

USDA Forest Service

URBANFOREST CONNECTIONS

webinar series

Second Wednesdays | 1:00 – 2:15 pm ET

www.fs.fed.us/research/urban-webinars



Forest Service
Urban Natural Resources Stewardship

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GIVE ME THE NUMBERS: HOW TREES AND URBAN FORESTS REALLY AFFECT STORMWATER RUNOFF



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Give Me the Numbers: How Trees and Urban Forests Really Affect Stormwater Runoff

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Typical Urban Development

- Remove tree canopy cover
- Remove ground cover
 - Vegetative
 - Detritus (mulch)
- Remove permeable top soil
 - Leaving dense subsoil
- Disturb/compact/pave over remaining soil
- Grass sod over subsoil



Image courtesy of Google Earth

Background

- 2010- State of Indiana valued statewide street trees providing \$24.1 million in stormwater management ([Davey Resource Group, 2011](#))
- Street trees provide approximately \$200/km in stormwater benefits (*Berland and Hopton, 2014*)



Tools for Design

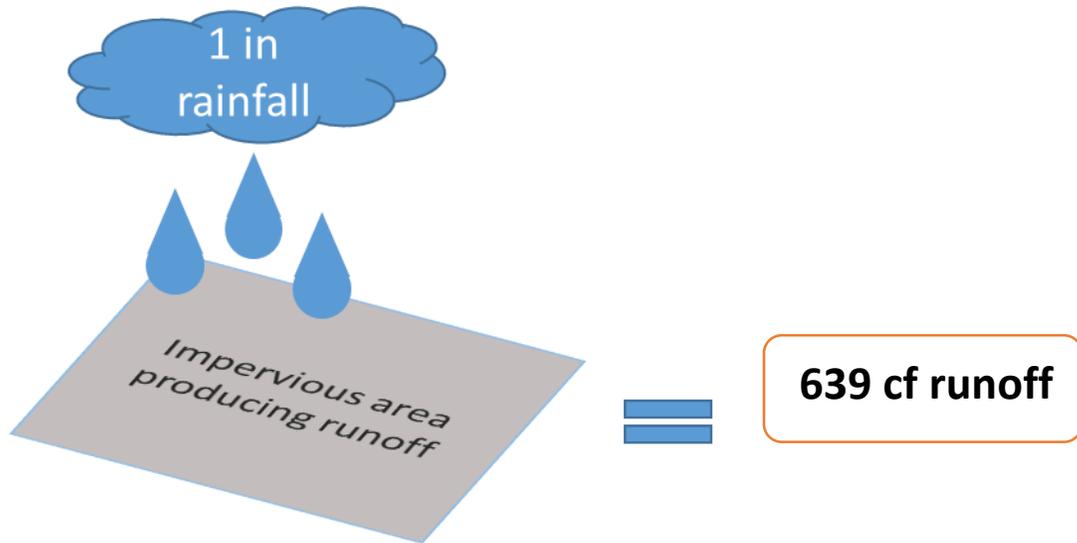
- Water Environment & Resuse Foundation (WERF)
 - Estimates Curve Numbers for BMPs
 - Site Design of BMPs including Urban Trees and Tree Box Filters

$$CN = \frac{1}{Area_{Total}} \sum_i CN_i Area_i$$

Practice/Land Type	CN
Rain gardens	35
Infiltration practices	40
Porous pavement	40
Soil amendments	60
Vegetated swales	60
Tree cover	70
Rain barrels/cisterns	75
Vegetated roofs	75
Downspout disconnection	80
Filter strips	80
Pocket wetlands	80
Tree box filters	85
Urban area	90
Impervious area	98

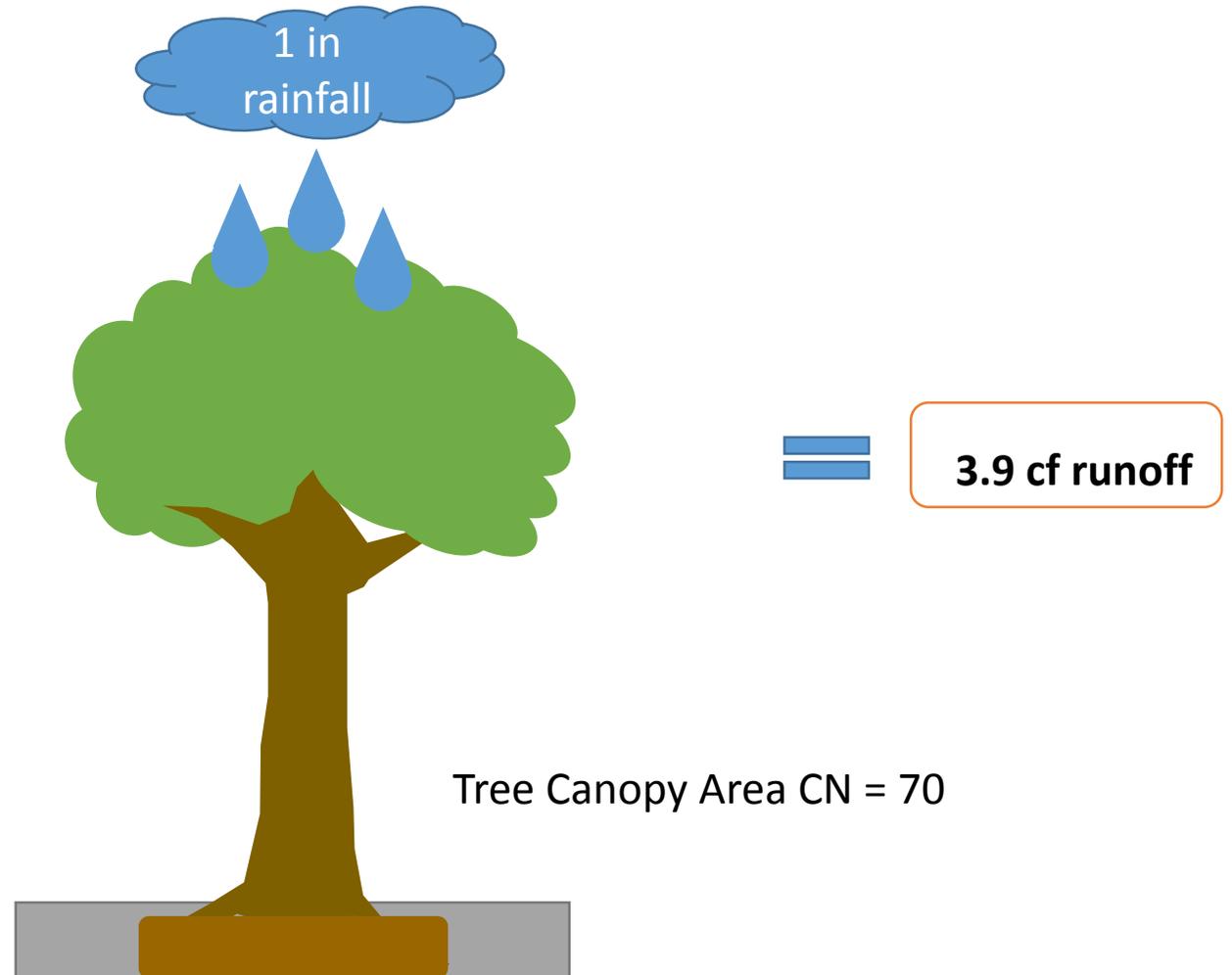
For Example : 10,000 sq ft of impervious cover

Without Trees



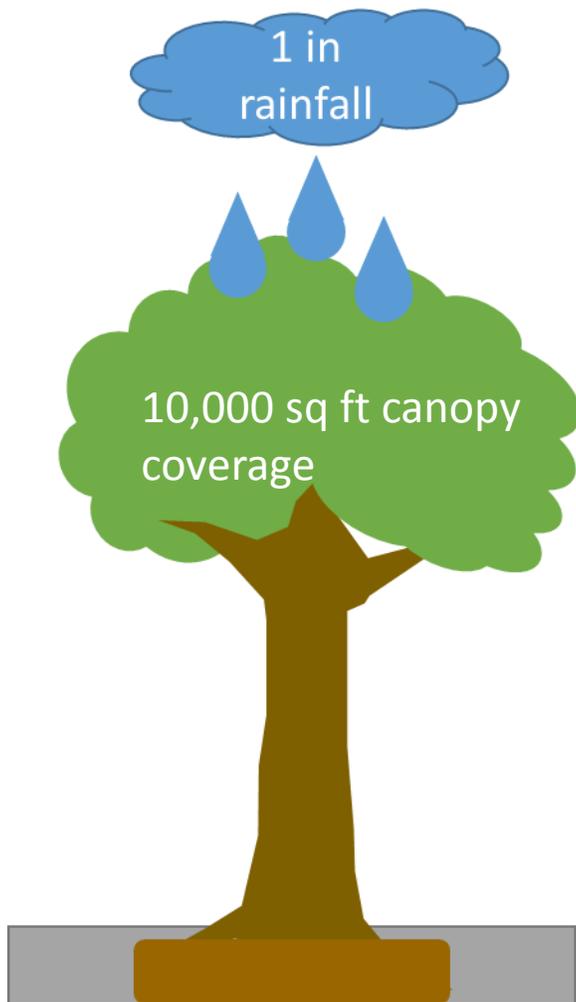
100% Impervious Cover CN = 98

With Trees

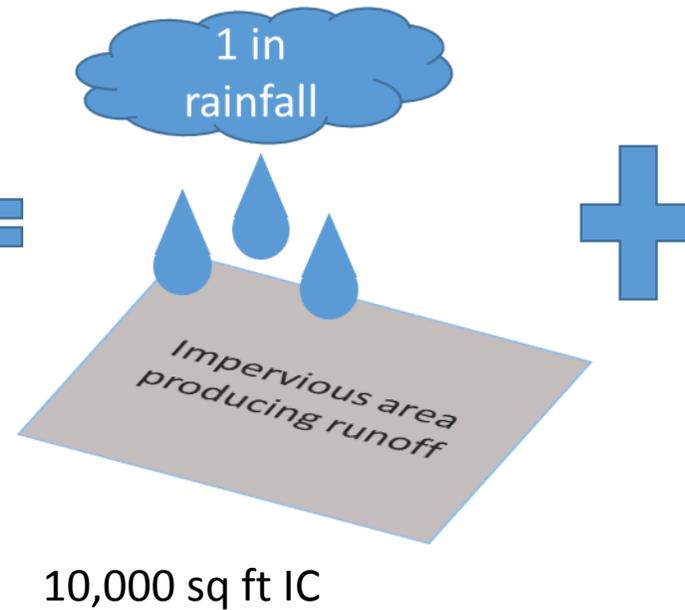


Tree Canopy Area CN = 70

Replacing trees with BMPs

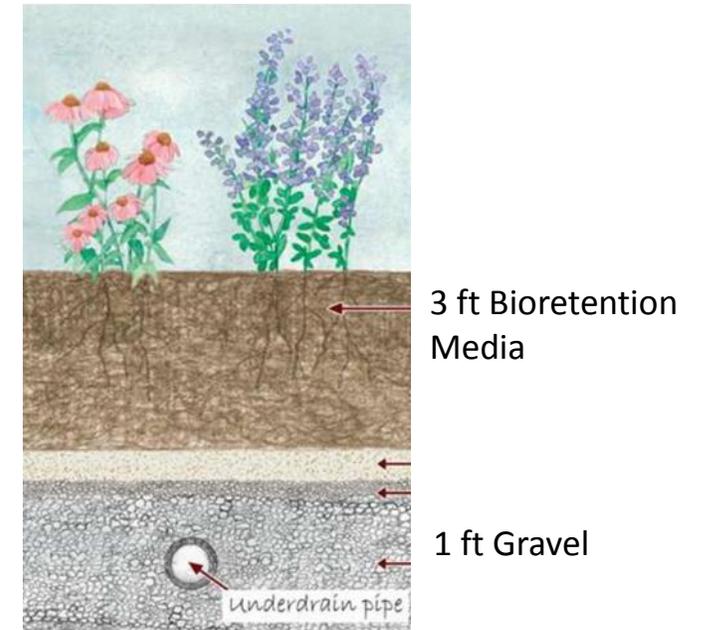


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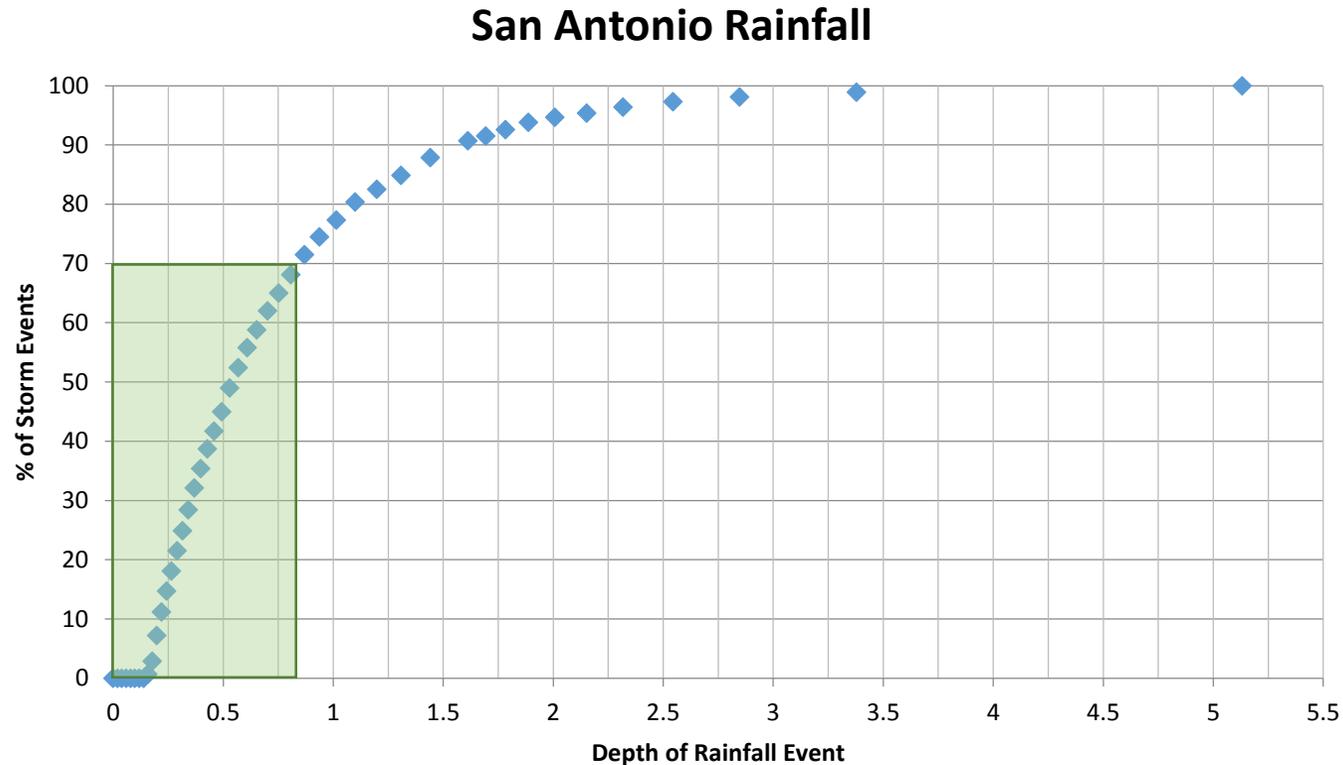
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Stormwater BMPs



655 cf = 25'x 10' Bioretention ~ \$2,500

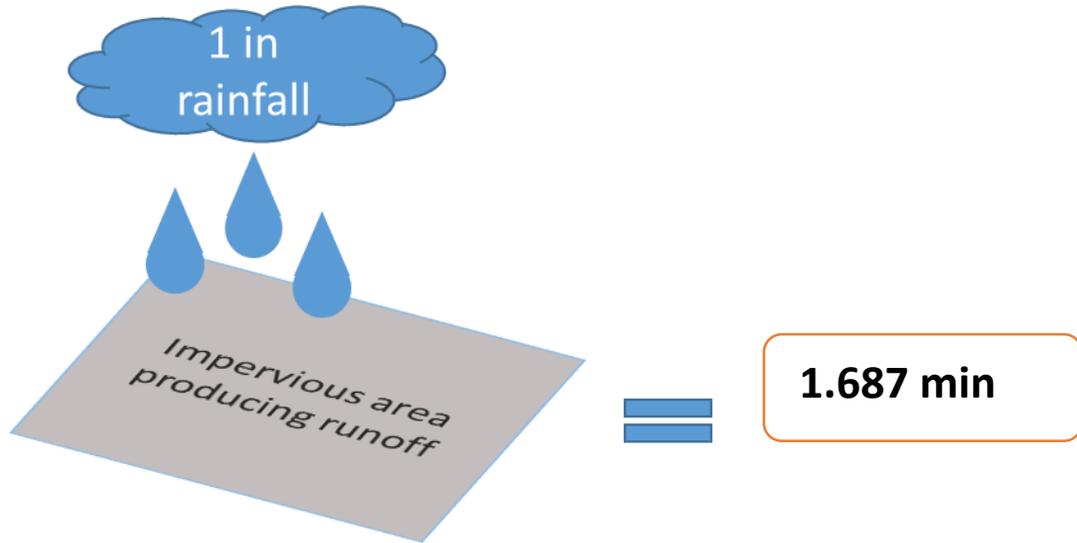
How an urban tree performs



- Provides 0.2 in to 0.8 in/unit canopy area *initial abstraction*
- San Antonio Texas = 25 to 70 % of Rainfall Events

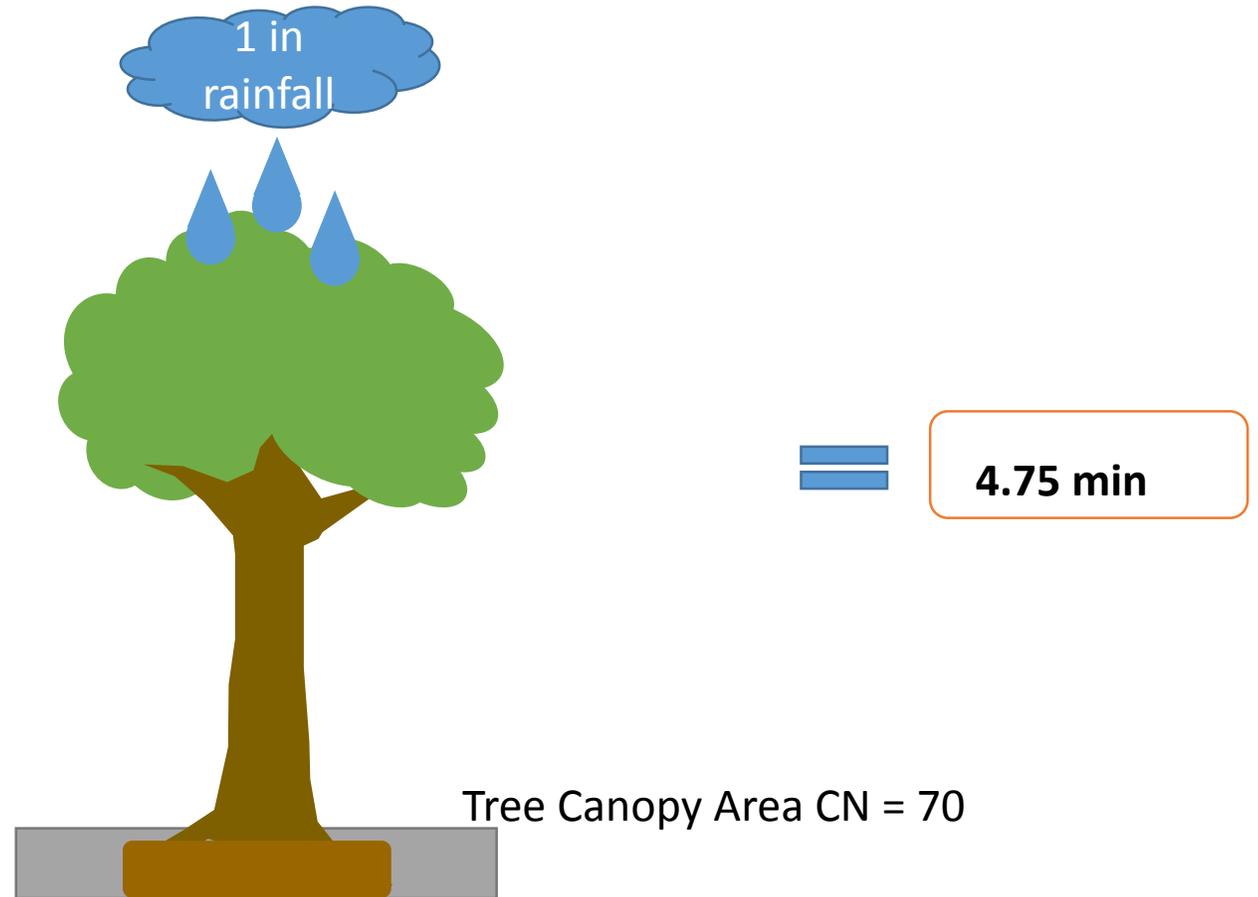
Beyond Volume...Time of Concentration

100 ft Without Trees



100% Impervious Cover CN = 98

100 ft With Trees

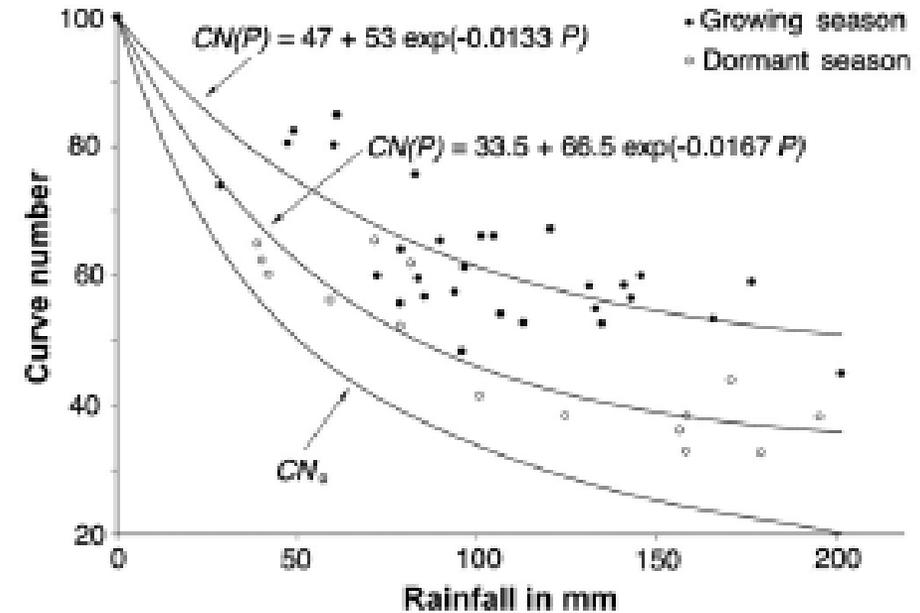


Tree Canopy Area CN = 70

183% decrease in flow

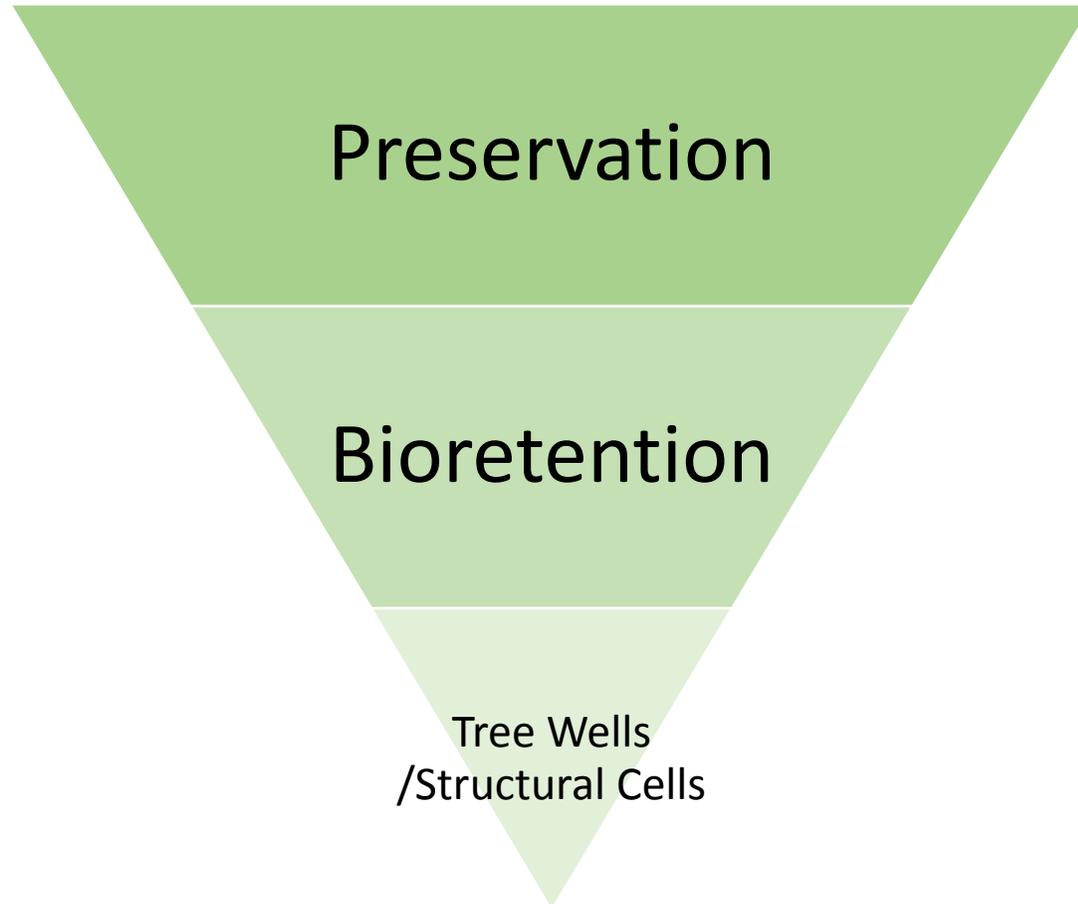
Remember...

- The Curve Number methodology (SCS) is an empirical parameter for **estimating** direct runoff .
- The method is impacted by soil type and antecedent conditions.
- Types of tree and time of year impacts the performance of the tree system.



(Tedela et al., 2012)

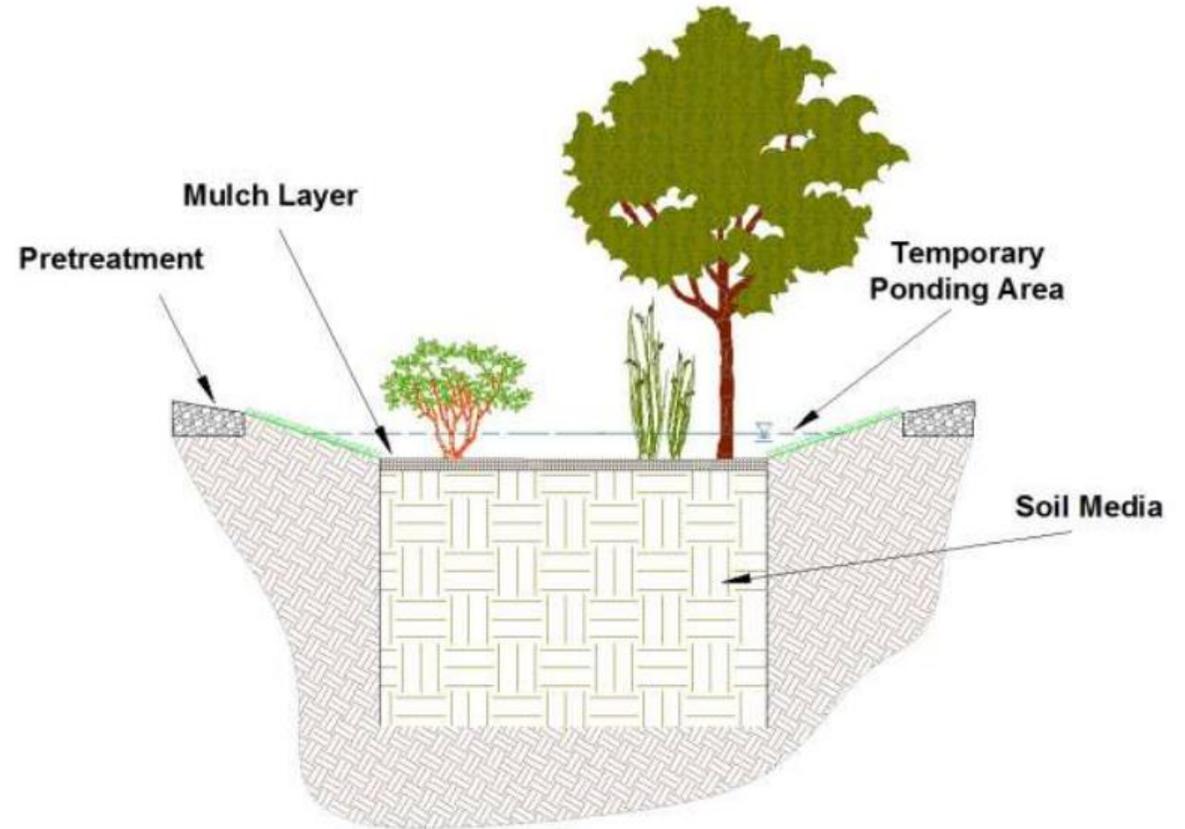
Using Trees in Urban BMPs



- Where possible preserve existing trees
 - Typically larger trees and provide more benefits than new smaller trees
- Incorporate Trees into BMPs such as bioretention, wetlands, etc
- Break up paving surfaces with tree wells

Tree BMP Guidance

- North Carolina
 - “A minimum of one (1) tree, three (3) shrubs, and three (3) herbaceous species should be incorporated in the bioretention planting plan unless it is a grassed cell.”
- Minnesota
 - “Incorporating trees into traditional bioretention practices is *Highly Recommended*.”
[\(\[http://stormwater.pca.state.mn.us/index.php/Types_of_tree_BMPs\]\(http://stormwater.pca.state.mn.us/index.php/Types_of_tree_BMPs\)\)](http://stormwater.pca.state.mn.us/index.php/Types_of_tree_BMPs)



Best of both worlds...



Photo Credit: Aarin Teague

- Interception or rainfall within the canopy can improve infiltration within bioretention.
- Between 46% and 72% of stormwater abstraction in bioswales can be attributed to trees (*Scharenbroch et al., 2016*)

Using Trees to Meet Stormwater Credit

Portland, OR

2004 Stormwater Management Manual

- Subtract Impervious Cover under trees within 25 feet of impervious cover that meets certain criteria
- Existing Tree = 50% of Existing Canopy, New Trees = 100 to 200 ft² of impervious cover

Indianapolis, IN

2007 Stormwater Green Infrastructure Supplemental Document

- Credits for new or exiting tree canopy within 20 feet of impervious surfaces.
- 1 tree= 100 ft² of Impervious Cover

Pine Lake, GA

2003 Ordinance

- Trees count towards site runoff requirements
- Trees = 10 to 20 gallons/in DBH

Minnesota

Volume, TSS, Phosphorus Credit

- Based on interception, evaporation, and infiltration
- Example : Mature Red Maple with infiltration area= 340 cf

Philadelphia, PA

2011 Stormwater Manual

- Reduction in impervious area

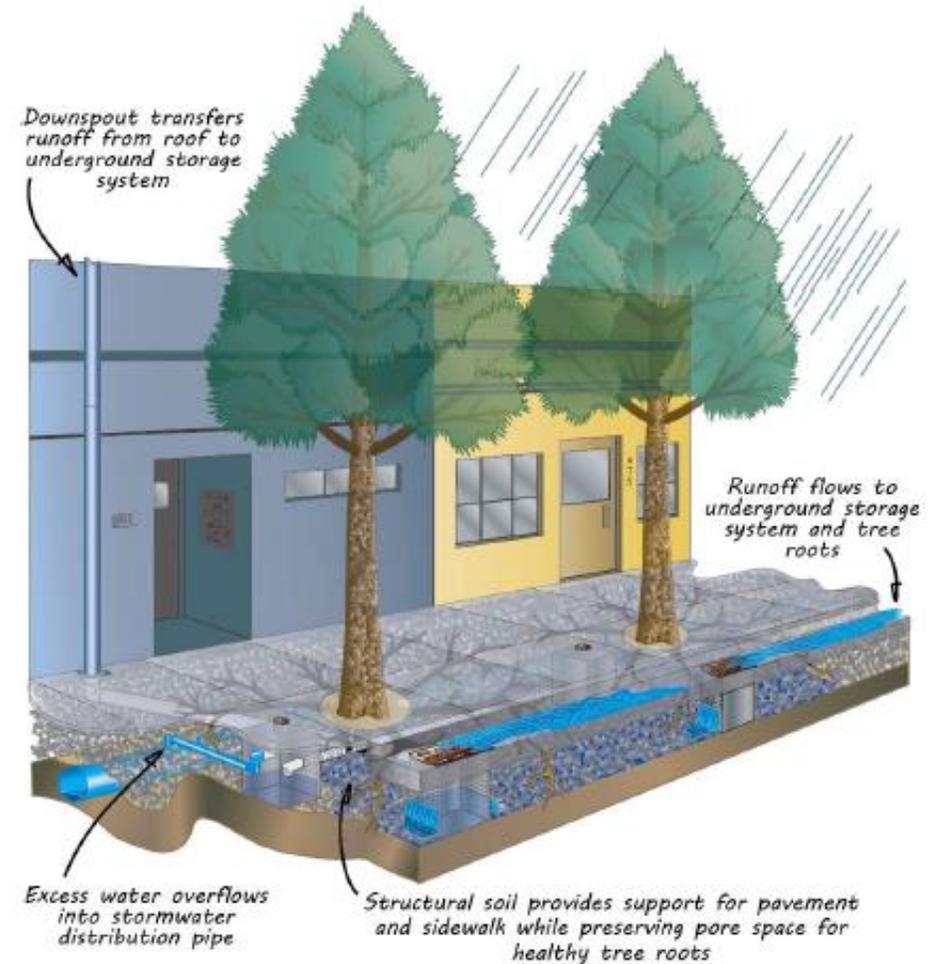
Washington, DC

2013 Guidebook

- Trees receive retention value
- Preserved Trees = 20ft³; New Trees = 10 ft³

Common methods for using urban trees as a BMP

- Tree Trenches or Boxes
- Structural Cells and Suspended Pavements
- Structural Soils
- Constructed Wooded Wetlands
- Wooded Extended Detention Basins
- Forested Filter Strips



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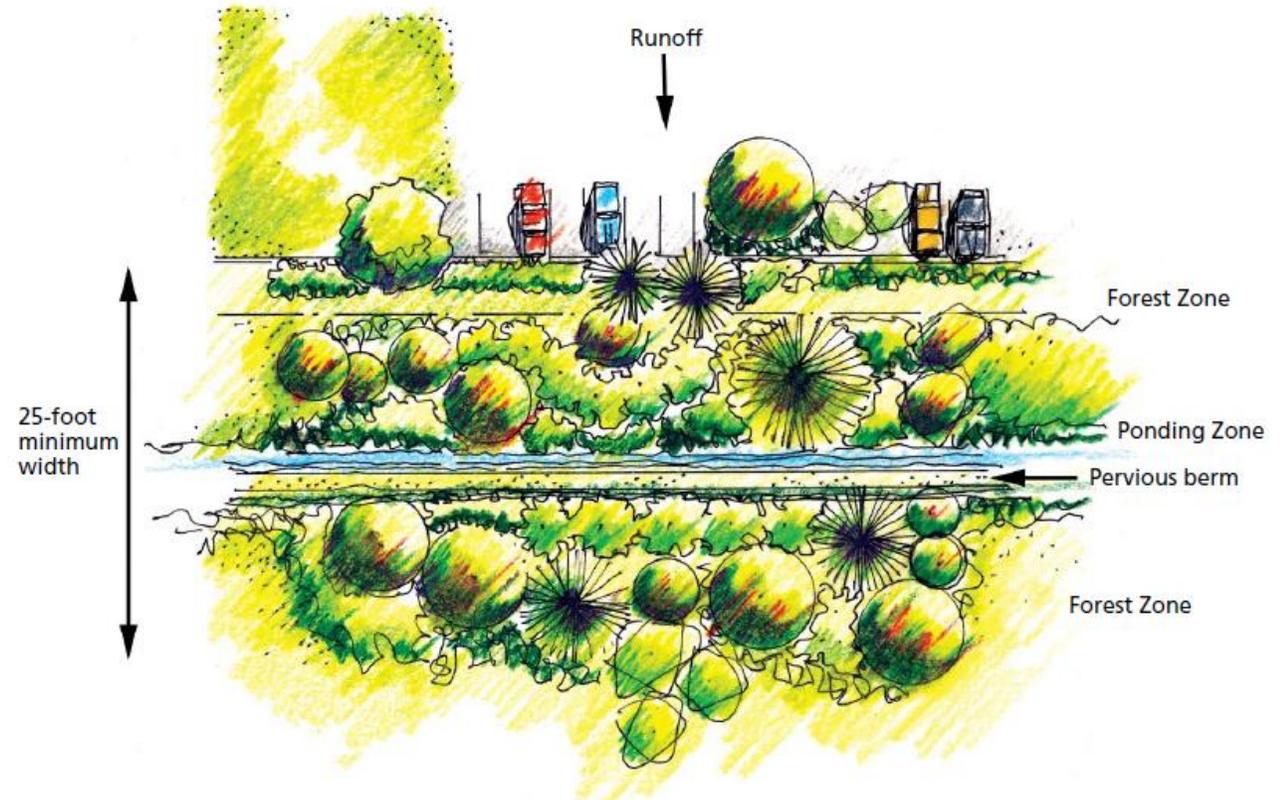


Credit Forest for Watersheds

<http://static1.1.sqspcdn.com/static/f/244488/1971760/1222816243880/Planting+Trees+in+Stormwater+Treatment+Dry+Ponds.pdf?token=pWqghh0lj3DrYFbF3rP14P0K710%3D>

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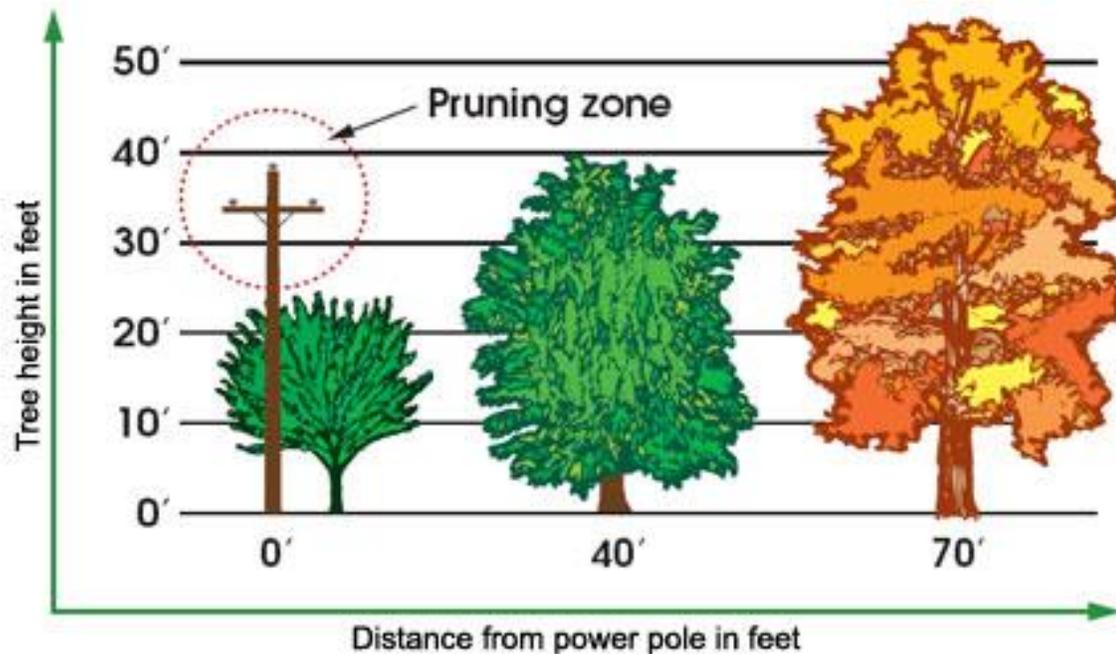


Credit Forest for Watersheds

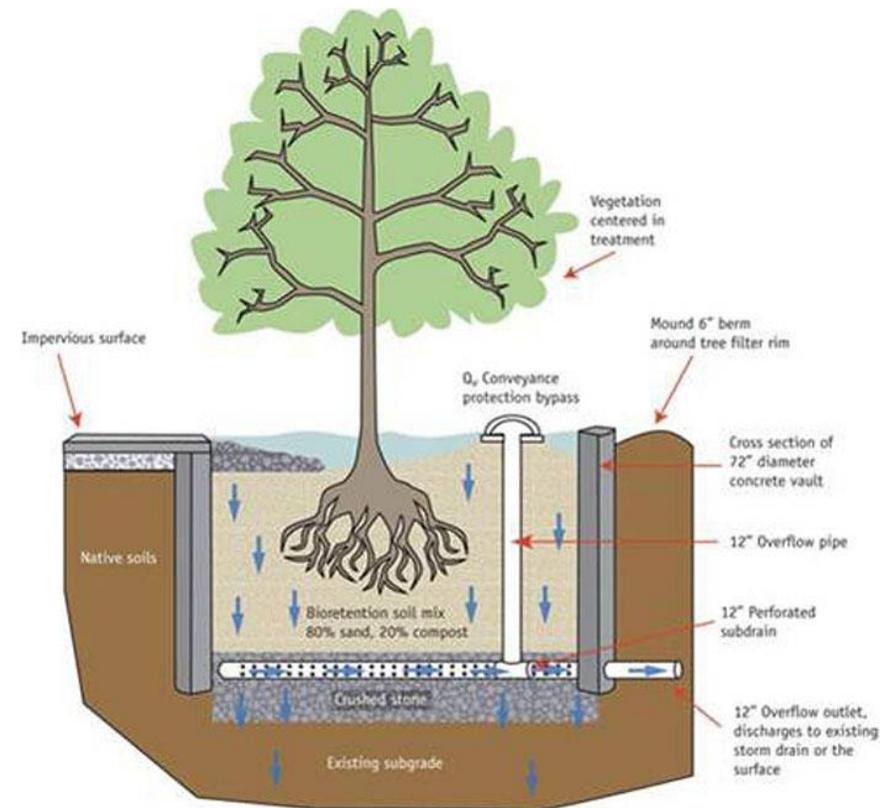
<http://static1.1.sqspcdn.com/static/f/244488/1971754/1222816187907/Forested+Filter+Strip.pdf?token=xloOchNlbzC6JuugUNtmfyCPjHk%3D>

Remember...

- Right Tree, Right Place, Right Time, Right Way



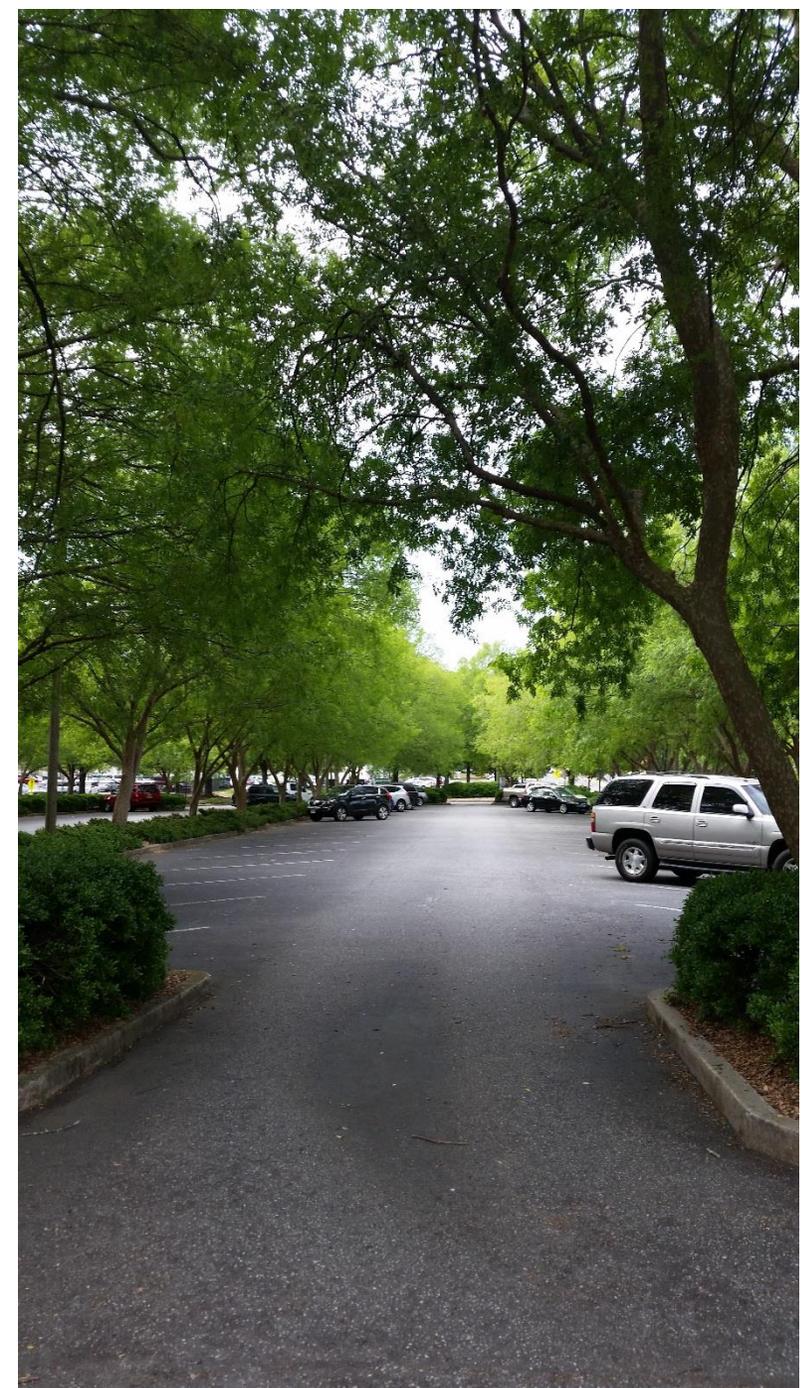
Credit Madison Gas and Electric
<https://www.mge.com/environment/trees-landscape/tree-planting.htm>



Credit Rutgers <https://njaes.rutgers.edu/pubs/fs1209/>

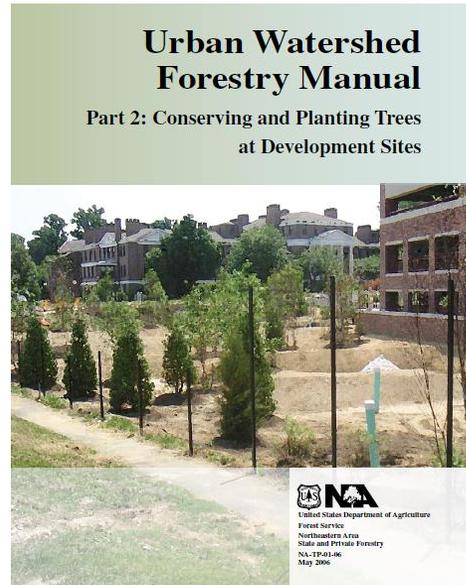
Conclusion

- Tree canopy retains rainfall
 - ~20% annual rainfall under canopy
 - First 2-4 mm of rainfall
 - 0.2 mm per m² of leaf area
- Canopy cover reduces rainfall intensity
 - Deciduous canopy 15 – 21%
 - Coniferous canopy 21 – 52%
- Trees transpire
 - ~1.5mm/day/m² canopy cover
 - 0.3 – 2.6 mm/day/ m² leaf area
 - Species and microclimate dependent



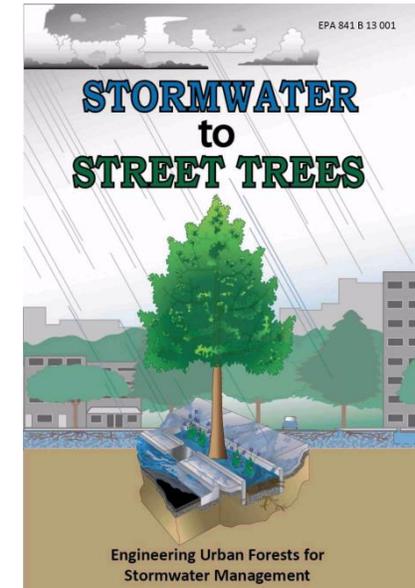
Resources

- US Forest Service
 - Published 2006
 - Manual for incorporating trees into BMPs



- [USFS Manual for Urban Forestry](#)

- US EPA
 - Manual for street trees



- [EPA Stormwater to Street Trees](#)

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