Adaptive Management of Urban Watersheds:

A Case Study from Fairfax County, VA

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Threats to Natural Communities and Streams

Land conversion and fragmentation
- Runoff from impervious surfaces
- Erosion of outfall and stream channels
- Changes to water temperature
- Changes to water chemistry (salinization)
- Lack of groundwater recharge

Over-simplification

Invasives species

Deer herbivory

Climate change

Compound effects (e.g., urban heat island effect)

Urban Stream Syndrome:
Eroded channel and exposed sewer line at Trapp Rd, Annandale, VA

Local Stormwater Program Overview

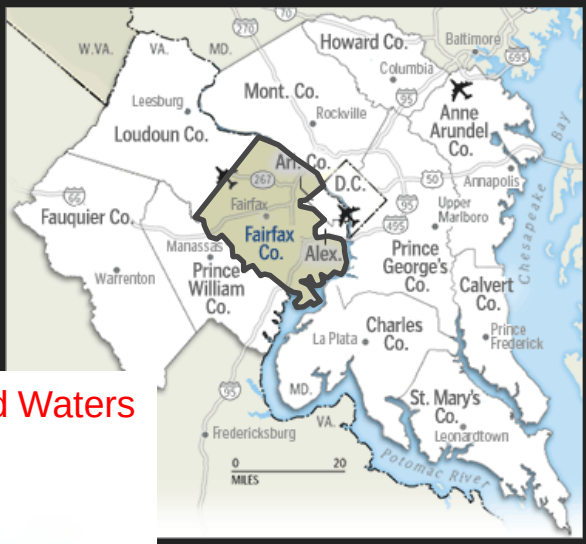
Fairfax County, Virginia

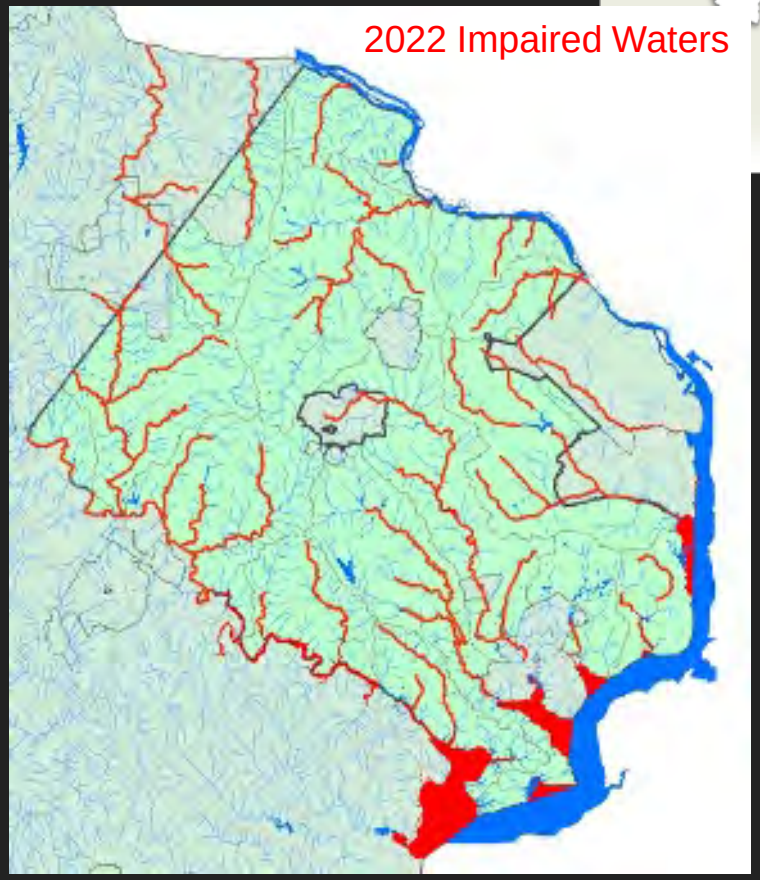
- Land area of approximately 400 square miles
- Population of approximately 1.1 million residents
- Land use 88% residential
- 30 watersheds with over 750 miles of perennial streams

Stream restoration drivers include:

- Municipal Separate Storm Sewer System (MS4) Permit regulates discharge and pollutants
- Chesapeake Bay TMDL* pollutant load reduction requirements
- Local TMDL (currently 12) pollutant load reduction requirements
- 109 impaired waterbodies and growing

* TMDL – Total Maximum Daily Load
Assigned by the VA Department of Environmental Quality





Impaired Segments:

77 Streams

3 Reservoir

29 Estuarine

109 Total

Stream Restoration Methods

What is Stream Restoration?

Refers to any NCD, RSC, LSR or other restoration project that meets the qualifying conditions for credits, including environmental limitations and stream functional improvement.

From the Chesapeake Stormwater Network "Stream Restoration Revisited" 2017 Webinar

Many urban restorations use NCD with RBC = Stable Transport System

Method*	Application
Natural Channel Design (NCD)	Changes stream plan form from current unstable stream type to a stable stream type using geometry based on analog stable system(s); presupposes bankfull channel
Reinforced Bed Channels (RBC)	Rock-lined armored channel often used on NCD projects in urban areas in conjunction with enlargement factors to reduce stream power
Legacy Sediment Removal (LSR)	Sediment removed from stream valley to restore historic elevations and create connected stream system
Floodplain Reconnection (FR)	Elevates channel so that frequently recurring storms overtop banks and flows access the floodplain
Beaver Dam Analogs (BDAs)	Wood structures are used to raise channel and reconnect to floodplain; often a baseflow channel is used
Regenerative Stormwater Conveyance (RSC)	Sand and wood matrix with intermittent stone grade controls are used to fill incised outfall channels to absorb and slow storm flows, stop erosion, elevate ground water and clean surface water

*Note that this list is not exhaustive

Urban Stream Restoration Using Natural Channel Design

Old Courthouse Spring Branch – Tysons Corner, VA

Pre-construction with exposed sanitary sewer manhole

Post-construction first growing season – June 2021

Urban Stream Restoration Using Natural Channel Design

Turkey Run @ Truro – Annandale, VA

Pre-construction

Post-construction second growing season – 2020

Urban Stream Restoration Using Natural Channel Design

Rabbit Branch Tributary – Burke, VA – April 2023

Cleared with construction access installed

Restored reach prior to planting

Stream Restoration Drivers, Concerns and Outcomes

Reasons Localities Do Stream Restoration

- Permit Compliance
- Flood Control - Conveyance
- Stability-Erosion & Infrastructure
- Functional Lift
- Aquatic Biological Impairment
- Pollution Prevention

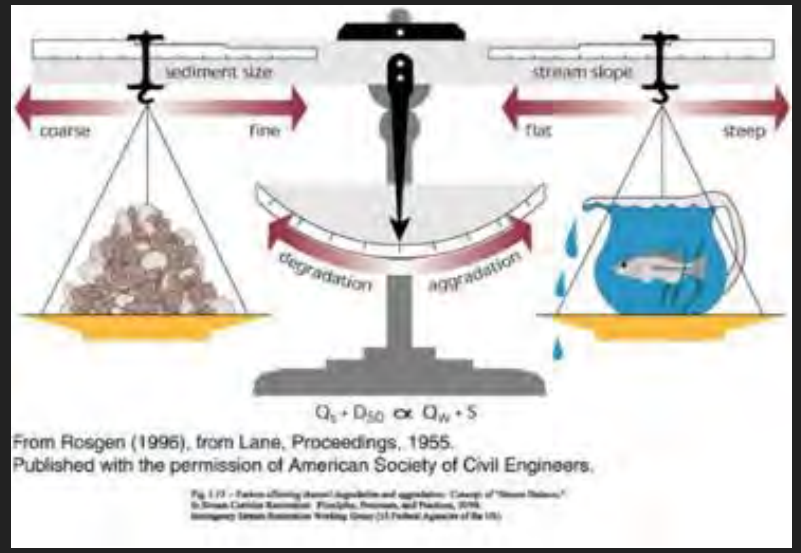
Reasons for Stakeholder Concern

- Tree Loss
- Impacts to Terrestrial Systems

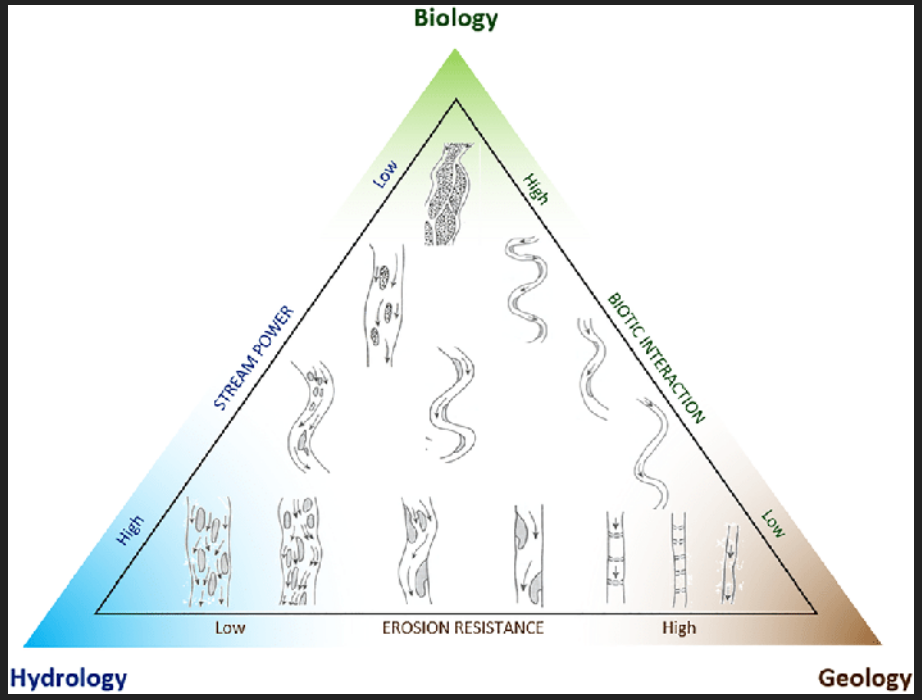
Ecological Outcomes of Stream Restoration

- Lack of Benthic Lift
- Degradation of Riparian Corridor
- Changes to Water Temp & Chemistry
- Loss of Epifaunal Substrate and Allochthonous Material

Stream Restoration Paradigms



Lane's Balance diagram, EW Lane 1955



Stream Evolution Triangle, Castro & Thorne 2019

Stream Function Pyramid, Will Harmon 2012

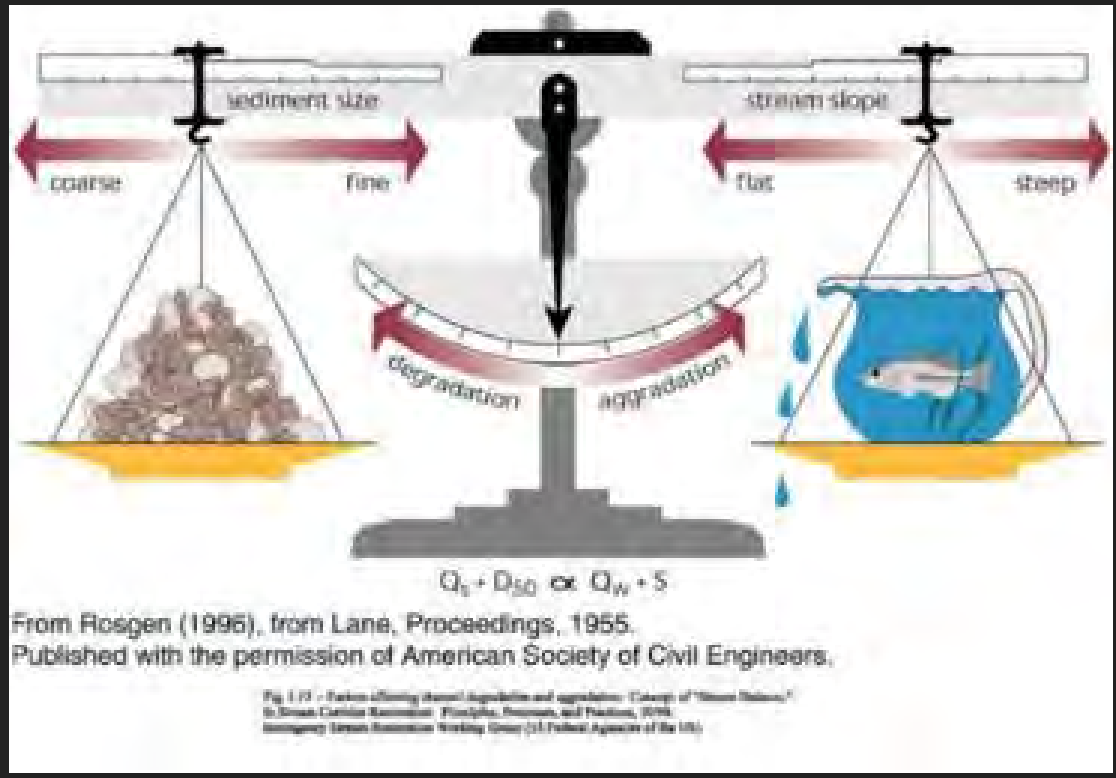
Current Urban Stream Restoration

Approach

- Channel-centric
- Little assessment of riparian system
- Focused on low maintenance, stable transport
- Primary drivers: sediment/nutrient reduction & infrastructure protection

Outcomes

- Achieves sediment/nutrient reduction & infrastructure protection goals
- Low maintenance
- Significant impact to riparian corridor
  - tree loss, floristic degradation
  - increased water temperatures
  - loss of allochthonous material
- No benthic improvement
- Potential changes to fish communities
- Biologic degradation



From Rosgen (1996), from Lane, Proceedings, 1955.
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Ecological Restoration Model

Focus on watershed/system.

Assess current ecological condition of the site.

Establish ecosystem target and functional goals.

Engage with and include stakeholders throughout project.

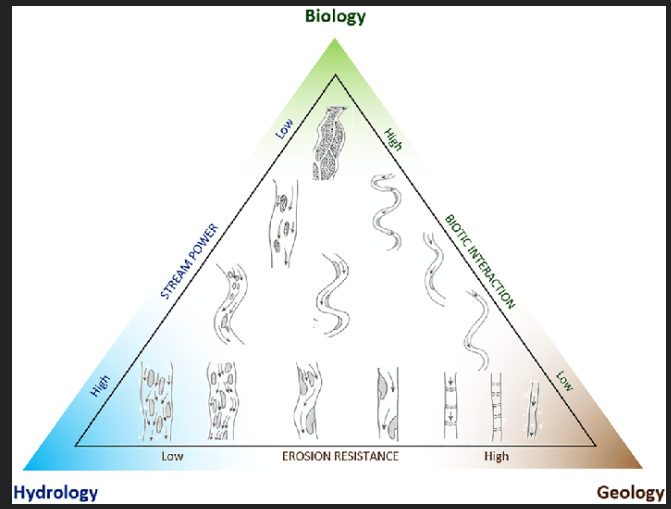
Establish clear and measurable goals and objectives.

- Use biological targets to include flora

Designate and describe reference site(s).

Adapt restoration approach to the landscape and local stakeholder needs.

Plan for, fund and implement pre and post monitoring and adaptive management.



SER SOCIETY FOR ECOLOGICAL RESTORATION

INTERNATIONAL PRINCIPLES AND STANDARDS FOR THE PRACTICE OF ECOLOGICAL RESTORATION

SER SOCIETY FOR ECOLOGICAL RESTORATION | UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030 GLOBAL PARTNER

Vegetative Community Mapping

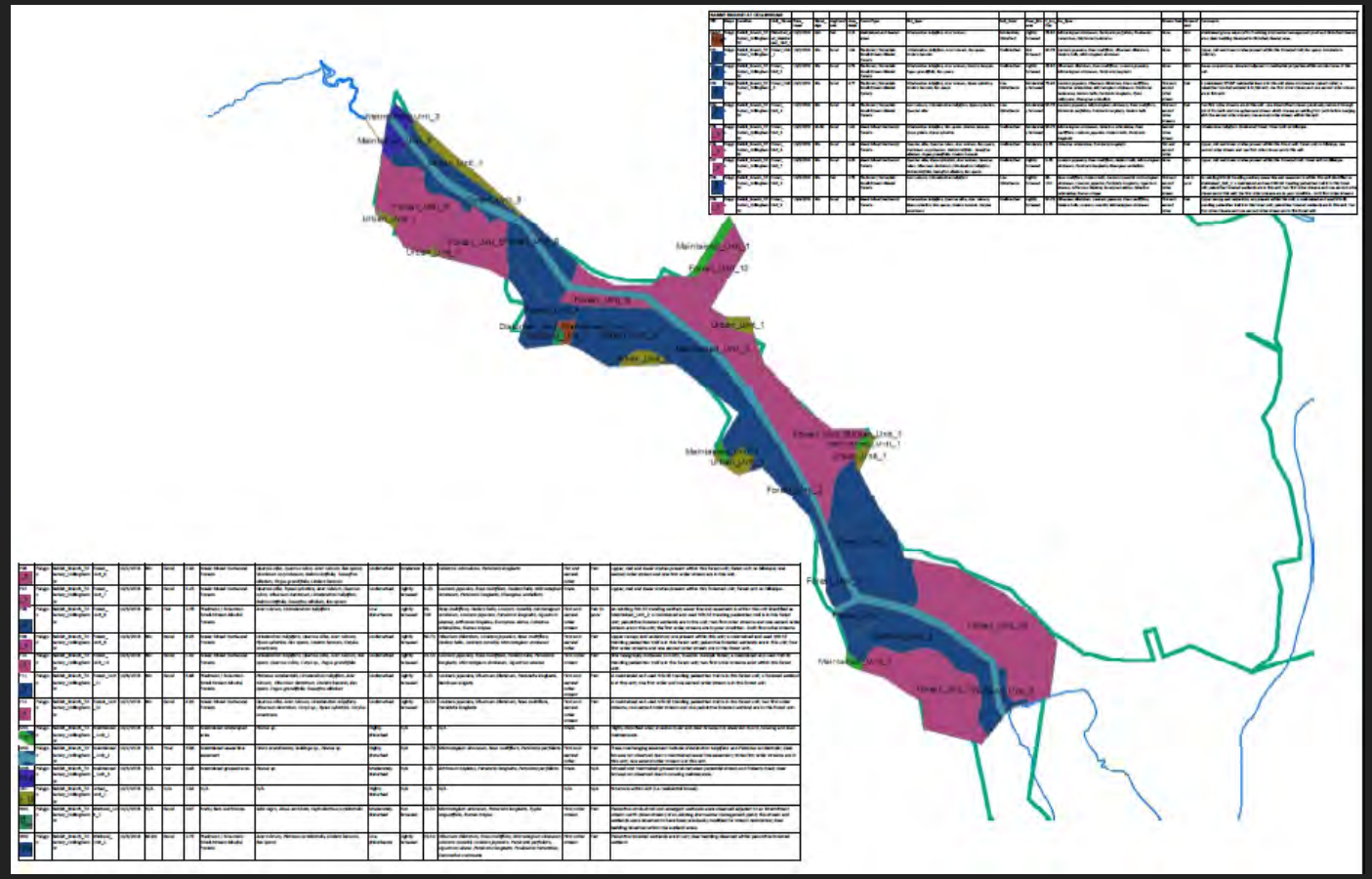
Must map vegetative community:

- Locations
- Type
- Condition

In order to:

- Preserve best components
- Know where restoration may be beneficial or impactful
- Design restoration
- Measure success

Bottom line: can't replace good or excellent quality communities



Community Inclusion

Stakeholder and Community Involvement*

- Outreach at beginning of planning process
- Recruit community members to serve on Design Team
  - Stakeholders participate in all decision making
- 35% design community meeting
- 65% design community meeting
- Pardon-our-dust preconstruction meeting
- Contact during 3-year post construction warranty

* Community interaction varies with community needs but generally includes all steps above.

On-site 65% design community site walk - staff and community members discussing how to protect a wetland feature, April 30, 2022

Old Courthouse Spring Branch II, Tysons, VA

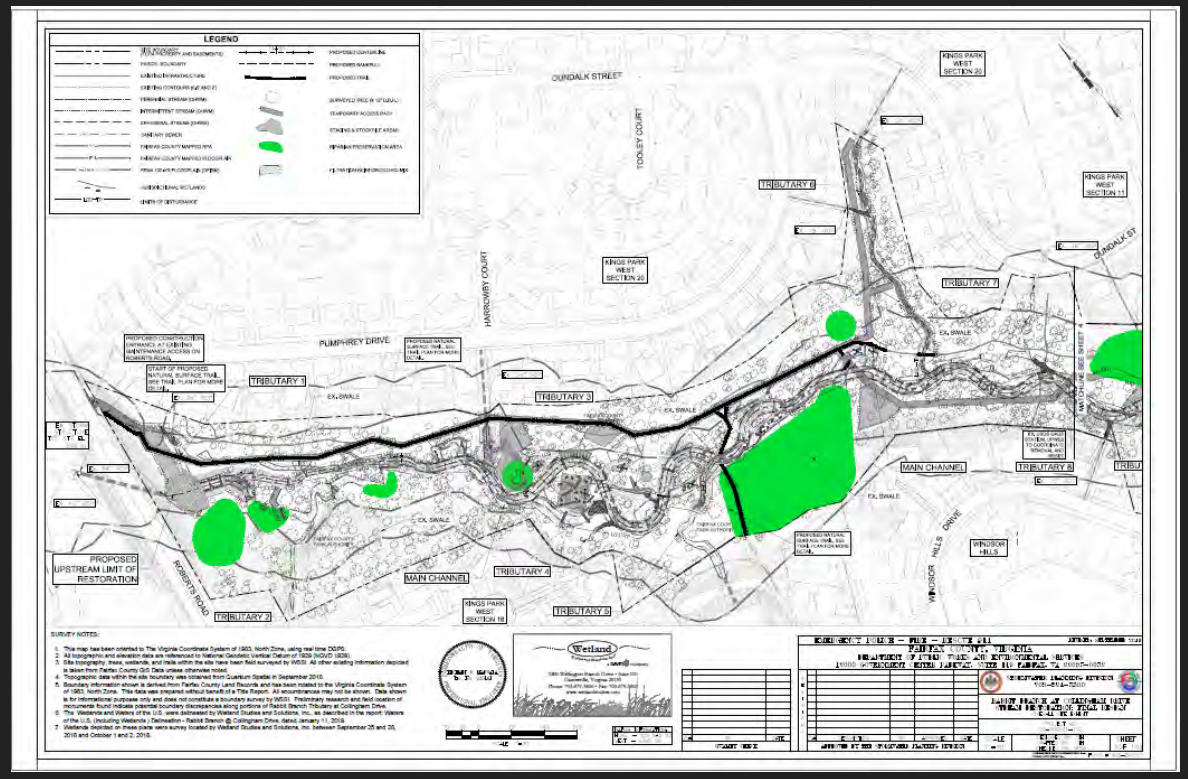
Creating a Resource Map to Guide Decisions

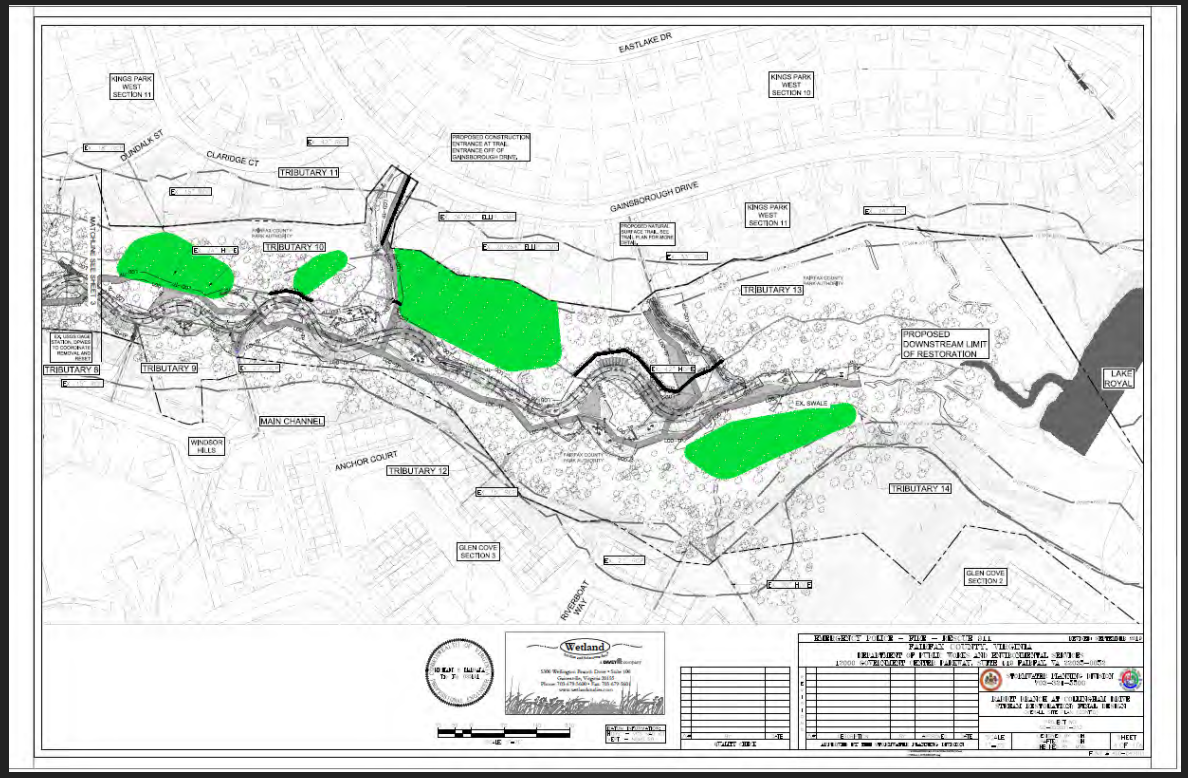
Include critical natural resources

Include roads/infrastructure

Include cultural & community resources

Etc.

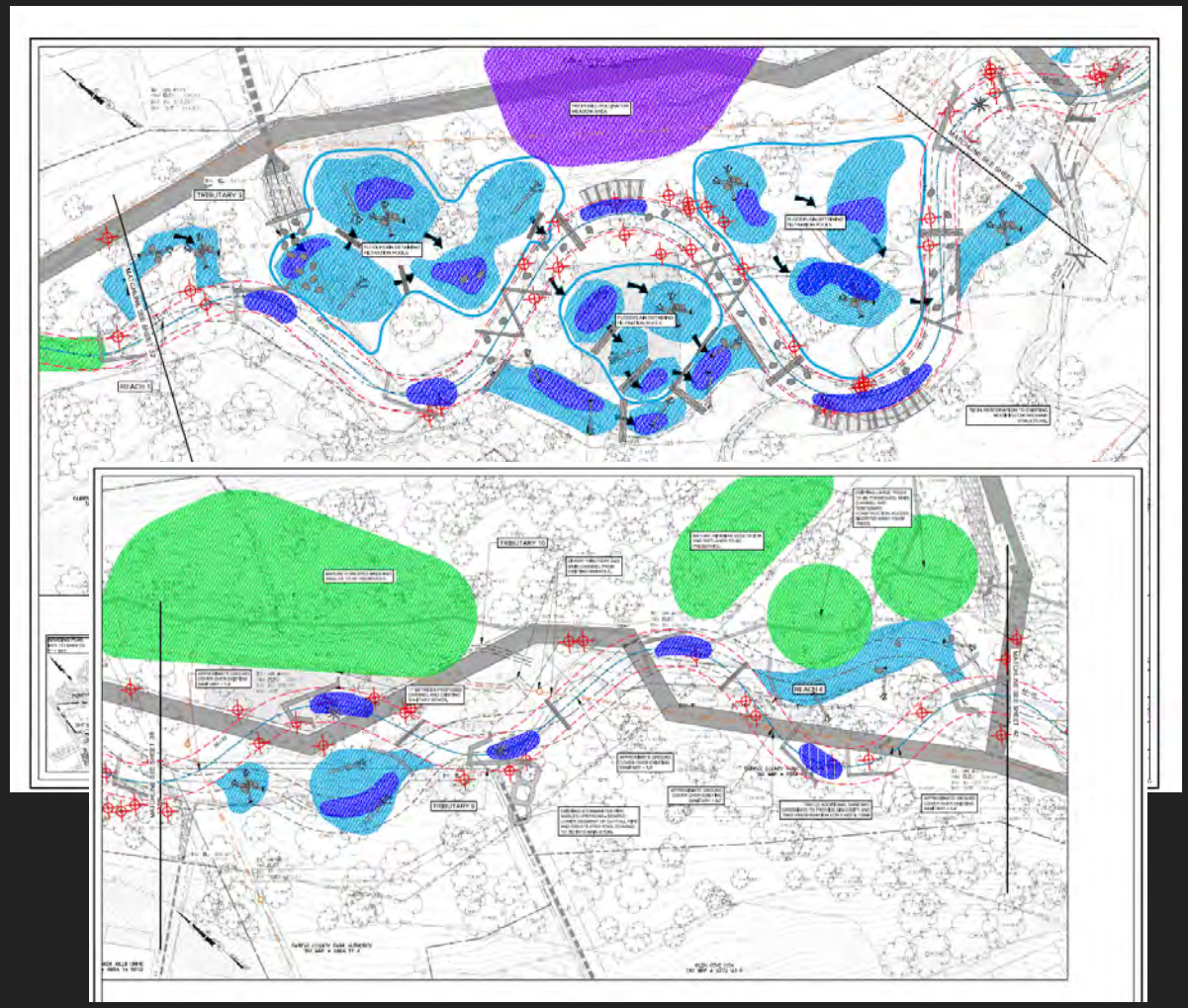




Rabbit Branch Tributary @ Collingham Dr. Stream Restoration

Functions Based Design

Rabbit Branch Tributary @ Collingham Dr.
Burke, VA - Pohick Creek Drainage



Stream functions checklist

2. Reach Level Assessment

Rapid assessment all based on observations. No measurements were taken during field visit.

Colvin Run II

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition			Proposed Condition		
			Rating	Overall by Level	Overall Reach	Rating	Overall by Level	Overall Reach
1 - Hydrology	Runoff	Flashiness	FAR	FAR	FAR	FAR*	FAR*	FAR*
		Concentrated Flow	FAR			F		
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	FAR		F	F	
		Entrenchment Ratio	FAR			F		
	Floodplain Drainage	FWS Rapid Assessment	FAR			F		
	Vertical Stability Extent	FWS Rapid Assessment	FAR			F		
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	FAR		F	F	
	Lateral Stability	Dominant Bank Erosion Rate	FAR			F		
	Bedform Diversity	Shelter for Fish	FAR			F		
		Pool-to-pool Spacing	FAR			F		
		Pool Depth Variability	F			F		
		Bed Mobility	FAR			F		
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	FAR		FAR*	FAR*	
	Detritus	FWS Rapid Assessment	FAR			FAR*		
5 - Biology	Macro	Presence	Refer to FFXCO Data			FAR*	FAR*	
		Tolerance				FAR*		
	Fish	Presence				FAR*		

* - Partial Functional Uplift

	Rating	Comment
Channel Evolution	FAR	Existing Rosgen Classification stream types change throughout the project area from a C4, incised C4, and F4. These differing stream types illustrate that the project area is still adjusting, but overall tending toward functioning conditions. Some areas have nearly recovered to a quasi-equilibrium state while other areas will possibly require decades before equilibrium reached.

Constraints	Downstream bridge culvert sets streambed elevation and may constrict flood flows.

Long Branch Central Watershed Management Project

Long Branch Local TMDL:

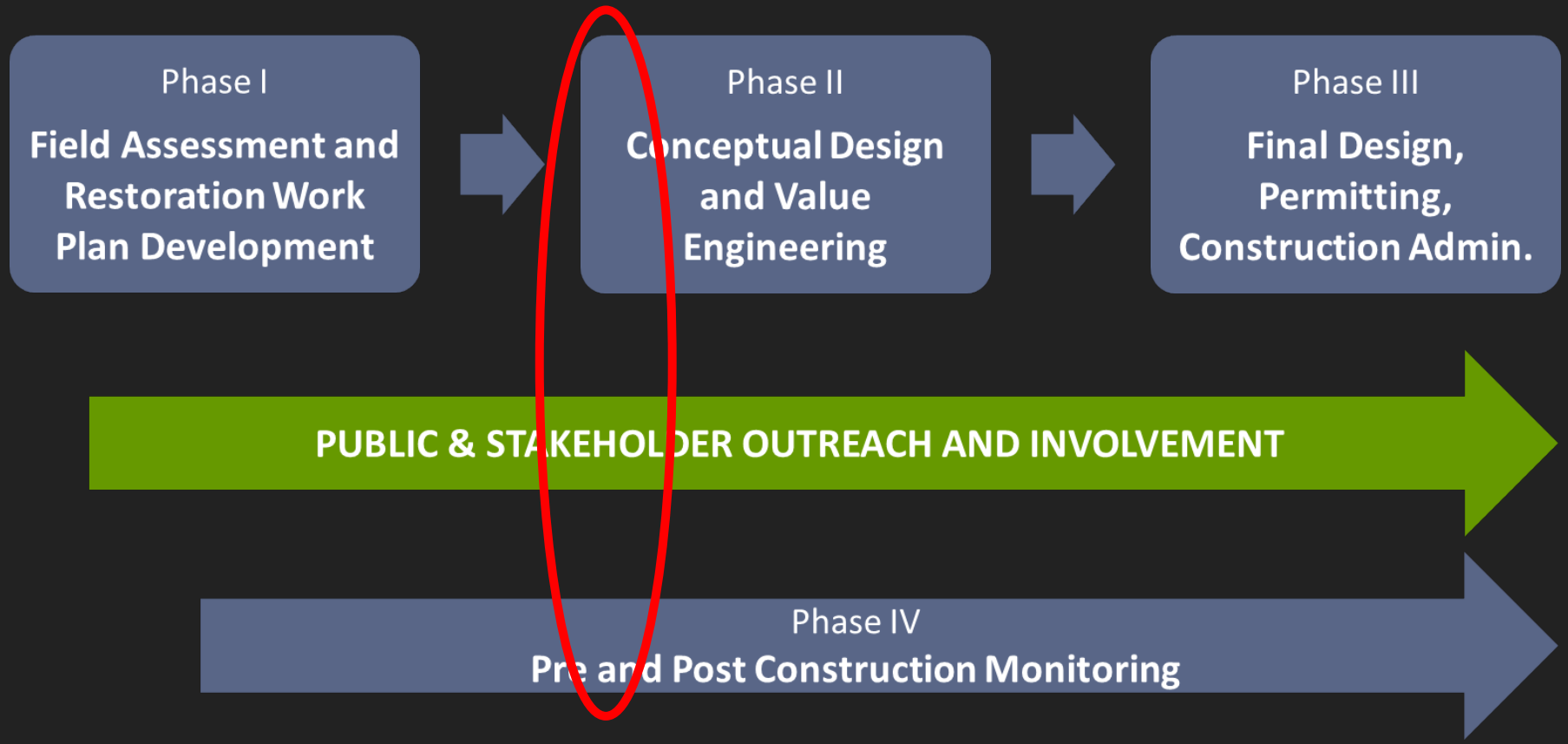
Benthic Impairment / Sediment Stressor

Total Estimated Sediment Load =	3,313 tons per year
Fairfax County Assigned Wasteload Reduction* =	1,569 tons per year

* This is the amount of sediment that Fairfax County is required to reduce coming out of Long Branch Central each year under the County's Municipal Separate Storm Sewer System (MS4) permit.

Watershed Assessments and Restoration Opportunity Identification

The overall approach to restoring Long Branch consists of four phases. Phase I, which complete, focused on watershed assessments and restoration opportunity identification. Phases II and III, beginning in 2023, will move selected projects through design and construction. Phase IV is ongoing and includes both watershed and project-specific monitoring. Public outreach is also ongoing.



Existing Information Review and Field Assessment Work Plan

Desktop Assessment

- Reviewed existing information, data and mapping
- Developed public outreach and participation plan
- Developed preliminary restoration goals
- Developed the field assessment plan
- Developed preliminary approach to monitoring

Watershed Profile

- Drainage Area: 3.8 square miles
- Current Imperviousness: 27%
- Stream Length: Approximately 12 miles
- Land Use:
  - Residential (58% of the watershed)
  - Non-Residential (28% of the watershed)
  - Open Space (3% of the watershed)
  - Recreation (11% of the watershed)

PLEASE GIVE US YOUR INPUT!

Long Branch Watershed Study P

biohabitats.maps.arcgis.com/apps/GeoForm/index.html?appid=8ec49b49685d47bcb8a890da636137f9

Biohabitats

Long Branch Watershed Study Public Input Ma

Welcome to the Long Branch Watershed Study Public Input Map. This application was designed to help gather local i
watershed residents and users of the Long Branch Stream Valley Trail. Additional information about the Watershed St
County's website at: https://www.fairfaxcounty.gov/publicworks/stormwater/plans-projects/long-branch-central-wate

To fill out the map:

1. Let us know about the areas you value or areas of concern within the Long Branch watershed.
2. Add a description of the place or experience. If the place or experience falls into a common category, indicate that
3. Locate the relevant location for your response on the map.
4. Submit and share your opinion with the world!

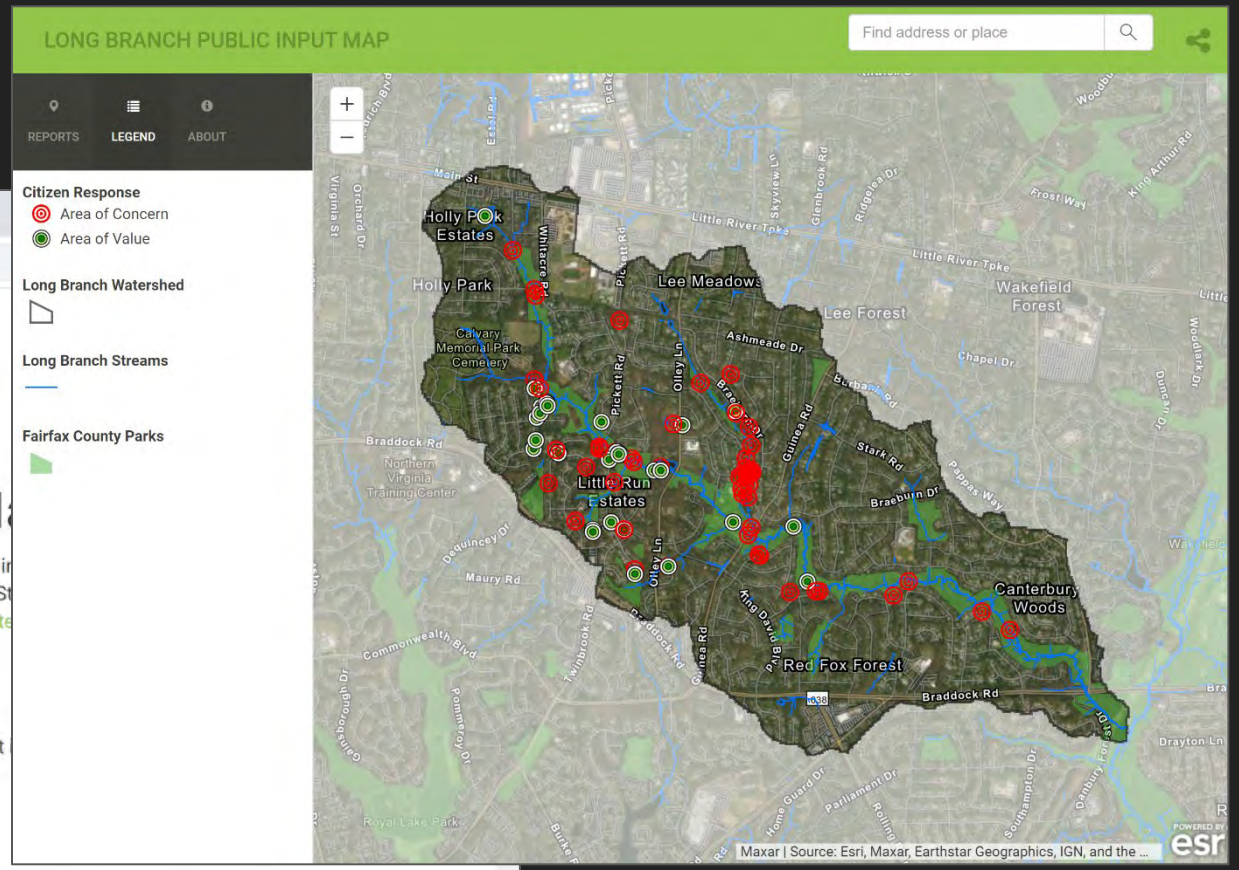
Thank you for contributing to the Long Branch Watershed Study. Your responses to this web form are a valuable resource for the planning team. This tool will help us create a map of the watershed from your point of view. The map will be updated with every entry. Click here to go directly to the map.

If you have any questions, comments or concerns, please reach out to Charles Smith, Fairfax County Watershed Projects Implementation Branch - Central Chief: Charles.Smith@fairfaxcounty.gov

To return to the Fairfax County Long Branch Watershed Project website, click here.

Note that comments must be submitted before viewing public responses. Changes to the form will be lost if the form is not submitted.

Note that no personal information will be collected, stored or shared.



https://www.fairfaxcounty.gov/publicworks/long-branch-input

Field Assessment and Restoration Opportunity Identification

Stream Corridor Assessments

- Assessed ~12 miles of stream and ~150 outfalls
- Assessments conducted:
- Stream Restoration Assessment
- Physical Habitat Assessment
- Floodplain Vegetation Assessment
- BANCS Assessment
- Miscellaneous (resident interactions & points of interest)
- Pipe Crossing
- Outfall: Regenerative Stormwater Conveyance (RSC) Potential
- Outfall: Repair Needs
- 548 soil tests along 6.5 miles (274 bulk density, 274 nutrients)

County-Maintained Stormwater Facility Assessments

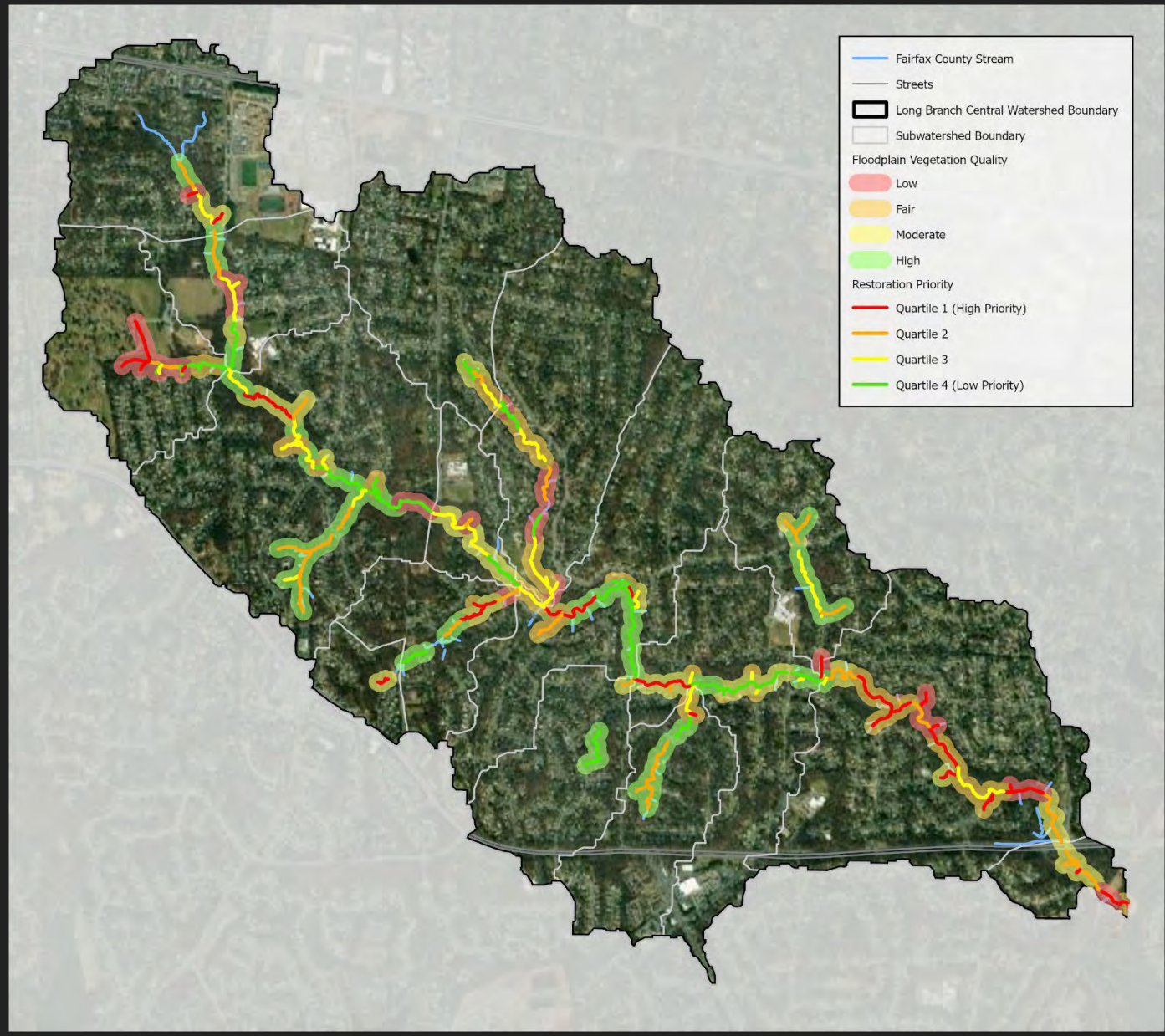
- Assessed retrofit potential of 21 existing stormwater management facilities

Preliminary Project Identification and Prioritization

- Watershed assessment data used to identify and prioritize potential projects.
- Scoring schemas developed for three project types: stream restoration, RSCs, and stormwater BMP retrofits.
- For stream restoration, prioritization scoring criteria applied on a reach-by-reach basis.
- Each potential project scored within its project type.
- While scoring metrics varied by project type, a similar scoring framework developed and applied across all three project types.

Scoring metrics organized into three bins:

- **Ecological benefits**: parameters included sediment load addressed, floodplain vegetation quality, etc.
- **Ancillary benefits**: parameters included public input obtained via County complaints database, correspondence with County staff, field crew interactions, and the public input map.
- **Feasibility**: parameters included constraints, property ownership, access, etc.



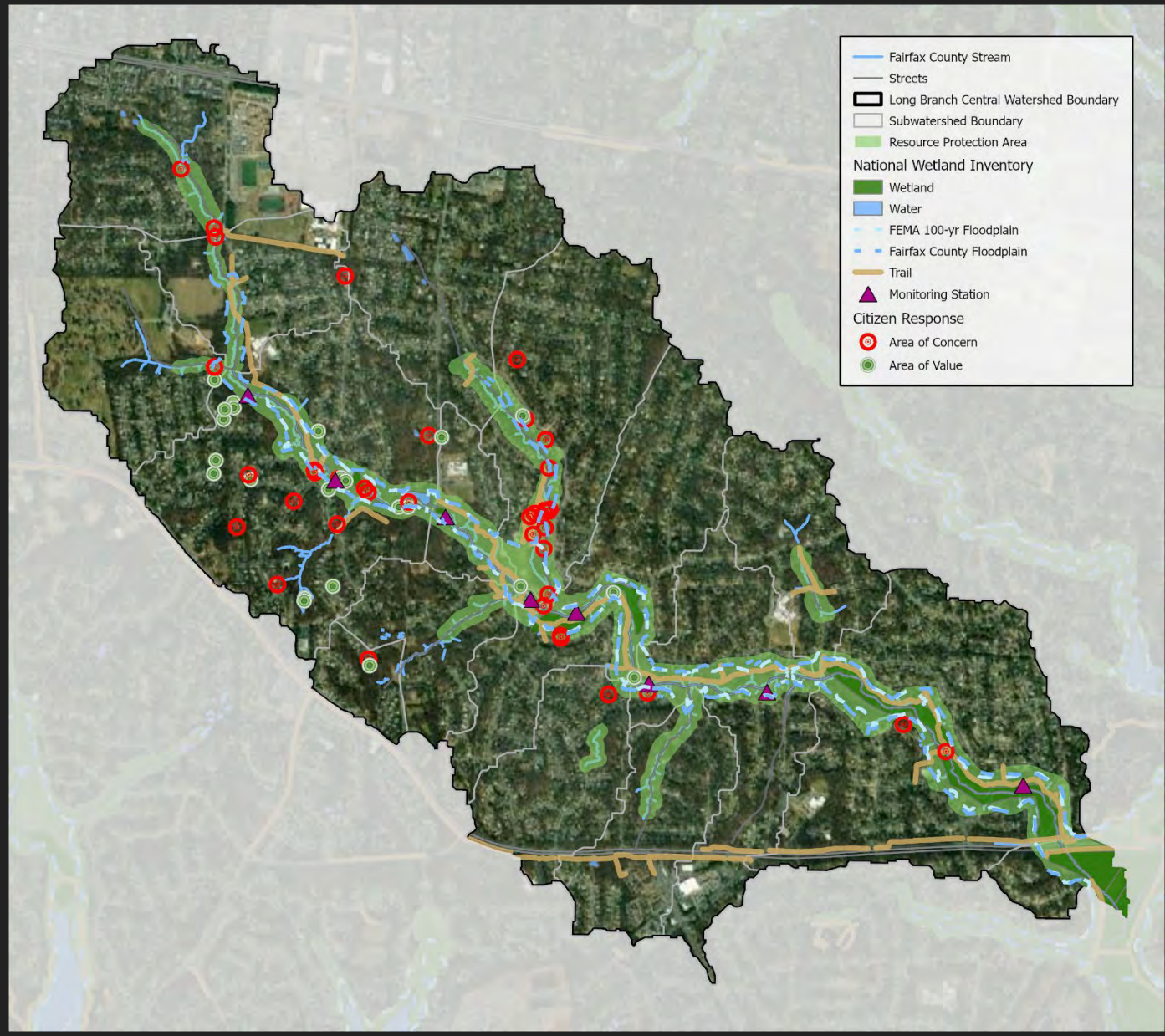
Environmentally Sensitive Areas Mapping

Prepared preliminary watershed-wide mapping of known high quality and environmentally sensitive areas.

- Streams
- Resource Protection Areas
- Wetlands
- FEMA 100-year Floodplain
- Fairfax County Floodplain
- Trails
- Monitoring Stations
- Citizen Responses – Areas of Concern and Areas of Value

Used existing data only, no additional field assessments or surveys conducted.

More detailed field assessments to be conducted prior to design.



Recommended Projects

Aggregated the stream reaches and outfalls verified in Phase I.B into project opportunities:

- 15 stream restoration projects
- 2 stream restoration + stormwater retrofit projects
- 3 stormwater retrofit projects

Aggregation driven by proximity, access, and project synergies (e.g., two outfalls that discharge to an adjacent stream reach will be considered one project).

Example: Tabard Place to Woodland Way

Western (Upstream) Reaches

- Good riparian forest.
- Poor channel condition.
- *Focus on instream stabilizing features to prevent erosion and no plan-form modification.*

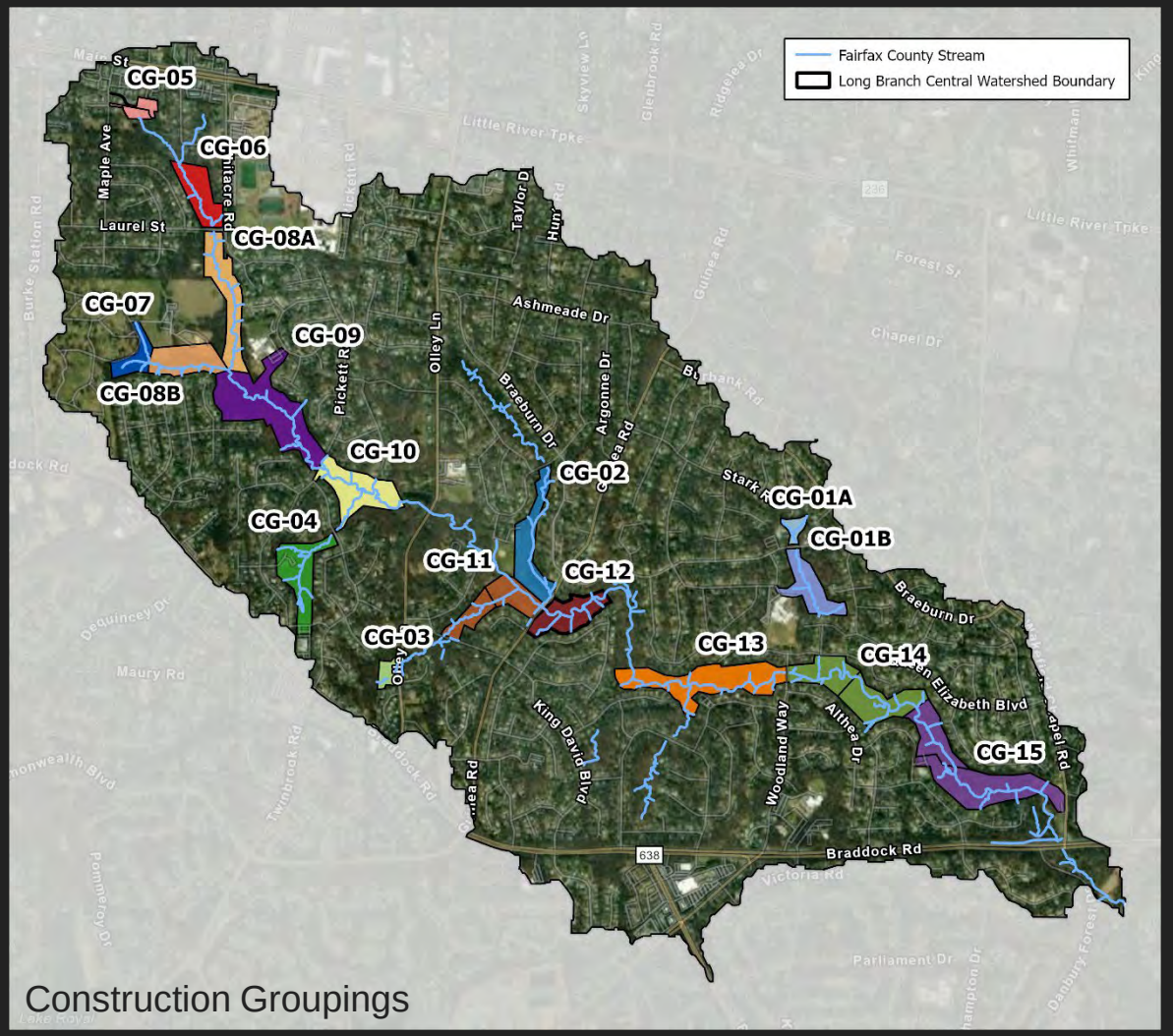
Eastern (Downstream) Reaches

- Good riparian forest and overall channel condition.
- Floodplain scour.
- *No channel modification.*
- *Add wood to channel to improve fish habitat and epifaunal substrate.*
- *Extensive floodplain plantings to promote regeneration and improve floodplain roughness.*

Long Branch Central WMA project webpage
https://www.fairfaxcounty.gov/publicworks/long-branch-input

Project Grouping for Design and Construction

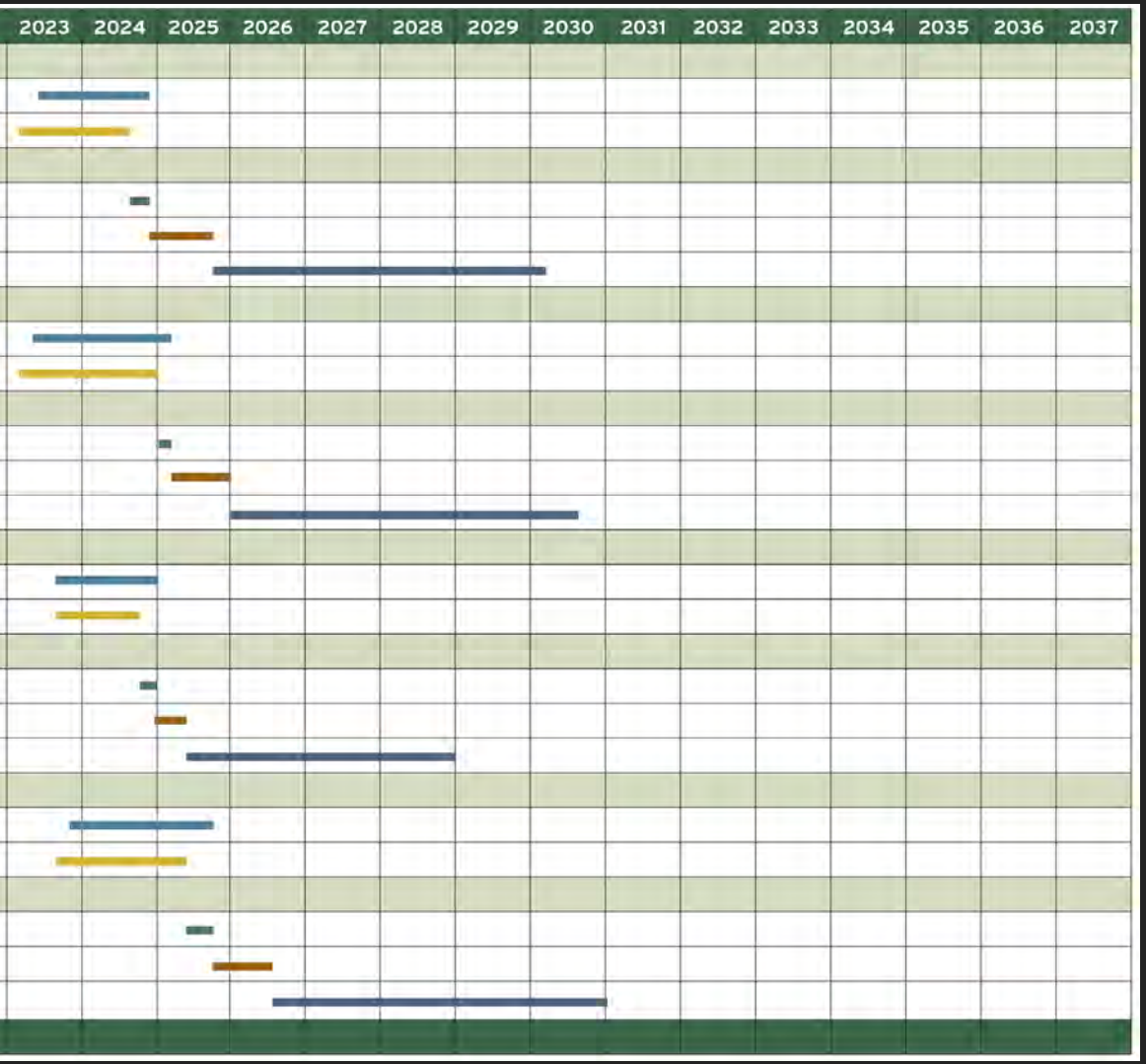
Design Groupings



Construction Groupings

Implementation Work Plan Schedule

TASK NAME	START	FINISH
DG-01 Ilda Pool & Willow Woods	**4/3/23**	**10/28/24**
Pre-Construction Monitoring	6/12/23	10/28/24
Design	4/3/23	8/2/24
CG-01A/B Ilda Pool & Willow Woods	**8/5/24**	**3/8/30**
Bidding	8/5/24	10/25/24
Construction	10/28/24	8/1/25
Post-Construction Monitoring	8/4/25	3/8/30
DG-02 Kristin Lane to Rutherford Park	**4/3/23**	**3/31/25**
Pre-Construction Monitoring	5/29/23	3/31/25
Design	4/3/23	1/3/25
CG-02 Kristin Lane to Rutherford Park	**1/6/25**	**7/12/30**
Bidding	1/6/25	3/28/25
Construction	3/31/25	12/5/25
Post-Construction Monitoring	12/8/25	7/12/30
DG-03 Olley Lane Pond	**8/7/23**	**12/23/24**
Pre-Construction Monitoring	8/7/23	12/23/24
Design	8/21/23	9/27/24
CG-03 Olley Lane Pond	**9/30/24**	**12/14/29**
Bidding	9/30/24	12/20/24
Construction	12/23/24	5/9/25
Post-Construction Monitoring	5/12/25	12/14/29
DG-04 Olde Forge Park	**8/21/23**	**8/18/25**
Pre-Construction Monitoring	10/16/23	8/18/25
Design	8/21/23	5/23/25
CG-04 Olde Forge Park	**5/26/25**	**12/27/30**
Bidding	5/26/25	8/15/25
Construction	8/18/25	5/22/26
Post-Construction Monitoring	5/25/26	12/27/30



Early Action Projects

Watershed-Wide Monitoring

Monitoring parameters and **purpose** are aligned with the **Fairfax Ecological Recovery Wheel**, the **Stream Functions Pyramid**, and **project goals**.

Monitoring began in late Fall 2021.

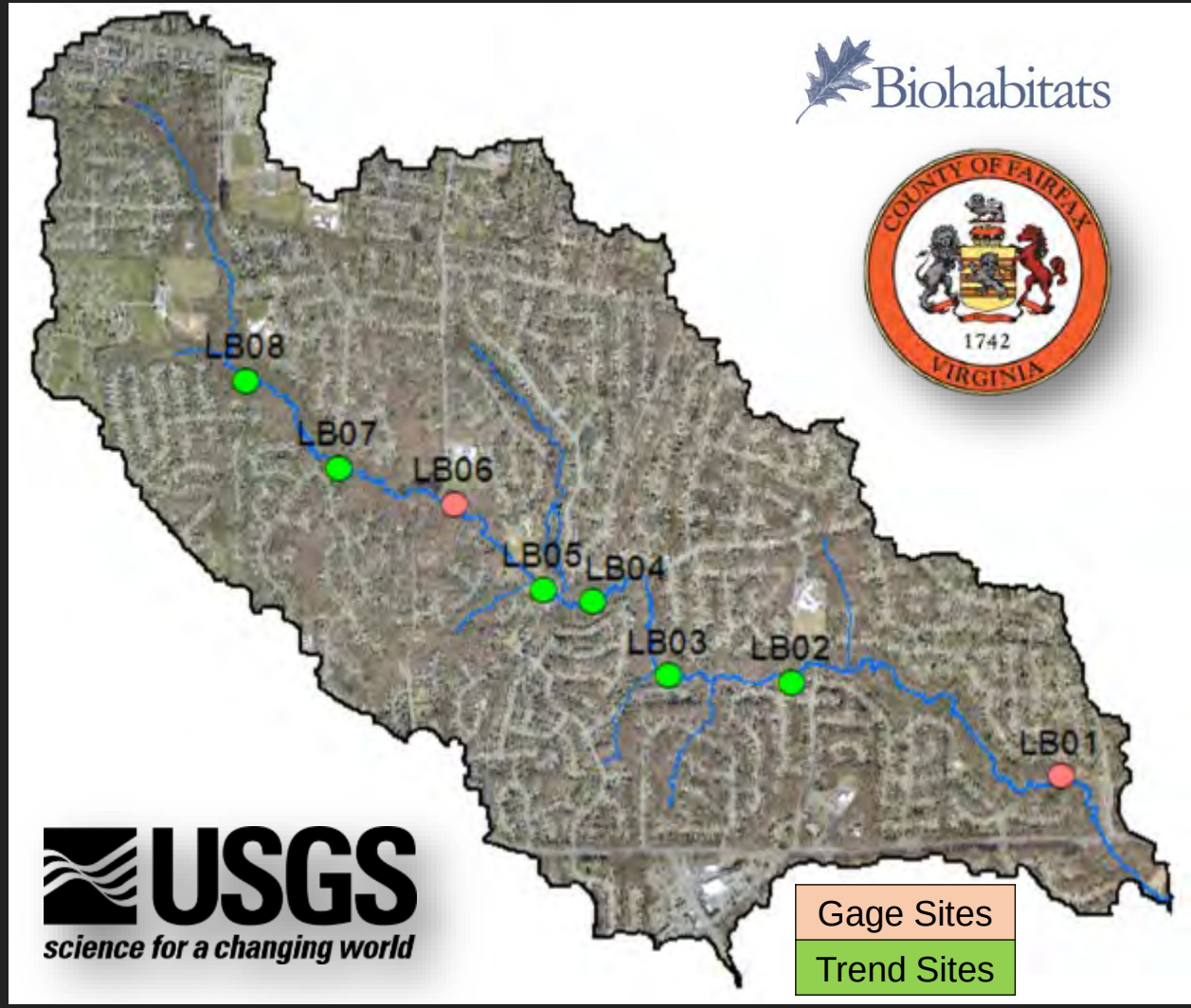
8 stations established - 2 gage sites and 6 trend sites

Year 1 (2022) monitoring includes:

- Flow Monitoring/Hydrology: Groundwater Levels; Time-Lapse Photography
- Erosion/Sediment: Bank Pins
- Geomorphology: Cross Section Surveys
- Biology: eDNA Sampling; Leaf Pack and Coarse Woody Debris

Year 2 (2023) and Year 3 (2024) monitoring includes:

- Continued monitoring established in Year 1
- Riparian Vegetation: Vegetation Community Mapping – Fairfax County's Protocol; growing season; only at monitoring station 6 where no restoration projects are proposed as a control site



Project-Specific Monitoring

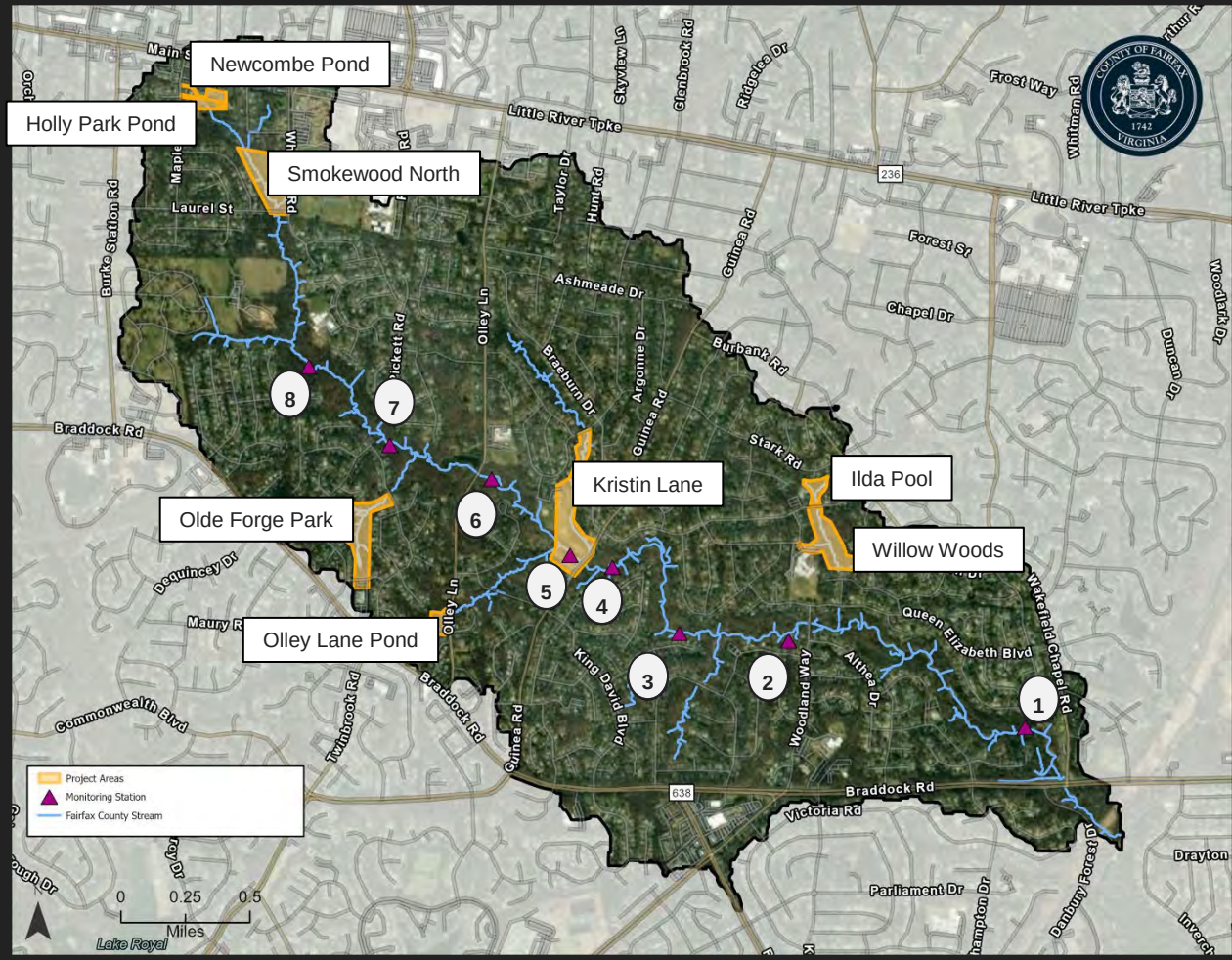
A general project monitoring framework aligns **project goals** with the **Stream Functions Pyramid** and the **Fairfax Ecological Recovery Wheel**.

A project-specific monitoring plan will be developed for each project.

Project-specific pre-construction monitoring beginning for eight projects in 2023.

Monitoring will include:

- Flow Monitoring/Hydrology: Groundwater Levels
- Erosion/Sediment: Bank Pins
- Geomorphology: Fairfax County RBP Habitat Assessment
- Biology: Leaf Pack and Coarse Woody Debris; Photo Documentation; Benthic Sampling
- Riparian Vegetation: Vegetation Community Mapping



Additional Information

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