

# Urban Stream Restoration

## The Past and Future

Where We've Been and Where We Need to Go Now

*Presented at:*



**STREAM RESTORATION**  
*Conference*

*Presented by:*

Will Wilhelm, P.E., CFM

**Kimley»»Horn**









*"A good river is nature's life work in song."  
- Mark Helprin*





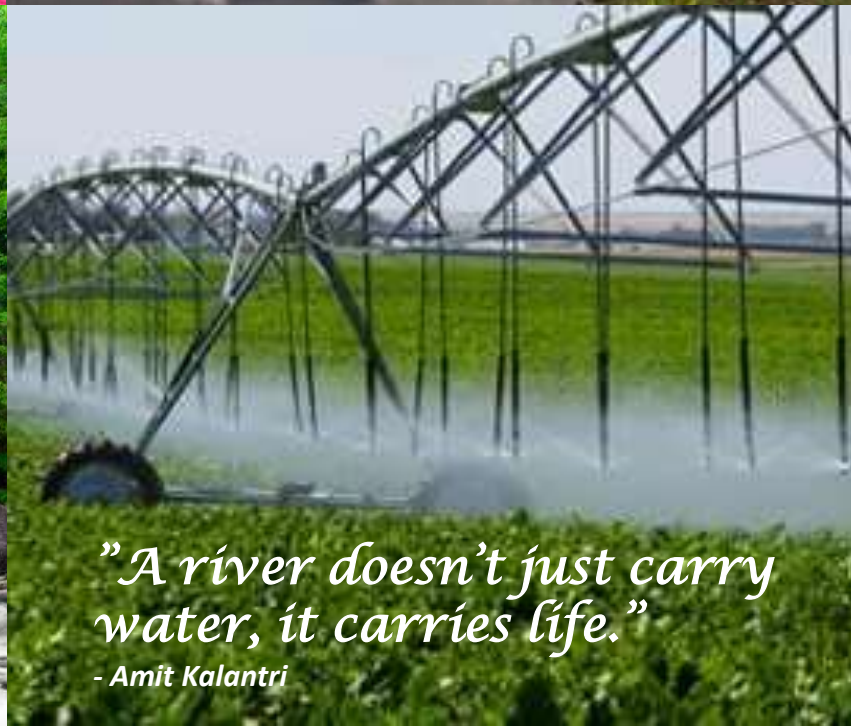
nrdc.org



earthjustice.org



Pinterest.com



*"A river doesn't just carry water, it carries life."*

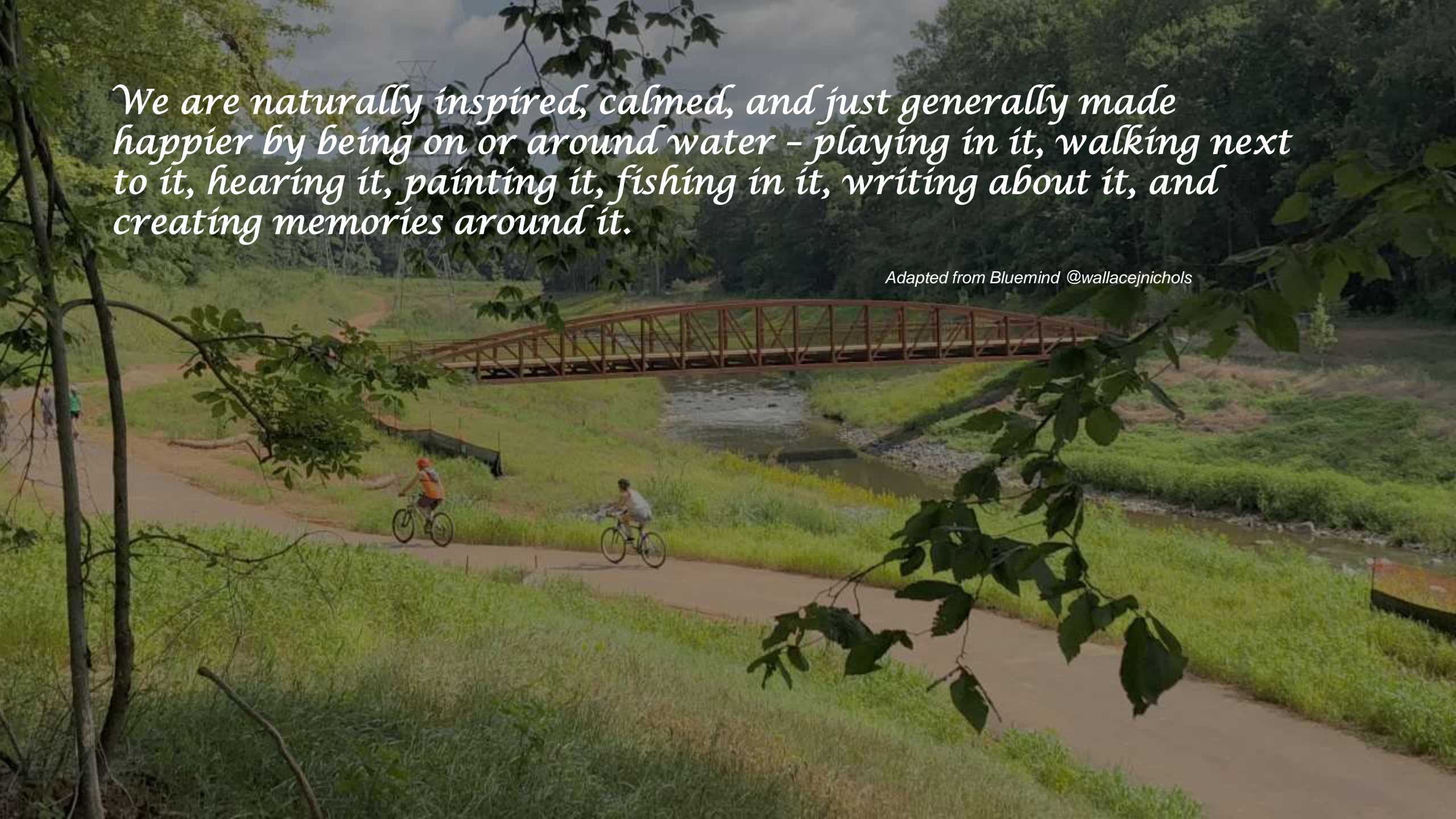
*- Amit Kalantri*



Courtesy: Mecklenburg County, NC

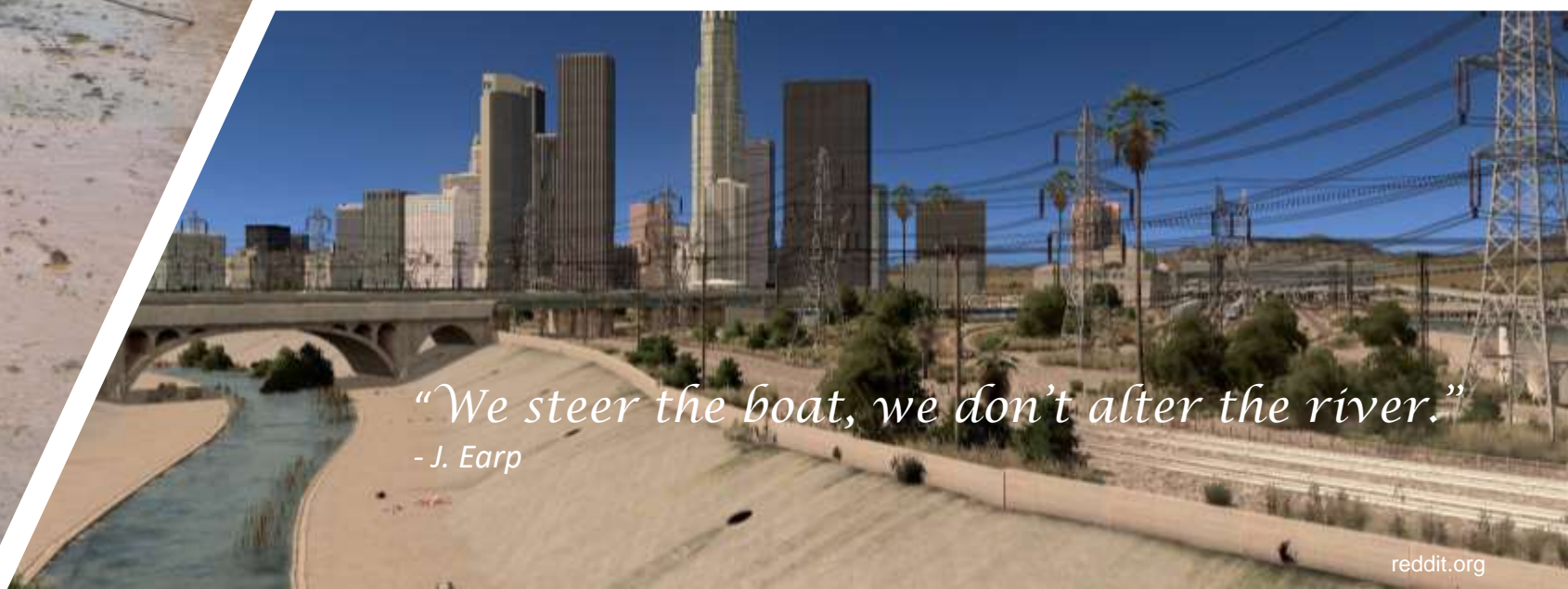
*We are naturally inspired, calmed, and just generally made happier by being on or around water – playing in it, walking next to it, hearing it, painting it, fishing in it, writing about it, and creating memories around it.*

*Adapted from Bluemind @wallacejnichols*





Smithsonianmag.com



*"We steer the boat, we don't alter the river."*  
- J. Earp

reddit.org





[Denverpost.com](https://www.denverpost.com)



STEVEN SPIELBERG Presents

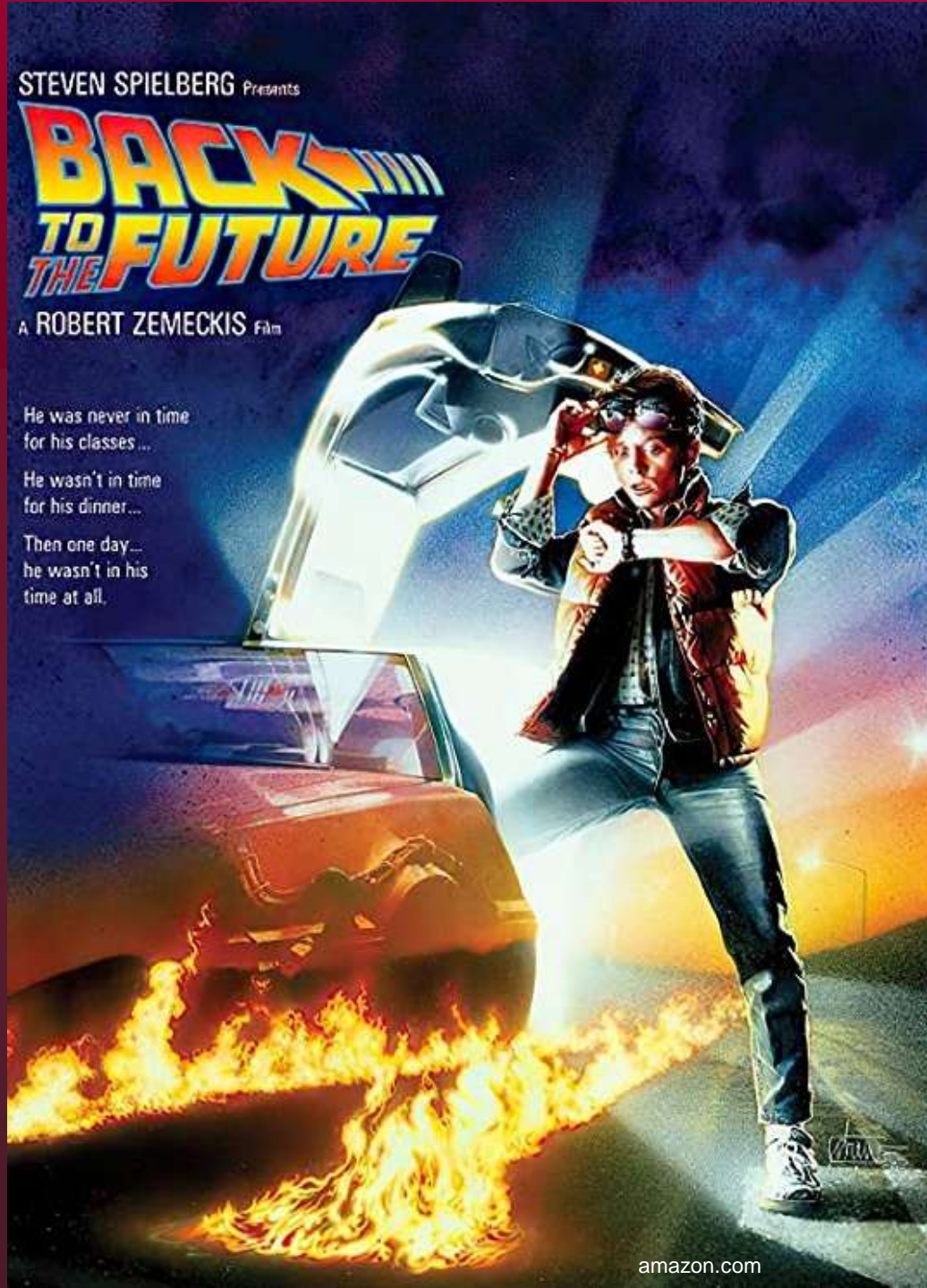
# BACK TO THE FUTURE

A ROBERT ZEMECKIS Film

He was never in time  
for his classes ...

He wasn't in time  
for his dinner...

Then one day...  
he wasn't in his  
time at all.





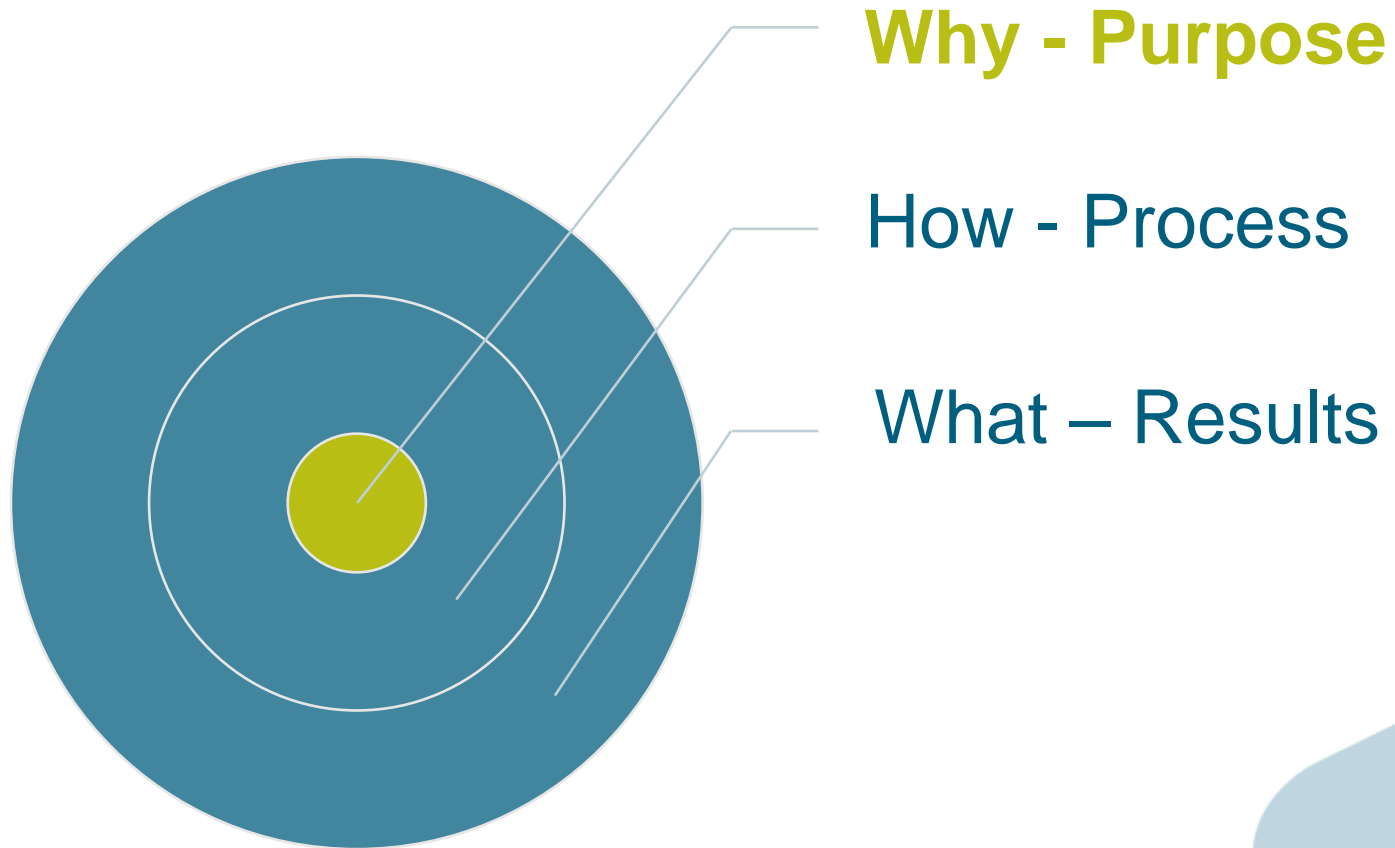
Courtesy: Mecklenburg County, NC



*“The river has great wisdom and  
whispers its secrets to the hearts  
of men”*

*- Mark Twain*

# Start With Why –Project Purpose





- Agua Nueva Outfall



# River Restoration

## Santa Cruz River: Tucson, Arizona Aquatic Ecosystem Restoration



### History

This reach of the Santa Cruz River is a key element of El Corazón de los Tres Ríos Norte, "The Heart of the Three North Rivers", a confluence of the Rillito River, the Cañada del Oro (CDO) and the Santa Cruz. For over 2000 years, the flow of these rivers supported vibrant pre-historic and historic settlement in the Tucson basin.

Many indigenous communities, including the Tohono O'odham, thrived in this area but other influences arrived from the south, including the historic expedition of more than 240 Spanish colonizers led by Spanish Lt. Colonel Juan Bautista de Anza. The Anza Trail now commemorates the 1775-1776 expedition.



**Before:** Erosion at Base of Bank Protection



**After:** Meandering River with Native Vegetation

## Before

### Ecology Transformed

These rivers also sustained a robust native wildlife community, supported by lush riparian vegetation. Years of human and natural impacts, including the introduction of treated wastewater, a series of floods including the historic 1983 event, and ensuing bank protection construction, provided setbacks to the area. The Santa Cruz River was degraded and no longer supported this vibrant ecosystem of the past.

In the early 2000's, a massive study was initiated. The Tres Ríos del Norte Ecosystem Restoration Feasibility Study, a partnership of the U.S. Army Corps of Engineers, Pima County, the City of Tucson, and Town of Marana, continues to provide valuable insights to all aspects of this area. Further improvements included the Agua Nueva Wastewater Management Plant. The improved quality of waters from the treatment plant into the Santa Cruz have generated a resurgence of native fish species and improved habitat. This surprising evolution is a strong basis for expanding environmental focus on the area.

## After

### The Transformation Continues

Many factors encourage a continued focus here. The myriad of benefits to the Tucson community will include destination tourism and community-wide education and recreation. Emphasis will be placed on cultural history and native ecosystem restoration.

The ever-evolving Loop trail system has proven to draw visitors from around the world. Its 55-mile vehicular-excluded connectivity around the Metro Tucson area makes cycling, strolling, roller-blading, dog walking and horseback riding a tranquil pleasure.

The Loop also provides access to the more rugged Tucson Mountain trail system along the western side of the Santa Cruz River. Interpretive signage will bring fascinating glimpses into the struggles and glories of early Arizona life and explorations.

The improved quality of the Santa Cruz River continues to support an unparalleled location for birding and the observation of wildlife, butterflies and other pollinator species. This continuing evolution will draw the community, and specifically our youth, to hands-on educational experiences. Whether the simple enjoyment of cooling, flowing waters in the middle of the desert, to netting and discovering hidden water creatures, to observing the colorful plumage and melodies of the local avian population, the benefits to the community will be innumerable and memorable.



**Living River of Words Youth Program**

Project Credit: PCWRP

# The Project: Why







BEFORE: RIVER AT BANK BASE

BEFORE



AFTER

CONSTRUCTED RIFFLE WITH VALLEY ROCK SILL

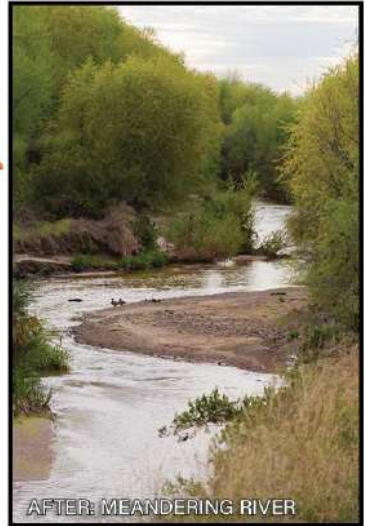
BENDWAY WEIR, TYP.

LOW FLOW, TYP.

RESTORED RIPARIAN VEGETATION

LOOP PATHWAY

# Santa Cruz River Management Plan: Columbus Park



AFTER: MEANDERING RIVER



- Stream Restoration
- Agua Nueva Outfall to Ina Road

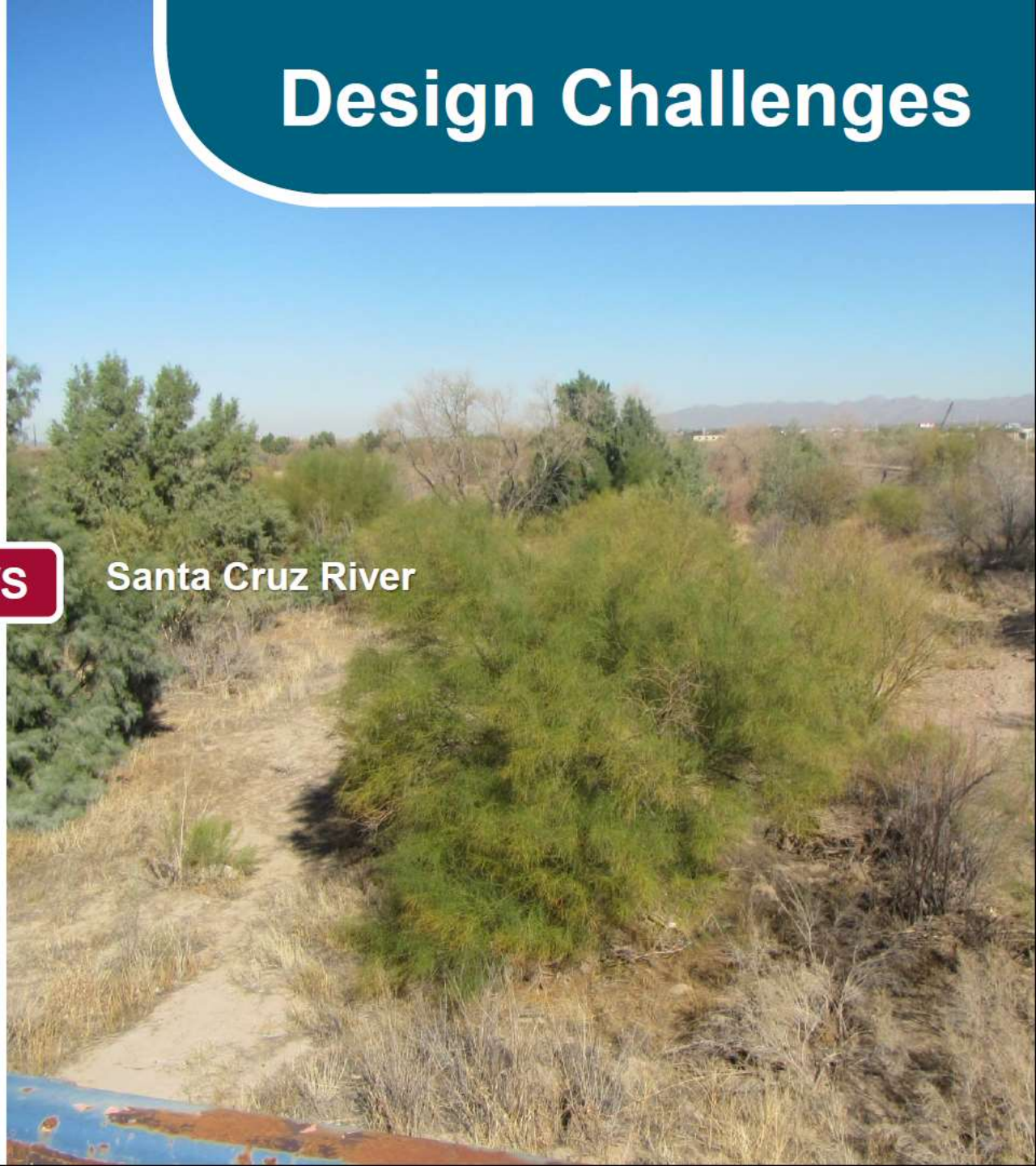


# Design Challenges



Effluent Channel

VS



Santa Cruz River

# Other Purpose(s) – Other Stakeholder

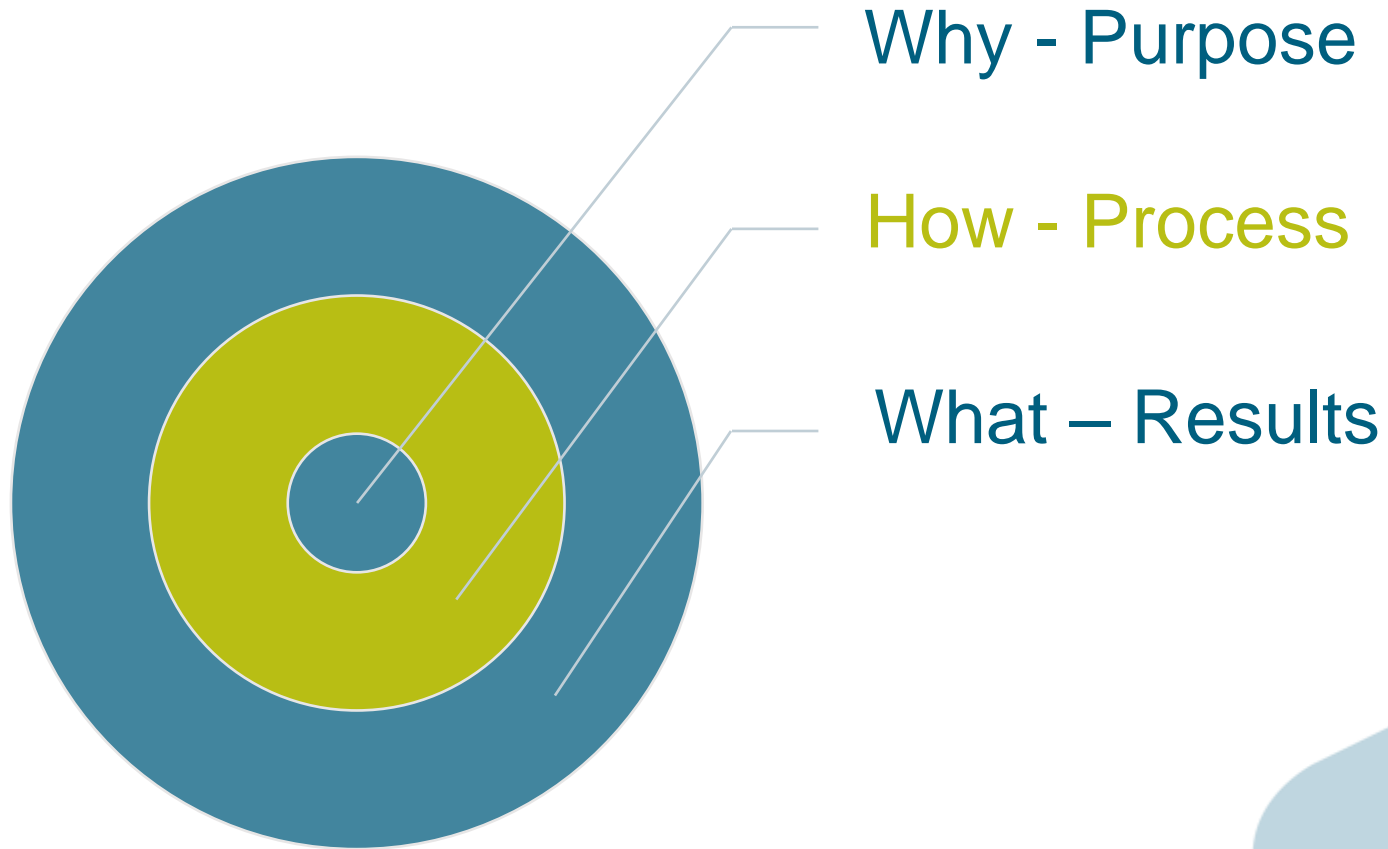


*Source: The Millennium Ecosystem Assessment defined these four categories of ecosystem services that contribute to human well-being, each underpinned by biodiversity*

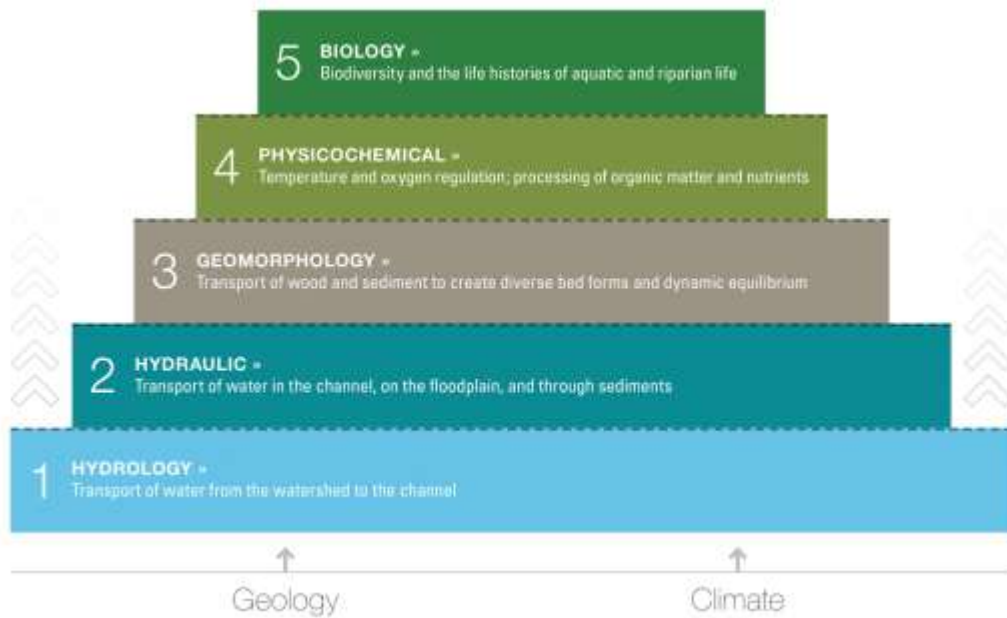


# How – Process

We have work to do here 😞



# Assessment and Protocols



Stream-mechanics.com




Courtesy: MHFD


# Design and Assessment Procedures

**EPA** United States Environmental Protection Agency

## The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest



## Regional Relationships for Bankfull Stage in Natural Channels of the Arid Southwest



Yun Healy, PE  
Mark Wilcox  
Nicholas N. Yim, PE


March 2005

**Natural Channel Design, Inc.**

United States Department of Agriculture

## Part 554 Stream Restoration Design National Engineering Handbook


### Chapter 1 Introduction: Ecological and Physical Considerations for Stream Projects



**USDA** United States Department of Agriculture

## Guidance for Stream Restoration

Steven E. Yochum



Forest Service National Stream & Aquatic Ecology Center Technical Note 554-102-0 May 2010



**StreamMechanics**

## A Function-Based Framework for Stream Assessment & Restoration Projects

ETA 643-N-10-006 • May 2010

## Stream Corridor Restoration

### Principles, Processes, and Practices


<http://www.usda.gov/nrcsr/restoration>

See this site for downloads, and details, and a listing of the book's chapters.

For The Federal Interagency Stream Restoration Working Group

Published October, 1993. Revised August, 2001.

## LOW-TECH PROCESS-BASED RESTORATION OF RIVERSCAPES DESIGN MANUAL



Revised 2010 • Revised 10

Edited by: Joseph M. Wilcox, Stephen H. Swartz, Technical Director, Jeremy G. Kistner & Scott R. Stahler

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**Utah State University**

2010 Utah Forestry Restoration Consortium, Department of Watershed Sciences

NOAA Technical Memorandum NMFS-NWFSC-112



## Science Base and Tools for Evaluating Stream Engineering, Management, and Restoration Proposals

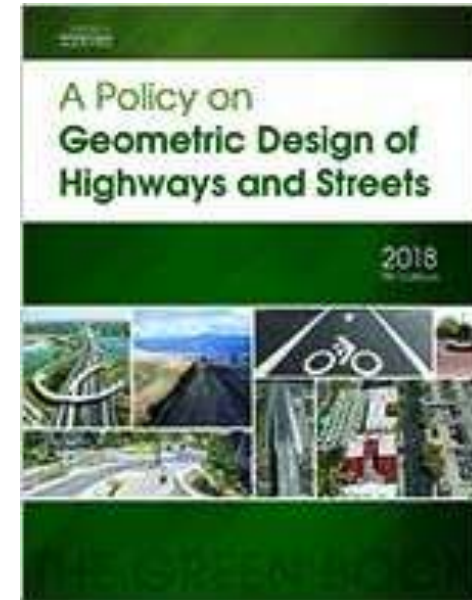
October 2011

U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service

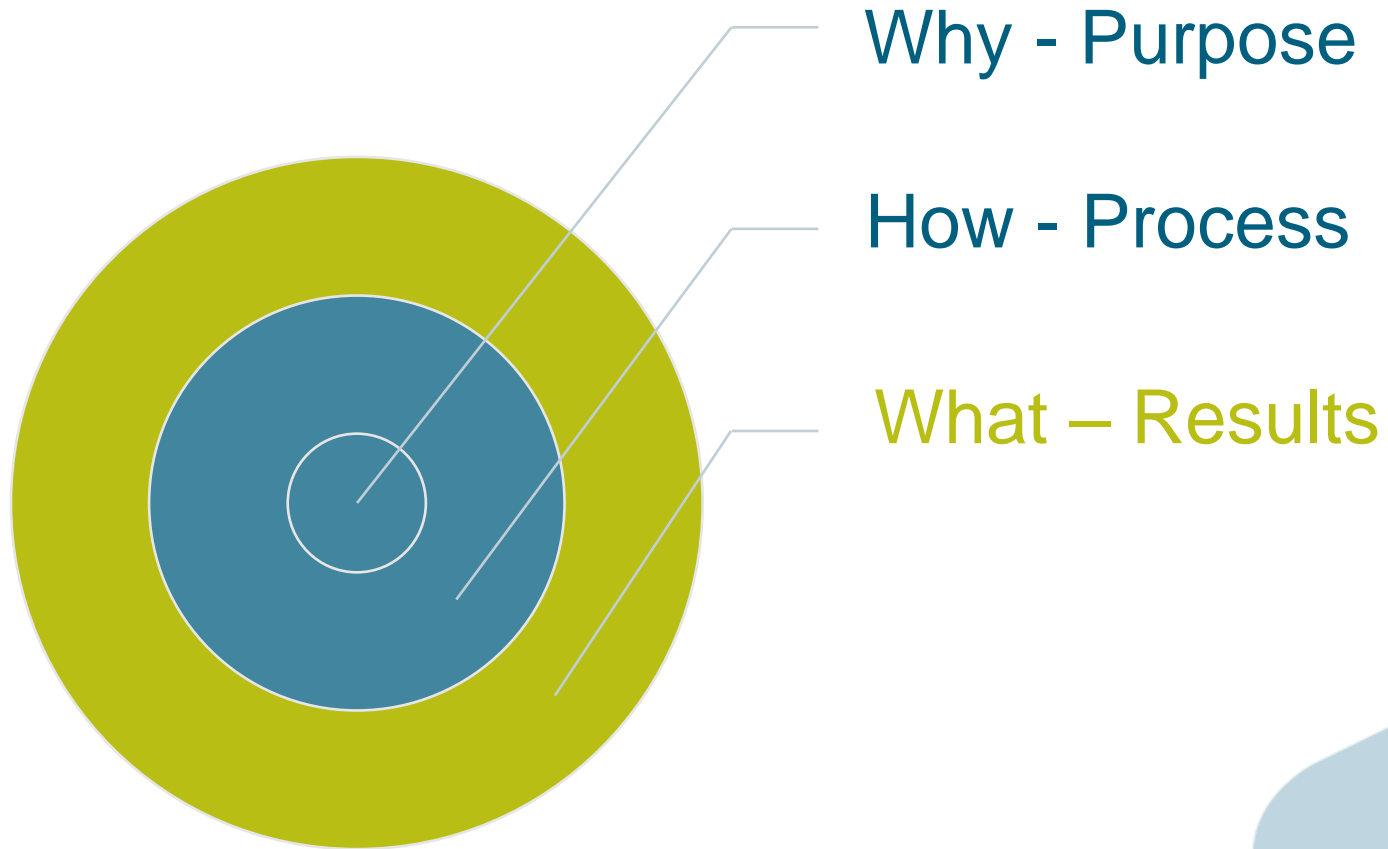


## AASHTO Technical Committee on Geometric Design Members

- 18 State Departments of Transportation
- National Association of County Engineers
- National League of Cities
- American Public Works Association
- Port Authority of NY, NJ
- Federal Highway Administration



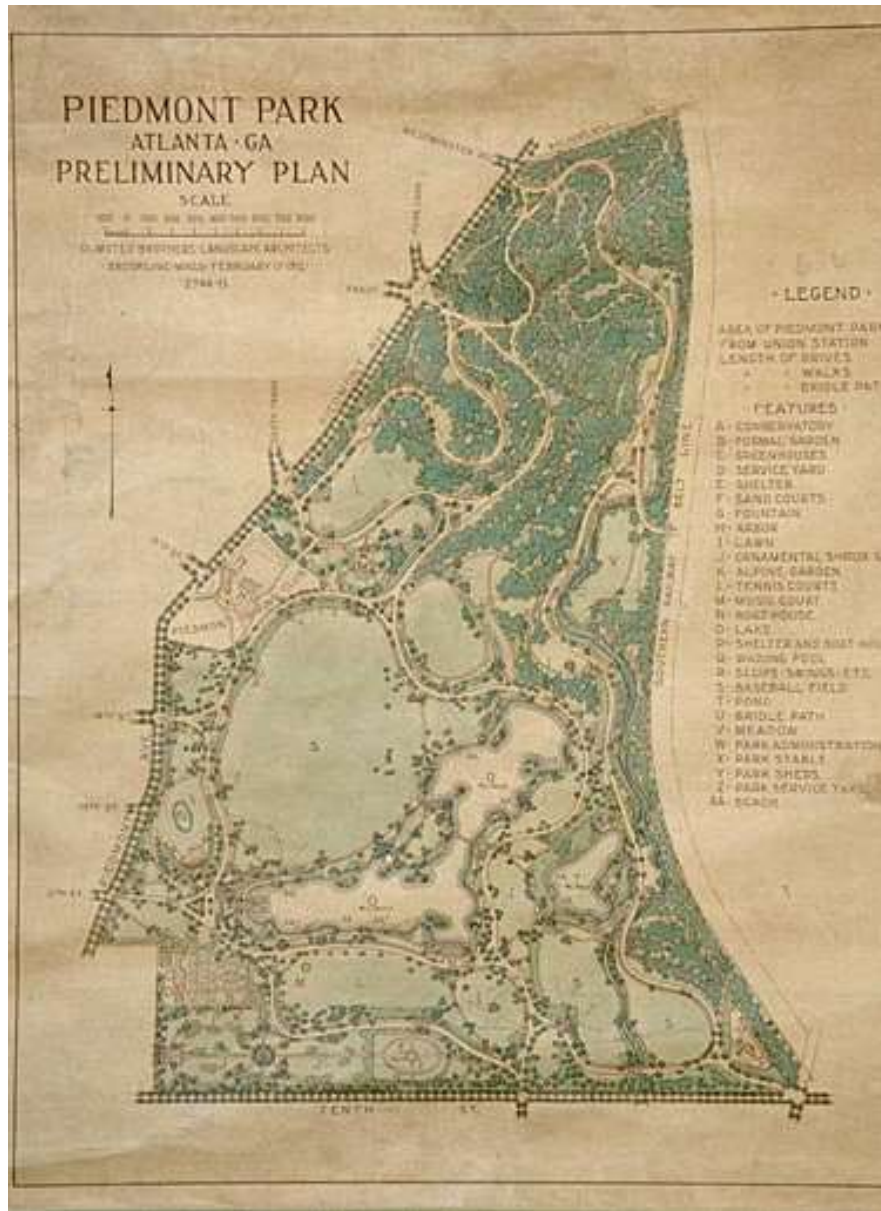
# Results

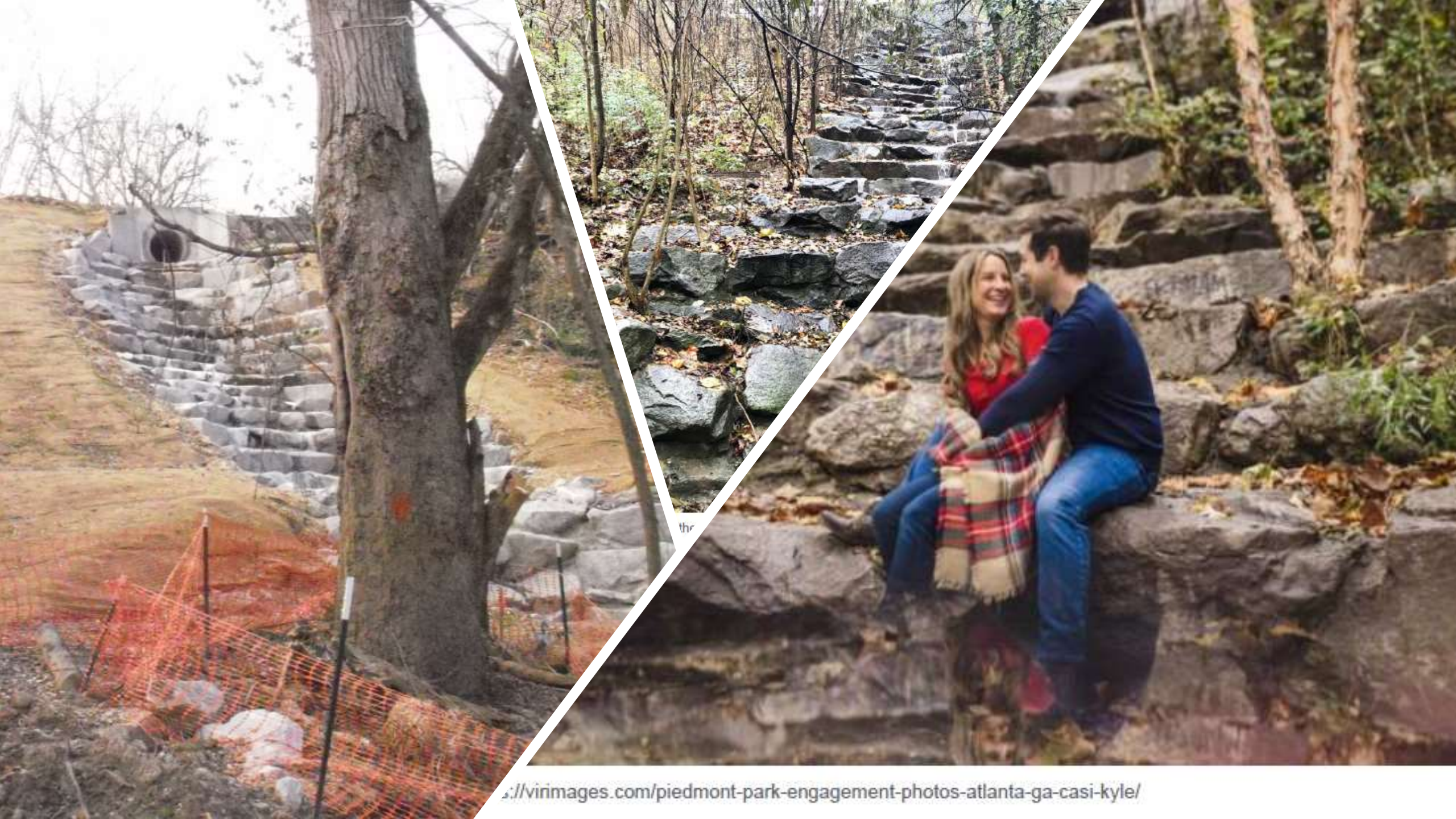






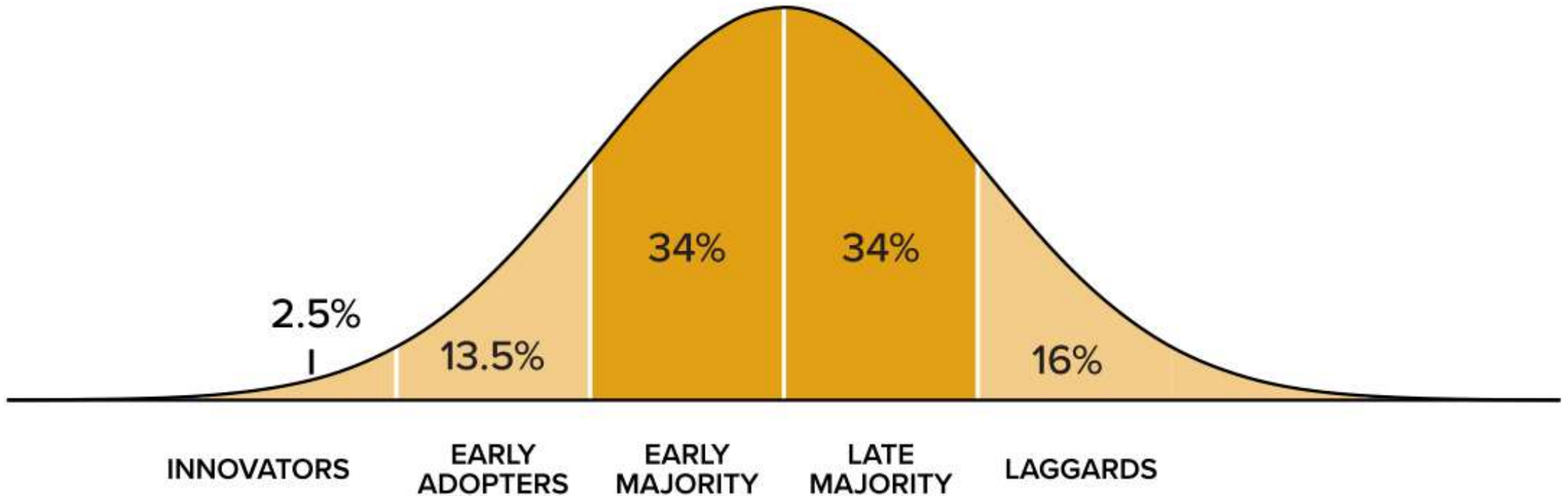






the

# Rogers Curve of Innovation



[smallformfactors.mil-embedded.com](http://smallformfactors.mil-embedded.com)





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