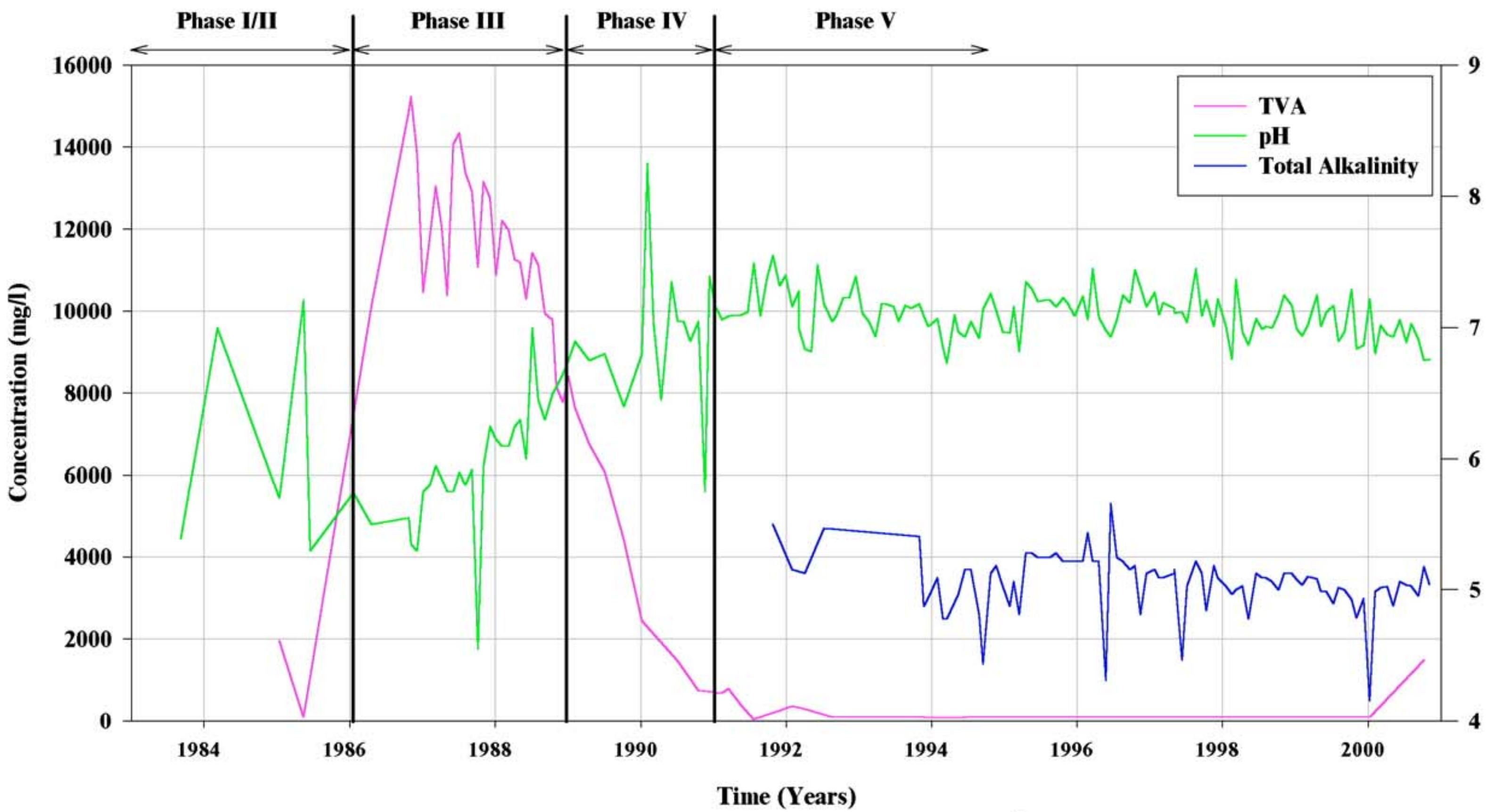
Notes:
1. Phase designation references the phases of waste degradation presented in Figure 2, after Pohland and Harper, 1986.
2. BOD_5 concentrations that are greater than COD concentrations are assumed to be reported in error.

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



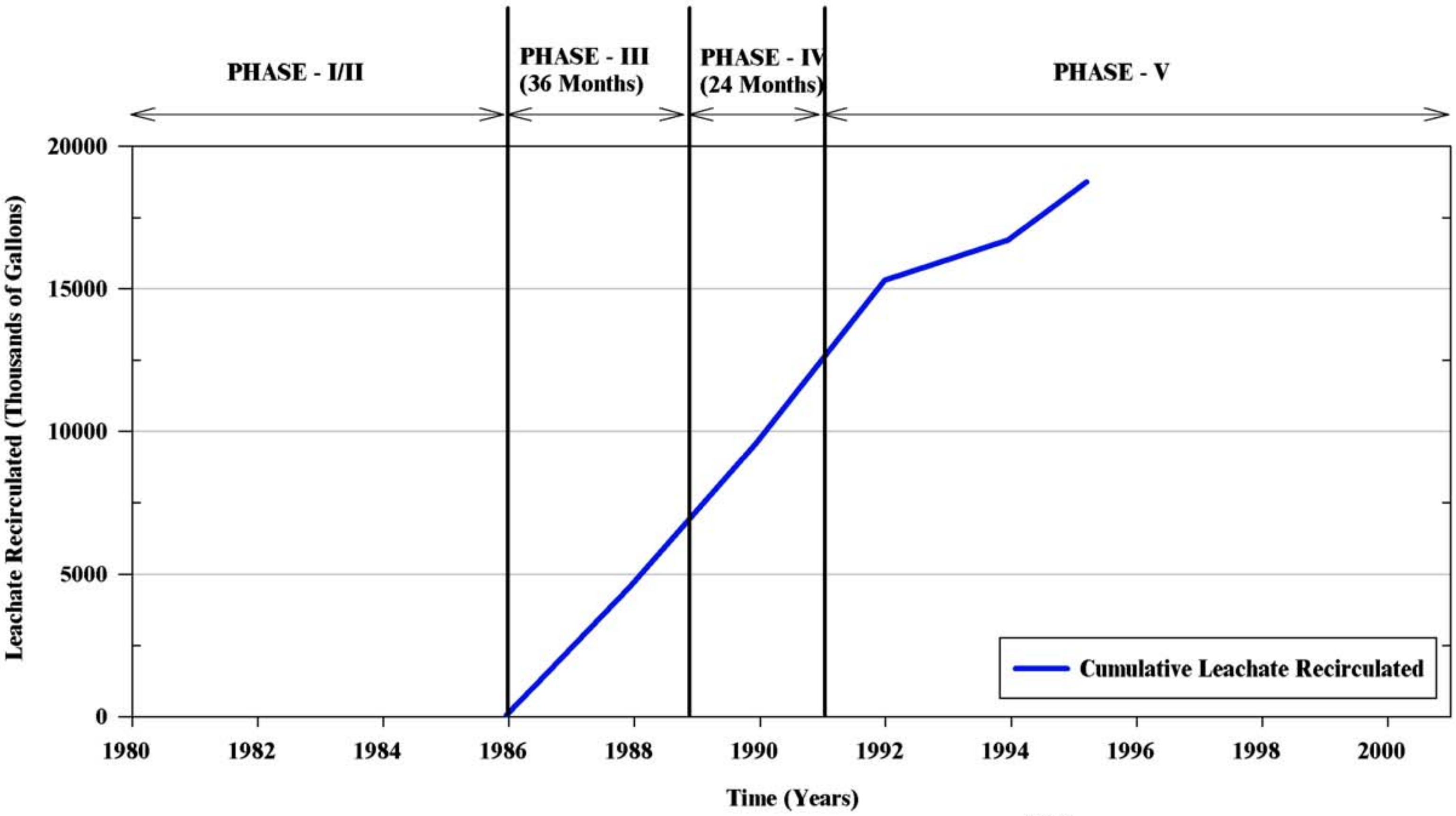
Note:
Phase designation references the phases of waste degradation presented in Figure 2, after Pohland and Harper, 1986.

Figure 8

WASTE DEGRADATION PHASE SUMMARY, DISPOSAL CELL B

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 Pohland and Harper, 1986.

DATA ANALYSIS APPROACH

2. Metals, VOCs and BTEX:

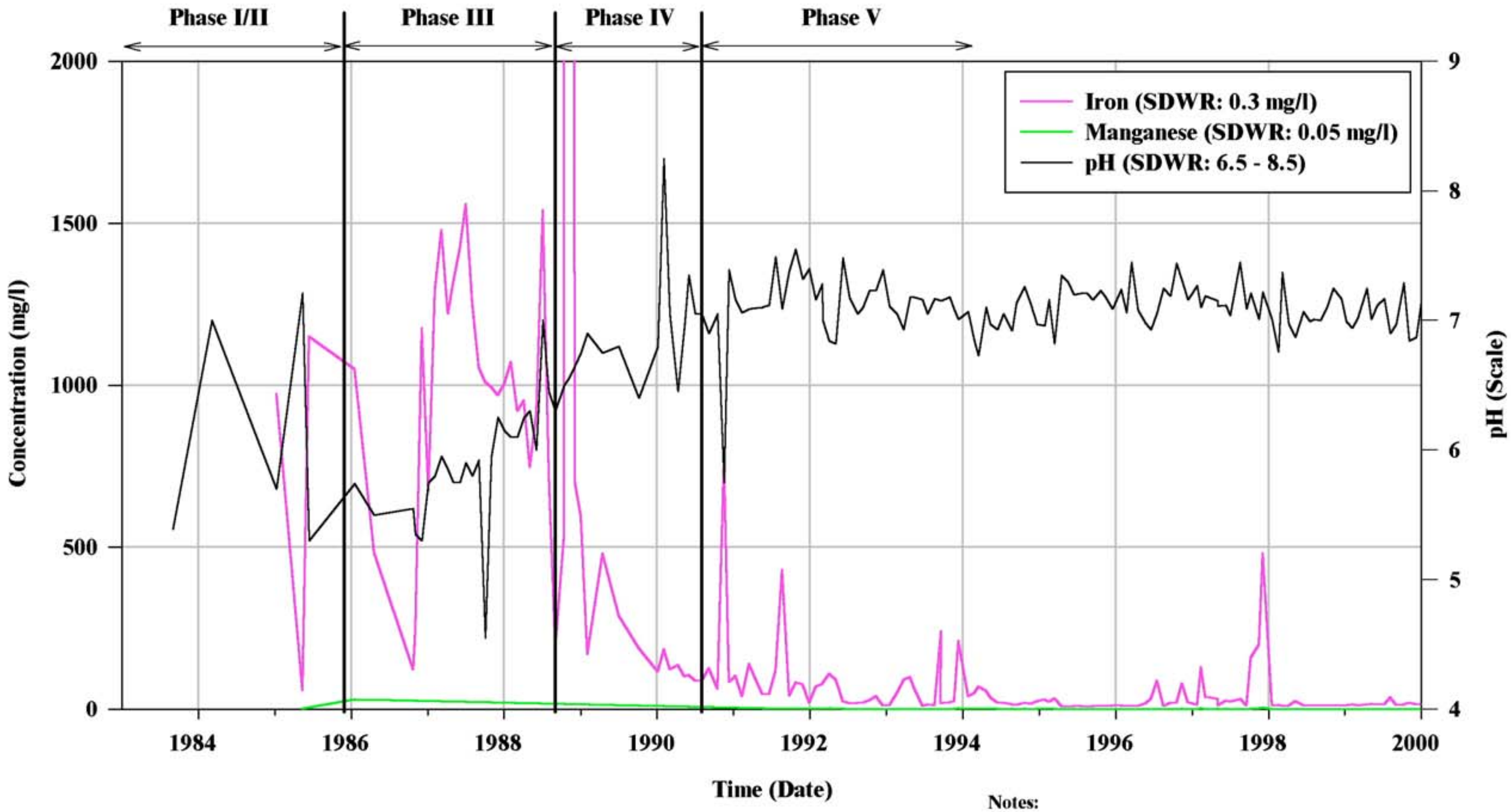
- Parameters were evaluated by tracking concentration versus time
- Final concentrations of these parameters were compared to Drinking Water Standards, and findings of previous studies (Kilmer and Tustin, 1999)

Figure 10

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



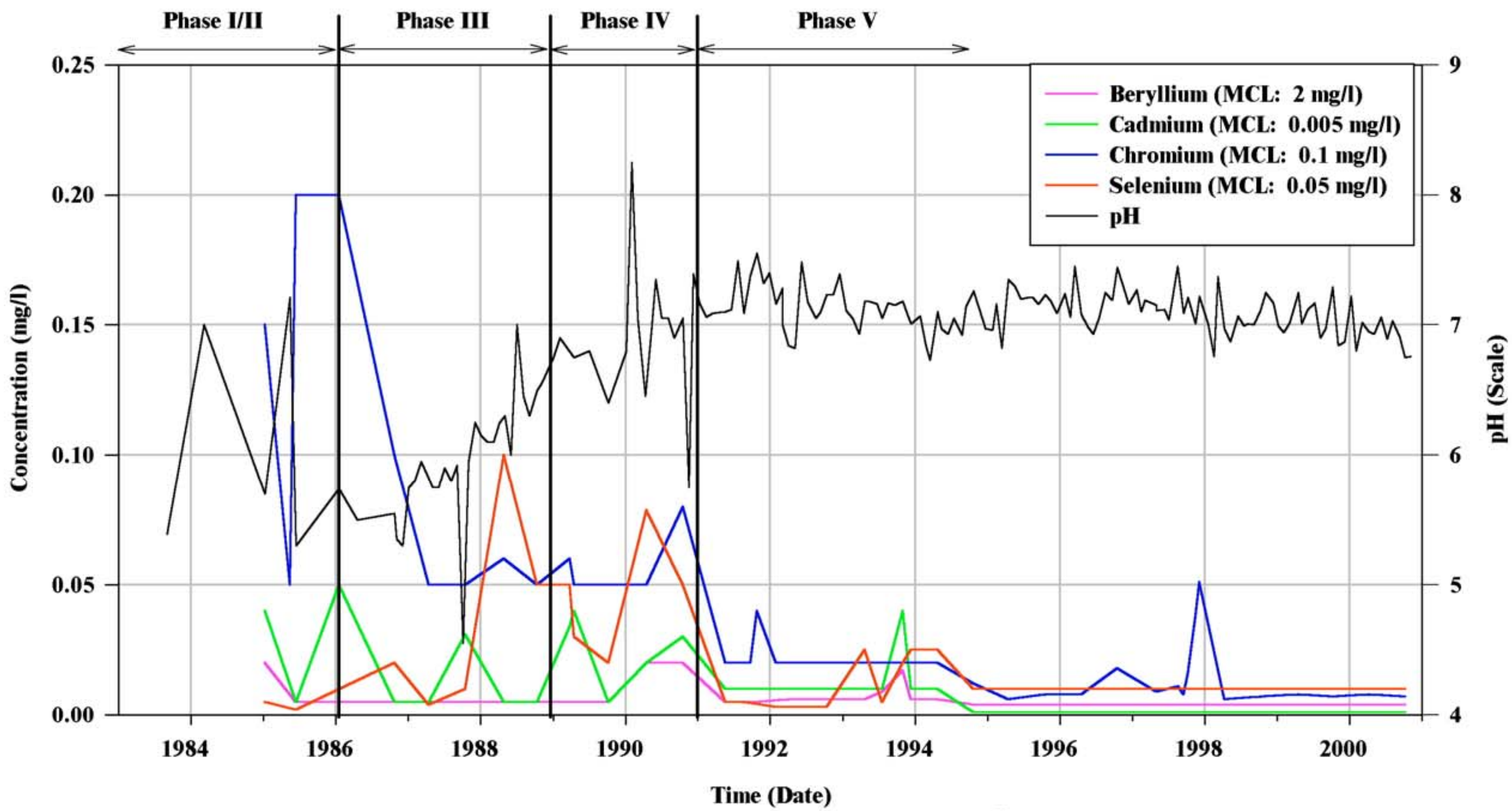
Notes:
1. Phase designation references the phases of waste degradation presented in Figure 2, after Pohland and Harper, 1986.
2. SDWR: Secondary Drinking Water Regulation.

Figure 9

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



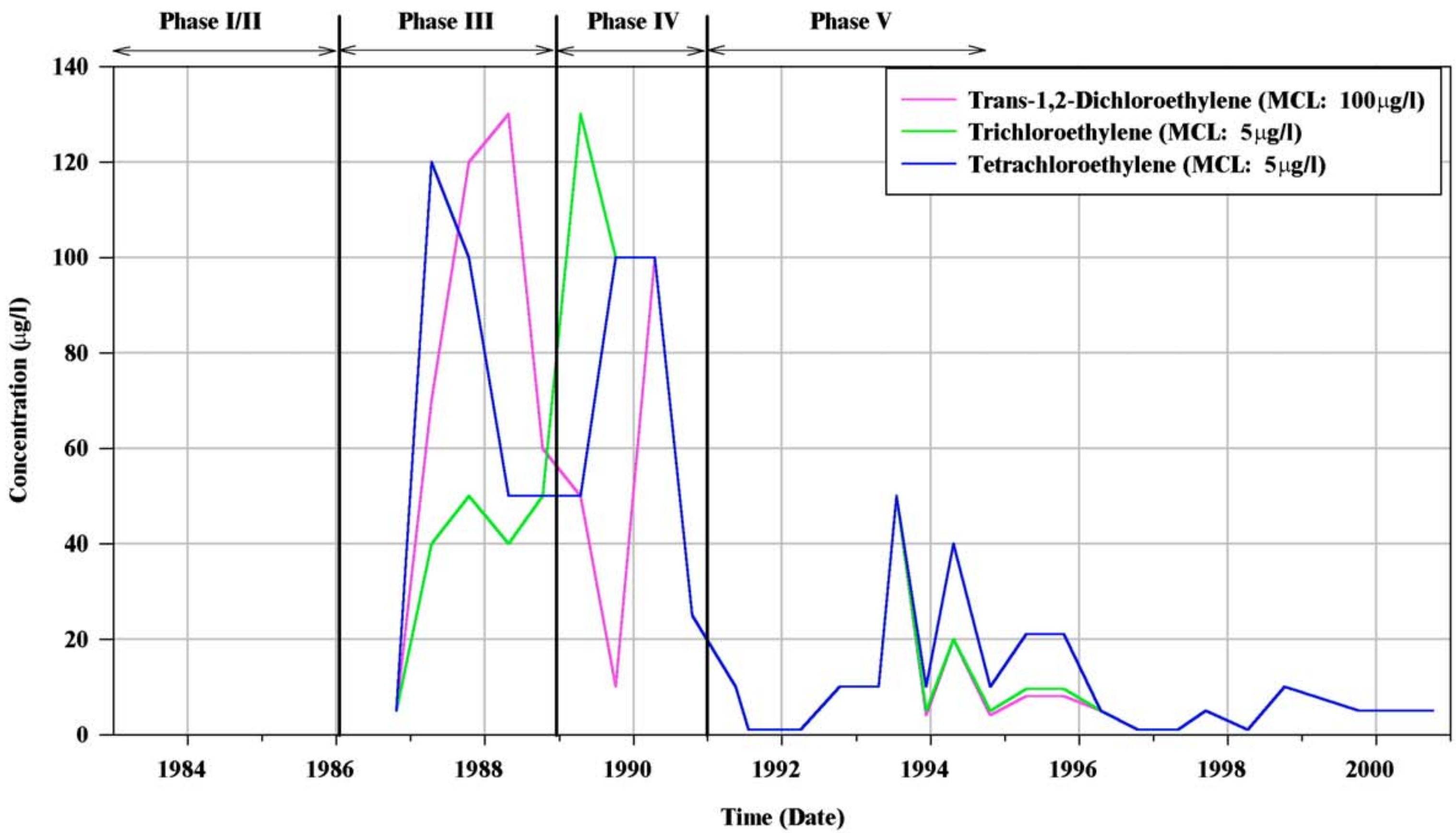
Note:
Phase designation references the phases of waste degradation presented in Figure 2, after Pohland and Harper, 1986.

Figure 12

LEACHATE QUALITY SUMMARY, TRANS-1,2-DICHLOROETHYLENE, TRICHLOROETHYLENE, AND TETRACHLORETHYLENE

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

Sandtown, Delaware



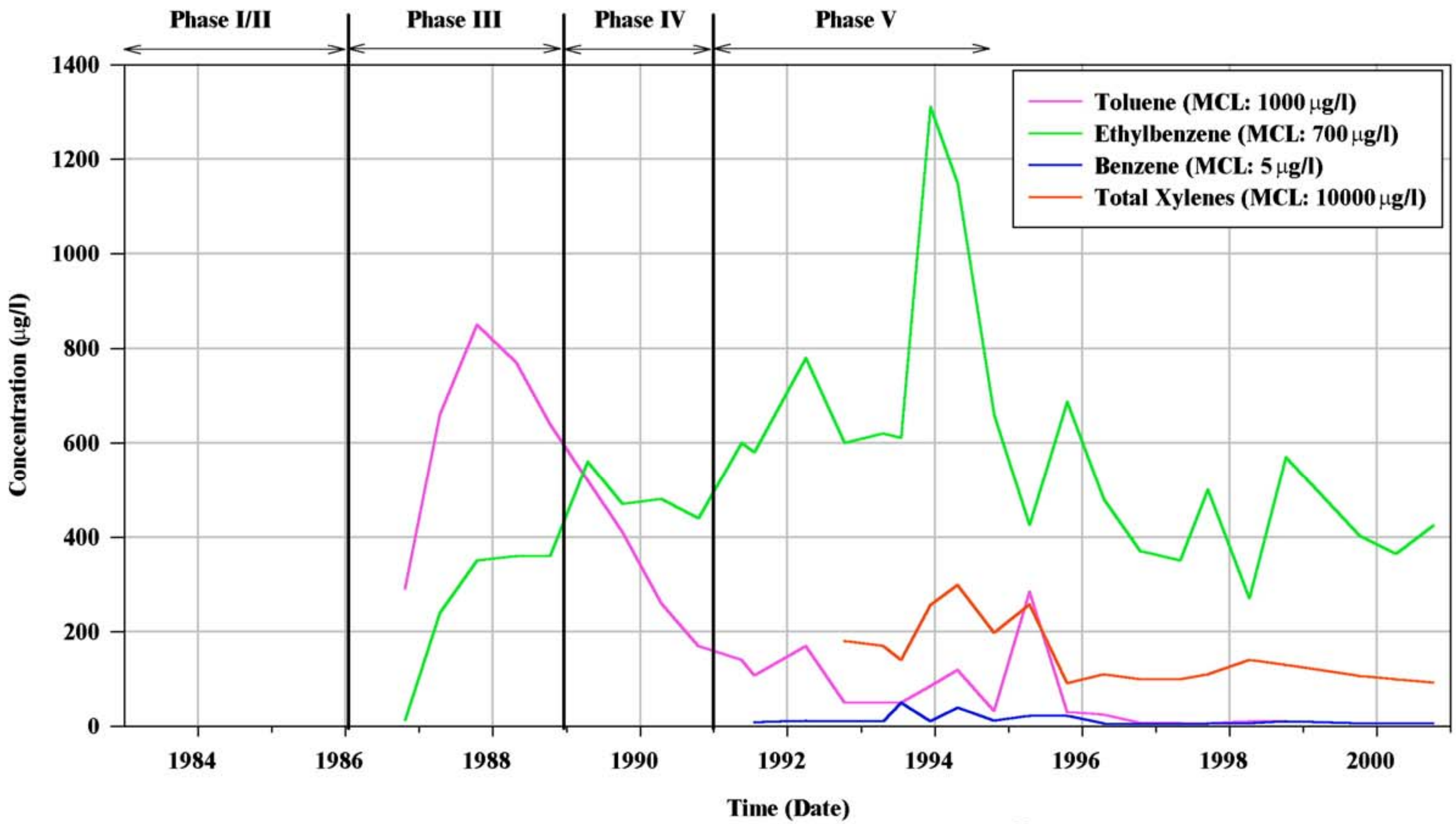
Note:
Phase designation references the phases of waste degradation presented in Figure 2, after Pohland and Harper, 1986.

Figure 13

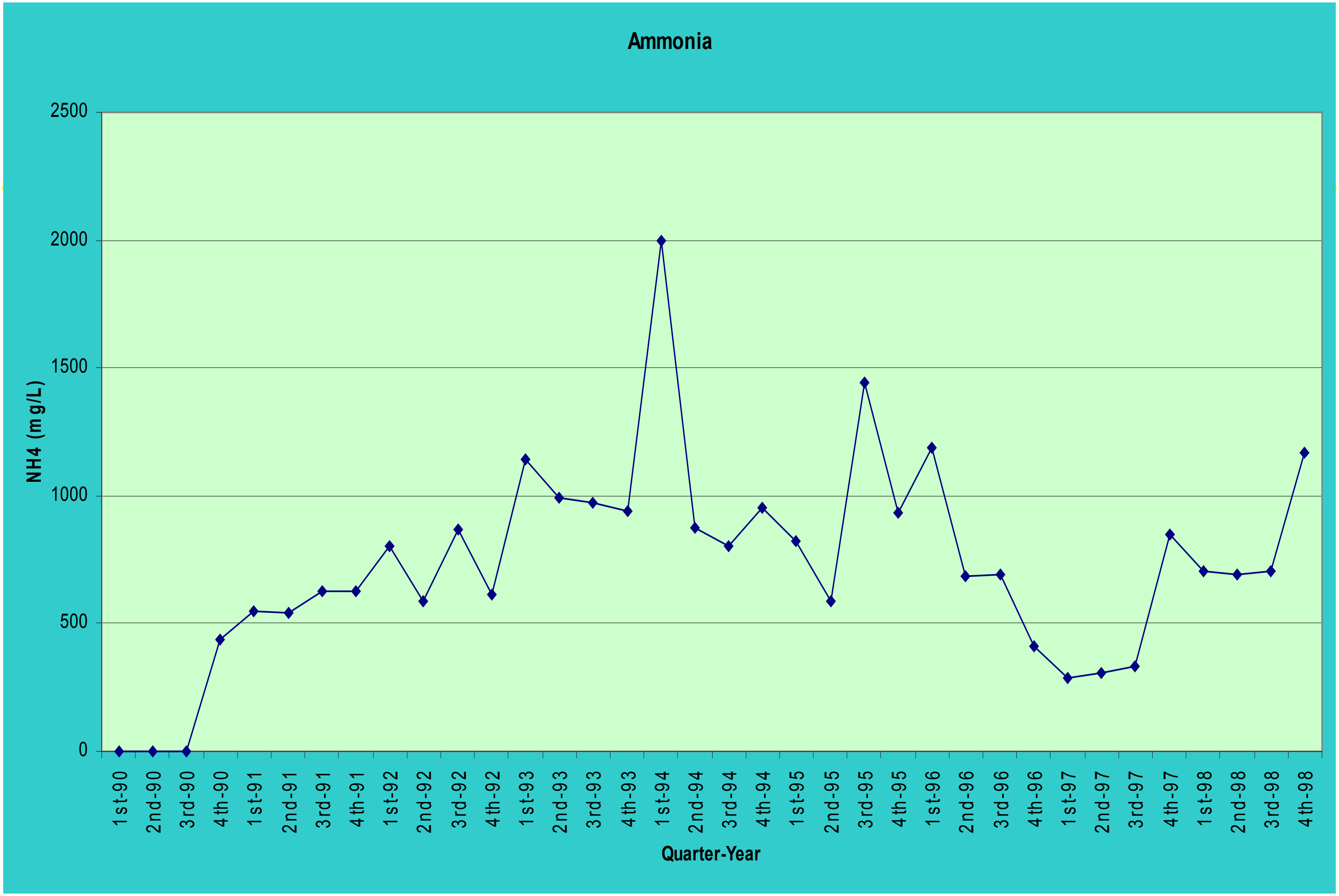
LEACHATE QUALITY SUMMARY, BTEX

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

Sandtown, Delaware



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



Ammonia
2500
2000
1500
1000
500
0
NH4 (mg/L)
1st-90
2nd-90
3rd-90
4th-90
1st-91
2nd-91
3rd-91
4th-91
1st-92
2nd-92
3rd-92
4th-92
1st-93
2nd-93
3rd-93
4th-93
1st-94
2nd-94
3rd-94
4th-94
1st-95
2nd-95
3rd-95
4th-95
1st-96
2nd-96
3rd-96
4th-96
1st-97
2nd-97
3rd-97
4th-97
1st-98
2nd-98
3rd-98
4th-98
Quarter-Year

CONCLUSIONS

- **The concentrations of waste degradation parameters in leachate followed the model suggested by Pohland and Harper, 1986.**
- **The data indicate that metals, VOCs and BTEX were not present at concentrations above their MCLs after a short period into Phase V.**
- **Based on WMI experience, this level of improvement in leachate quality is consistent with the improvements at other similarly operated leachate recirculating landfills.**

WM's Phytoremediation Projects

- Using poplar trees for groundwater remediation and leachate treatment (in-situ)
- Using engineered wetlands for leachate treatment for active sites and for end of post-closure care
- Diverse and native plants for better ecodiversity appears to be a desired outcome

WM WASTE MANAGEMENT

Ecolotree Inc., G.W. Remediation


5. 28. 2002


8. 3. 2001


4. 17. 2001

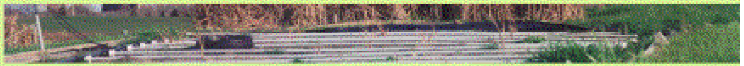

XTRA
4. 19. 2001


CATERPILLAR
4. 19. 2001


4. 19. 2001

A DIVISION OF ESG INTERNATIONAL INC.

CREATED WETLAND FOR WASTEWATER TREATMENT



TREATMENT TECHNOLOGIES®
NATURAL TREATMENT SYSTEMS

SEPTEMBER, 2002

Wetland Biofilter System

- Original research funded by:
  - -U.S. EPA
  - - Ontario Ministry of Environment
- Vertical Flow Wetland System
  - Enhanced aerobic zones = better ammonia and phosphorus reduction
  - Smaller foot print
  - Winter time operation

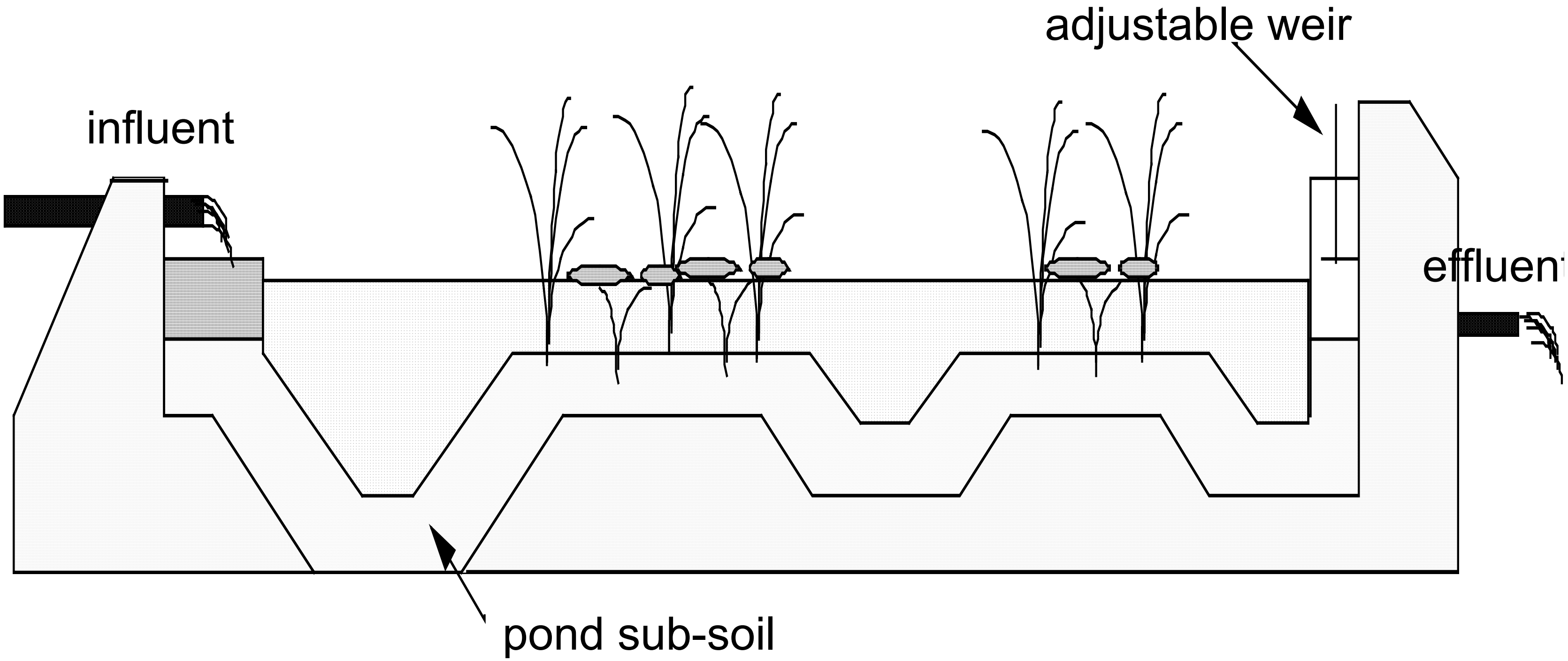
WASTE MANAGEMENT

Wetland designs:

- Surface-flow wetlands
- Subsurface horizontal flow wetlands
- Subsurface vertical flow wetlands

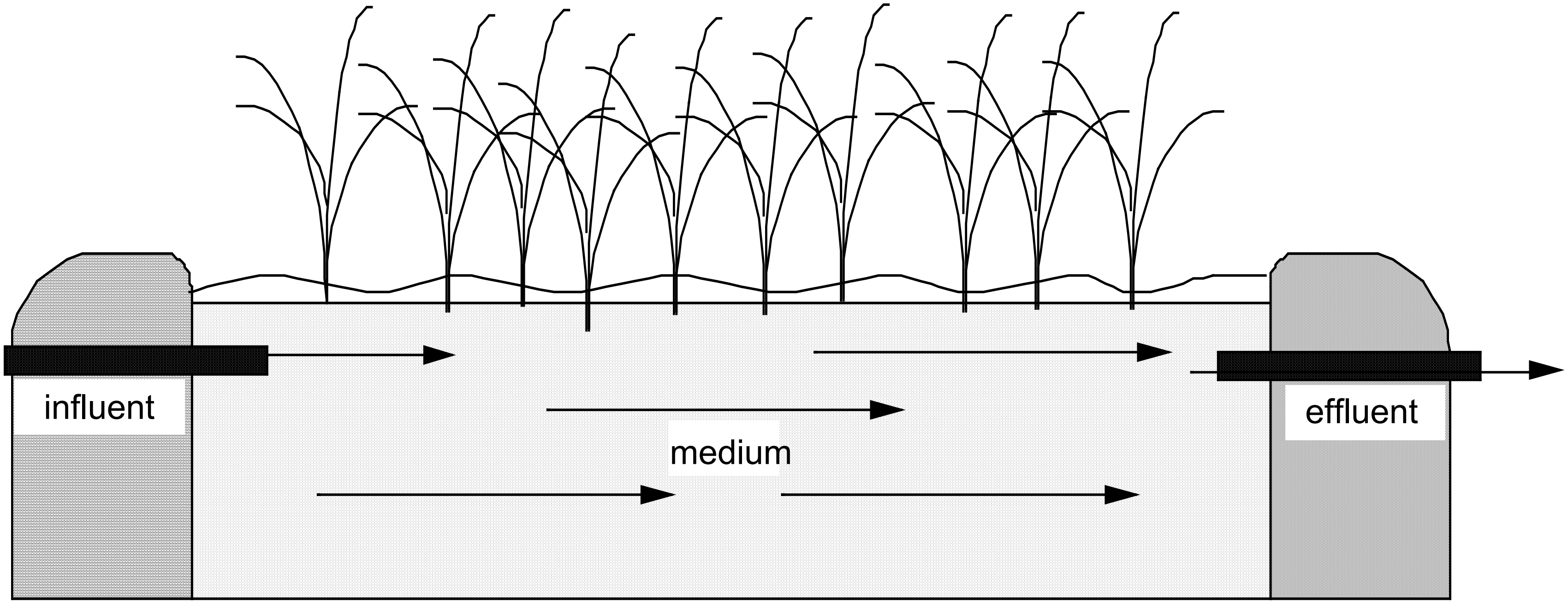
Surface-flow wetlands

- Mimic natural wetland systems / vegetation cultivated in shallow channels
- Wastewater flows through at low velocity
- Problems – poor winter performance
  - requires significant land area
  - Mosquito, odor


adjustable weir
influent
effluent
pond sub-soil

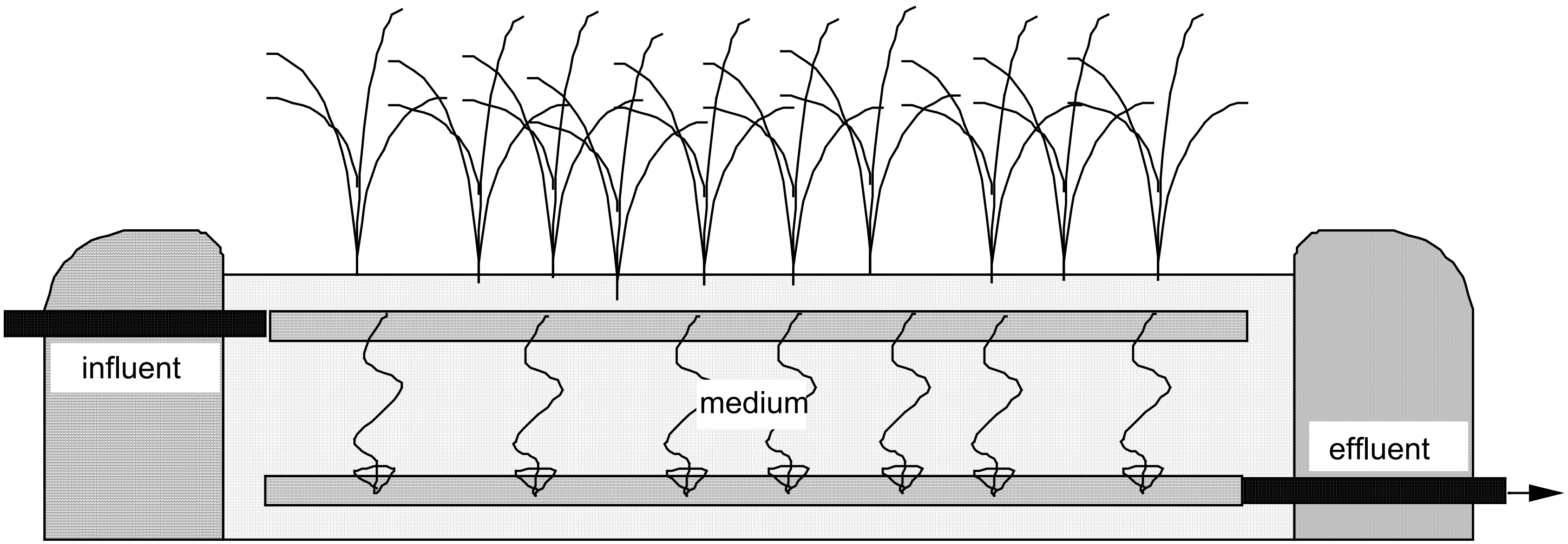
Subsurface Flow Wetlands

- Sand medium to support aquatic plants
- Water level maintained below the sand
- Wastewater flows horizontally
- Problems:
  - insufficient aerobic zones to allow for good ammonia reduction
  - Plugging of sand media leading to 'short circuiting'


influent
medium
effluent

Vertical Flow Wetlands

- Hybrid subsurface flow wetland
- History of development
- One or more cells in series
- Water percolates vertically down through medium


influent
medium
effluent

- Draws oxygen through the medium
- Allows for increased contact between wastewater and sand, bacteria
- Reduces the creation of channels (or short circuiting) around the roots of aquatic plants
- Efficient treatment even in winter
- Meets MOE discharge guidelines throughout the year (for sanitary sewage)

Hydraulic loading rates & wetland size

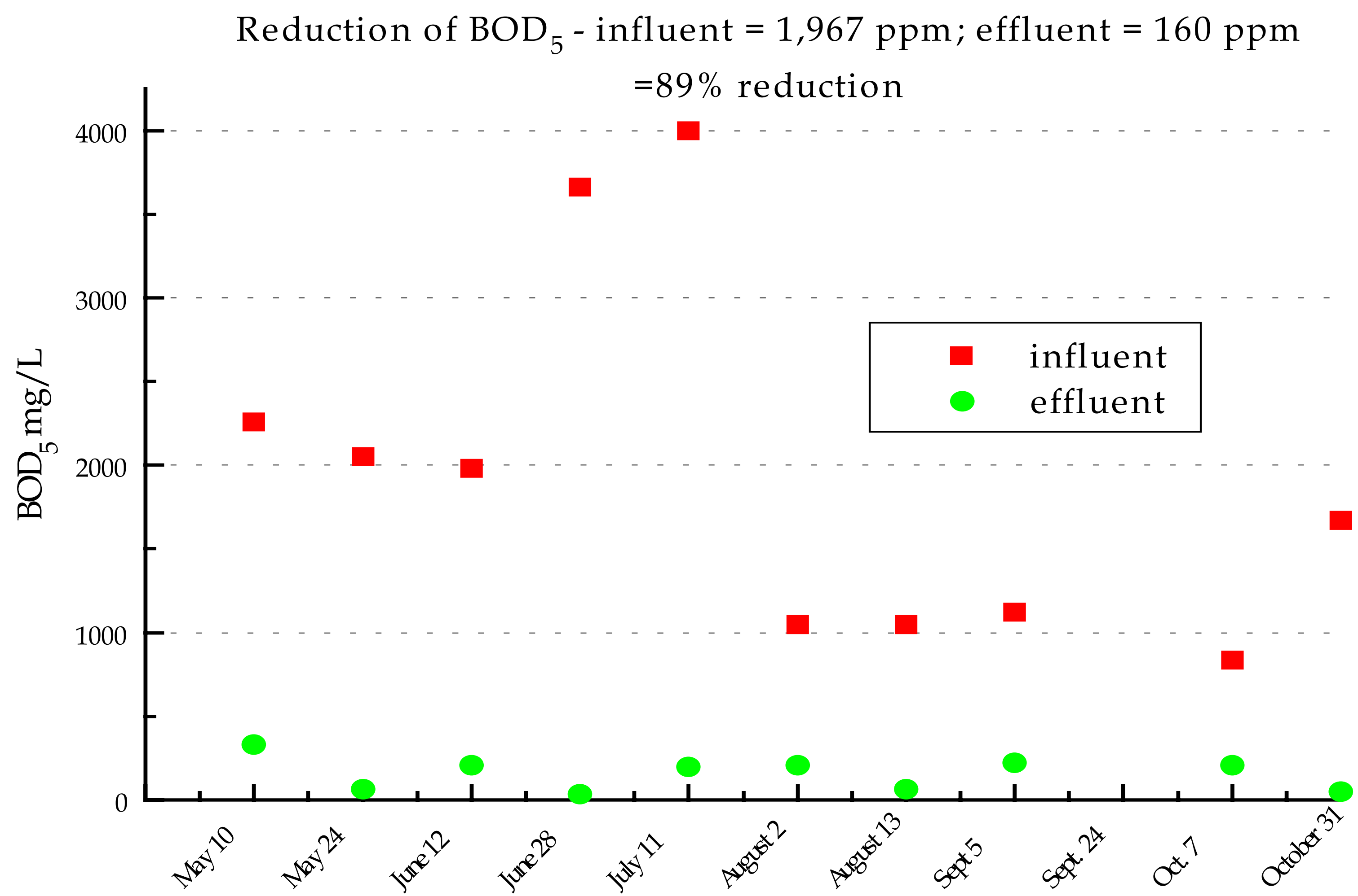
- Controlled by 1) influent characteristics
  2) design objectives

- Liquid swine manure 30 L/m^2/day (6 gal/yd^2)
- Sanitary sewage : 120 L/m^2/day (24 gal/yd^2)
- Greenhouse leachate 300 L/m2/day (60 gal/yd^2)

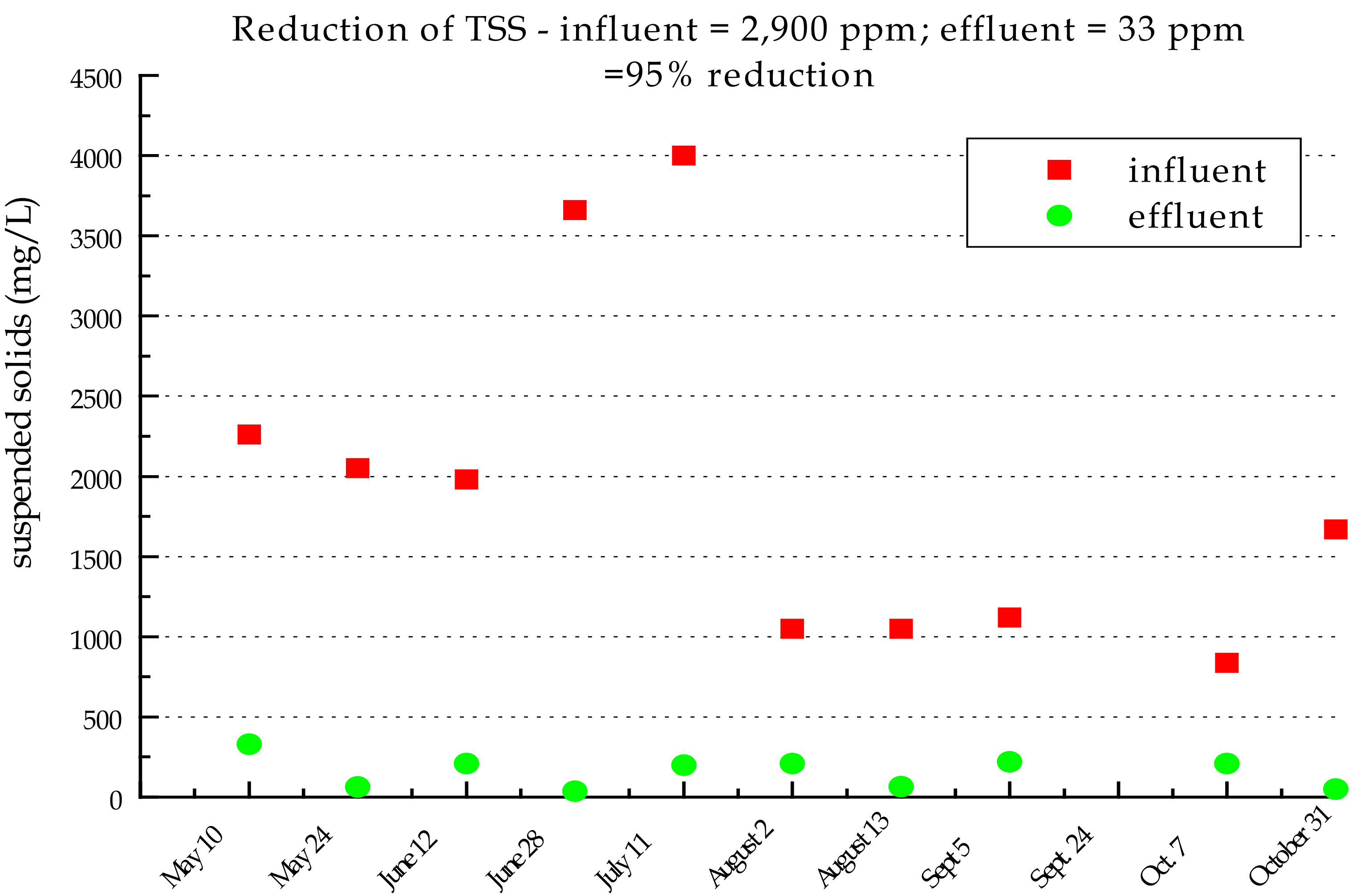
WASTE MANAGEMENT

Treatment of liquid swine manure

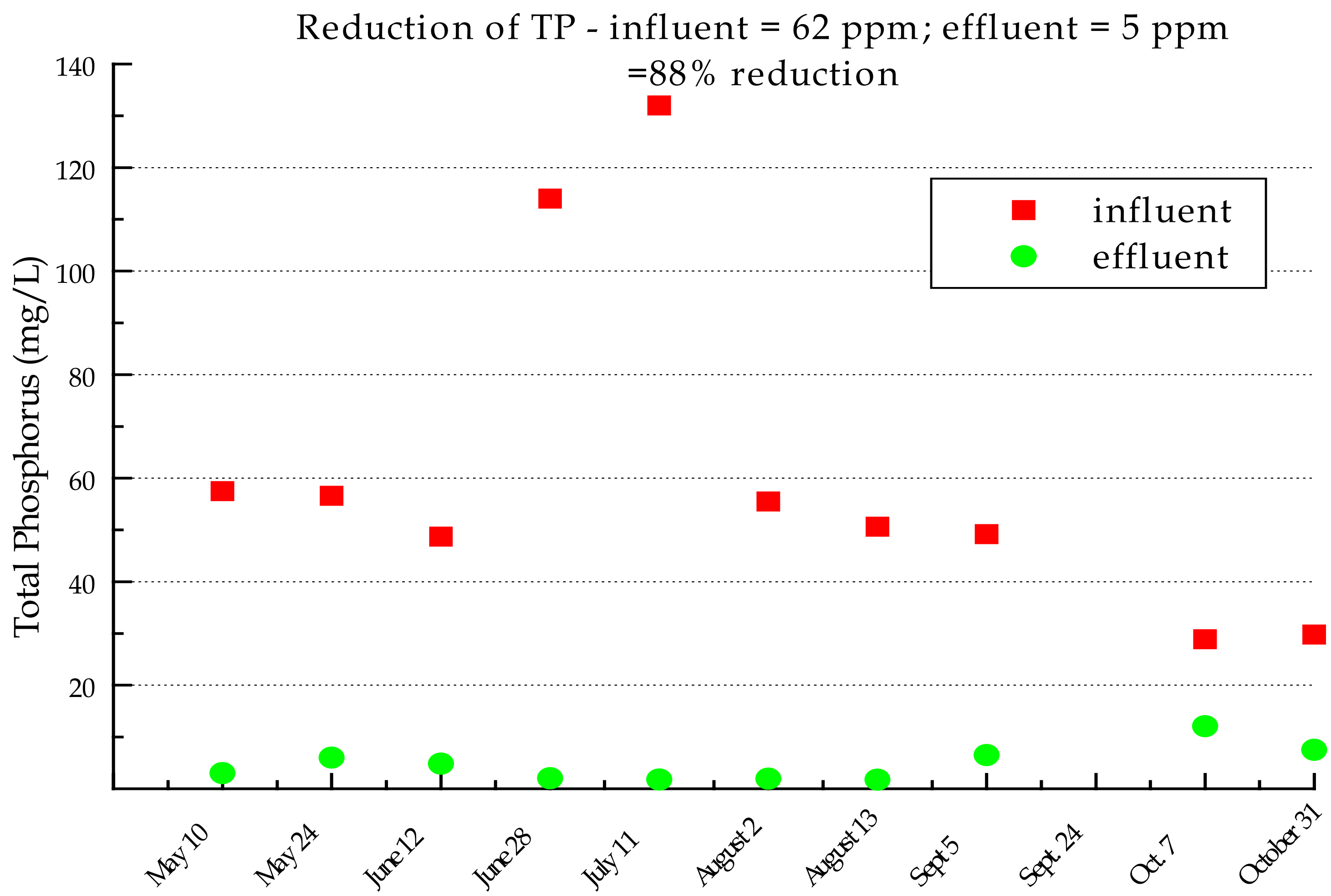
- Purpose: reduce odors from the storage lagoon
- 2,000 weaner pigs
- 2,000 L/day of Liquid Swine Manure drawn from the storage lagoon
- Treated water discharged back into the lagoon



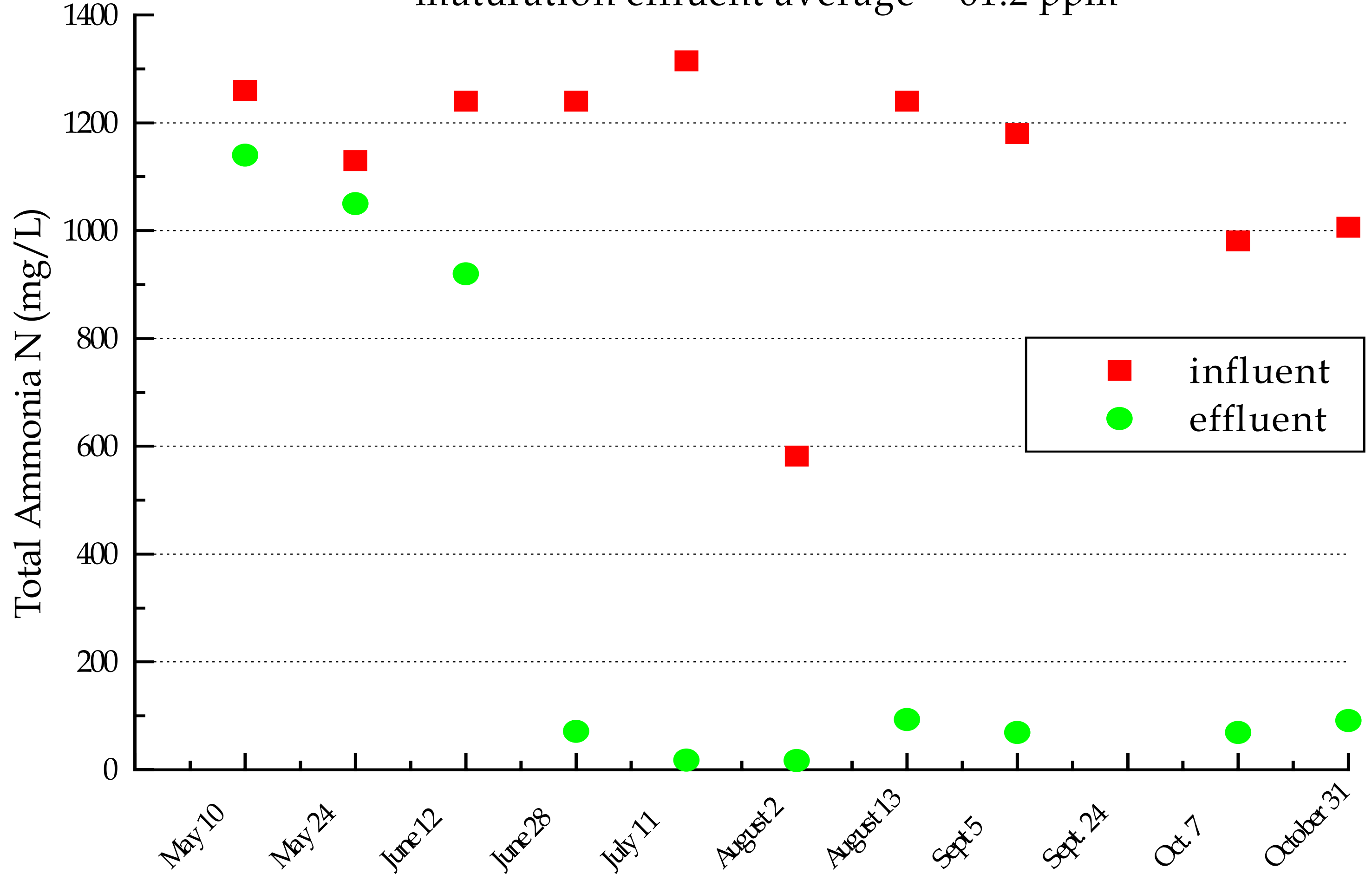
Reduction of BOD5 - influent = 1,967 ppm; effluent = 160 ppm
=89% reduction
BOD5 mg/L
4000
3000
2000
1000
0
influent
effluent
May 10
May 24
June 12
June 28
July 11
August 2
August 13
Sept 5
Sept. 24
Oct. 7
October 31



Reduction of TSS - influent = 2,900 ppm; effluent = 33 ppm
=95% reduction
suspended solids (mg/L)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
influent
effluent
May 10
May 24
June 12
June 28
July 11
August 2
August 13
Sept 5
Sept. 24
Oct. 7
October 31

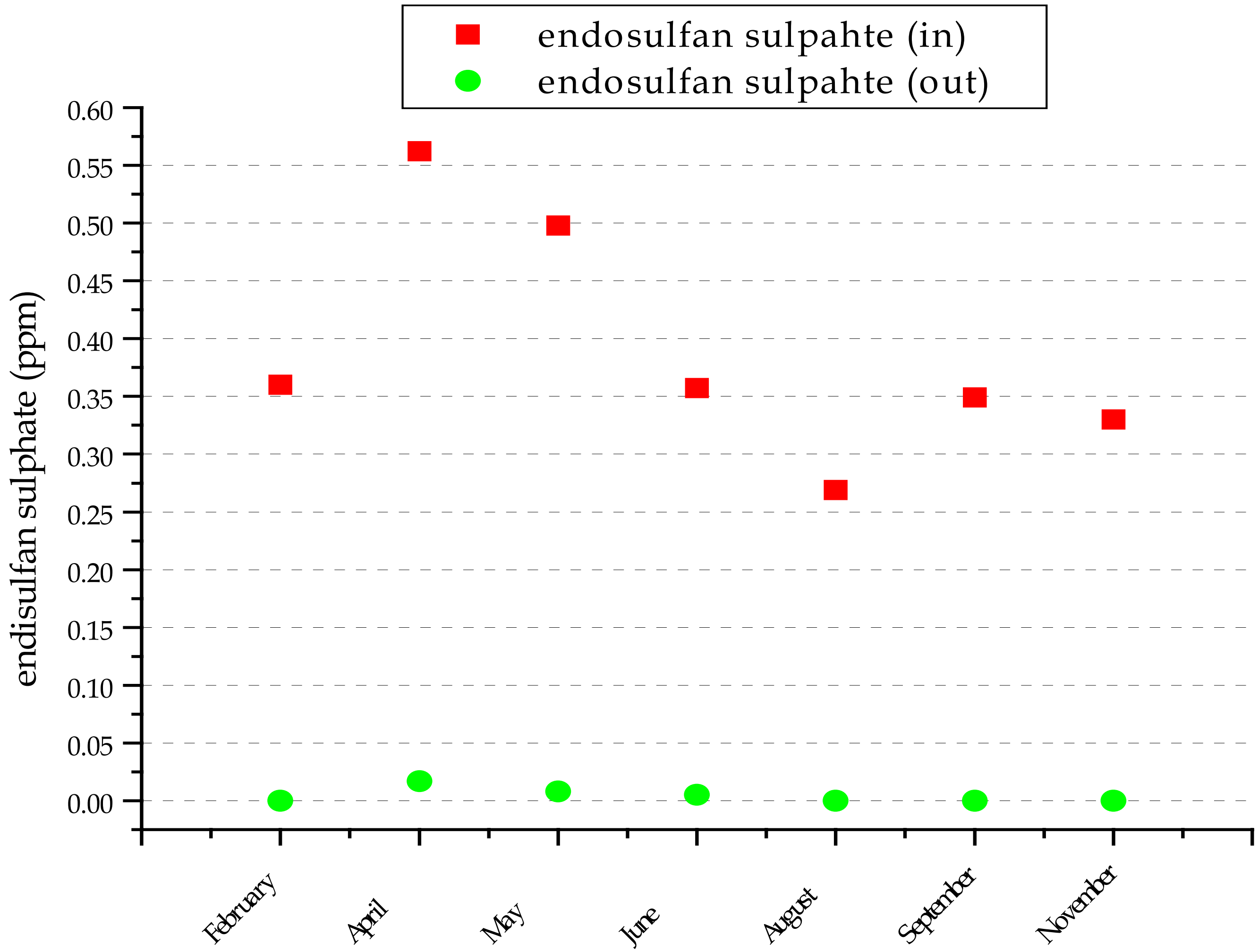

Reduction of TP - influent = 62 ppm; effluent = 5 ppm
=88% reduction
Total Phosphorus (mg/L)
140
120
100
80
60
40
20
influent
effluent
May 10
May 24
June 12
June 28
July 11
August 2
August 13
Sept 5
Sept. 24
Oct. 7
October 31

Reduction of Ammonia - influent = 1,117 ppm; after system maturation effluent average = 61.2 ppm



RosaFlora Greenhouses

- Treatment of irrigation leachate water
- 400,000 liters / day (100,000 gal/day)
- endosulfan (organochlorine pesticide)
- 2-300 times P.W.Q. Guidelines
- H.L. of 300 liters / m2 day (60 gal/yd^2)
- 1,600 yd^2 wetland system



endosulfan sulpahte (in)
endosulfan sulpahte (out)
endisulfan sulphate (ppm)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
February
April
May
June
August
September
November

SUMMARY

- **WM's investment in ACAP has been a huge success**
- **Use of alternate caps will expand if regulations are flexible**
- **Phytoremediation can enhance remedial technologies and enhance the end of post-closure care**

WASTE MANAGEMENT