The Evolution and Implementation of a science-based Stormwater Management Program to Facilitate Asset Protection and Stream Restoration

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Sanitation District No. 1 of NKY

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Outline
• Background
• Monitoring
• Approach
• Pilot Results
• Success Stories
• Next Steps
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Why do we manage storm water runoff ?

- Historically—
  - Flood Control
  - Narrative
  - Presumptive Approach
  - "Design Storms"

- No Consideration
  - Water Quality
  - Channel Protection
  - Stream Integrity
    - Ecological
    - Hydrological
    - Geomorphological

***Storm water runoff often considered one of the most serious threats to the integrity of our rivers and streams!

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Why?

- Impacts of flow alteration well established
  - Changes to flow regime (Poff et al, 1997) (>7700 citations)
  - Urban Stream Syndrome (Walsh et al, 2005) (>3000 citations)
  - Stream Function Pyramid (Harman et al, 2012)
    - (~100 citations as EPA guidance)

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Restoring Stream Integrity

Biological

Physicochemical

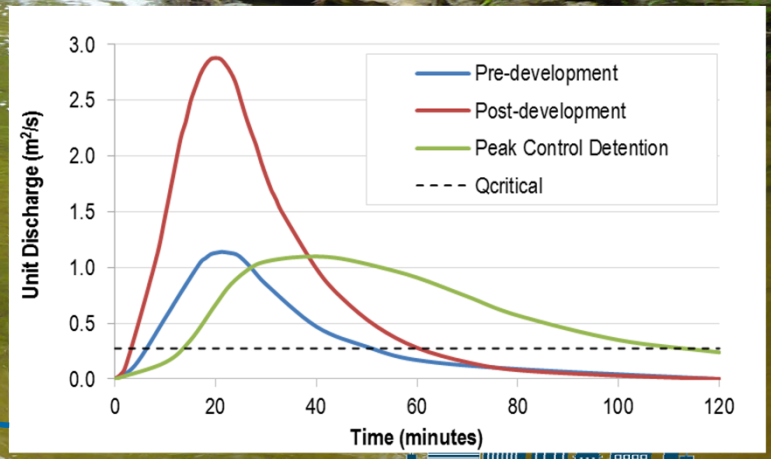
Geomorphology

Hydraulics

Hydrology

Storm Water Controls

Stream Function Pyramid (Harman et al, 2012)



Bledsoe (2002)

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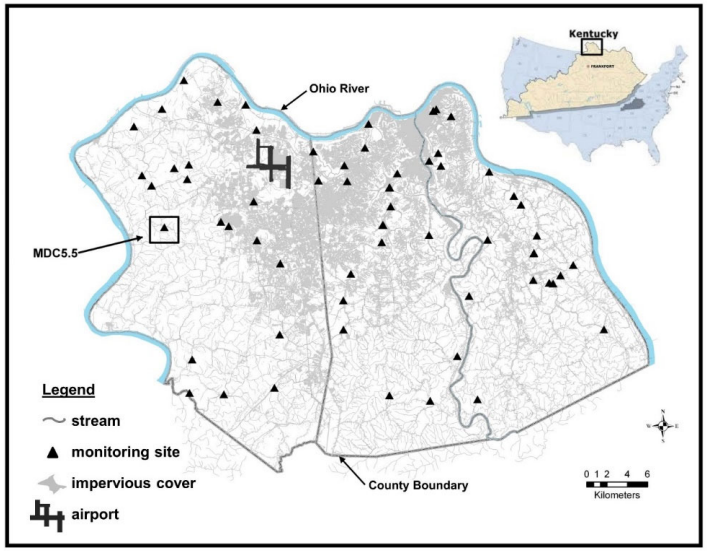
Stream Assessment Program

- ~75 sites:
  - Water Quality
  - Biology
  - Physical Habitat
  - Stream Stability (Hydromod)



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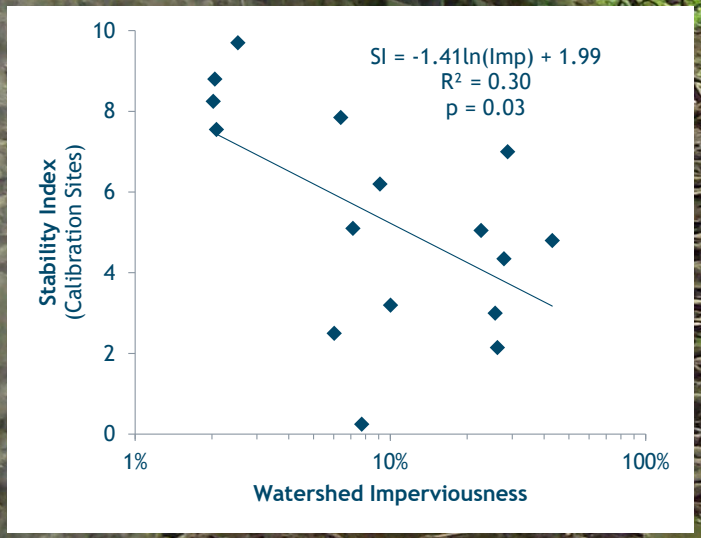
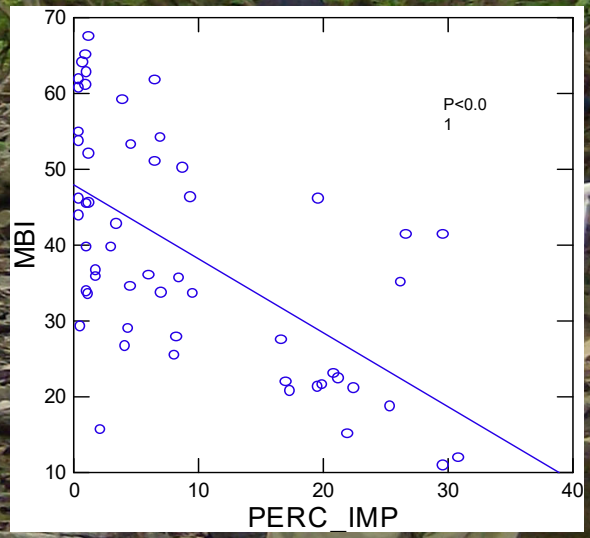
Baselines….





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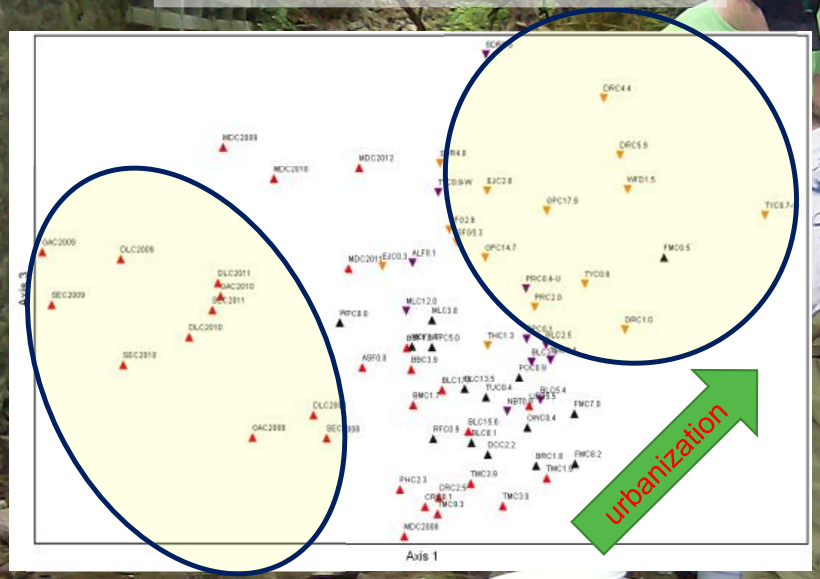
Baselines….(cont)

Community Structure Changes



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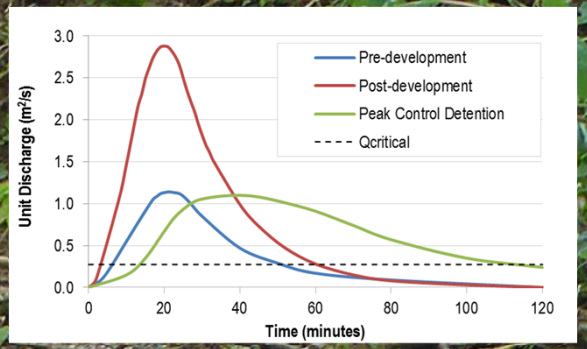
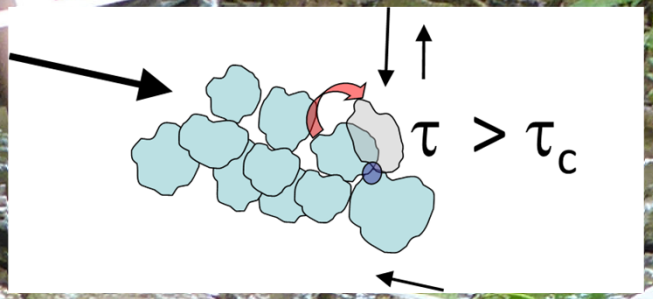
Establish Thresholds





Critical Flow Concept or Qcritical

Analysis of the 2-yr, 2-hr storm from Fort Collins, CO by Bledsoe (2002), Journal of Water Resources Planning and Management

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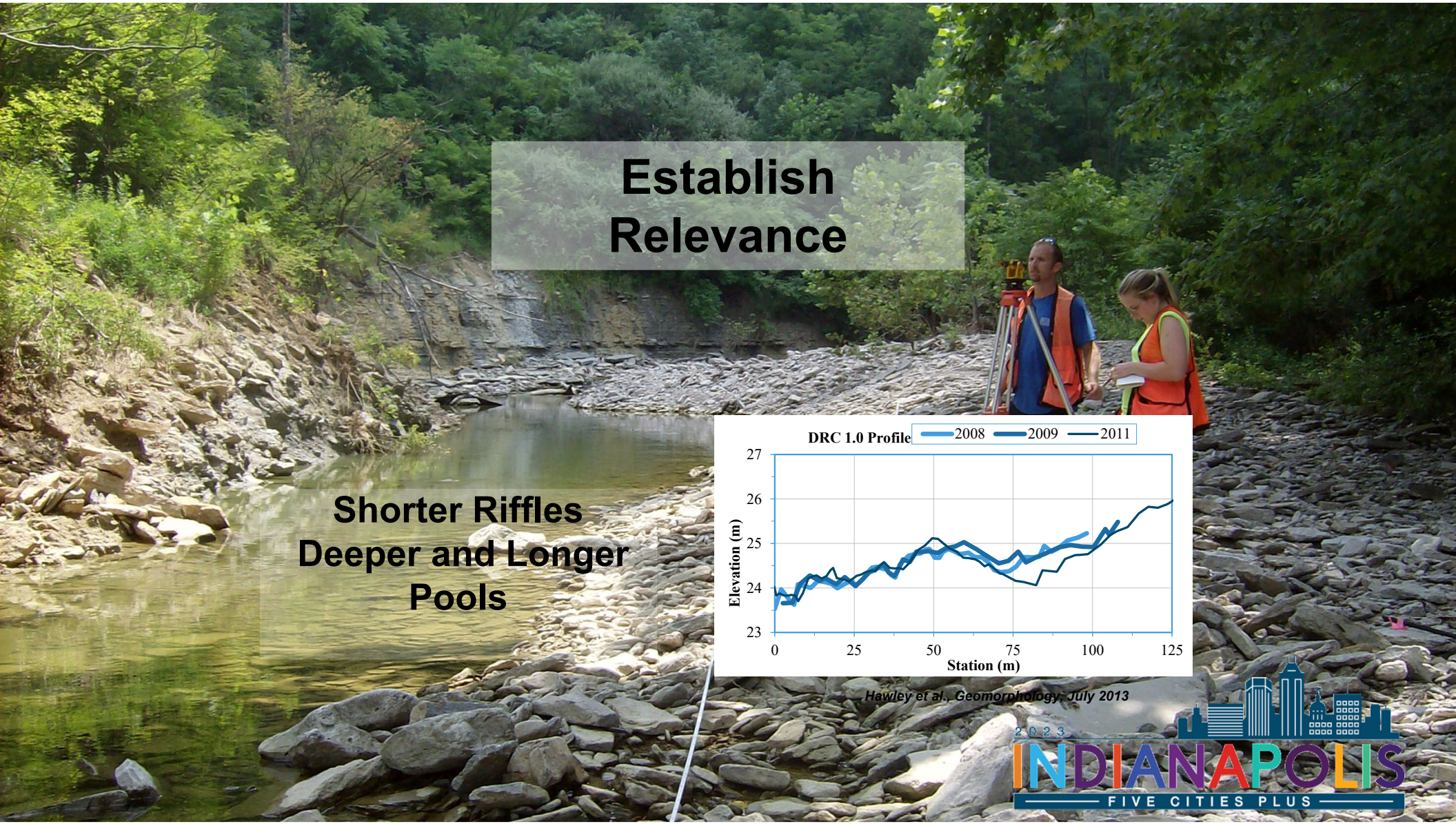
Establish Relevance



Shorter Riffles
Deeper and Longer Pools

Hawley et al., Geomorphology, July 2013

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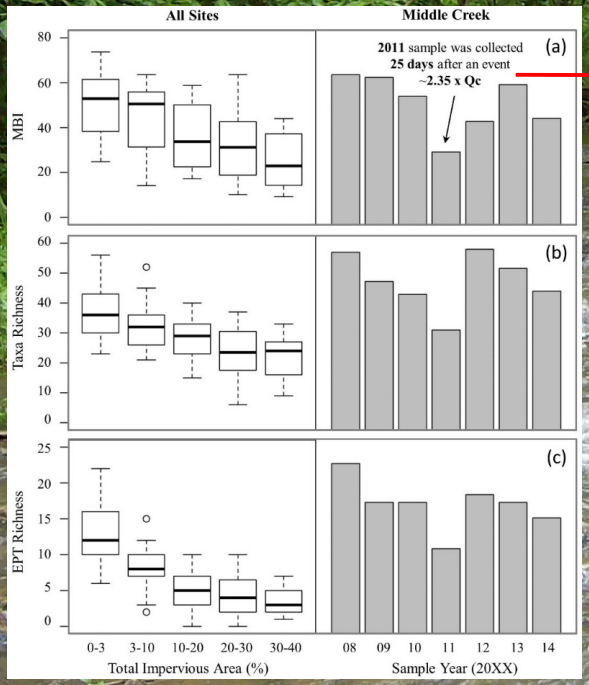
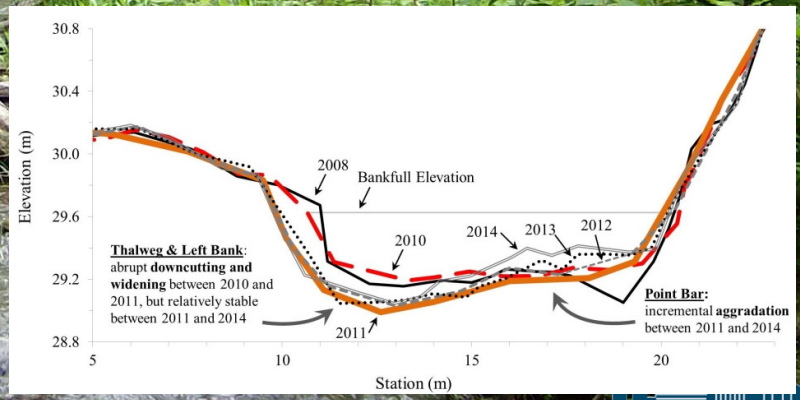
Biological Relevance of $Q_{critical}$



-Impacts in index scores, EPT and overall richness



Adapted from Hawley et al. (Accepted, Freshwater Science)

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Case Study!
Hydrologic Restoration Example
Detention Basin Retrofit

Sustainable Streams LLC
Science · Service · Solutions

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

BCCDKY
Boone County Conservation District, Kentucky

SDI

Study Area

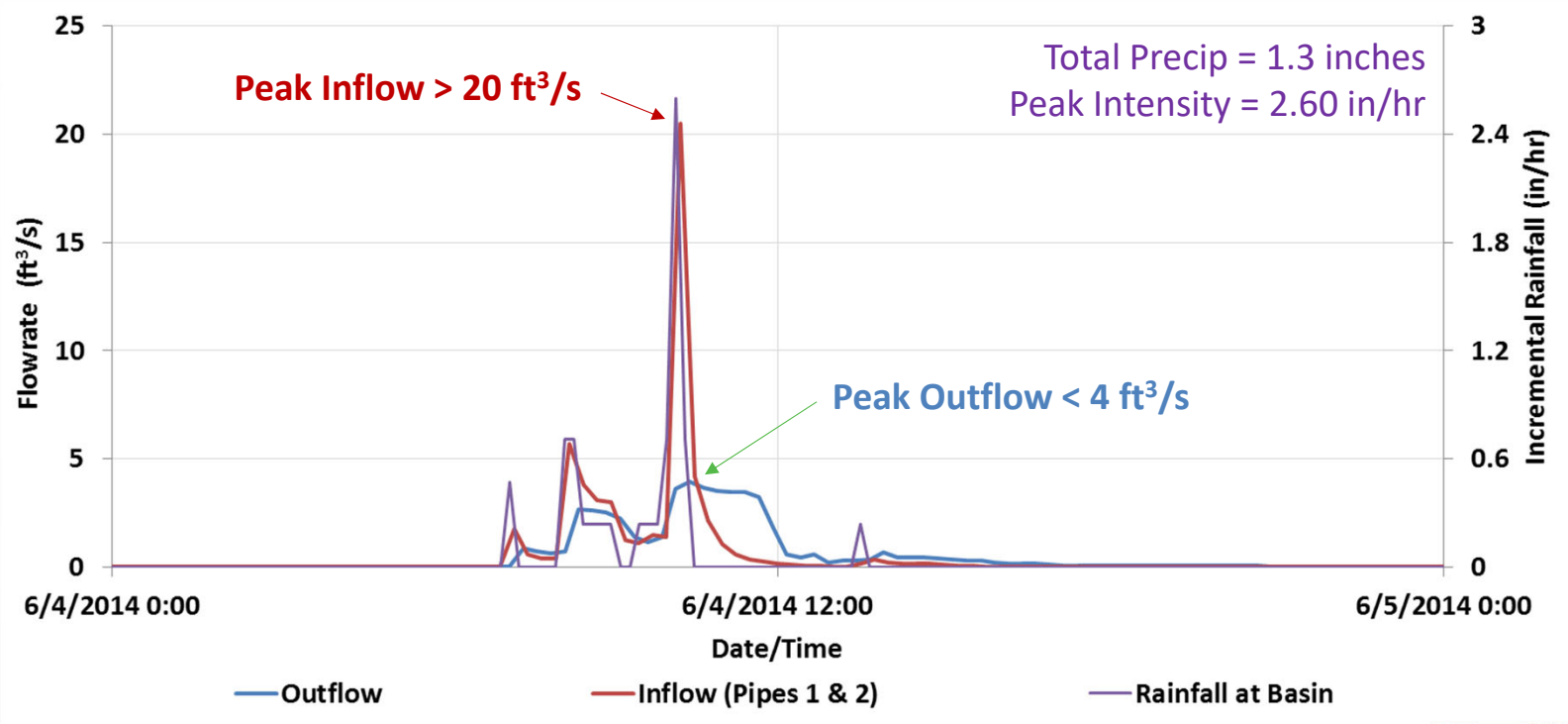

Wright Blvd
N Bend Rd
N Bend Rd
237
Inflow2
Inflow1
Site Rain Gage
Outflow
Spur
Downstream
Upstream
NWS Rain Gage < 1 mile
(Airport)
237

Detention Basin Retrofit

Simple change to the outlet control structure

Detention Basin Retrofit

Post-installation Monitoring



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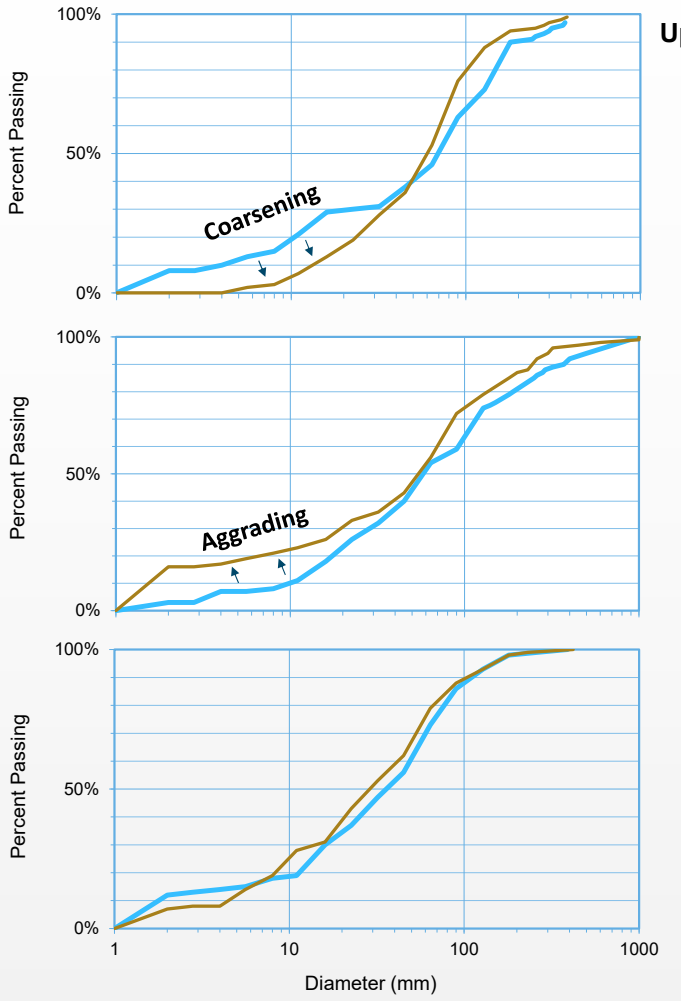
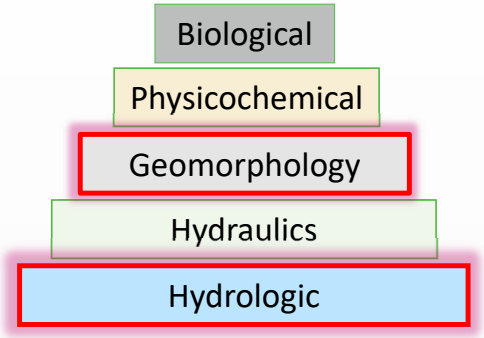
Restricted High Flows Reduces Streambed Erosion





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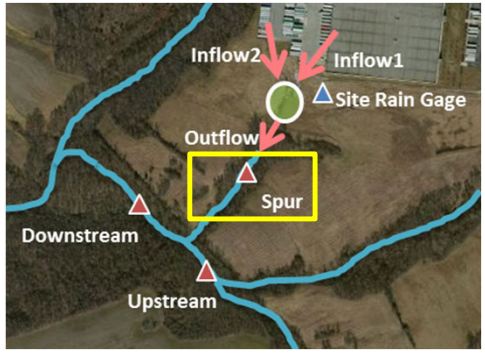
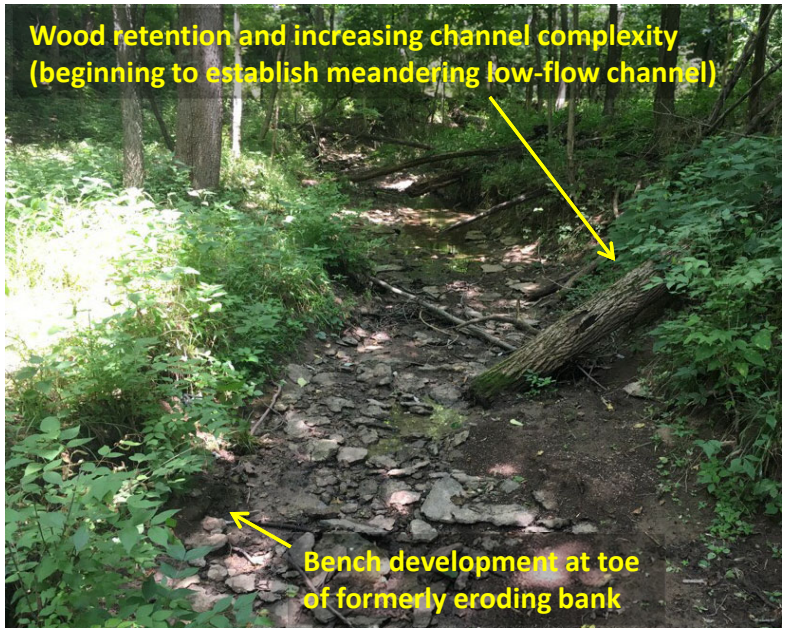
→ Improved Bank Stability & Habitat in Spur

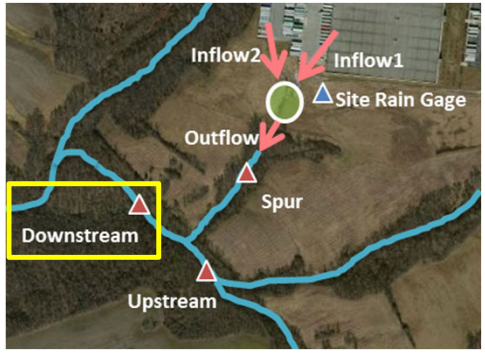


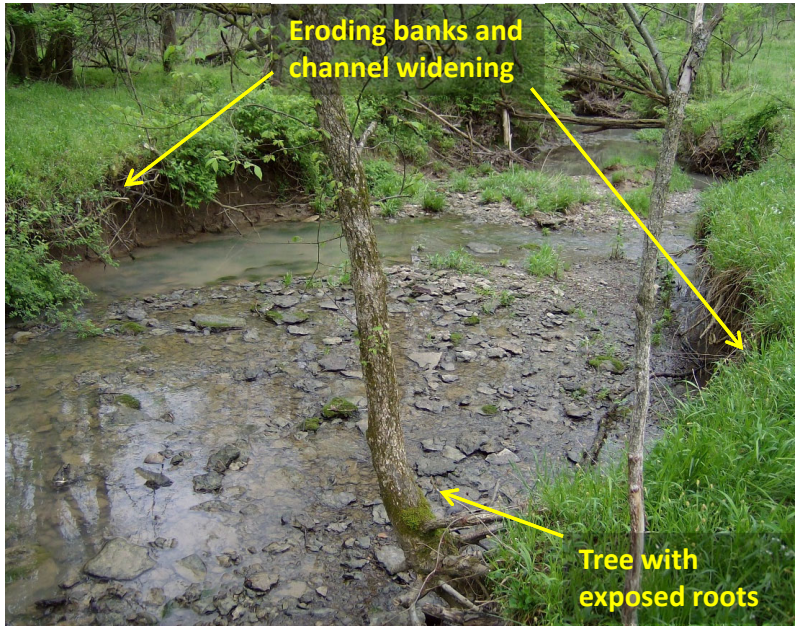
8/26/13 Looking upstream



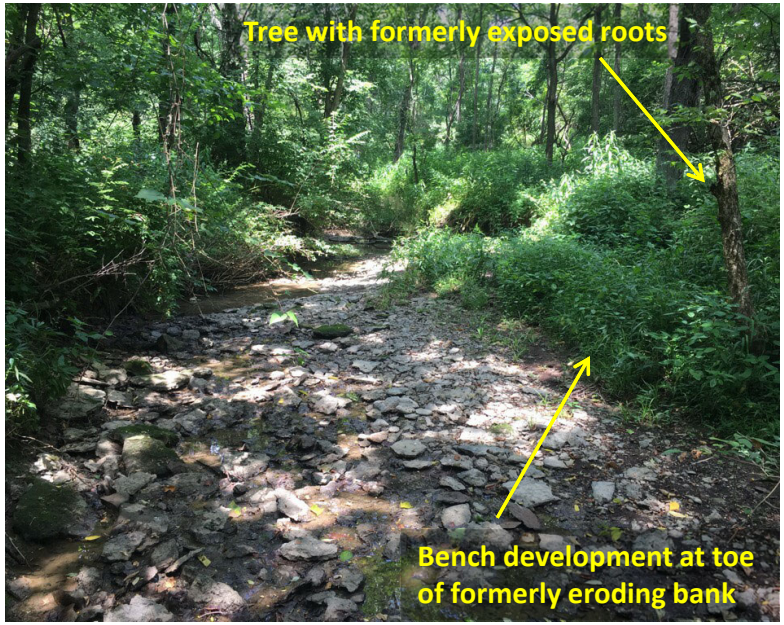
7/8/19 Looking upstream

→ Improved Bank Stability & Habitat Downstream



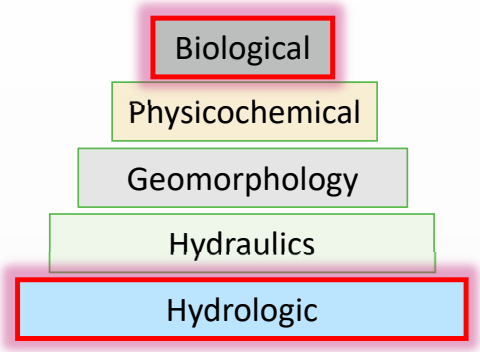


4/29/13 Looking downstream



7/8/19 Looking downstream

Restoration of Baseflows Supports Ecological "Lift"



~Dozen native minnows in 1st pool immediately downstream of the outfall on 9/16/16 (2 circled). Flow was evident coming out of the basin despite the dry/hot week

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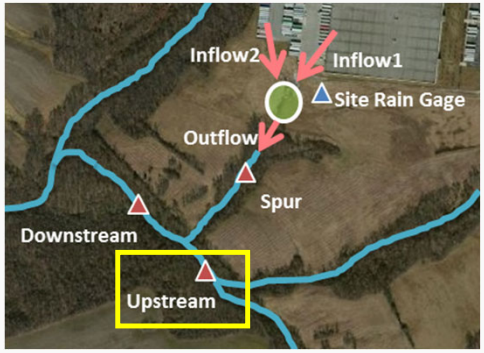
→ Worsening Stability & Habitat Upstream (Control Site)



8/26/13 Looking downstream

7/8/19 Looking downstream

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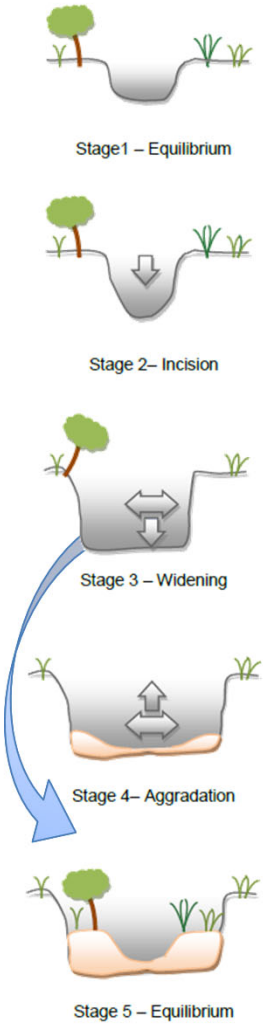
Habitat Recovery



Channel Evolution Sequence in Response to Increased Flows from Urbanization, Adapted from Schumm et al. (1984) and Hawley et al. (2012)

4/15/13 **RBP 113 (Poor)**

11/5/19 **RBP 143 (Avg)**

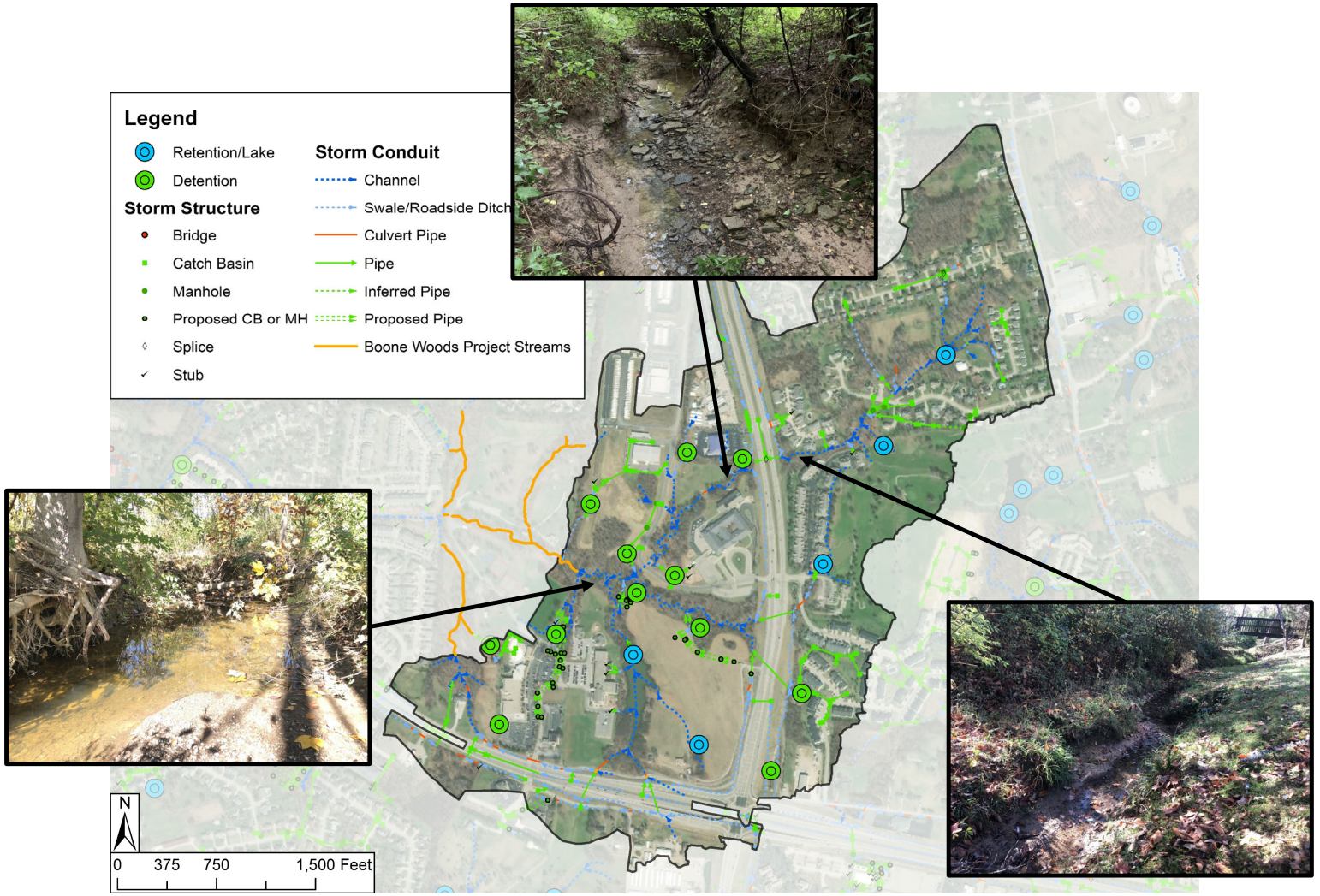
Spur Site

RBP 109 (Poor) **4/29/13**

RBP 146 (Avg) **11/5/19**

Downstream Site

Scaling Up to Larger Watersheds



Case Study: Riffle Restoration and asset protection

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Habitat Recovery

7/13/2018 RBP 87 (Poor); MBI 53.41 Fair

9/25/2019 RBP 104 (Poor); MBI – 57.66 Fair

8/18/2020 RBP 146 (Good); MBI 62.3 Good

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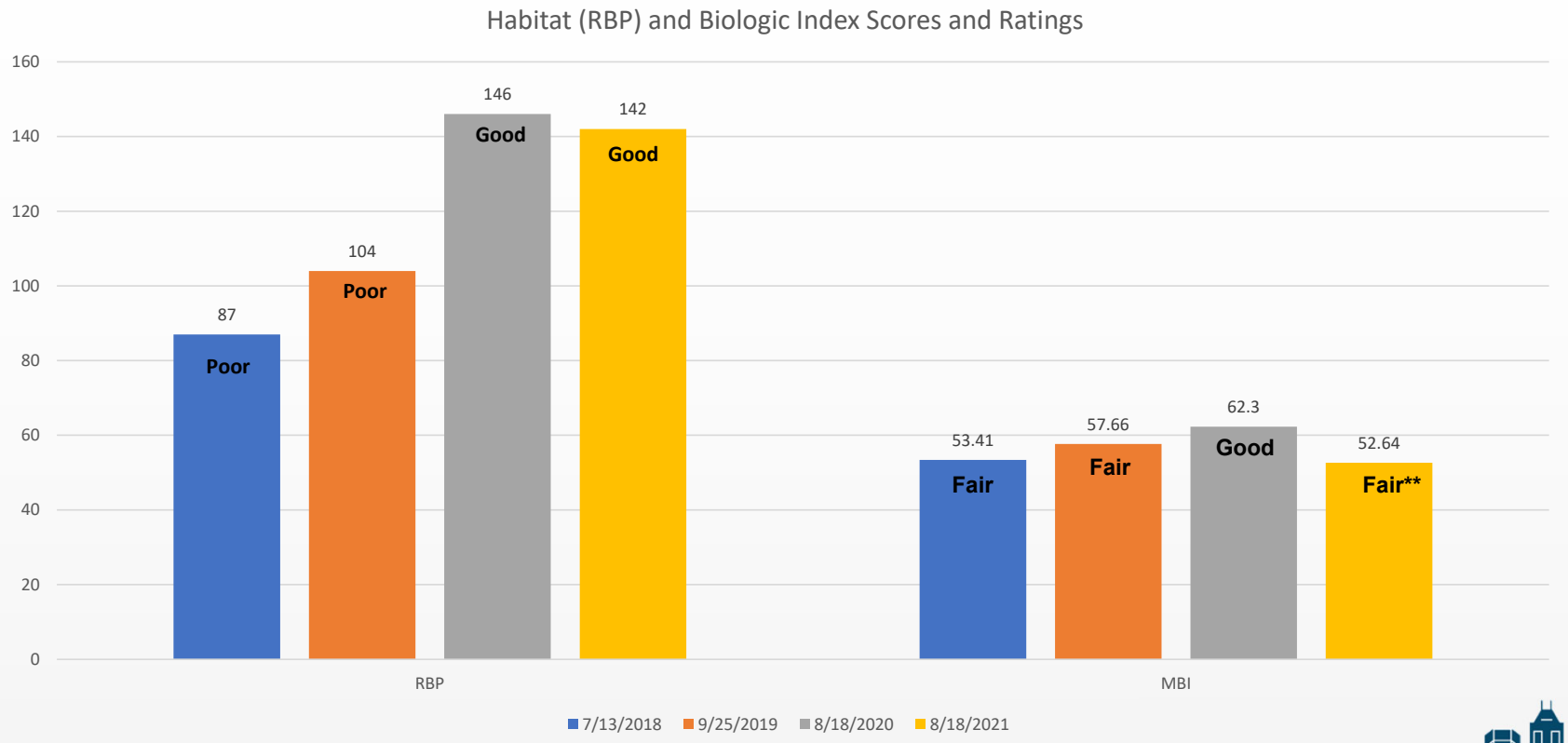

**Sample was collected in close proximity to rain event

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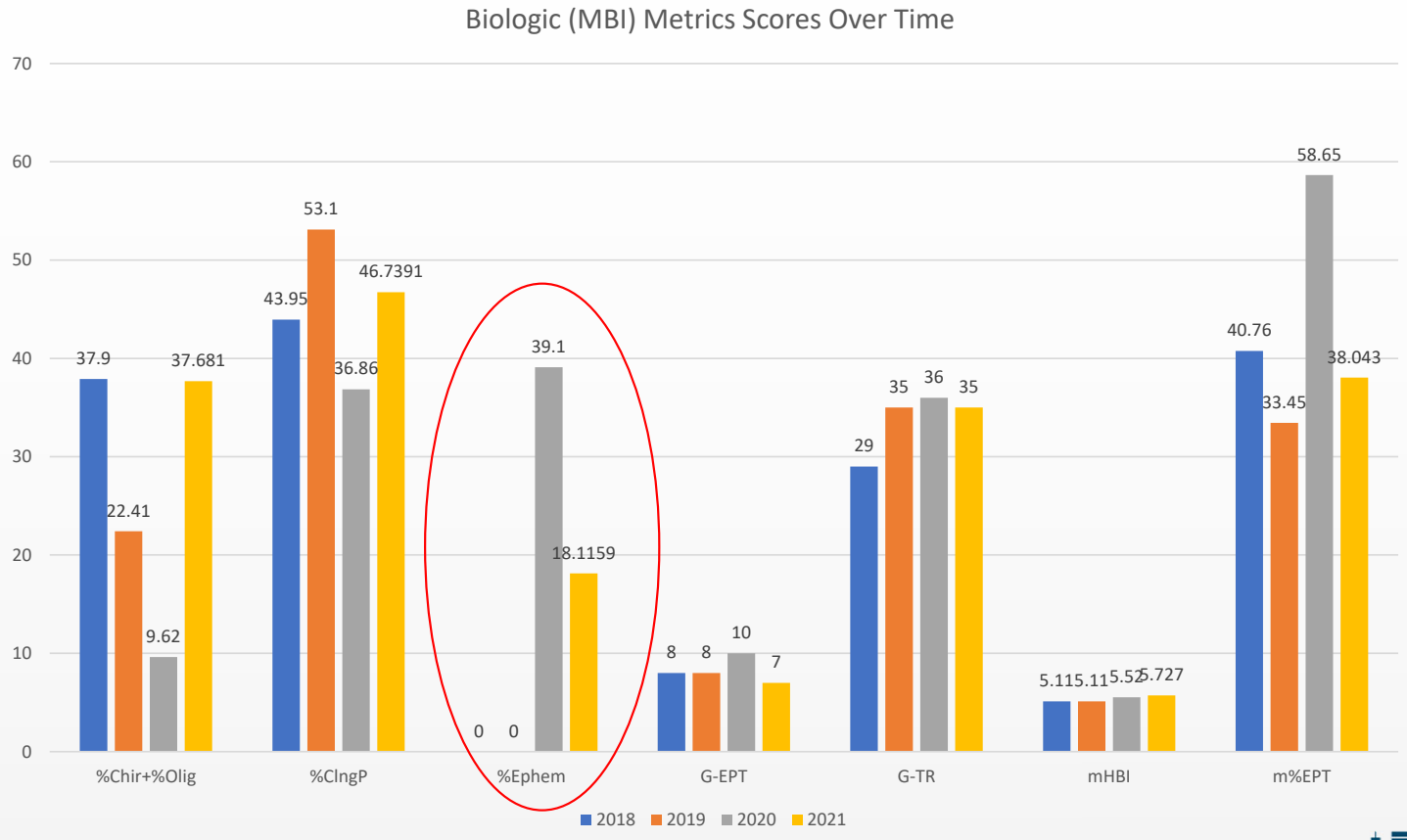

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SD1-Northern Kentucky Stream and Wetland Umbrella Mitigation Bank

Dry Creek Stream Restoration Project

Service Area 6
Kenton County, KY

Sanitation District No. 1 of Northern Kentucky

US Army Corps of Engineers, Louisville District

US Army Corps of Engineers ID: LRL-2020-325

June 2021

Success Story #1

- US Army Corps invitation to proceed
  - One of first Urban Stream in KY
- Founded in Hydrologic Restoration
  - Stormwater management
  - Calibrated restoration approach
  - Demonstrated Ecological Lift
  - Restore stream integrity

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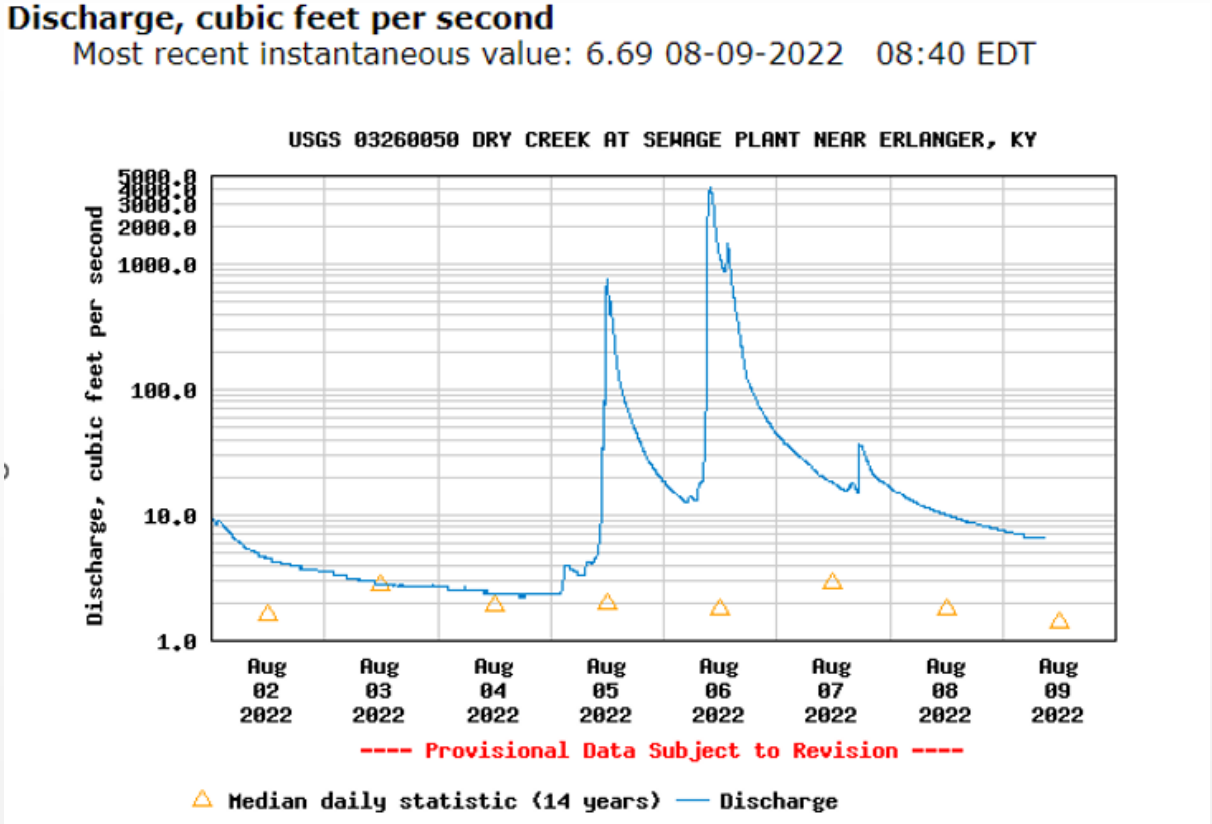
Urban Stream Challenges



USGS regional equation 2y: ~1,700 cfs

Site specific equation 2y: ~3,350 cfs
(12 year data record)

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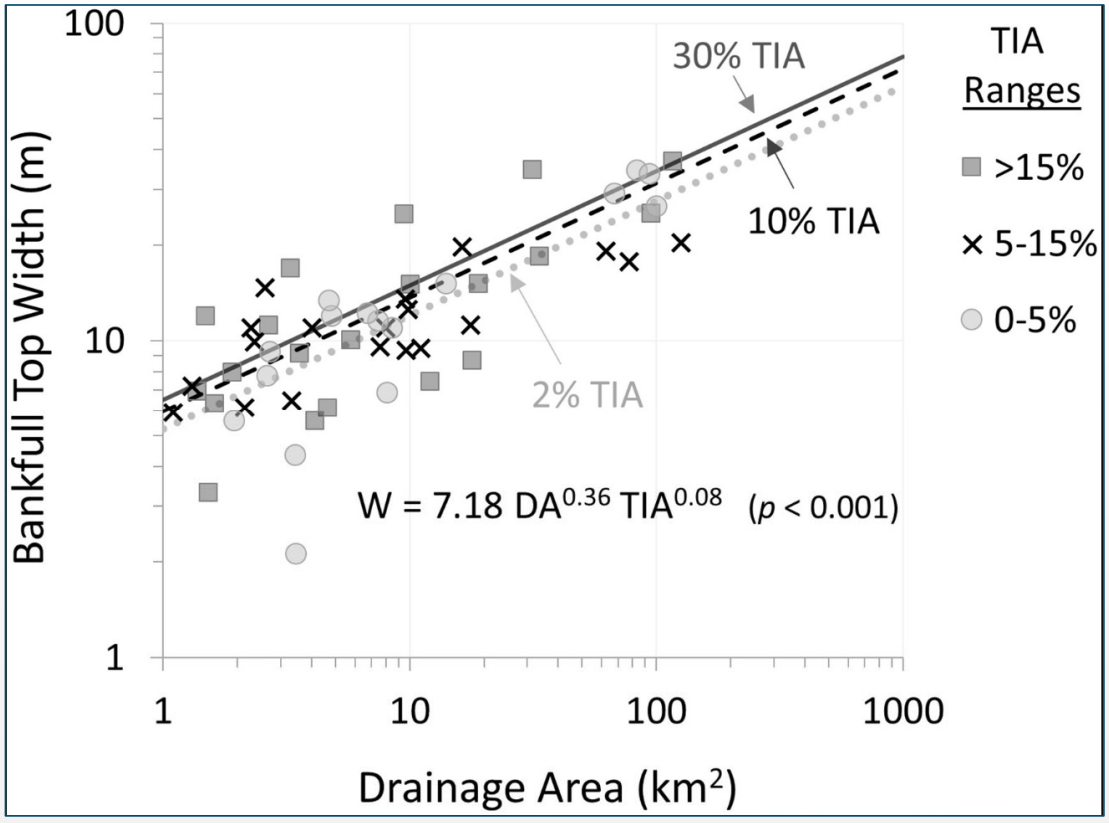
Erosion Rates



-48 sites in analysis
-Urban sites ~25% wider

Adapted from Hawley et al. (2020)

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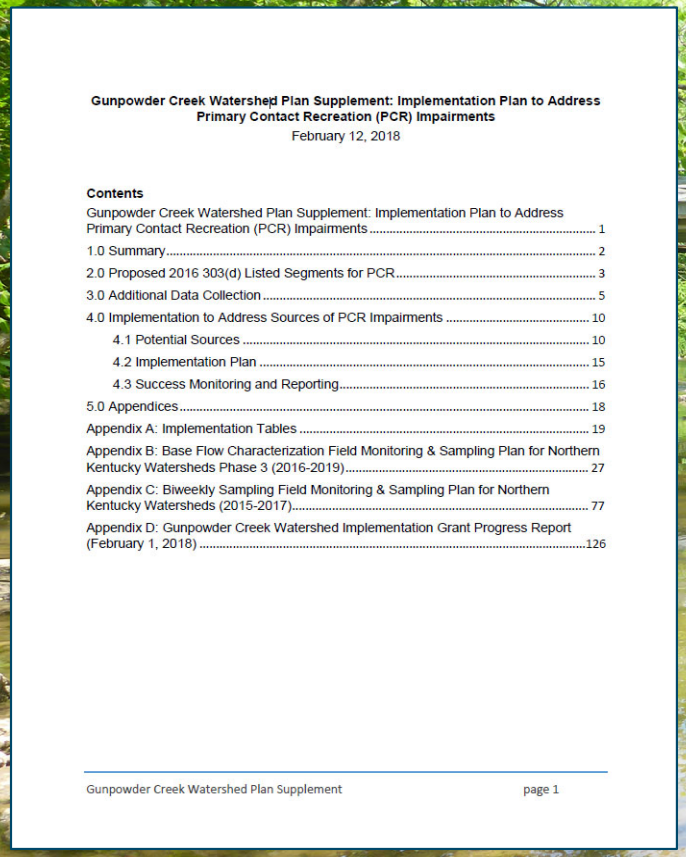
Success Story #2: Gunpowder Creek TMDL Alternative



Gunpowder Creek Watershed Plan Supplement: Implementation Plan to Address Primary Contact Recreation (PCR) Impairments

February 12, 2018

Contents

- Boone County Conservation District and SD1 developed a Primary Contract Recreation (PCR) Supplement
- Submitted the Watershed Plan and PCR Supplement to Kentucky Division of Water and EPA Region 4 – Oct 2017
- Kentucky Division of Water approval and EPA R4 acceptance of the plans as a TMDL Alternative – Feb 2018
- TMDL Alternative covers both PCR and Aquatic Life 303(d) listed segments

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Success Story #3

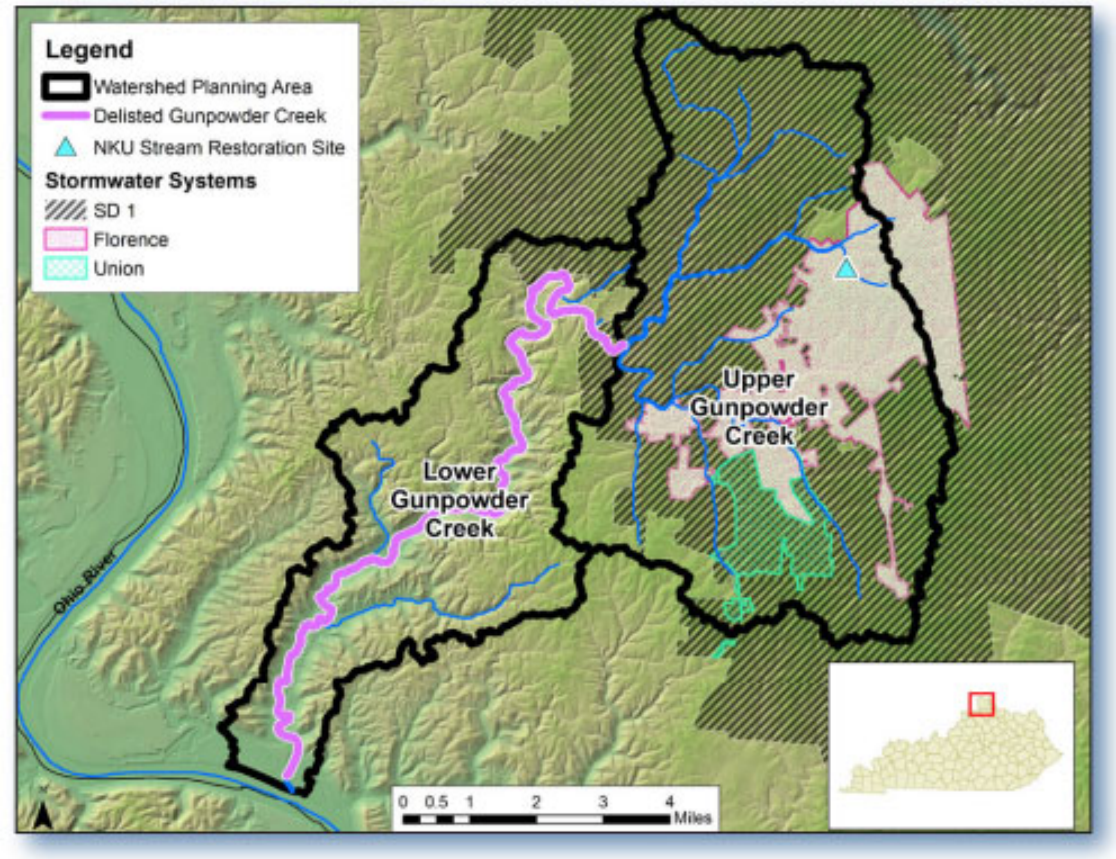
NONPOINT SOURCE SUCCESS STORY

Kentucky

Watershed Planning and Partnerships Lead to Gunpowder Creek Delisting

Waterbody Improved

The Kentucky Division of Water (DOW) added a 15-mile segment of Gunpowder Creek (miles 0.0–15.0) to the 2002 Clean Water Act (CWA) section 303(d) list/Integrated Report as impaired (nonsupport) for warm water aquatic habitat (WAH) due to siltation and land development. After years of local improvements to stormwater controls, agricultural conservation practices, watershed planning, and stream restoration efforts, macroinvertebrate community data collected in 2014 indicated the segment fully supports its WAH designated use. As a result, DOW delisted the sedimentation/siltation impairment for this Gunpowder Creek segment in the 2018/2020 Integrated Report to Congress.



-Comprehensive Planning
-Restoration
-Retrofits
-Wetland Construction
-Land Preservation
-Monitoring
-Collaboration

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Wrapping up

- Comprehensive Monitoring Program
- Identified Management Targets
- Inform Decision Making
- Updated Rules and Regulations
- Updating Existing Facilities
- Mitigation Banking Expansion
- Stream De-listing

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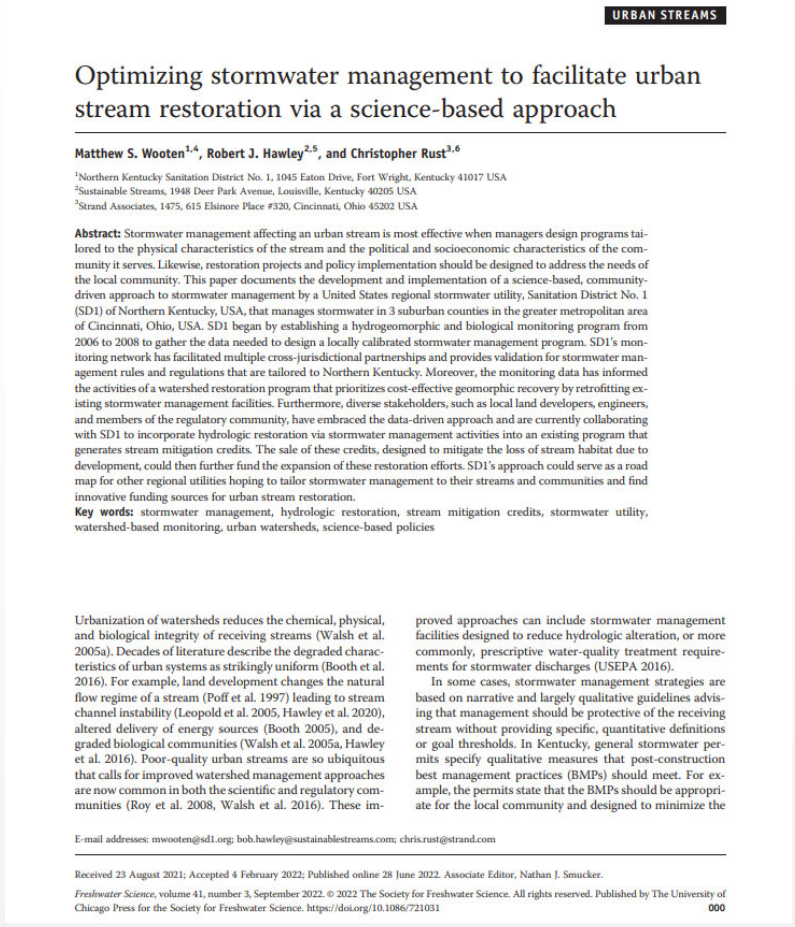
Validation



URBAN STREAMS

Optimizing stormwater management to facilitate urban stream restoration via a science-based approach

Matthew S. Wooten[1,4], Robert J. Hawley[2,5], and Christopher Rust[3,6]

[1]Northern Kentucky Sanitation District No. 1, 1045 Eaton Drive, Fort Wright, Kentucky 41017 USA
[2]Sustainable Streams, 1948 Deer Park Avenue, Louisville, Kentucky 40205 USA
[3]Strand Associates, 1475, 615 Elsinore Place #320, Cincinnati, Ohio 45202 USA

Abstract: Stormwater management affecting an urban stream is most effective when managers design programs tailored to the physical characteristics of the stream and the political and socioeconomic characteristics of the community it serves. Likewise, restoration projects and policy implementation should be designed to address the needs of the local community. This paper documents the development and implementation of a science-based, community-driven approach to stormwater management by a United States regional stormwater utility, Sanitation District No. 1 (SD1) of Northern Kentucky, USA, that manages stormwater in 3 suburban counties in the greater metropolitan area of Cincinnati, Ohio, USA. SD1 began by establishing a hydrogeomorphic and biological monitoring program from 2006 to 2008 to gather the data needed to design a locally calibrated stormwater management program. SD1's monitoring network has facilitated multiple cross-jurisdictional partnerships and provides validation for stormwater management rules and regulations that are tailored to Northern Kentucky. Moreover, the monitoring data has informed the activities of a watershed restoration program that prioritizes cost-effective geomorphic recovery by retrofitting existing stormwater management facilities. Furthermore, diverse stakeholders, such as local land developers, engineers, and members of the regulatory community, have embraced the data-driven approach and are currently collaborating with SD1 to incorporate hydrologic restoration via stormwater management activities into an existing program that generates stream mitigation credits. The sale of these credits, designed to mitigate the loss of stream habitat due to development, could then further fund the expansion of these restoration efforts. SD1's approach could serve as a road map for other regional utilities hoping to tailor stormwater management to their streams and communities and find innovative funding sources for urban stream restoration.

Key words: stormwater management, hydrologic restoration, stream mitigation credits, stormwater utility, watershed-based monitoring, urban watersheds, science-based policies

Urbanization of watersheds reduces the chemical, physical, and biological integrity of receiving streams (Walsh et al. 2005a). Decades of literature describe the degraded characteristics of urban systems as strikingly uniform (Booth et al. 2016). For example, land development changes the natural flow regime of a stream (Poff et al. 1997) leading to stream channel instability (Leopold et al. 2005, Hawley et al. 2020), altered delivery of energy sources (Booth 2005), and degraded biological communities (Walsh et al. 2005a, Hawley et al. 2016). Poor-quality urban streams are so ubiquitous that calls for improved watershed management approaches are now common in both the scientific and regulatory communities (Roy et al. 2008, Walsh et al. 2016). These improved approaches can include stormwater management facilities designed to reduce hydrologic alteration, or more commonly, prescriptive water-quality treatment requirements for stormwater discharges (USEPA 2016).

In some cases, stormwater management strategies are based on narrative and largely qualitative guidelines advising that management should be protective of the receiving stream without providing specific, quantitative definitions or goal thresholds. In Kentucky, general stormwater permits specify qualitative measures that post-construction best management practices (BMPs) should meet. For example, the permits state that the BMPs should be appropriate for the local community and designed to minimize the

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Received 23 August 2021; Accepted 4 February 2022; Published online 28 June 2022. Associate Editor, Nathan J. Smucker.

Freshwater Science, volume 41, number 3, September 2022. Published by The University of Chicago Press for the Society for Freshwater Science. https://doi.org/10.1086/721031

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Hawley, R. J., M. S. Wooten, K. R. MacMannis, and E. V. Fet. 2016. When do macroinvertebrate communities of reference streams resemble urban streams? The biological relevance of Qcritical. *Freshwater Science* 35:778–794.

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Hawley, R. J. 2021. Expanding catchment-scale hydrologic restoration in suburban watersheds via stream mitigation crediting—A Northern Kentucky (USA) case study. *Urban Ecosystems* 25: 133–147

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Thank you!
Discussion?
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Insert Title Here

Comparison One

- Bullet One
  - Sub-Bullet 1
  - Sub-Bullet 2

Comparison Two

- Bullet One
  - Sub-Bullet 1
  - Sub-Bullet 2

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