

# Trees & Soils:

## How much can they alter Urban Hydrology?

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# Elements of perviousness tied to trees and soils

- Canopy intercepts and directs rainfall
- Soil surface permits water infiltration
- Soil subsurface transmits/stores water

# Soil Characteristics and Management Affect these Elements of Perviousness

- Canopy
  - Soil quality affects tree size, growth rate, and survival
- Soil surface
  - Surface cover/mulch, grade affect infiltration
- Subsurface transmission/storage
  - Tree root distribution, depth affects transmission of water along root channels
  - Soil physical characteristics determine storage and transmission potential







# Characteristics of these elements—

Spatially variable

Temporally variable

Strongly affected by site-level management





What is the  
uncertainty in  
these elements  
of perviousness?

Canopy

Soil surface  
transmission

Soil subsurface  
transmission/storage

# Site-level Effects on Canopy

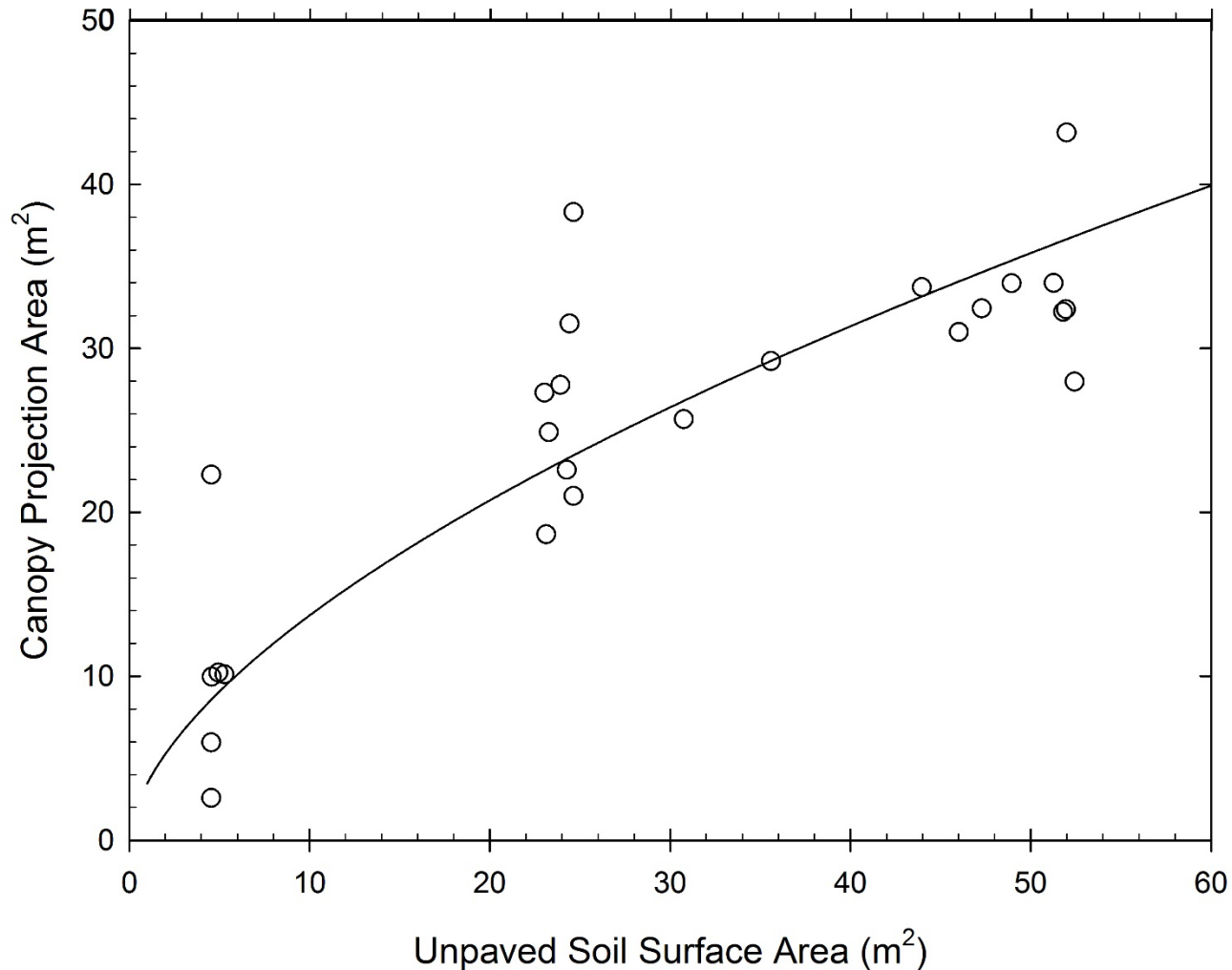




# Site-level Effects on Canopy



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Day & Amateis (2011) *Urban Forestry & Urban Greening*



# Site-level Effects on Canopy

*Tilia tomentosa* after 14 yrs...

# of trees to equal 1 acre: 112  
# of trees to equal 1 hectare: 278

# of trees to equal 1 acre: 809  
# of trees to equal 1 hectare: 2000



# Site-level Effects on Canopy

*Ulmus* 'Morton' After 6 years...

Agricultural Soil

# of trees to equal 1 acre: 130

# of trees to equal 1 hectare: 321

Simple grading, urban  
land use change

# of trees to equal 1 acre: 191

# of trees to equal 1 hectare: 472

Rehabilitated soil

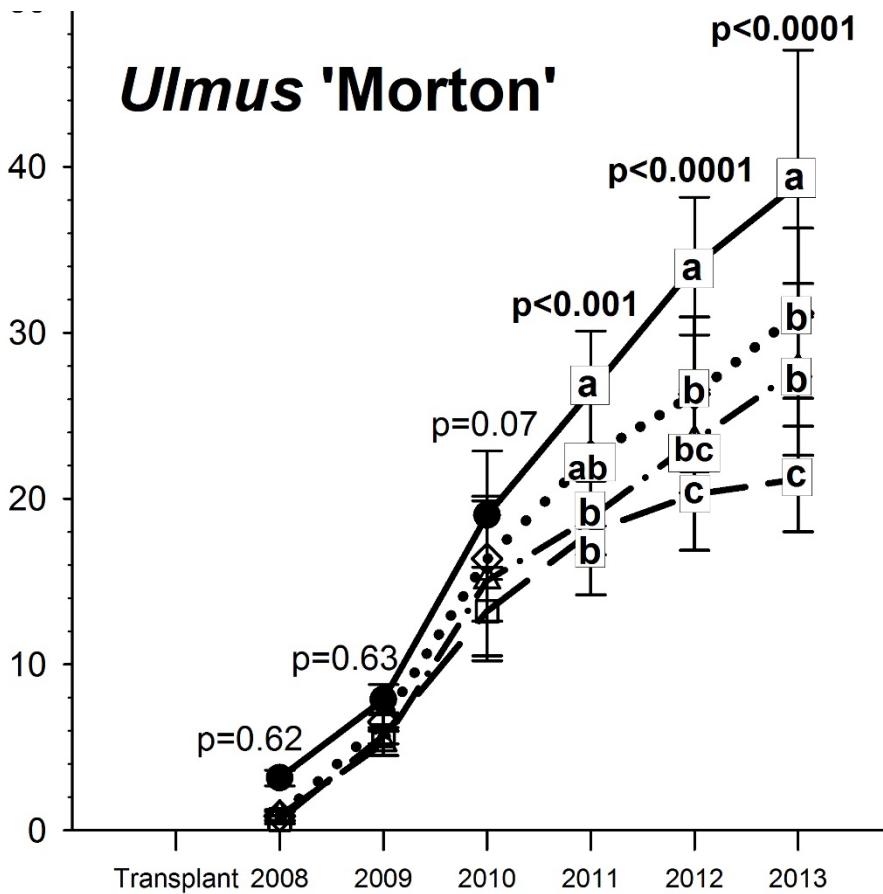
# of trees to equal 1 acre: 104

# of trees to equal 1 hectare: 256

Layman et al. in preparation



# Site-level Effects on Canopy



After 6 years...  
divergence of growth

Layman et al. in preparation

# Surface Treatments



Mitchell et al.



# Surface Treatments have traditionally been thought of in terms of moisture retention and weed suppression









# Preliminary Data— Rainfall intercepted/retained

**Bare soil—~16 mm**

**Pea Gravel with Geotextile underlay—~13 mm**

**Hardwood Bark—~23 mm**

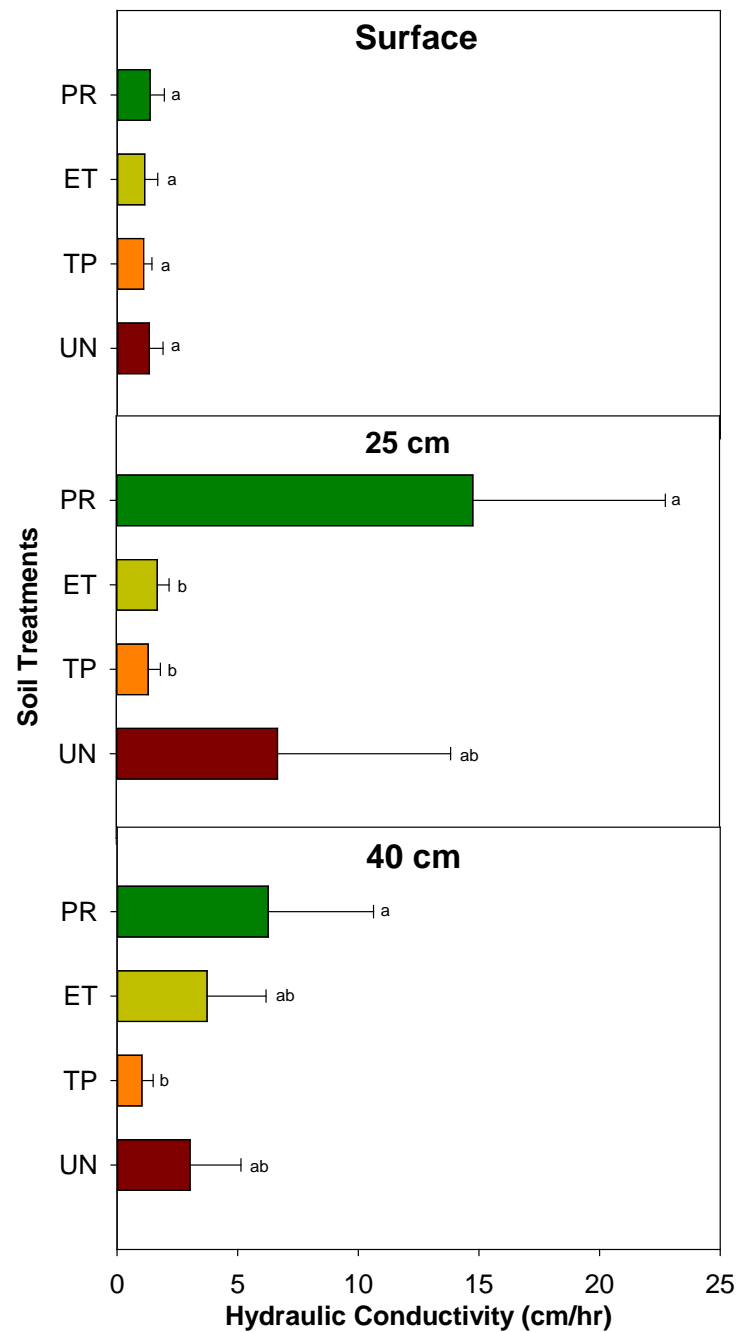
**Pine Straw—~20 mm**

Caveats—variability high, data collection ongoing,  
varying moisture conditions

Mitchell et al.

# Internal Drainage

Subsoil drainage meets or exceeds undisturbed condition





# Site-level Effects Subsurface Permeability 10-40 cm (Ksat)

Agricultural Soil—4 to 5 cm/hr  
Compare to HSG **B**

**Urban land  
use change**



Simple grading, urban land use change—1 to 2 cm/hr  
Compare to HSG **C or D**

**Soil  
Management**

Rehabilitated soil—10 to 11 cm/hr  
Compare to HSG **A or B**

Chen et al. in review

# Site-level Effects Subsurface Permeability

Roots can increase  $K_{sat}$ , but only if they penetrate soil.

*Acer rubrum*—from 4.7 cm/hr to 10.8 cm/hr

*Quercus velutina*—from 4.7 cm/hr to 14.04 cm/hr

*Fraxinus pennsylvanica*—from 0.17 cm/hr to 4.7 cm/hr

The lower the initial infiltration, the greater the potential increase.

Bartens et al. (2008) *J. Env. Qual.*

# Uncertainty in elements of perviousness tied to trees and soils

- Canopy intercepts and directs rainfall
  - Canopy size, density, morphology
- Soil surface permits water infiltration
  - Management can change HSG
- Soil subsurface transmits/stores water
  - Greater than rainfall potential, or less



# Uncertainty in elements of perviousness tied to trees and soils

- Canopy X soil surface X subsurface
- However, these factors are linked, so magnitude of effect is likely greater—rather than likely to cancel each other out



Thank you  
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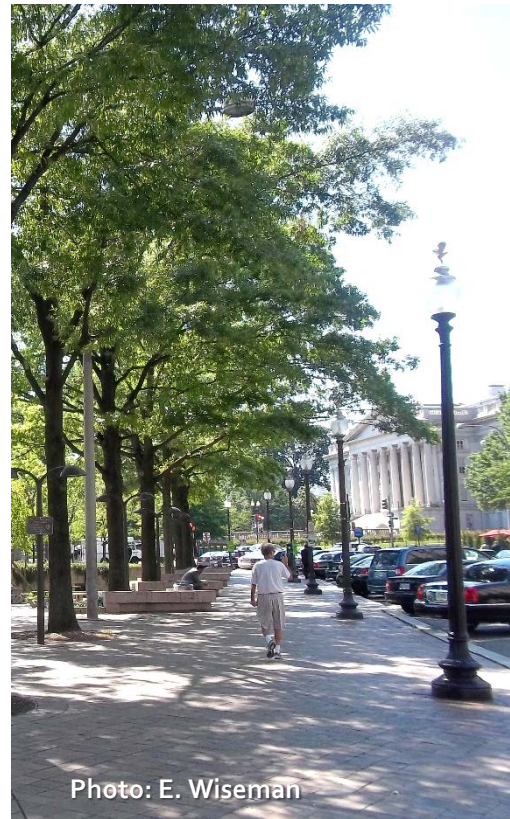


Photo: E. Wiseman