2017 National Watershed & Stormwater Conference

Welcome to the Webcast

- Continuing Education Credits – We are offering PDHs for our national watershed and stormwater conference. A registered attendee must watch the entire webcast to be eligible to earn a pdf Certificate of Completion that will be sent out after webcast to the person who registered for the webcast. The certificate will indicate the Number of PDH hours earned. The varying nature of certification requirements for each state means we cannot guarantee that CEU's will be awarded and it is up to the individual to determine if CEU's or PDH's will be awarded based on the policies of their local certifying board. Email webcast@cwp.org with questions.

2017 National Watershed & Stormwater Conference

To Adjust How the Slides Appear on Your Screen – To make the slide area larger, go to Full Screen under the Meeting Tab.

To Answer a Poll Question – Polling questions appear during the webcast. To answer a poll question, click on the radio button to the left of your answer and click submit. Do not type your answer in the chat box.

To Ask a Question – The right corner of the screen contains a Q&A chat box. Type your question in the box and click on the send question icon to submit it. We will try to answer as many questions as possible during and after the webcast.

2017 National Watershed & Stormwater Conference

Thanks to Our Sponsors

Patron Level

STRAUGHAN ENVIRONMENTAL

Ecotone Inc.
RIVERS · WETLANDS · FORESTS · WILDLIFE · STORMWATER

Gold Level

EQR

STORMWATER MAINTENANCE & CONSULTING

2017 National Watershed & Stormwater Conference

Thanks to Our Sponsors

Silver Level

FURBISH

CBTRUST Chesapeake Bay Trust

res

stormwatersystems

Bronze Level

WATERSHED CONSULTING ASSOCIATES, LLC

HATCHER GROUP Inspiring change for good

ANDERSON DAVIS

DDM

AH

Wetland

2017 National Watershed & Stormwater Conference

Thanks to Our Hub Location Funders

Omaha

Philadelphia

Boston

Opti
active intelligence | clean water

2017 National Watershed & Stormwater Conference

Webcast Team

Susan Ashbrook,
Sustainability Director
The City of Columbus, OH

Dr. Jon Hathaway, Assistant Professor,
University of Tennessee Department of Civil and Environmental Engineering

Todd Gartner, Senior Associate & Natural Infrastructure for Water Manager at the World Resources Institute

Bill Hodgins
Senior Water Resources Engineer
Center for Watershed Protection

Blueprint Columbus:

An Integrated Plan for Reducing Sewer Overflows and Improving Stormwater

THE CITY OF COLUMBUS
DEPARTMENT OF PUBLIC UTILITIES

BLUE PRINT COLUMBUS

Agenda

- Background/Timeline
- Blueprint Approach
- Benefits
- Vacant Lot Repurposing Pilot
- Getting Started
- Lessons Learned So Far

Background

- Columbus under two state consent orders
- 2002 CSO Order
  - Plan submitted in 2005
  - Largely complete except for tunnel
  - CSO volumes have reduced dramatically
- 2004 SSO Order
  - Requires elimination of sanitary sewer overflows and basement back-ups
  - Original plan submitted in 2005
  - Included two 14-mile long deep sewer tunnels

SSOs

- Unlike combined sewer overflows
- Sanitary sewers much smaller and not designed to carry rain
- Nonetheless, rain can infiltrate thru cracks, leaks, illicit connections, foundation drains of older homes, etc.
- Original plan to build overflow tunnels
  - Allow problem (infiltration) to continue

Why Integrated Planning?

- CSO work is almost complete
  - Spent a billion dollars to capture a billion gallons of overflow
- SSOs are a fraction of the overflow volume, but three times the cost
  - SSO tunnels do little for water quality as they do not improve stormwater
  - SSO tunnels do not create local jobs or much investment in local economy

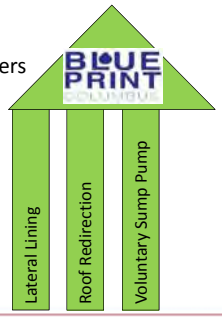
Blueprint Approach

- Instead of building more infrastructure, invest in fixing our infrastructure
- Root of problem is rainwater getting into sanitary system
  - Invest in sanitary system, public and private to keep rainwater out
  - Focus on residential areas
- Creates opportunity to improve stormwater discharges
  - Route water away from houses to streets
  - Treat with green infrastructure before discharging
- Improve rivers, neighborhoods, local economy

The Four Pillars

Keep rain water out of sanitary sewers

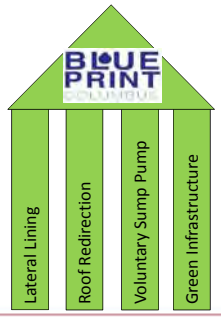
- Lateral lining
- Roof redirection
- Sump pump



The Four Pillars

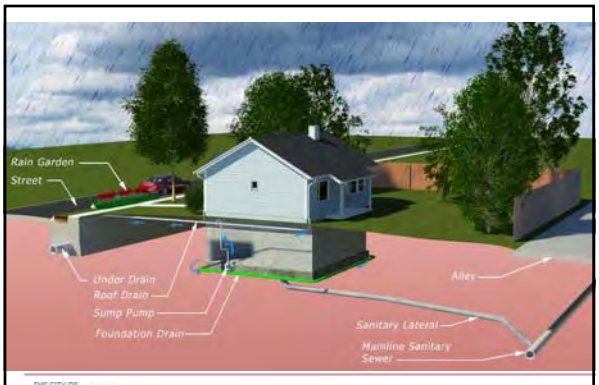
Improve stormwater discharges

- Green infrastructure



The Fourth Pillar: Green Infrastructure

- Redirecting rainwater away from sanitary into streets may make localized flooding worse
- Adding more stormwater to storm sewer could further impair water quality
- Solution: install enough GI to meet "do no harm" plus create a significant water quality benefit



Benefits of Blueprint Plan

- Job Creation
  - GI maintenance jobs
  - Smaller construction projects
- Neighborhood Impacts
  - Green amenities
  - Renewed laterals
- Addressing the problem rather than the symptom

Benefits of Blueprint Plan

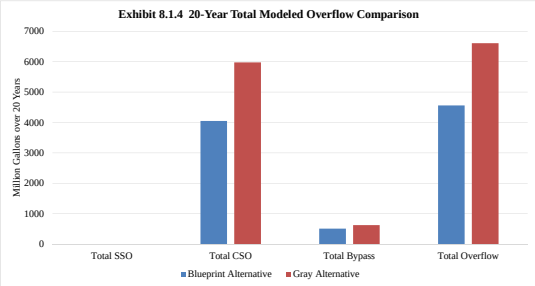
- Blueprint includes $959 M in renewed infrastructure
  - Approximately half of this will go towards lining laterals
  - Solving the source of the problem that will only get worse if left alone
- The gray plan only includes $390 M in renewed infrastructure
  - Gray depends on building new assets rather than fixing the existing assets
  - Does not include the liability that homeowners face with lateral failures
  - Rates will be the same but homeowners will incur more costs

Blueprint Has Significant Water Quality Advantages

- In addition to do no harm, City is currently designing GI to remove 20% of TSS from controlled areas
- If that remains do-able, Blueprint will remove 342 tons of sediment annually once full buildout occurs
- That's 44 Hanks!

Columbus Zoo's Hank weighs 15,600 pounds

Blueprint Provides Additional Water Quality Benefits



Repurposing Vacant Lots

- In original agreement with Ohio EPA, agreed to do pilot on vacant lots
- Purpose was to determine feasibility, cost effectiveness, public acceptability
- Constructed 4 installations
- Largest is Southside Settlement Heritage Park

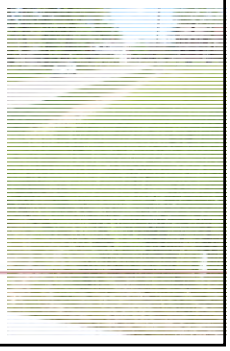
Repurposing Vacant Lots

Before and After SSHP

Created neighborhood amenity




South Side Vacant Lot Repurposing

Getting Started!

- Blueprint plan identifies the areas of the City that need to have Infiltration reduction
  - Total of approximately 18,000 acres
- Divided into 20 project areas
- Prioritized based on several factors

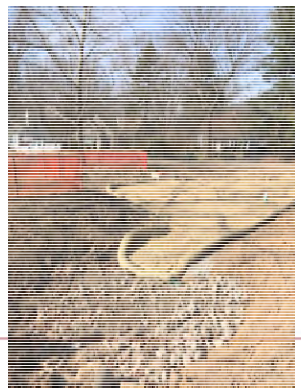
First Project Area: Clintonville

- Approximately 997 acres and 2875 homes
- Divided area into six sub sewer sheds
- GI Engineering started with surveying in 2014
- Construction began 2017

Clintonville Green Infrastructure

- Building approximately four acres of GI
- 430 separate installations
- Construction costs approximately $18M
- In addition, three impervious roads (pavers)

Construction is Underway

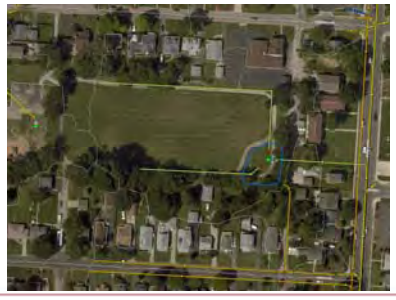


Next Area: Linden

- GI is in design
- Neighborhood very different demographics
  - Much higher percentage of rentals
- Chance to repurpose some vacant lots and improve parks

Kenlawn Park

Kenlawn Park Solution



Lessons Learned

Public Outreach Critical

- SSSH Park – met with every civic group and area commission multiple times resulting in very supportive community
- Clintonville outreach has been very intensive – mostly positive
  - Big and small meetings, door to door lit drops, area meetings, road shows
  - Sump pump volunteers – everything from social media to church bulletins

Lessons Learned

Southside Settlement Heritage Park

- Adding playground equipment and other park amenities
  - Modest increase in construction cost and huge win for neighborhood

Clintonville

- Included pervious pavement on a street which neighbors have been asking for sidewalk
  - was a small investment that generated a lot of support
  - Public Service Department able to finish the sidewalk to the school

Lessons Learned

Solicit public input, be open to making changes

- Moving location of rain gardens
- Remain sensitive to neighborhood aesthetics and safety concerns

Questions?

Learn more at: Columbus.gov/Blueprint

Susan E. Ashbrook
seashbrook@columbus.gov
614-645-0807

AGENDA

00 Intro
01 Inspire
02 Enable
03 Finance
04 Scale

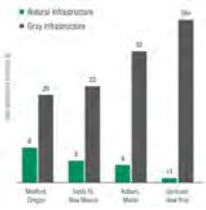
WORLD RESOURCES INSTITUTE

00 | INTRO

Why Natural Infrastructure

WHY GREEN + GRAY?

Reduce capital expenses and treatment costs



Source: IUCN 2015

WORLD RESOURCES INSTITUTE

WHY GREEN + GRAY?

Improve climate resilience & business flexibility

Source: IUCN 2015, App Developer

WORLD RESOURCES INSTITUTE

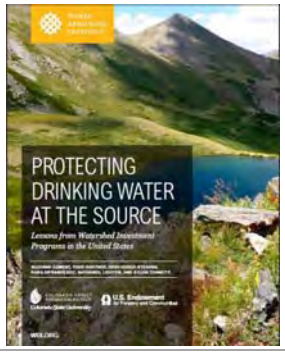
WHY GREEN + GRAY?

Meet urban-rural development and water stewardship goals

Source: IUCN 2015

WORLD RESOURCES INSTITUTE

Enabling Conditions for Success



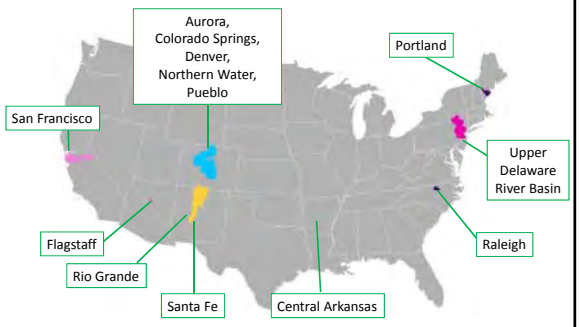
WORLD RESOURCES INSTITUTE

U.S. Endowment for Forestry and Communities

NRCS Natural Resources Conservation Service

Colorado State University

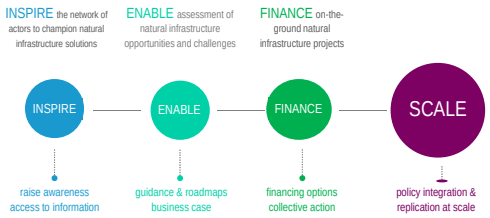
13 Case Studies



Key Lessons & Enabling Conditions for Success

Phase of Program	Lessons
Building Momentum	1. Identify risks and opportunities to rally support
	2. Build partnerships to fill essential roles and responsibilities
	3. Articulate a clear vision of success
	4. Cultivate champions and advocates
Designing the Program	5. Develop a scientifically informed plan for the land
	6. Evaluate the business case for investment
	7. Identify funding sources and financing mechanisms
Implementing the Action Plan	8. Engage landowners to protect and restore natural infrastructure
	9. Manage and administer the program
	10. Monitor performance to demonstrate results

Collaborative Approach to Catalyze a Movement

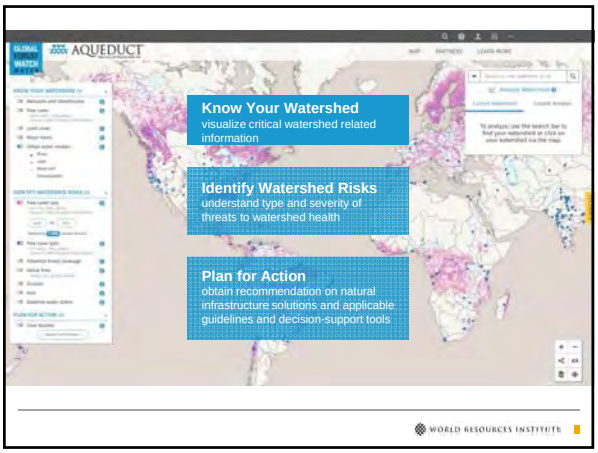


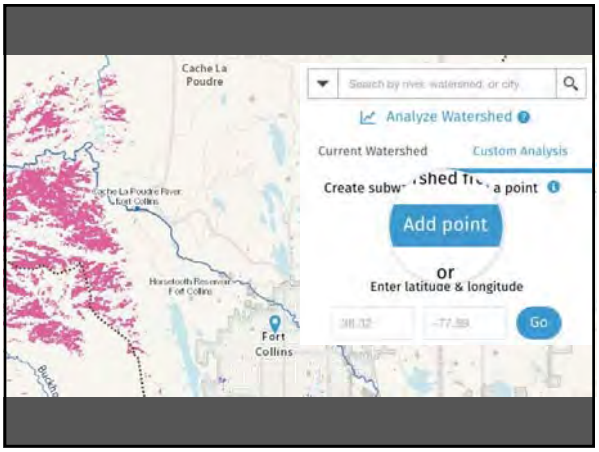
01 | INSPIRE

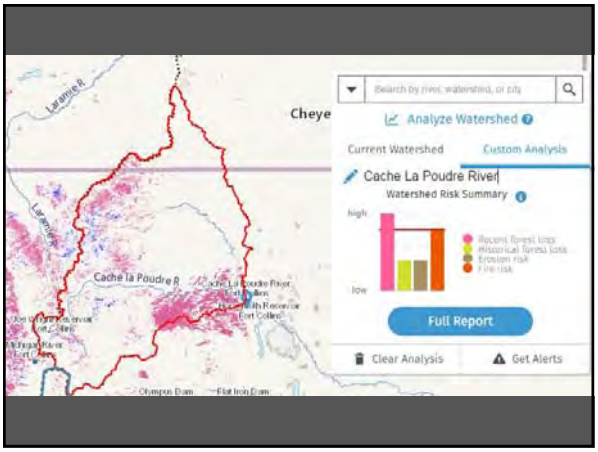
Awareness & Information

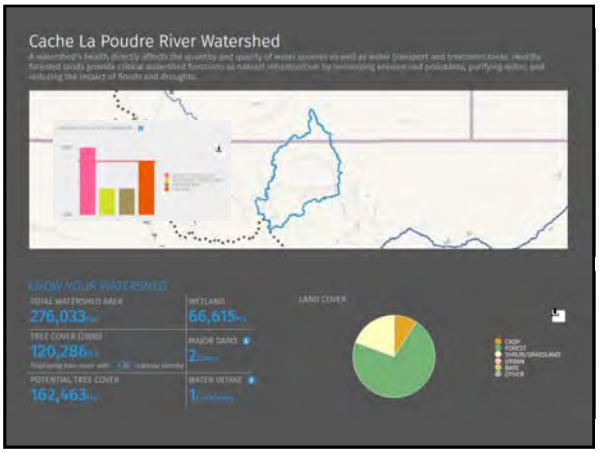
Catastrophic Events → Pipeline of Investable Projects

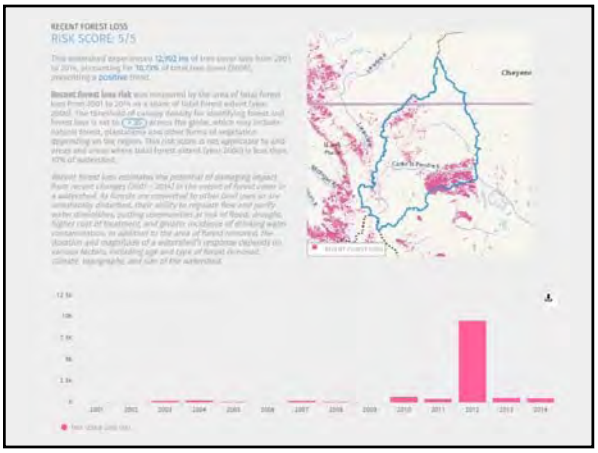

THE SCHERMAN FOUNDATION
WORLD RESOURCES INSTITUTE
GLOBAL FOREST WATCH WATER
BETA
WORLD RESOURCES INSTITUTE


AQUEDUCT
Know Your Watershed
visualize critical watershed related information
Identify Watershed Risks
understand type and severity of threats to watershed health
Plan for Action
obtain recommendation on natural infrastructure solutions and applicable guidelines and decision-support tools
WORLD RESOURCES INSTITUTE


Cache La Poudre
Search by river, watershed, or city
Analyze Watershed
Current Watershed
Custom Analysis
Add point
or
Enter latitude & longitude
Go
Fort Collins


Search by river, watershed, or city
Analyze Watershed
Current Watershed
Custom Analysis
Cache La Poudre River
Watershed Risk Summary
high
low
Full Report
Clear Analysis
Get Alerts


Cache La Poudre River Watershed
KNOW YOUR WATERSHED
TOTAL WATERSHED AREA
276,033
WETLAND
66,615
TREE COVER (2000)
120,286
MAJOR DAMS
2
POTENTIAL TREE COVER
162,463
WATER INTAKE
1
LAND COVER


RECENT FOREST LOSS
RISK SCORE: 5/5

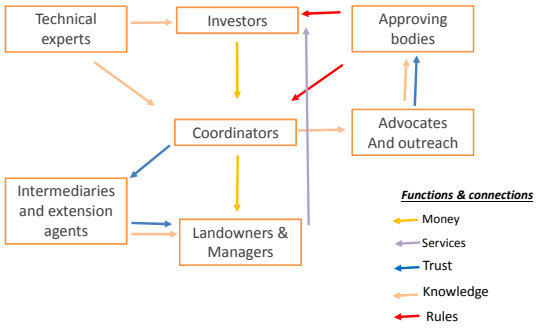
U.S. DOD Installation Water/Watershed Risk Prioritization

THE SCHERMAN FOUNDATION

GLOBAL FOREST WATCH WATER BETA

WORLD RESOURCES INSTITUTE

Build Capacity & Partnerships to Achieve a Shared Vision



WORLD RESOURCES INSTITUTE

Healthy Watersheds Consortium Grant Program

- 9 awards in 7 states (year 2 awards announced in May)
- $2+ million (3:1 leverage)
- Projects Expected Results:
  - 236K acres/35 stream miles protected (3yrs)
  - 5.5 million acres conserved (20yrs)

NRCS

U.S. Endowment for Forestry and Communities

WORLD RESOURCES INSTITUTE

Cultivate Champions – Pay Attention to the Messenger!

Former Raleigh Mayor Charles Meeker receiving Raleigh Environmental Stewardship award for leadership in sustainable development, April 2014

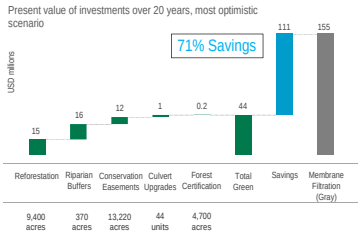
WORLD RESOURCES INSTITUTE

02 | ENABLE

Guidance & Business Case

The Business Case: Portland, ME

Detailed financials of green-gray infrastructure approaches for securing clean drinking water in Portland, ME



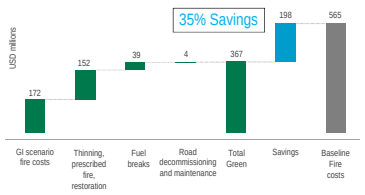
Source: Talberth, J. et al. 2012. Insights from the Field: forest for Water. Washington, DC: Wild Resources Institute

WORLD RESOURCES INSTITUTE

The Business Case: Northern Front Range, CO

Preliminary summary financials for natural infrastructure
Approaches for managing fire risks in Northern Front Range, CO

Present value of investments over 20 years, Base Case Scenario



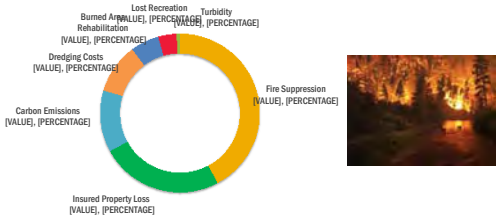
Source: Talberth, J. et al. 2014. Analysis of the Cache la Poudre and Big Thompson Watersheds of Colorados Front Range – Preliminary Report. WRI and CSE

WORLD RESOURCES INSTITUTE

The Business Case: Northern Front Range, CO

Preliminary summary financials for Northern Front Range, CO
Distribution of (real-time) Savings, USD millions

Base Case Scenario



Source: Talberth, J. et al. 2014. Analysis of the Cache la Poudre and Big Thompson Watersheds of Colorados Front Range – Preliminary Report. WRI and CSE

WORLD RESOURCES INSTITUTE

Monitor Performance to Demonstrate Results

Type of metric	Practice-based	Performance-based
Ecological	- Acres treated/protected/restored - Miles of streambanks restored or protected - Length of fire fuel breaks created	- Water quality (e.g. turbidity, temperature) - Reservoir level and tributary flow volume - Amphibian and fish populations
Economic	- Funds raised - Dollars spent (annual total and per acre)	- Treatment cost reduction - Number of jobs created - Forest health harvest revenue

WORLD RESOURCES INSTITUTE

03 | FINANCE

Financing sources & mechanisms

Sustainable Funding & Financing Mechanisms

Program name	Years funded	Funds invested	No. of investors	Primary financing mechanisms
Delaware River	5	$1.9 million	3	Grants
Central Arkansas	8	$27.7 million	5+	Watershed protection fee; nutrient impact fee; government cost-share
Portland, Maine	2	$400,000	2	Allocation from utility's general operating fund
Upper Neuse, North Carolina	10	$5.6 million	5+	Watershed protection fee; nutrient impact fee; grants and donations
Rio Grande	2	$1 million	multiple	Grants
Santa Fe	7	$9.5 million	4	Congressional earmark; water rate increase; municipal bond
Flagstaff	7	$12 million	12	Municipal bond
San Francisco	10	$50 million	2	Municipal bond & utility operating budget

WORLD RESOURCES INSTITUTE

Western Forests in Crisis

PROBLEM: OVERGROWN FORESTS

- Overgrowth intensifies drought and wildfire
- Water quality threatened
- Hydropower generation severely affected
- US Forest Service facing rising suppression costs

1929 | Today

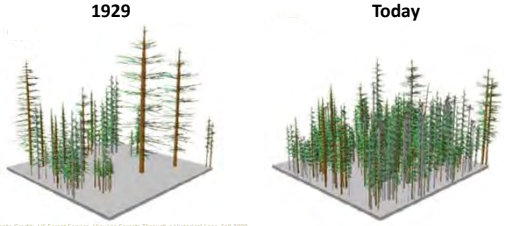
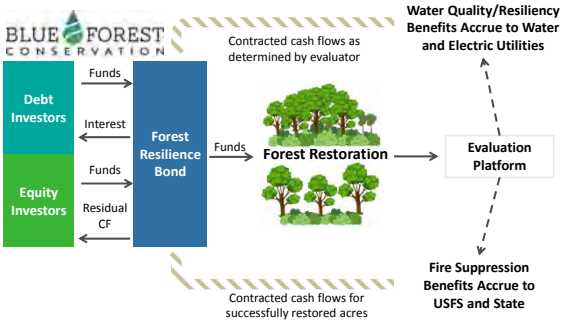


Photo Credit: US Forest Service, Viewing Forests Through a Historical Lens, Fall 2009

WORLD RESOURCES INSTITUTE

Solution - Forest Resilience Bond



WORLD RESOURCES INSTITUTE

Collaborating with BLUE FOREST CONSERVATION

WORLD RESOURCES INSTITUTE
encourage capital
Brownstein Hyatt Farber Schreck
ORRICK
SIERRA NEVADA CONSERVANCY
natural capital PROJECT
THE ROCKEFELLER FOUNDATION
U.S. Endowment for Forestry and Communities
GORDON AND BETTY MOORE FOUNDATION
the David & Lucile Packard FOUNDATION
NRCS

WORLD RESOURCES INSTITUTE

04 | SCALE

Scale up to meet water challenge

Moving from Pilot to Policy - AB 2480

PACIFIC FOREST TRUST

POLICY

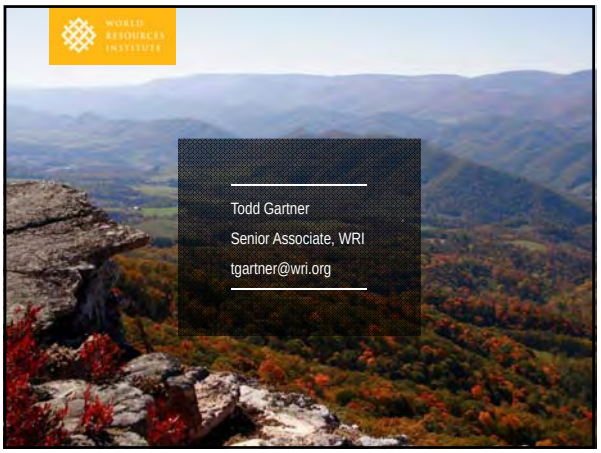
PROMOTING WATER SECURITY, NATURALLY

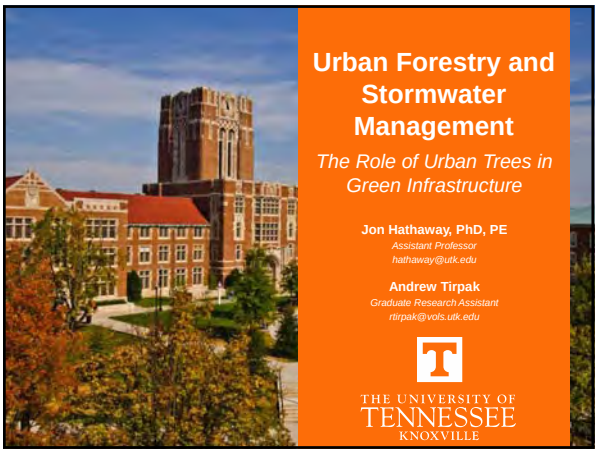
California's population is projected to hit 50 million by 2050, increasing demand for an already scarce resource—cool, clean water. This increased demand in a warmer and drier state dramatically highlights the critical need to improve the reliability of our primary water supply. To help address this, Pacific Forest Trust is working closely with California Assemblymember Richard Bloom on his pioneering legislation, AB 2480, which recognizes source watersheds as infrastructure and a critical component of the state's water system. AB 2480 also calls for a prioritized and comprehensive investment plan to restore and conserve key

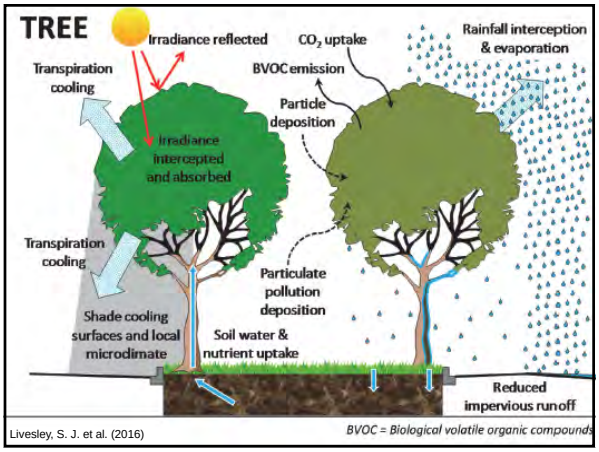
WORLD RESOURCES INSTITUTE

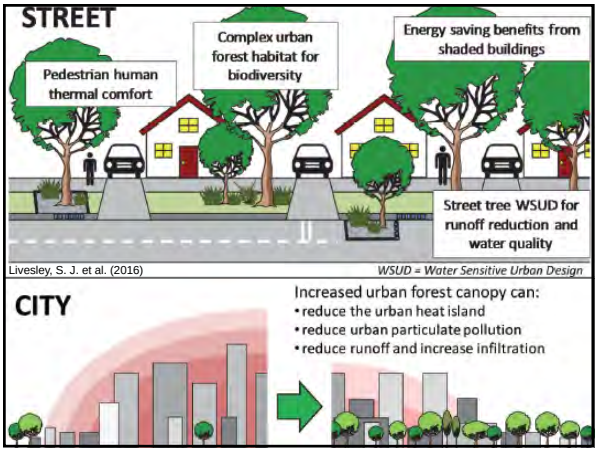
Major Near Term Policy Opportunities

WORLD RESOURCES INSTITUTE



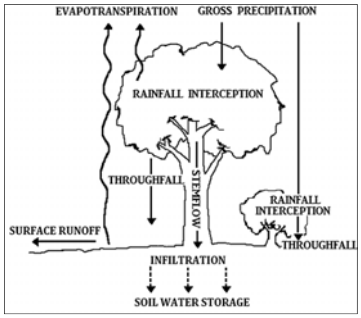






Urban Trees: Stormwater Benefits

- **Hydrology**
  - Interception
  - Transpiration
  - Infiltration
- **Water Quality**
  - Linked to N and P reduction
  - Limited research



Inkilainen, E. N. M. et al. (2013)

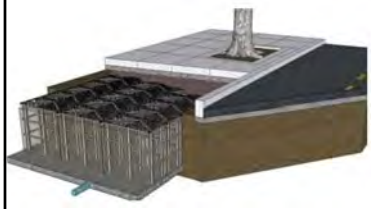
Research Gaps

- Tree function in urban environment vs natural/forested environment
- Localized vs watershed-scale tree canopy effects on urban hydrology and water quality
- Canopy impacts on runoff and infiltration from impervious/pervious urban areas
- Role of urban trees in green infrastructure, stormwater management, regulations and policy

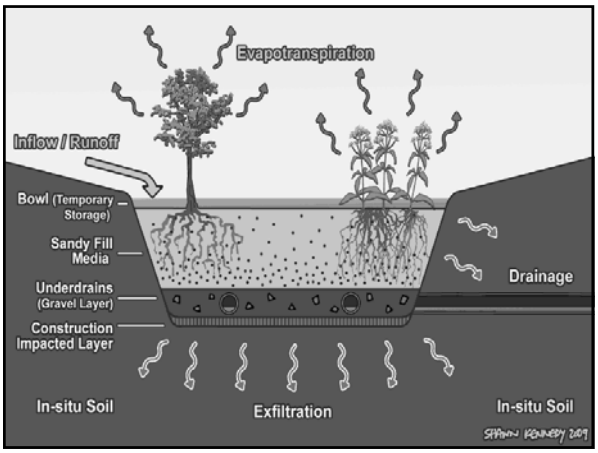
Kuehler et al. (2016)

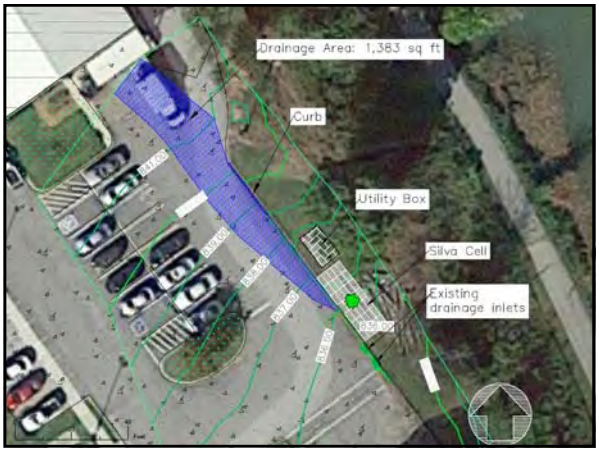
Suspended Pavement Systems

- Pavement support structure
- Promotes healthy urban trees



- Non-compacted soil allows roots to grow and access air/water

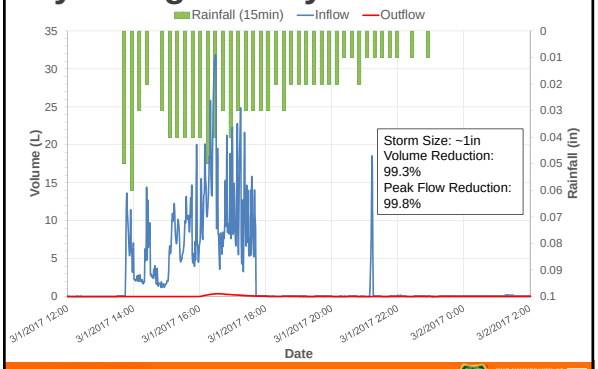




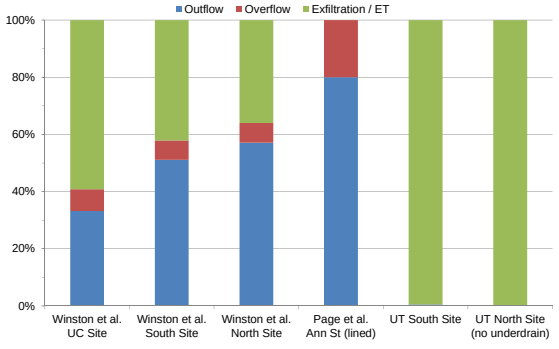
Construction and Installation

	Davis et al. 2012	Winston et al. 2016	Page et al. 2015*	UT Cells
Watershed (m^2)	1836 - 5261	1900 - 3600	2242 – 2873	128 – 133
Bioretention area (m^2)	102 – 149	57 – 182	27.6	22 – 27
Bioretention area (%)	2.8 – 6.6	2.9 – 5.0	5.5 – 6.6	17.4 – 20.6
Bowl Volume (m^3)	23.6 – 36.0	35 – 60	1.38	2.3 – 2.8
Media Depth (m)	0.9 – 1.2	0.6 – 0.9	0.8	0.7
Soil texture	Sandy loam / Sand	Loamy sand	Loamy sand	Loamy sand
Sand / Clay (%)	70/20 – 96/4	87/9	87/7	85/10
Organic Matter (%)	–	1 – 4	3 – 6	5

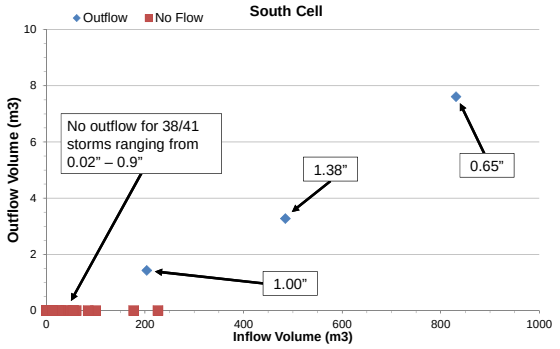
Hydrologic Analysis

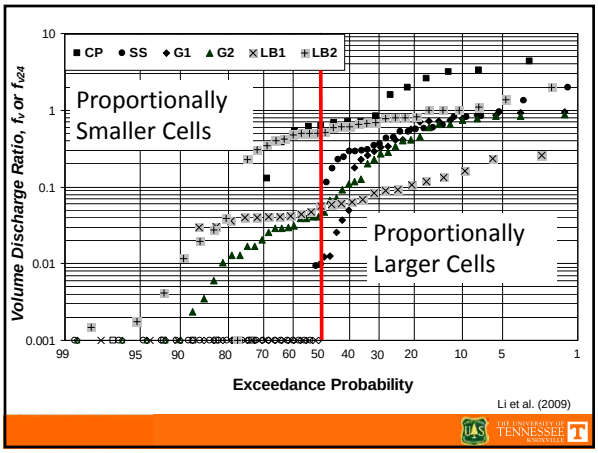


Performance Comparison



Runoff Reduction Performance





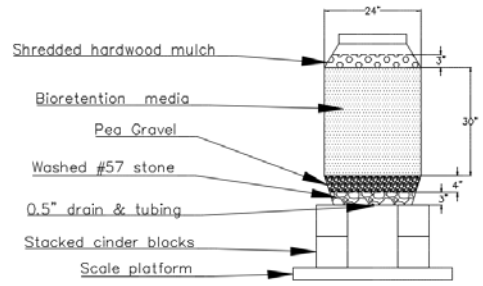
Preliminary Conclusions

1. Suspended pavement systems are effective at reducing runoff volumes and peak flows
2. Limited storage volume ("bowl volumes") in suspended pavement systems can lead to oversized practices – design storm critical

Future Work:

- Characterize ET contributions to water balance via sap flow sensors
- Analyze water quality benefits associated with trees in suspended pavement systems

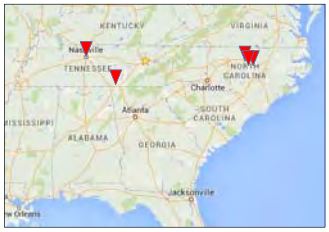
Bioretention Column Study



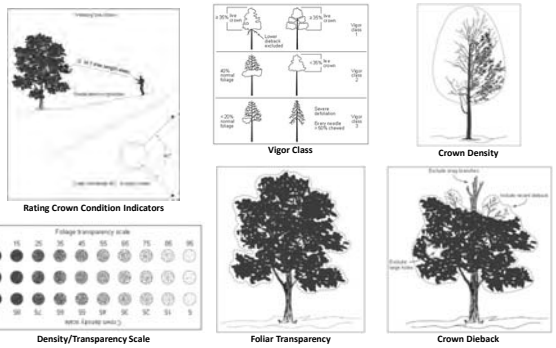
Bioretention Column Study

Bioretention Tree Health Surveys

- Jun-Aug '15
- 5 cities
- 38 practices
- 97 trees

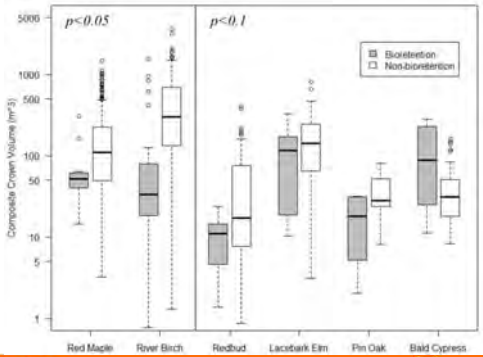


Tree Crown Condition Indicators



How does the health of bioretention trees compare to other urban trees?

Bioretention vs Non-bioretention Trees



Comparing Tree Health

- Many tree species appear to be *less healthy*
- Incompatibility with species-specific growing preferences:

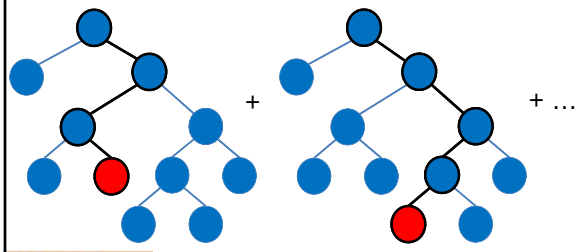
Species	*Soil pH*	*Saturated or very wet soil*	*Moist, well-drained soil*	*Occasionally dry soil*	*Very dry soil*
Bald Cypress	4.5-6.0				
Pin Oak	4.5-6.5				
River Birch	3.0-6.5				
Red Maple	4.7-7.3				
Redbud	5.0-7.9				
Lacebark Elm	4.8-7.0				

Bassuk et al. (2009)

What bioretention parameters influence tree health?

randomForest Algorithm

- Ensemble learning-based regression technique using numerous decision trees



High-Importance Parameters

Category	*Predictor Variable*	*Comments*
Bioretention Media Composition	Fines (%)	Reinforces findings in tree health comparison study; media should align with species-specific habitat preferences
	Sand (%)	
	Organic Matter (%)	Influences soil fertility, structure; OM standards vary
Bioretention Media Chemistry	Buffer pH	Controls change in bioretention media pH over time
	Copper	Micronutrient; deficiency leads to crown defoliation and dieback (other micronutrients are also key)
	Potassium	Vital to plant functions (photosynthesis, water regulation, cell expansion); req'd in large amounts
Tree Selection and Planting	Planting Location	Should reflect tree tolerance to inundation
	Species Selection	Species should be tolerant of bioretention environment

Tree Health Survey Conclusions

1. Trees should be selected based on their ability to tolerate the unique conditions found in bioretention practices. Species-specific preferences for growing conditions should be considered.
2. Species selection should be guided by analysis of bioretention media composition, prioritizing the high-importance parameters.

Literature Cited

- Livesley, S. J., E. G. McPherson, and C. Calfapietra (2016). "The Urban Forest and Ecosystem Services: Impacts on Urban Water, Heat, and Pollution Cycles at the Tree, Street, and City Scale". Journal of Environmental Quality, 45, 119-124.
- Inkilainen, E. N. M., M. R. McHale, G. B Blank, A. L. James, and E. Nikinmaa (2013). "The role of the residential urban forest in regulating throughfall: A case study in Raleigh, North Carolina, USA". Landscape and Urban Planning, 119, 91-103.
- Kuehler, E., J. Hathaway, A. Tirpak (2016). "Quantifying the benefits of urban forest systems as a component of the green infrastructure stormwater treatment network". Ecohydrology. 2017;e1813. https://doi.org/10.1002/eco.1813
- Denman, E. C., P. B. May, and G. M. Moore (2016). "The Potential Role of Urban Forests in Removing Nutrients from Stormwater". Journal of Environmental Quality, 45, 207-214.
- Davis, A. P. et al. (2012). "Hydrologic Performance of Bioretention Storm-Water Control Measures". Journal of Hydrologic Engineering, 17(5), 604-614.
- Winston, R. J., J. D. Dorsey, and W. F> Hunt (2016). "Quantifying volume reduction and peak flow mitigation for three bioretention cells in clay soils in northeast Ohio". Science of the Total Environment, 553, 83-95.
- Page, J. L., R. J. Winston, and W. F. Hunt (2015). "Soils beneath suspended pavements: An opportunity for stormwater control and treatment". Ecological Engineering, 82, 40-48.
- Li, H. et al. (2009). "Mitigation of Impervious Surface Hydrology Using Bioretention in North Carolina and Maryland". Journal of Hydrologic Engineering, 14(4), 407-415.
- Zarnoch, S. J., W. A. Bechtold, and K. W. Stoke (2004). "Using crown condition variables as indicators of forest health". Canadian Journal of Forest Research, 34, 1057-1070.
- Schomaker, M. E., S. J. Zarnoch, W. A. Bechtold, D. J. Latelle, W. G. Burkman, and S. M. Cox (2007). "Crown-Condition Classification: A Guide to Data Collection and Analysis". General Technical Report SRS-102, United States Department of Agriculture (USDA) Forest Service (USFS) Southern Research Station.
- Bassuk, N., D. F. Curtis, B. Z. Marranca, and B. Neal (2009). "Recommended Urban Trees: Site Assessment and Tree Selections for Stress Tolerance". Urban Horticulture Institute, Department of Horticulture, Cornell University.

Questions?

2017 National Watershed & Stormwater Conference

Questions?

2017 National Watershed & Stormwater Conference

Thanks for Joining Us for Session 2
Innovation in Practice – Integrated Water Resources Management and Implementation

The next online webcast session on:
Emerging Tools in Watershed Protection, Restoration, and Implementation

Begins at

3 PM Eastern
2 PM Central
1 PM Mountain
12 PM Pacific

Just keep your connection to the conference open
(don't leave Adobe Connect) and we'll see you then!