Field Water Balance of Evapotranspiration Covers in Northwest Ohio

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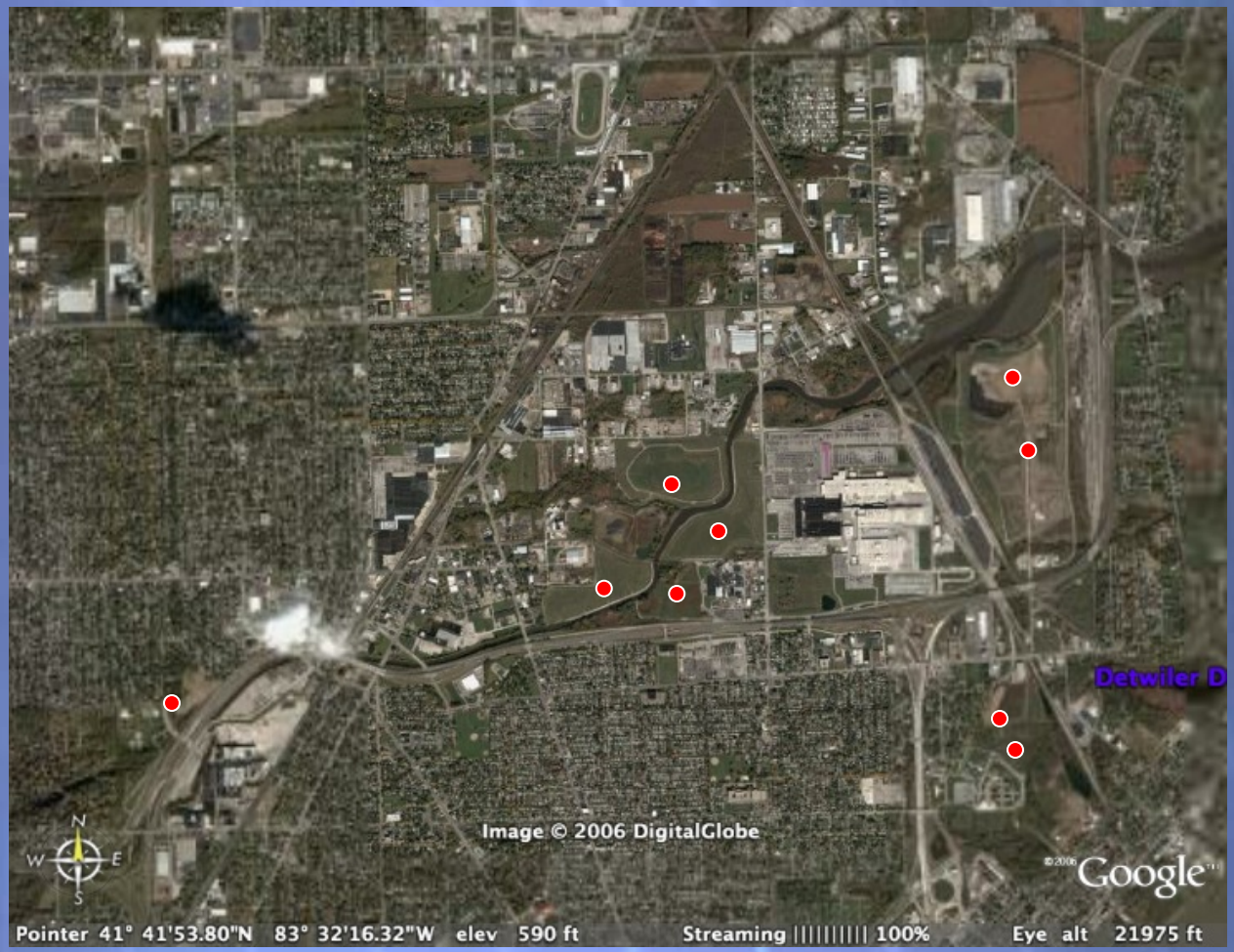
Issues of Concern

- Final closure of landfills and waste sites

Toledo, OH

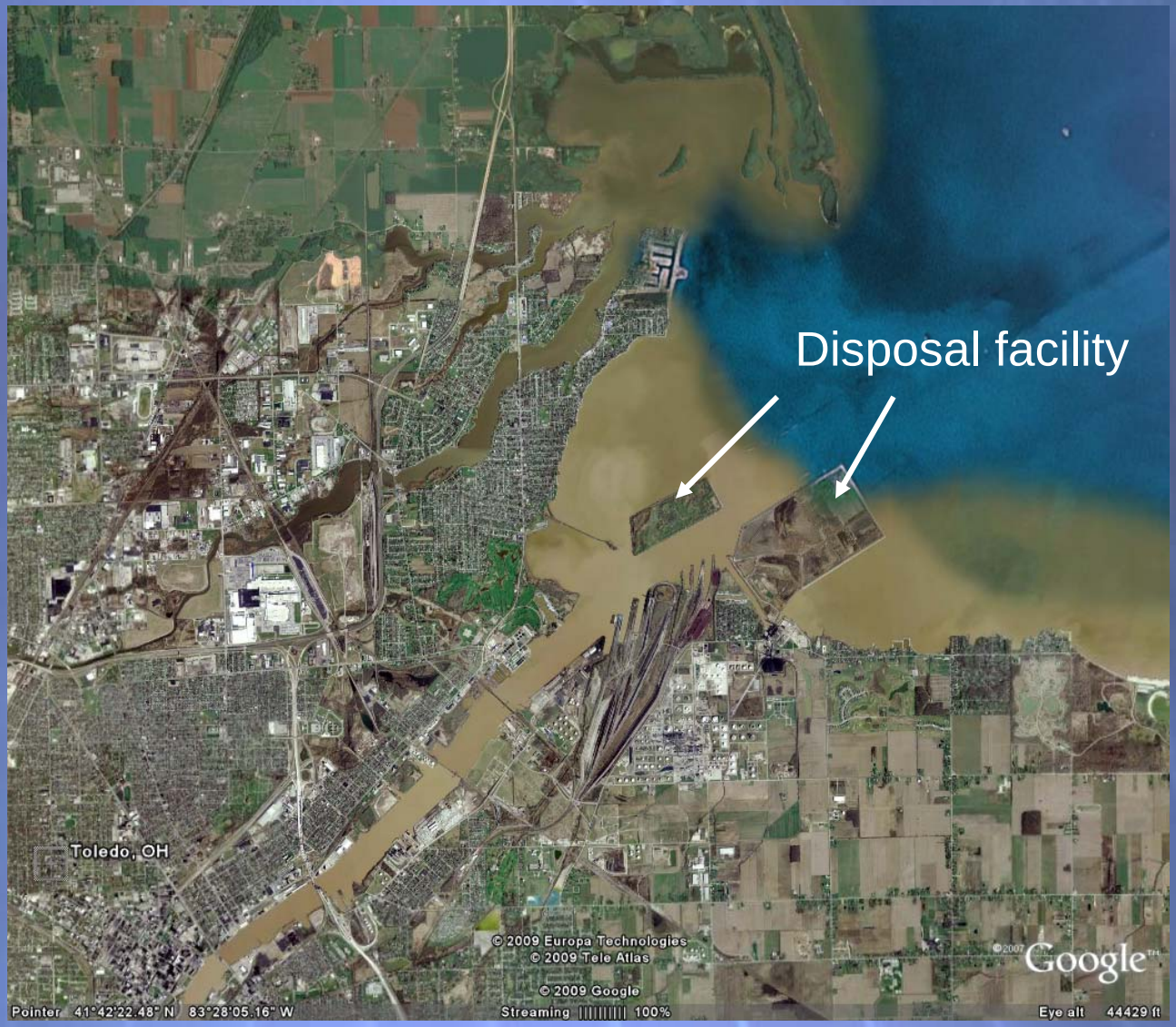


● = Landfill or waste site

Issues of Concern

- Final closure of landfills and waste sites
- Management of dredged sediment

Dredged sediment

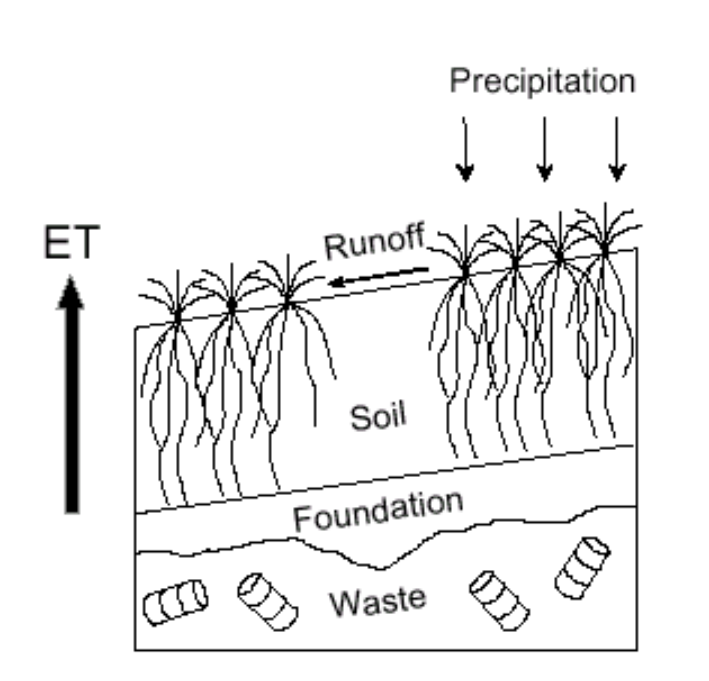


Contaminant	Dredged sediment (ppm)	U.S. Drinking Water Standards (mg/L)	Ohio - Land Application Standards (ppm)
Arsenic	11.3	0.01	75
Cadmium	7.5	0.005	85
Copper	96.4	1.3	4,300
Nickel	65.5		420
Selenium	11.4	0.05	100
Zinc	294.6		7,500

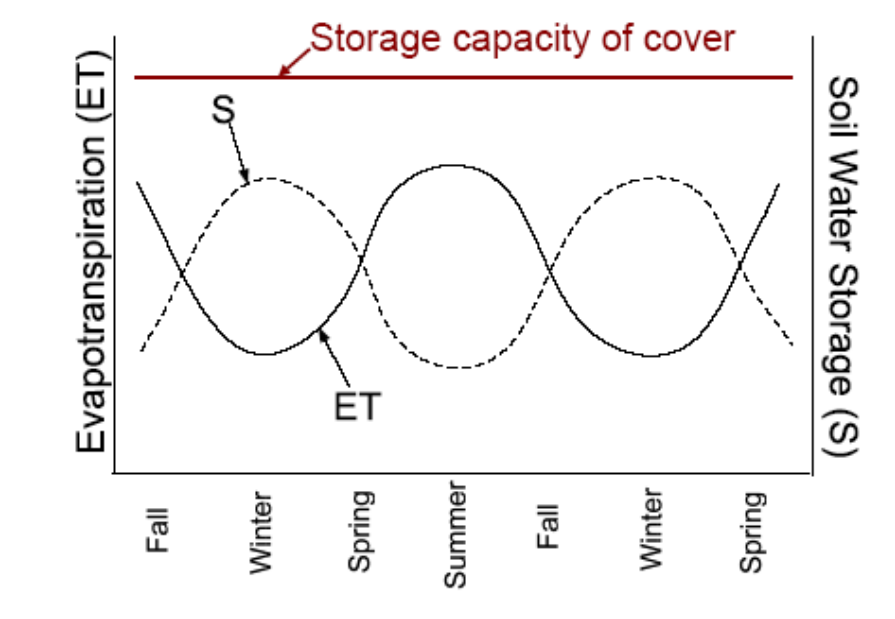
The goal of this research is to design a final cover for landfills and other waste sites that:

- Produces allowable rates of percolation
- Uses dredged sediment to increase the storage capacity in a disposal facilities
- Uses native plants to promote habitat restoration
- Cost less than conventional covers

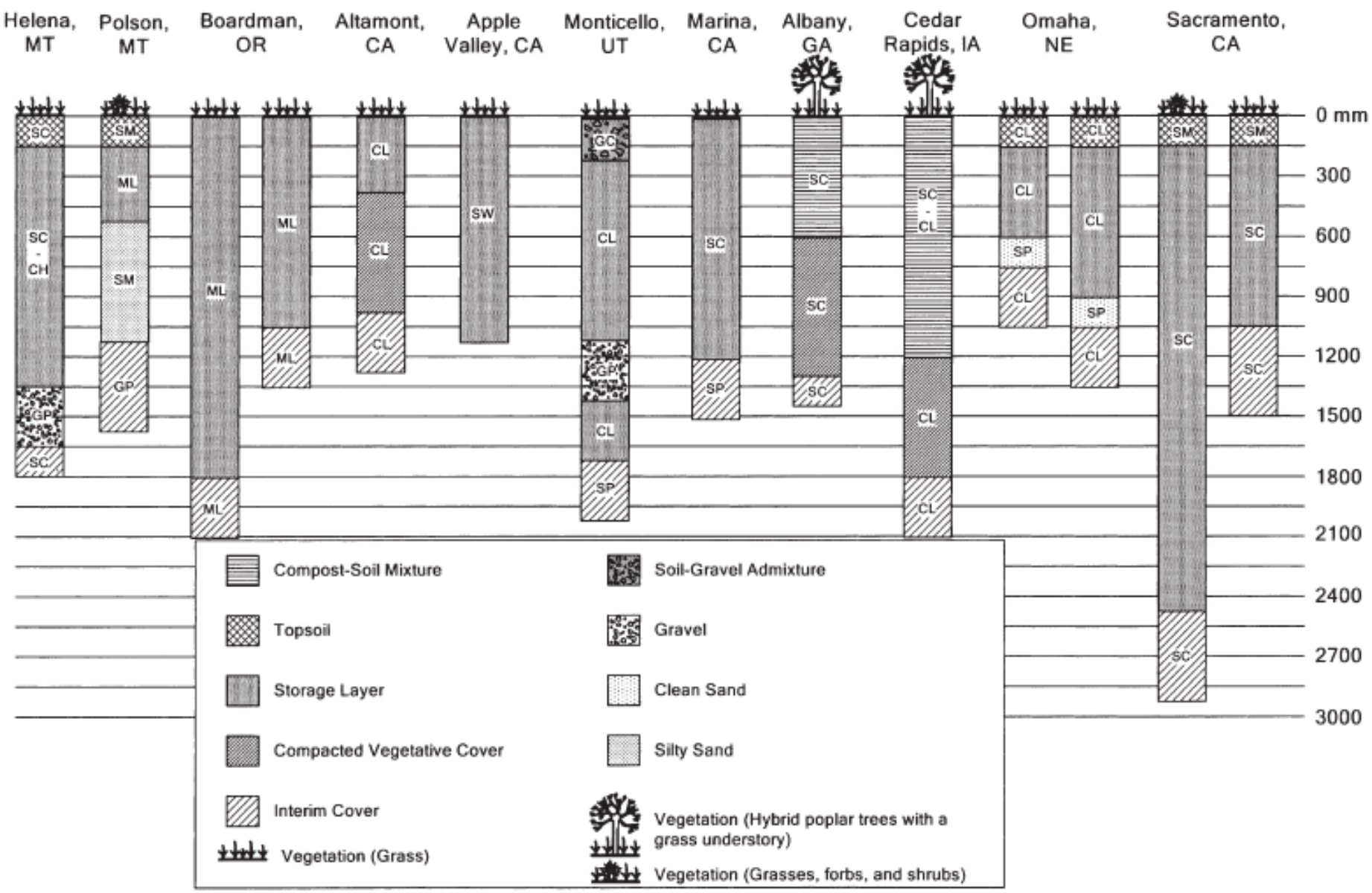
Evapotranspiration Covers



Hauser and Gimon, 2001



Benson et al. 2006



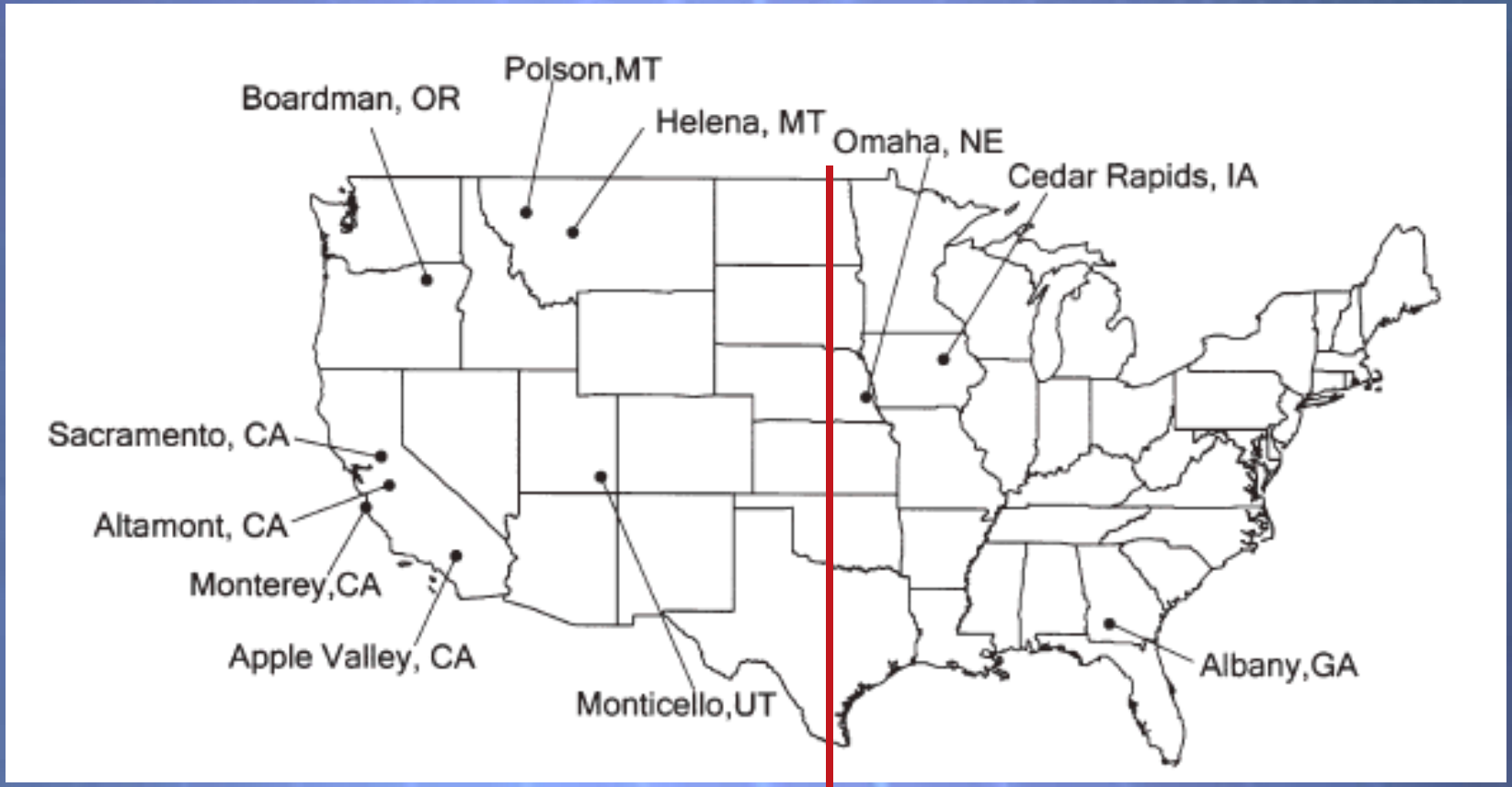
CL = low-plasticity clay; CH = high-plasticity clay; GC = clayey gravel;
GP = poorly graded gravel; ML = low-plasticity silt; SC = clayey sand;
SM = silty sand; SP = poorly graded sand; and SW = well-graded sand

Albright et al. 2004

Characteristics of plant species appropriate for an ET cover

- Native to the region
- Perennial
- Rapid growth rate
- Adapted to various soil conditions
- Have extensive root system
- Function over entire growing season

PROBLEM!!!



Albright et al. 2004

Factors leading to high percolation rates

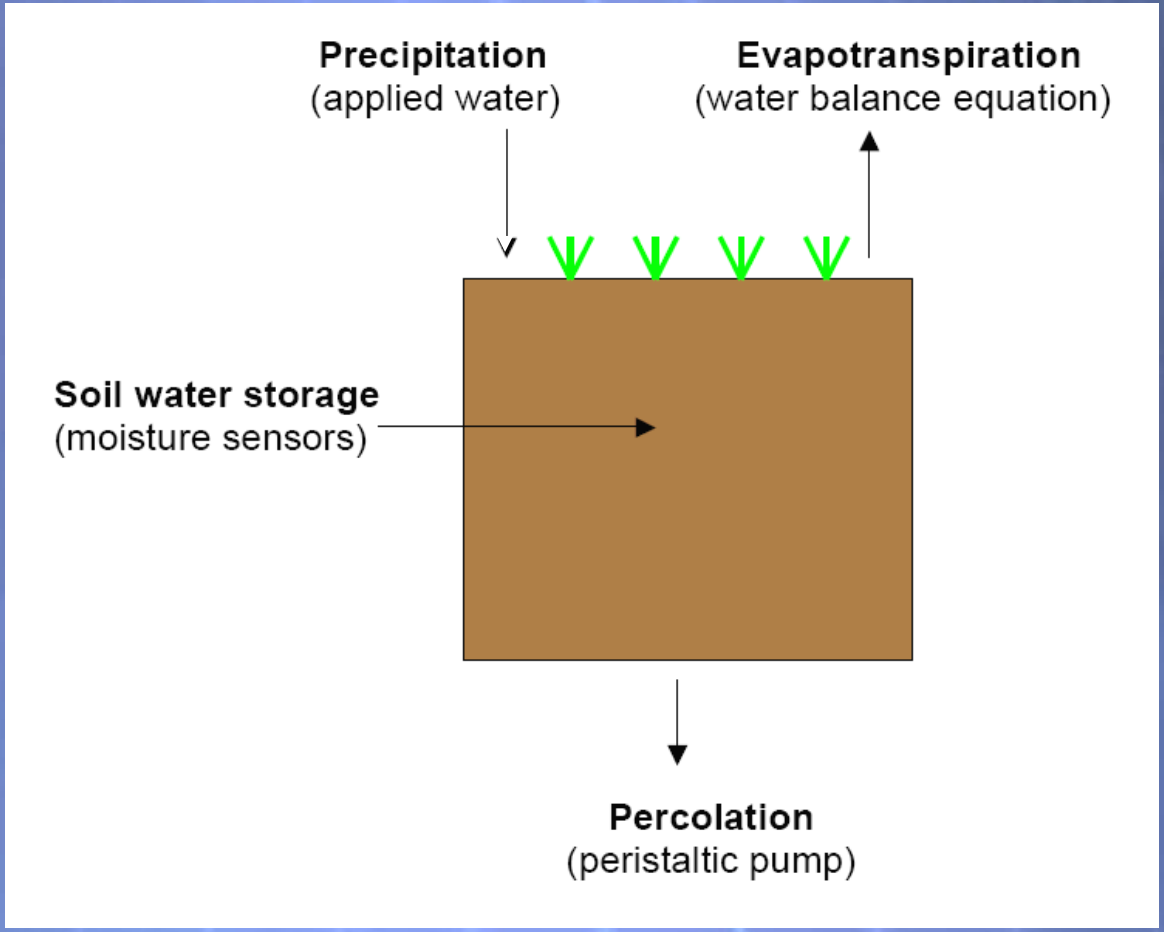
- Water storage capacity
- Plant species
- Duration of monitoring period

- Objectives

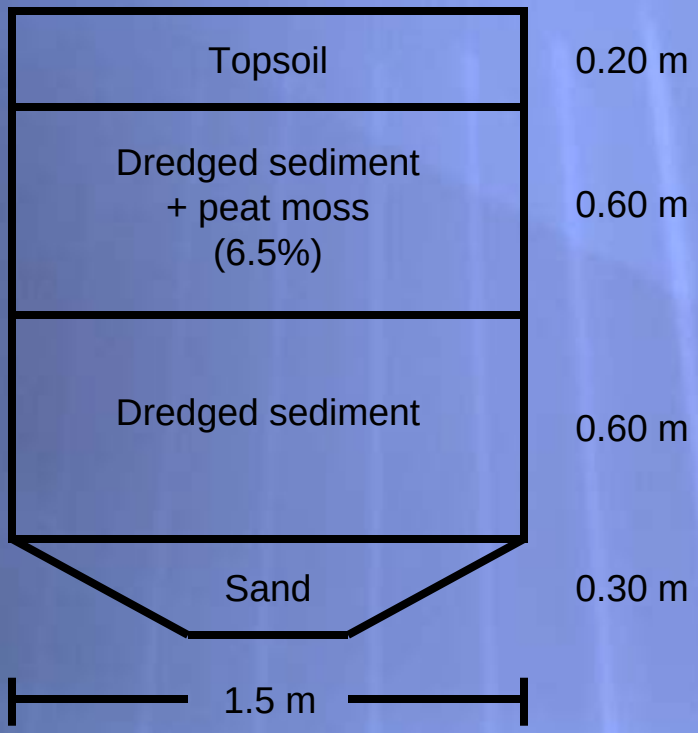
1. Monitor the performance of ET covers using mature vegetation and immature vegetation
2. Determine the suitability of ET covers for northwest Ohio

- Rate of percolation less than 32 cm per year is considered *successful*.

P = ET + SWS + PER


Precipitation
(applied water)
Evapotranspiration
(water balance equation)
Soil water storage
(moisture sensors)
Percolation
(peristaltic pump)

Soil profile



In-ground lysimeter

Soil	Sand %	Silt %	Clay %	FC ($cm^3\ cm^{-3}$)	K_s ($cm\ sec^{-1}$)
TS	72.33	14.67	13.0	0.20	8.9×10^{-4}
DS + PM	45.33	40.0	14.67	0.35	1.6×10^{-3}
DS	45.33	40.0	14.67	0.31	2.9×10^{-4}
Sand	100	0	0	0.10	4.8×10^{-3}

Under construction in late May

- Treatments:
  - Mature vegetation (5-10 yrs old)
  - Immature vegetation (seeds)
- Watering regimes:
  - Simulate 2006 (116 cm)
  - 100-yr rainfall event (11.7 m over 24 hrs)

Mature vegetation: big bluestem, Canada goldenrod

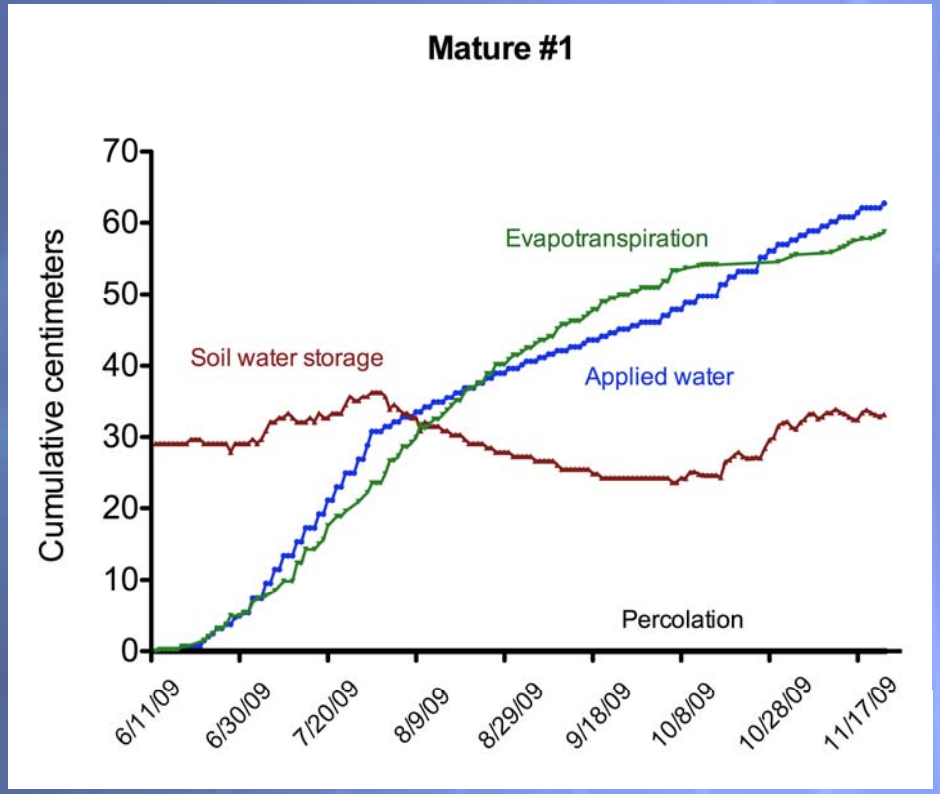
Immature vegetation: big bluestem, black-eyed susan, indian grass, little bluestem, poverty grass, stiff goldenrod, switchgrass, tall boneset, virginia wildrye, yarrow

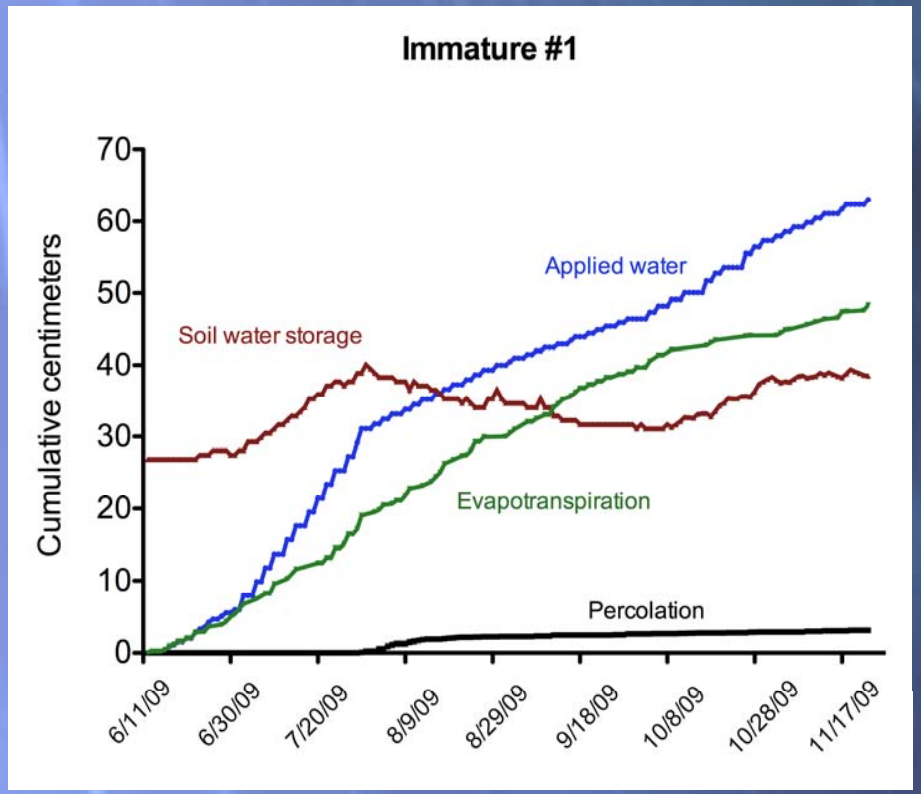
June 5, 2009

July 16, 2009

November 2, 2009

November 2, 2009


Mature #1
Cumulative centimeters
70
60
50
40
30
20
10
0
Evapotranspiration
Soil water storage
Applied water
Percolation
6/11/09
6/30/09
7/20/09
8/9/09
8/29/09
9/18/09
10/8/09
10/28/09
11/17/09


Immature #1
Cumulative centimeters
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Applied water
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6/11/09
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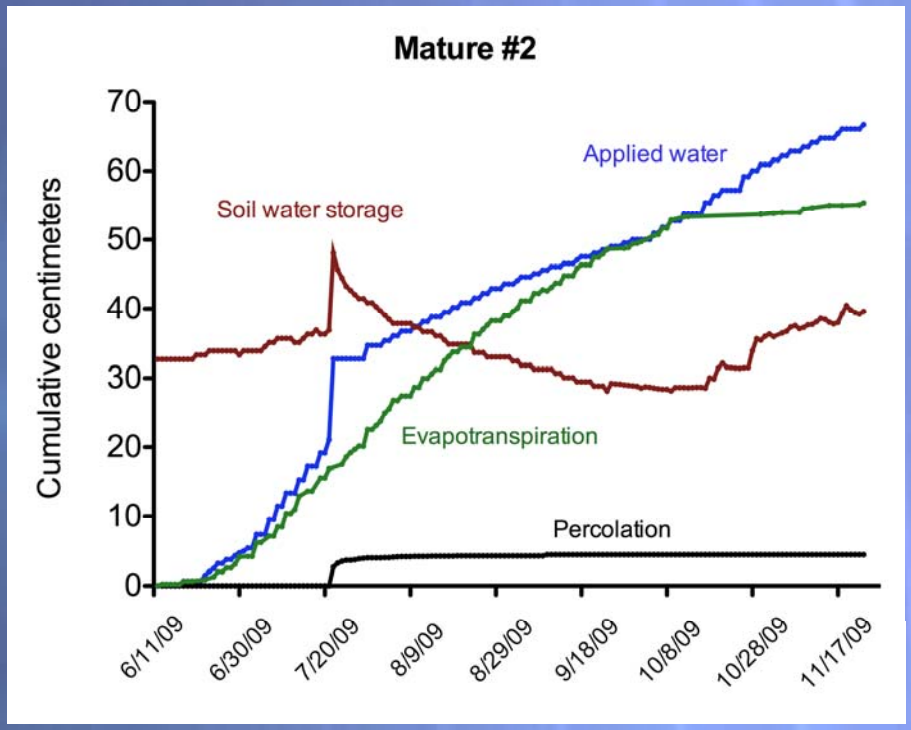
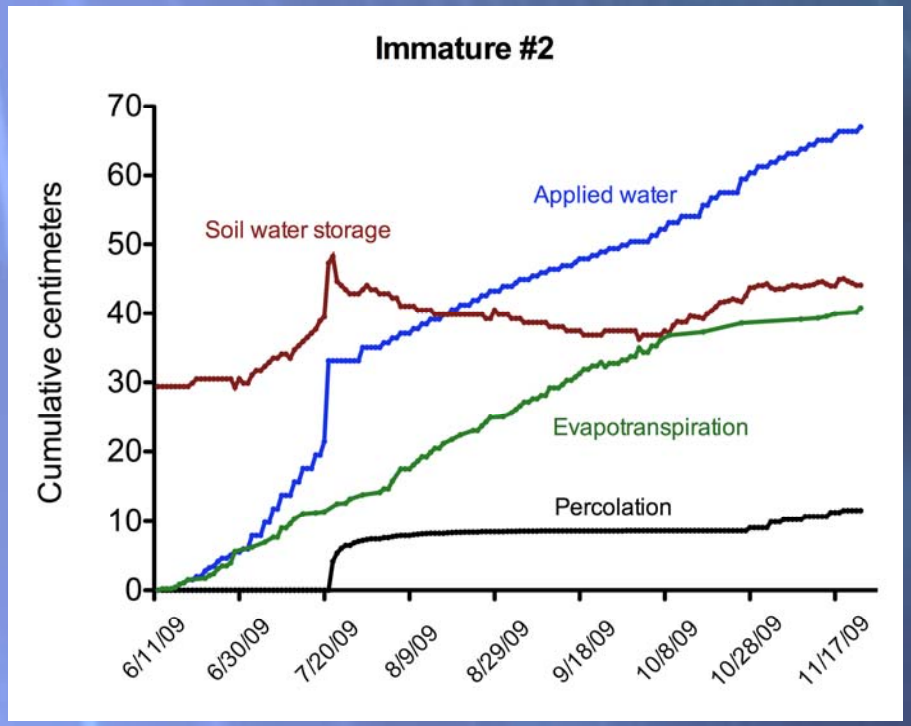

Mature #2
Cumulative centimeters
70
60
50
40
30
20
10
0
Applied water
Soil water storage
Evapotranspiration
Percolation
6/11/09
6/30/09
7/20/09
8/9/09
8/29/09
9/18/09
10/8/09
10/28/09
11/17/09


Immature #2
Cumulative centimeters
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50
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10
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Applied water
Soil water storage
Evapotranspiration
Percolation
6/11/09
6/30/09
7/20/09
8/9/09
8/29/09
9/18/09
10/8/09
10/28/09
11/17/09

Summary

Totals	Mature #1	Immature #1	Mature #2	Immature #2
Applied water (cm)	62.72	63.05	66.69	67.02
ET (cm)	58.70	48.39	55.37	40.80
P:ET	1.07	1.30	1.20	1.64
Percolation (cm)	0.00	3.08	4.46	11.53
Percolation rate (cm yr^{-1})	0.00	6.77	9.81	25.35

Future work

- Monitor ET covers through the 2010 Spring
- Simulate ET cover performance using ‘Soil and Water Assessment Tool’ (SWAT)
- Monitor ET covers on-site

Acknowledgments

- USDA Cooperative State Research, Education, and Extension Service (Grant #2006-38894-03732)
- National Science Foundation: GK-12 Program
- University of Toledo Stranahan Arboretum
- S & L Fertilizer
- Deanna Bobak, Matt and Ryan Gorr, Rajiv McCoy, Jordan Rofkar, Adam Waltz
- Hull & Associates, Inc.