

Recommended Solutions for Cuyahoga South Stormwater Master Plan

John Aldrich, CDM Smith, Water Resource Engineer

Rachel Webb, NEORSD, Senior Project Manager

May 20, 2019



Key Topics

- Regional Stormwater Management Program
- Stormwater Master Planning Approach/Objectives
- CRS Master Plan Findings and Recommendations
- Case Studies:
 - #1: Solutions to restore stream/floodplain function
 - #2: Integrated subwatershed solutions
- Key Conclusions and Lessons Learned



At a glance:

- Political subdivision of the State of Ohio
- Created by Court Order in 1972
- Regional agency separate and distinct from municipalities and counties



At a glance

- Own, operate 3 wastewater treatment plants
- 1 million customers
- 330 miles of sewers
- Water quality monitoring
- Lake Erie beach monitoring, maintenance
- 420+ miles regional stormwater system

Easterly

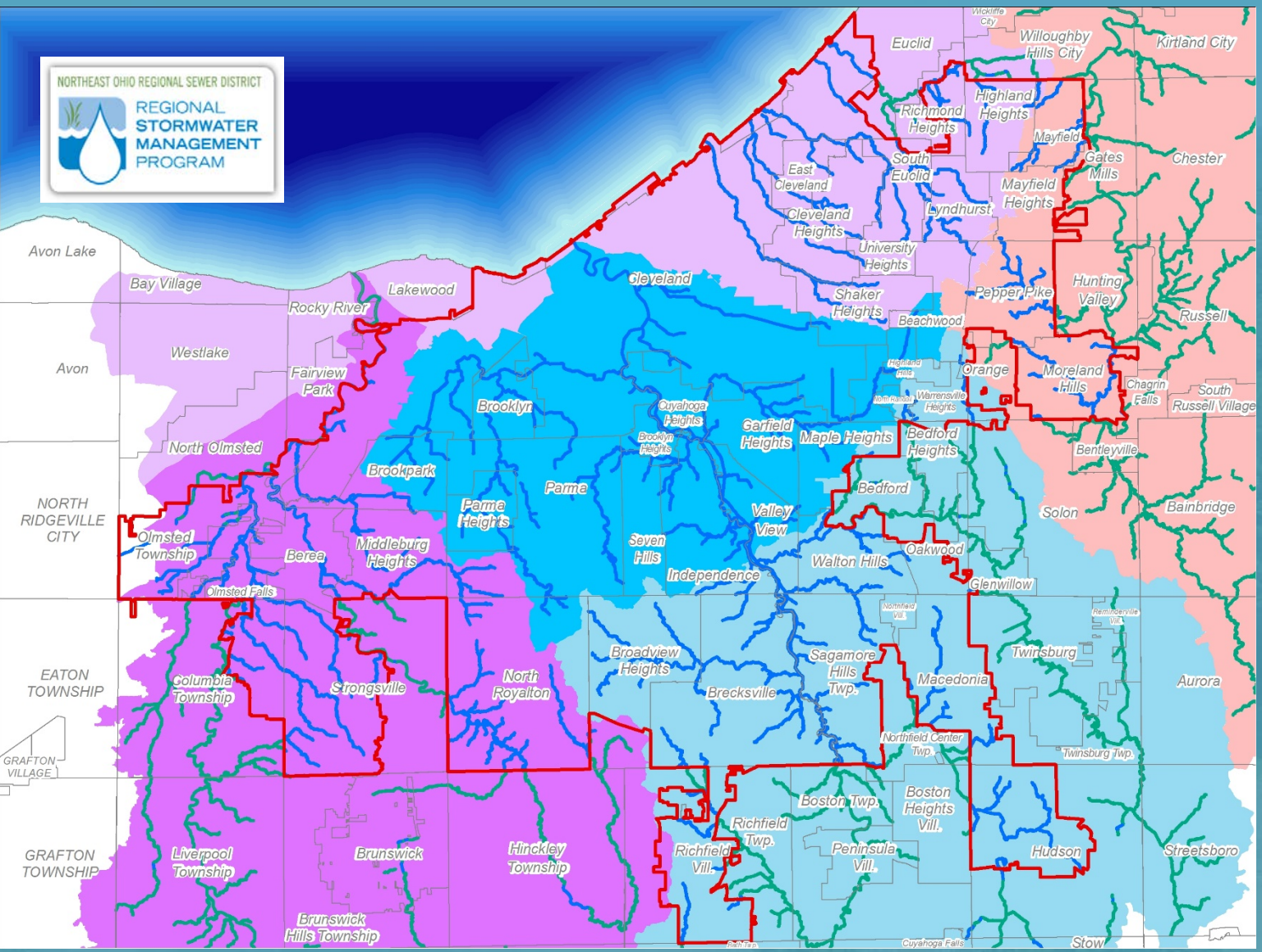
Southerly

Westerly

NORTHEAST OHIO REGIONAL SEWER DISTRICT



REGIONAL
STORMWATER
MANAGEMENT
PROGRAM

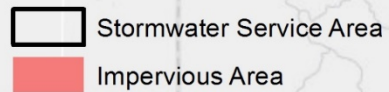


- Impervious Surface Fee
- Service Area: 355 sq. mi.
- Contributing Watershed Area: 1,524 sq. mi.
- Regional Stormwater System (RSS) in Service Area: 445+ mi.
 - 300 acre drainage
 - Intercommunity Drainage

NEORSD Stormwater Service Area - Impervious Area (December 2017)

Total Impervious Area = 112 sq. mi.
31% of Total Land Cover

Impervious Surfaces



**Impervious Surfaces = Stormwater Runoff
Stormwater Runoff = Flooding and Erosion**

*Pepper Pike, Ohio
Pepper Luce Creek
August, 2017*

Shaker Boulevard



Infrastructure Issues

Blocked basin outlet

35 Cubic Yards of Debris Removal

Mill Creek, Cleveland/Warrensville Heights



Pre-Maintenance

Infrastructure Issues

Blocked basin outlet

35 Cubic Yards of Debris Removal

Mill Creek, Cleveland/Warrensville Heights



Post-Maintenance



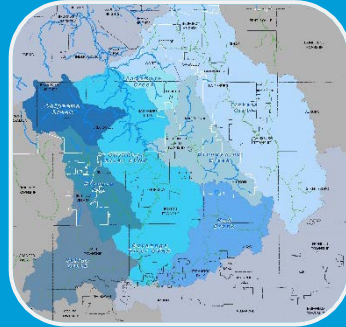
Streambank erosion on Doan Brook threatens Cleveland Museum of Art



Regional Stormwater Management Program



Inspect &
Maintain



SW
Master
Plans



Construct
Projects



Encourage
Good
Practices



Program Goals

- *Leverage* the watershed-based approach to deliver equitable services to customers, partners, member communities, and NEORSD staff
- *Perform* modeling and master planning to:
 - Identify problems and recommend and prioritize projects for the Stormwater Construction Plan,
 - Direct operations and maintenance projects along the RSS, and
 - Support projects within the local stormwater system
- *Identify* and communicate policy needs and encourage watershed stewardship in all member communities

Program Goals

- ***Complete*** water resource projects involving stormwater maintenance, construction, and acquisition to:
 - Arrest stormwater-induced erosion through stabilization of stream and river banks
 - Mitigate flood risk
 - Accomplish physical, chemical, and biological water quality protection and enhancement
 - Monitor and maintain stormwater conveyance through debris removal and stormwater asset management



Chagrin River & Lake Erie Tribs:
Complete SWMP In 2021

Cuyahoga River North:
Complete SWMP In 2019

Cuyahoga River South:
SWMP Complete

Rocky River:
Complete SWMP In 2020

Stormwater Master Plans

- Cuy. River South: \$5.2M
- Cuy. River North: \$8.0M
- Rocky River: \$4.9M
- Chagrin River and Lake Erie Direct: \$10.0M

Stormwater Master Planning Approach

Operational Performance Evaluation

- Identify areas of erosion and flooding through modeling, field assessments, and monitoring

Alternatives Development & Evaluation

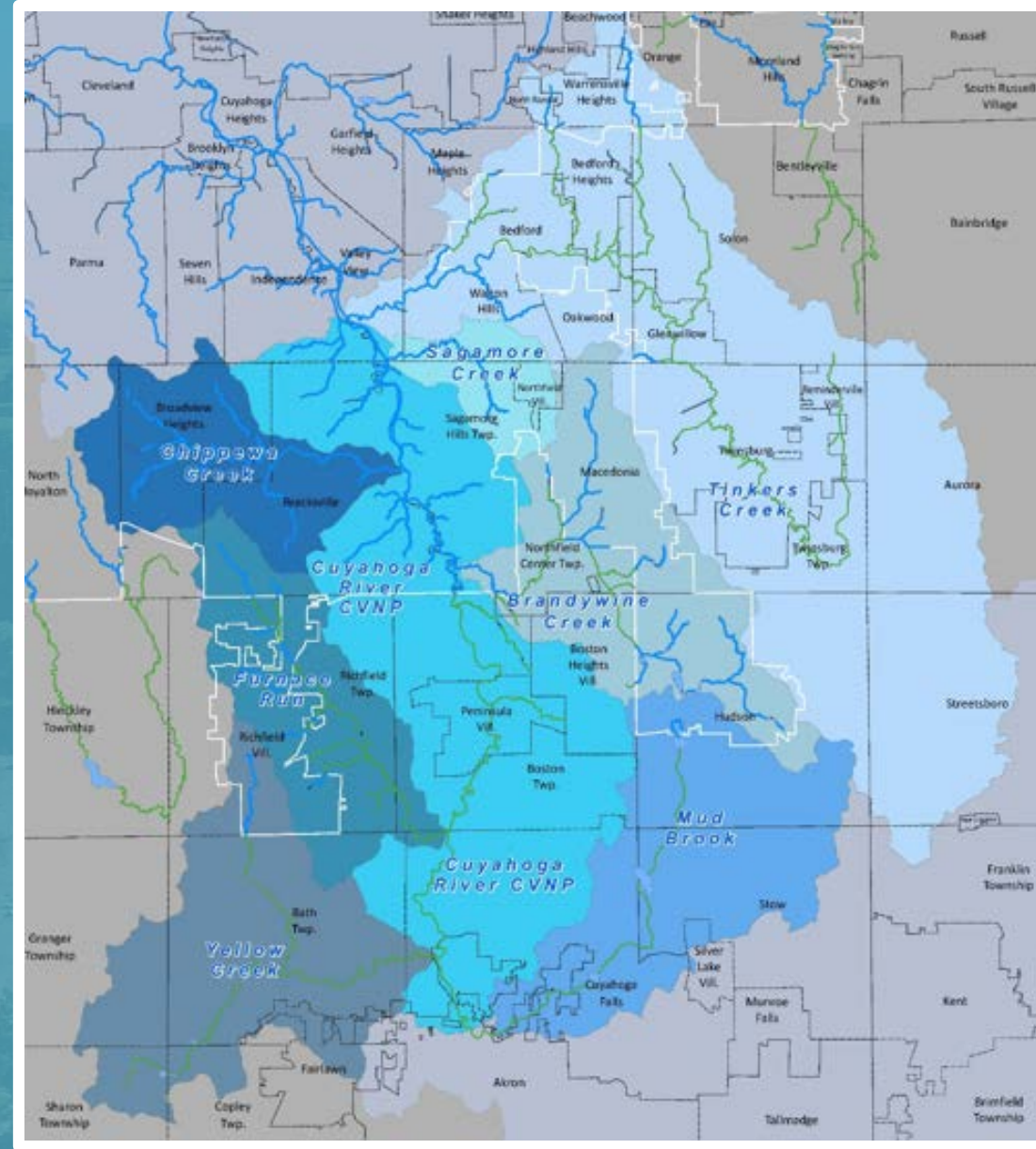
- Comprehensive set of solutions, incorporating stream health, function, habitat, and water quality improvements

Development of Master Plans

- Recommended policies, construction projects, maintenance activities, and areas for preservation

Cuyahoga River South SWMP Overview

- Total Study Area – 288 sq. mi.
 - 89 sq. mi. in Service Area
 - 9 Subwatersheds
 - 24 Member Communities
 - Includes Cuy. Mainstem Alternatives Development
- August 2016 – March 2019
- Over \$200M in recommendations



Findings and Recommendations

- Identified *87 locations* where flooding, erosion, and/or structural condition do not meet the District's Acceptable Level of Risk (ALR)
- Locations in private and public land
 - Project responsibility not specifically identified



Hydraulic
Performance

Sediment & Debris



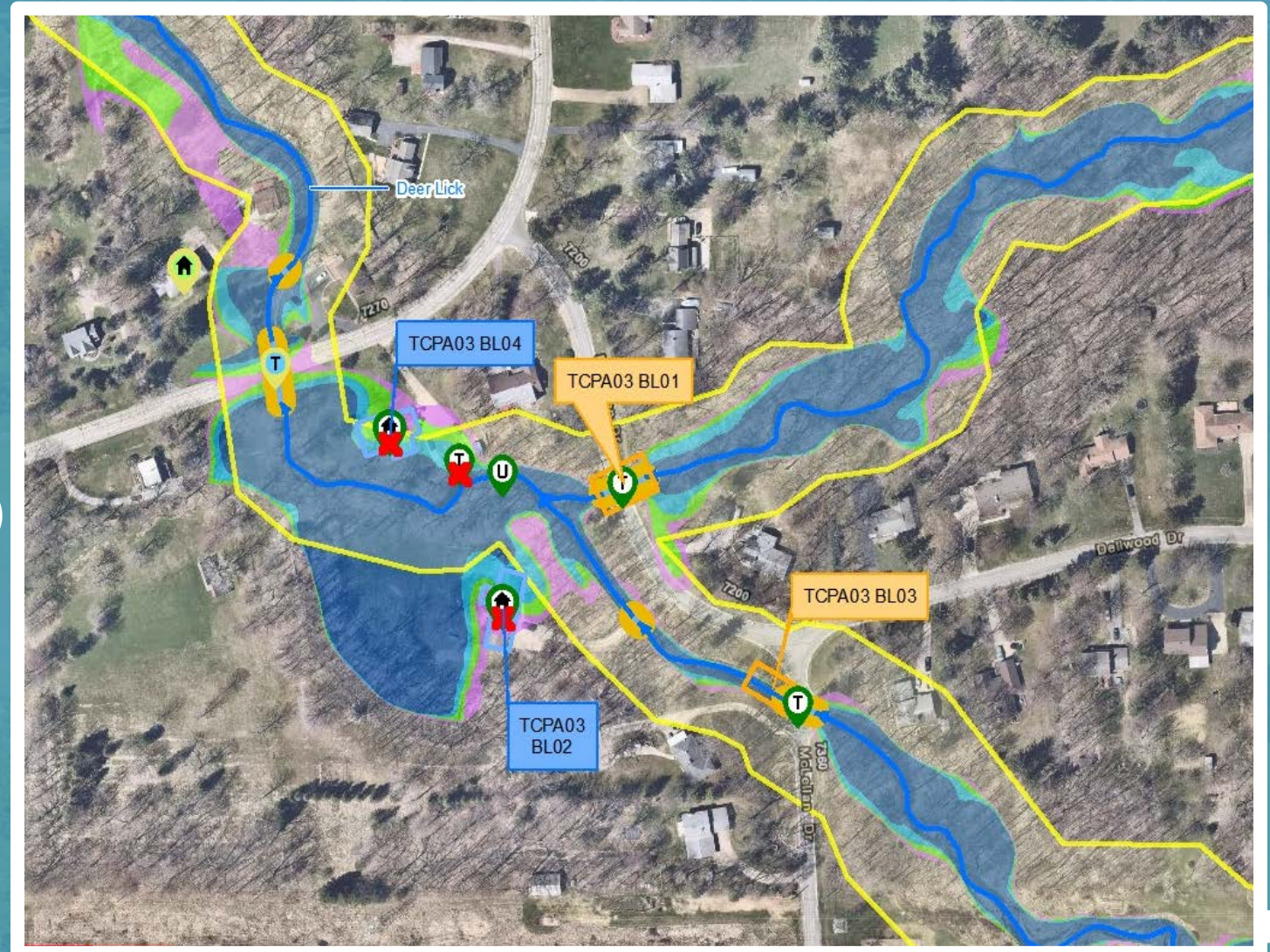
Erosion



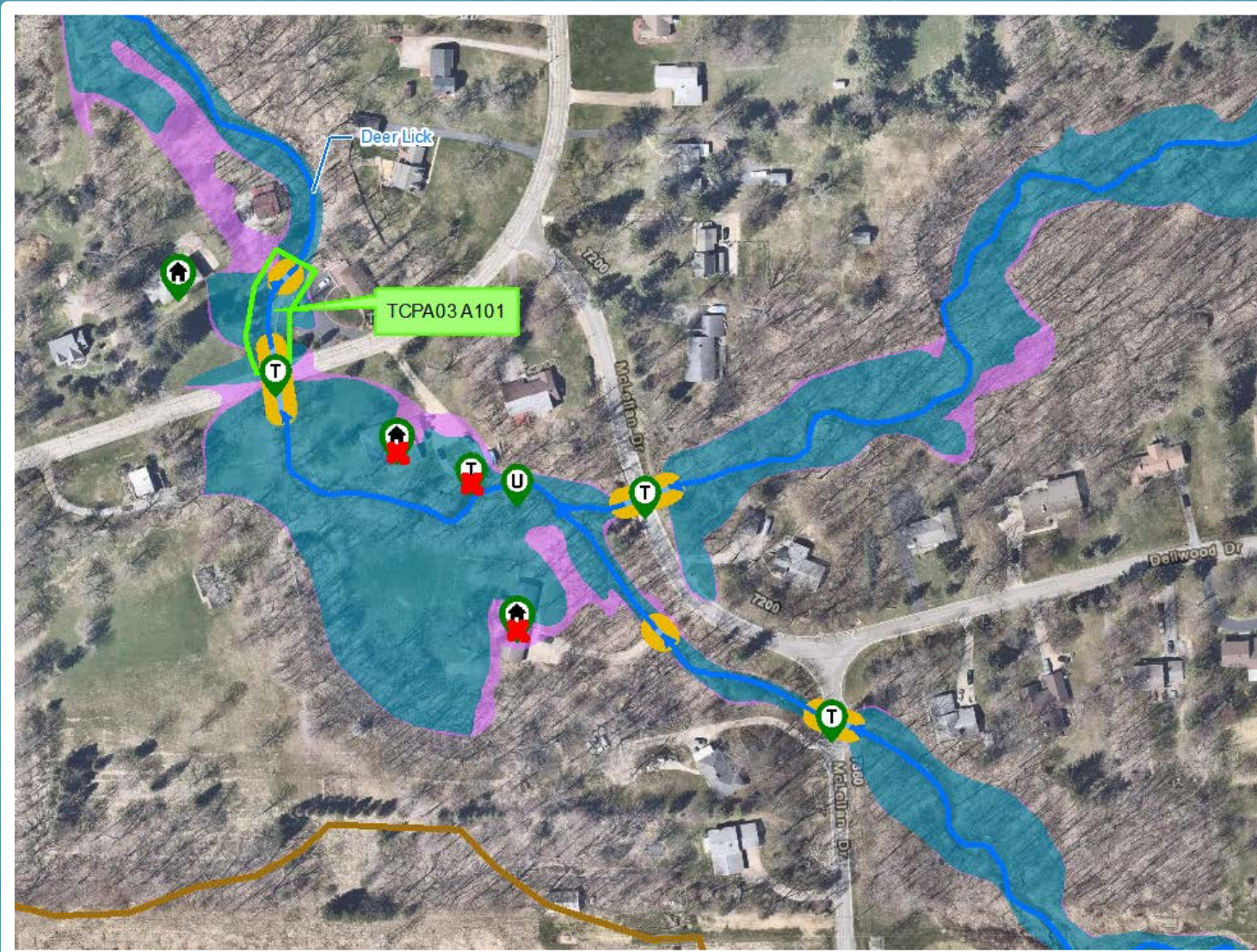
Structural Integrity

Findings and Recommendations

- **Baseline solutions** to maintain/restore existing system function:
 - **Policies** to maintain RSS function (e.g., “no-net-loss” of floodplain storage / riparian function, local stormwater system controls)
 - **Repairs** to RSS assets (\$7.5M) to restore erosive streambanks, deteriorating structures, etc.



Findings and Recommendations



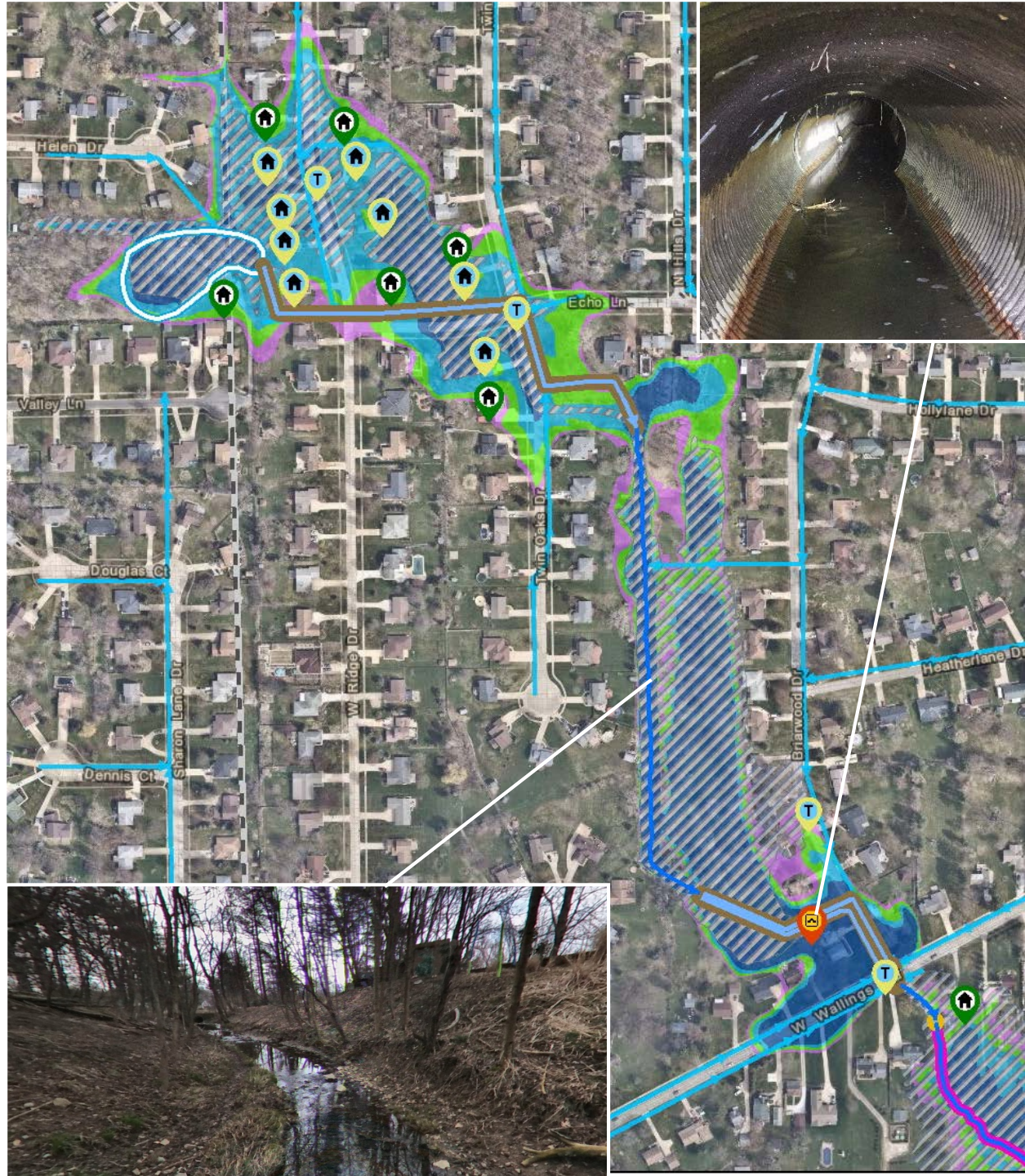
- *System enhancements* to increase RSS function (\$196.3M)
 - Floodplain / stream restoration
 - Conveyance improvements while mitigating downstream impacts
 - New/enhanced detention basins
 - Property acquisition / flood mitigation

Case Study #1: Echo Lane, Broadview Heights

• **Flooding:**

Issue	Number Flooded			
	10-Year	25-Year	50-Year	100-Year
Residential Flooding				
-- Foundation	4	7	8	15
-- First Floor		3	6	8
Roadway Flooding				
-- Inundated	3	3	3	4
-- Impassible	1	3	3	3

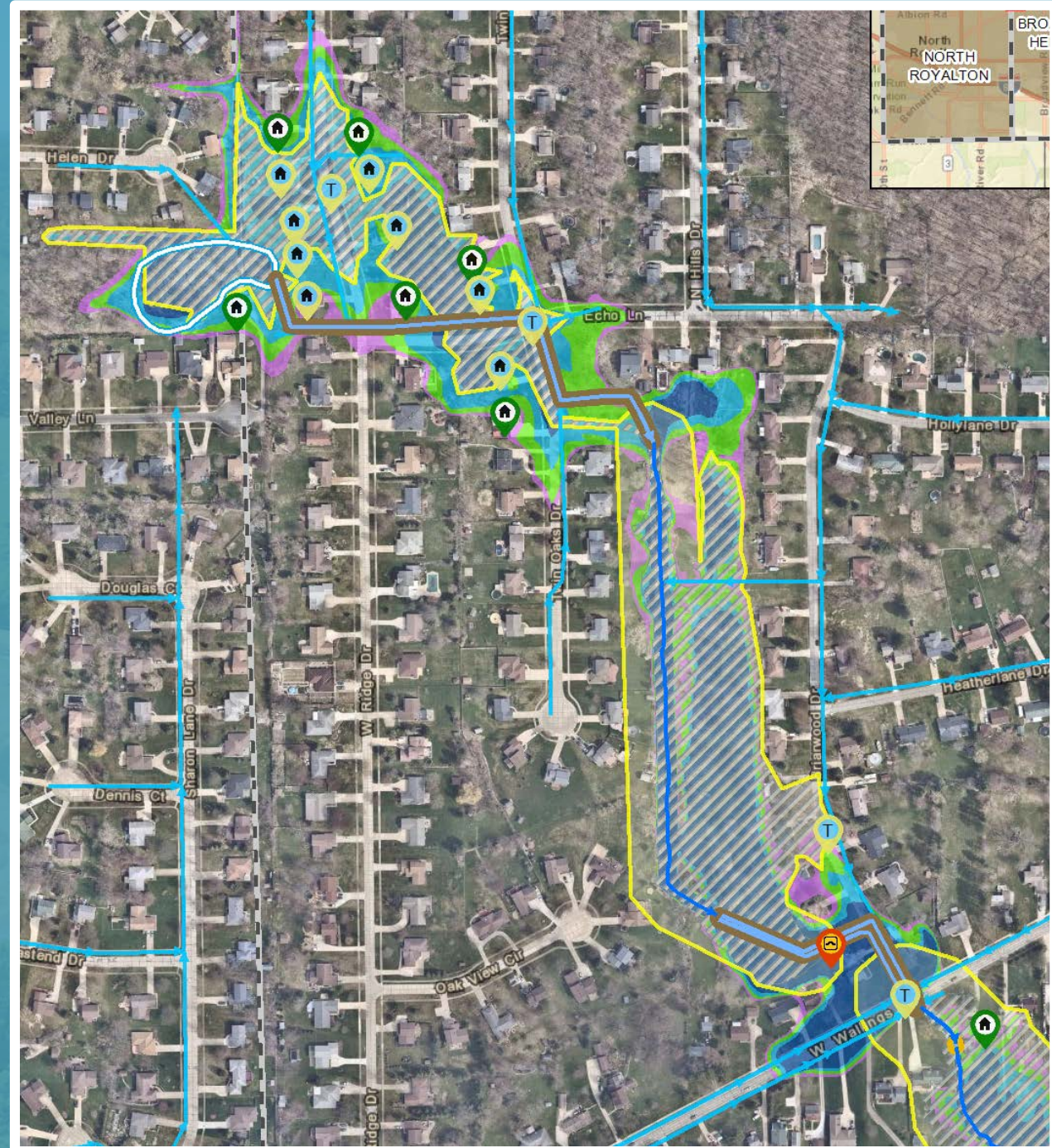
- **Erosion:** No infrastructure threatened
- **Structural:** One culverted stream has a visible void
- **Water Quality:** Straight, channelized stream with little habitat, separated from floodplain, riparian areas; culverted stream barrier to fish passage.



Case Study #1: Echo Lane, Broadview Heights

Baseline Solutions

- No-net-loss of 16 ac-ft of floodplain storage
- Preserve/restore 8 acres of vegetated riparian area
- Increased inspection/maintenance to address debris blockages

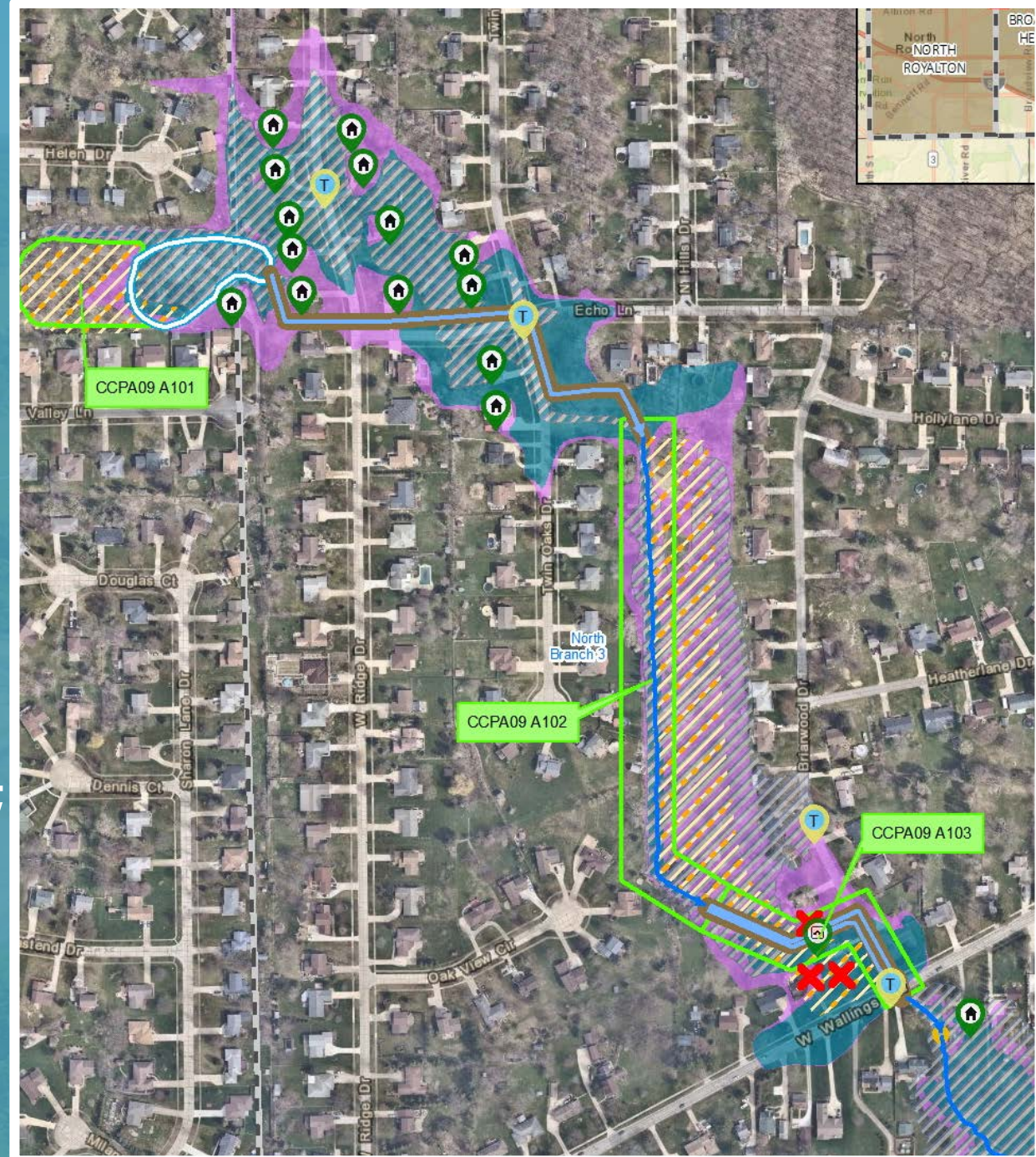


Case Study #1: Echo Lane, Broadview Heights

Alternative 1: Detention and Stream Restoration

- A101: Enlarge and deepen the basin from 1 to 2 acres (from 5 to 11 acre-feet of storage).
- A102: Create 1,200 linear feet of channel restoration with connected floodplain
- A103: Demolish existing culverted stream; create 630 linear feet of channel restoration with connected floodplain.

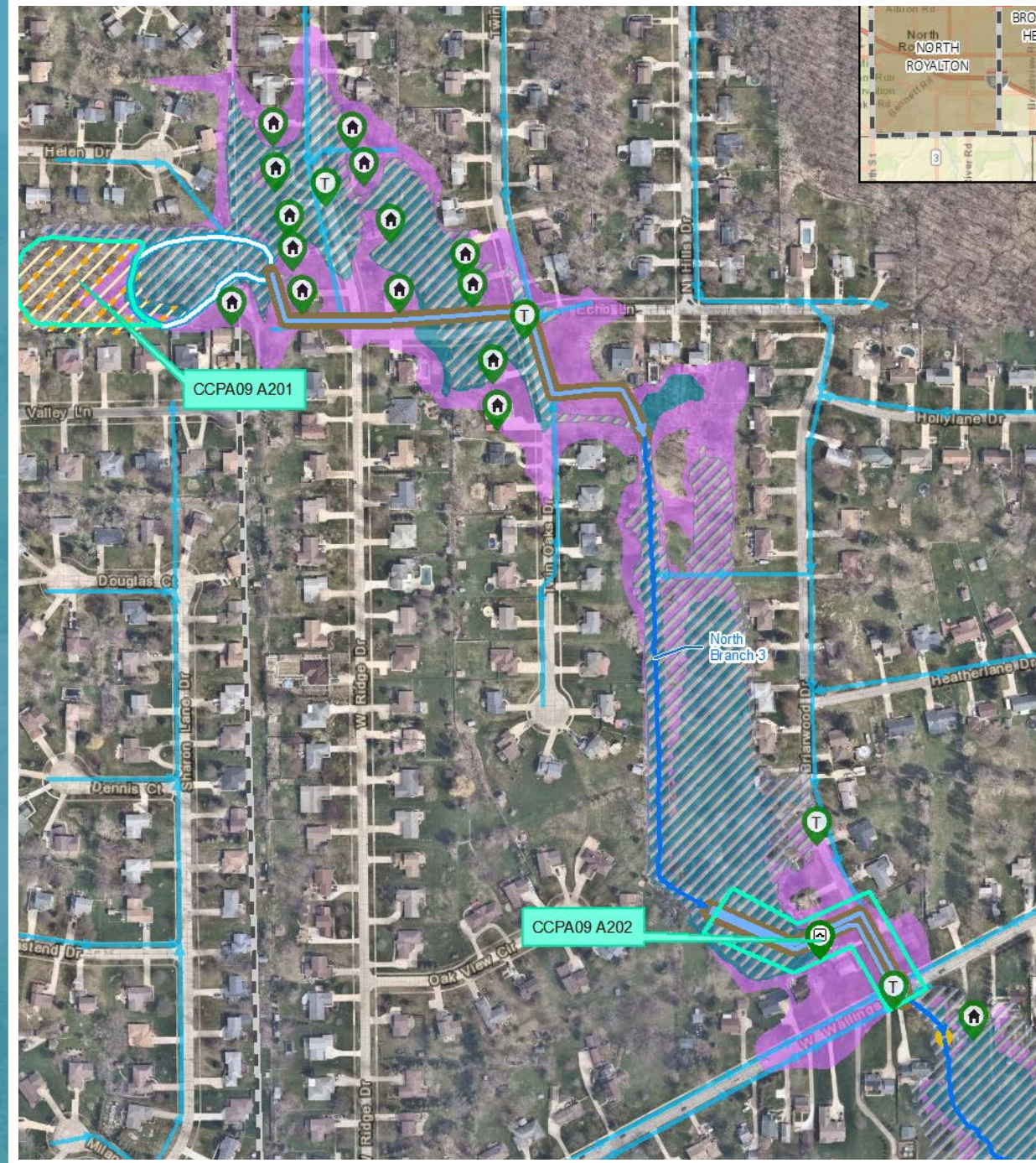
Estimated Project Cost: \$11,696,000



Case Study #1: Echo Lane, Broadview Heights

Alternative 2: Detention and Conveyance

- A201: Enlarge and deepen the basin from 1 to 2 acres (from 5 to 11 acre-feet of storage).
- A202: Replace/enlarge culverted stream
- Estimated Project Cost: \$3,496,000



Case Study #1: Echo Lane, Broadview Heights

Project Scorecard

- Both alternatives mitigate flooding
- Alternative 1 improves geomorphic function/ecologic health. Alternative 2 does not.
- Stream restoration under Alternative 1 is less maintenance-intensive.
- Alternative 1 is over 3 times more expensive, with significant implementation issues

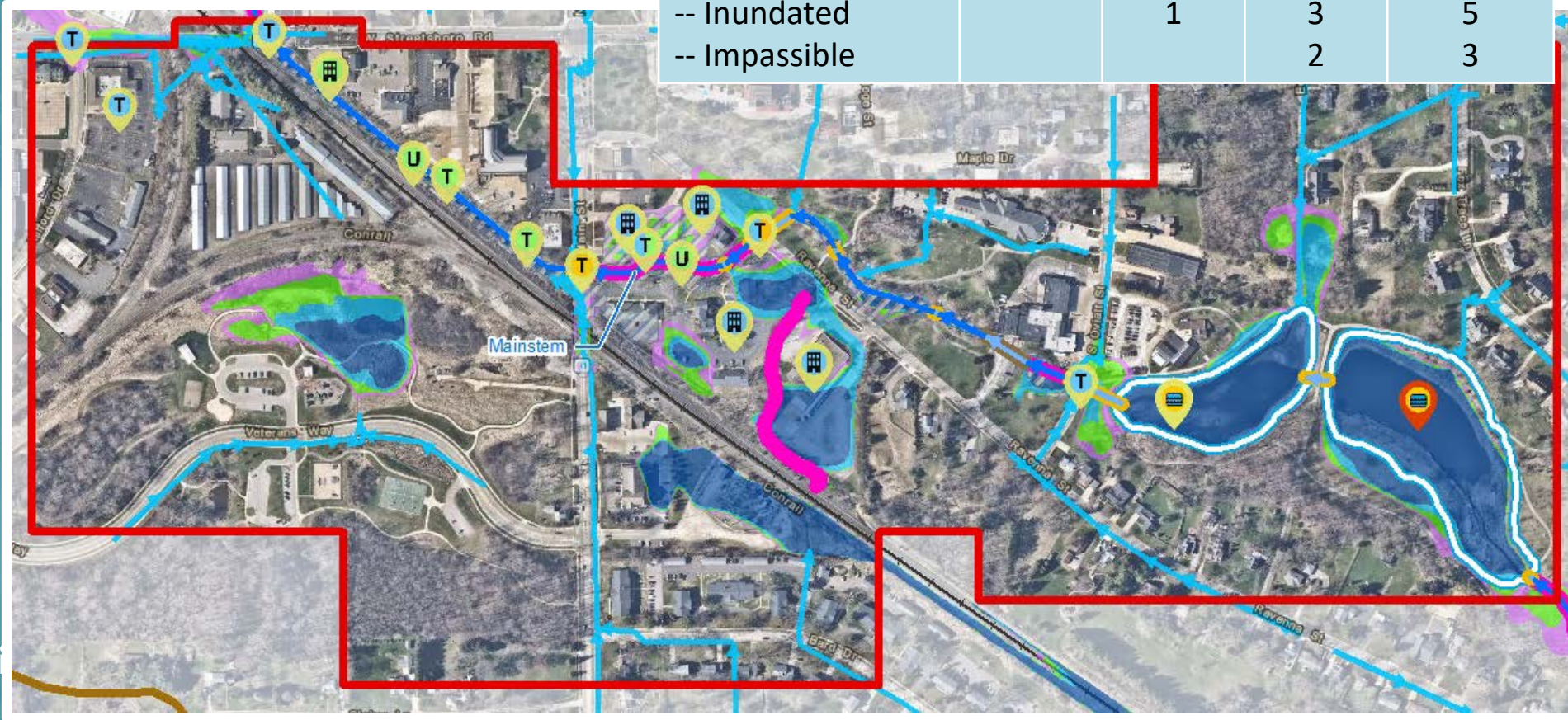
Alternative 1 is the preferred alternative.

Estimated Alternative Costs						
Criteria		Alternative 1		Alternative 2		
Construction Costs (BL+Alt)		\$11,696,000		\$3,496,000		
Business Case Evaluation of Alternatives						
Criteria		Alternative 1		Alternative 2		Weight
		Score*	Rationale	Score*	Rationale	
ECONOMICS	Life Cycle Costs	-2	Over three times the cost of alternative 2	2	One third the cost of alternative 1	25.00
	Flood Damage Mitigation	2	Solves entire flooding problem/achieves BRE	1	Partially Achieves BRE	
	Erosion/Structural Damage Mitigation	2	ALR achieved in existing condition*	2	ALR achieved in existing condition*	
	Subtotal	2.00		5.00		
	Weighted Subtotal	16.67		41.67		
ENVIRONMENTAL	Vertical Stability	2	New channel and daylighted stream access floodplain for 2-year storm	-1	Canal in project area does not access floodplain until 10-year storm	25.00
	Lateral Stability	2	Stream velocities at target/permissible values	-1	Excessive velocities in straight canal as-is (channel is rocked)	
	Runoff Volume and Pollutant Loading	2	Basin storage reduces flows/loads. Some attenuation in new channel	1	Basin storage reduces flows/loads.	
	Fish Community	2	Remove culverted stream/improved passage	0	No change in passage potential	
	Habitat Preservation/Restoration	2	Stream restoration for culverted stream	-1	Riparian area width unchanged/very narrow	
	Preserve/ Restore Natural Land	2	Widen riparian area	-1	Expanded riparian areas in and about basins	
	Subtotal	12.00		-3.00		
	Weighted Subtotal	50.00		-12.56		
O&M	Frequency	2	Daylighted stream	-1	Moderate O&M costs for basins and culverted stream	25.00
	Simplicity	2	Less maintenance for stream than for culverted stream prone to sedimentation	0	Standard/simple maintenance techniques	
	Subtotal	4.00		-1.00		
	Weighted Subtotal	50.00		-12.50		
IMPLEMENTATION	Property Acquisition	-2	Acquire land adjacent to one basin/multiple owners along daylighted stream	-1	Acquire land adjacent to basin	25.00
	Construction Impacts	-2	Construction in subdivision extensive footprint	-1	Construction in open lands adjacent, and for existing culverted stream only	
	Ease of Construction	-2	Culverted stream demolition and daylighting	-1	Standard excavation and grading	
	Regulatory	-1	Disturbs > 5 acres	0	Routine	
	Subtotal	-7.00		-3.00		
	Weighted Subtotal	-43.75		-18.75		
TOTAL SCORE		Alternative 1		Alternative 2		Total
		72.92		-2.14		100.00
Comments		Alternative 1 has the higher score and is the recommended alternative.				

Case Study #2: Downtown Hudson

- **Flooding:** see table
- **Erosion:** Threatens one non-residential building, three parking lots, and two utilities
- **Structural:** Two crossings and two basins exhibit structural deterioration.
- **Water Quality:** Channel entrenched, straight, with limited riparian area, habitat, and floodplain.

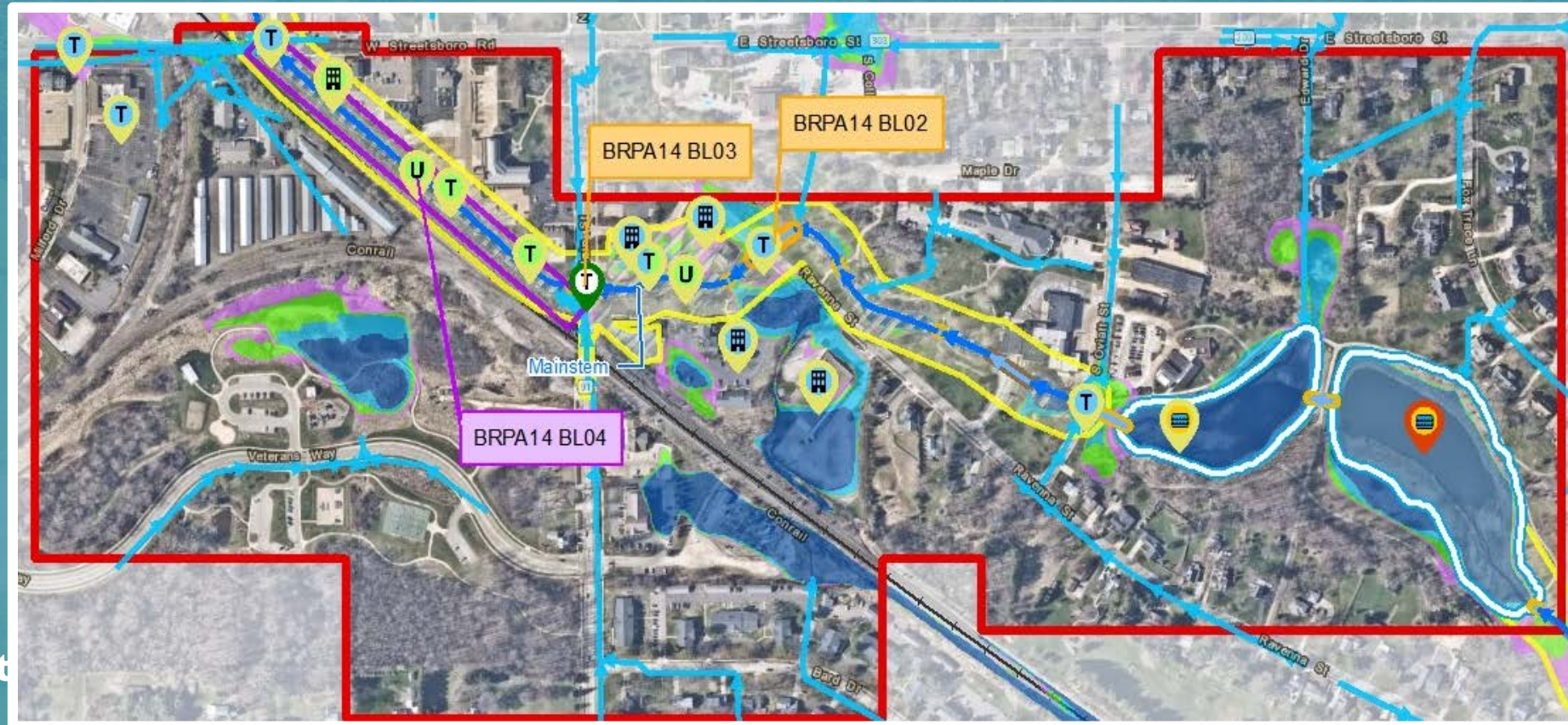
Asset	Number Flooded			
	10-Year	25-Year	50-Year	100-Year
Non-Res Buildings				
-- Foundation		1	3	4
-- First Floor		1	2	3
Roadways				
-- Inundated		1	3	5
-- Impassible			2	3



Case Study #2: Downtown Hudson

Baseline Conditions

- No-net-loss of 85 ac-ft of floodplain storage
- Preserve/restore 17 acres of vegetated riparian area
- Increased inspection/maintenance to address debris blockages
- Repair RSS assets:
 - BL02: Remove and replace CMP culvert structure, and replace headwall
 - BL03: Patch the inside of the barrel top slab and repoint deficient masonry joints
 - Cost: \$293,000



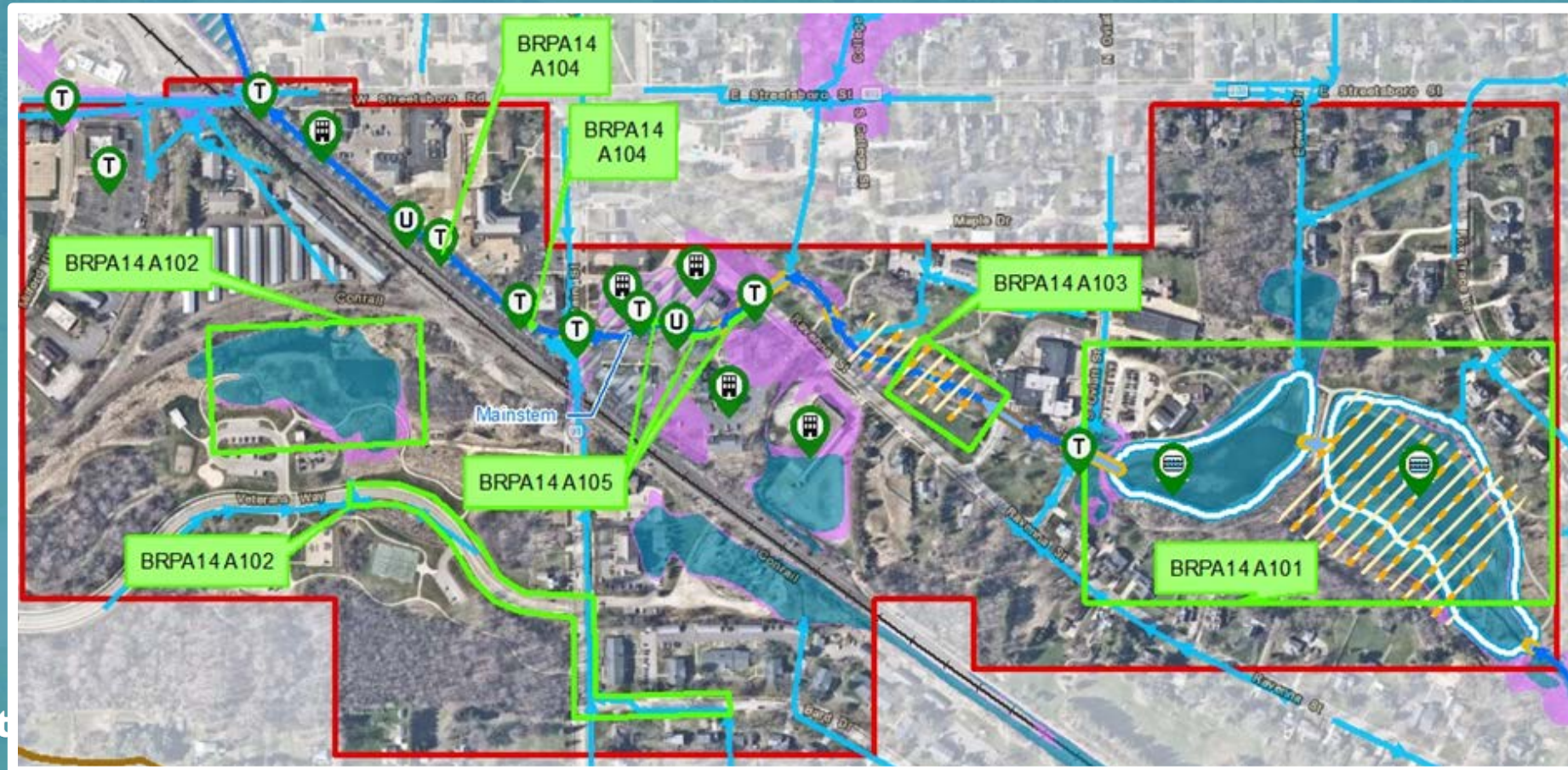
Case Study #2: Downtown Hudson

Alternative 1: Expand detention, stabilize streambank

- A101: Increase detention by 9.5 ac-ft, with operational controls to lower pool.
- A102: Redirect flow to existing wetland for detention, water quality.
- A103: New 5 ac-ft detention facility.
- A104: Toe boulder stabilization
- A105: Stacked rock wall stabilization

Estimated Project

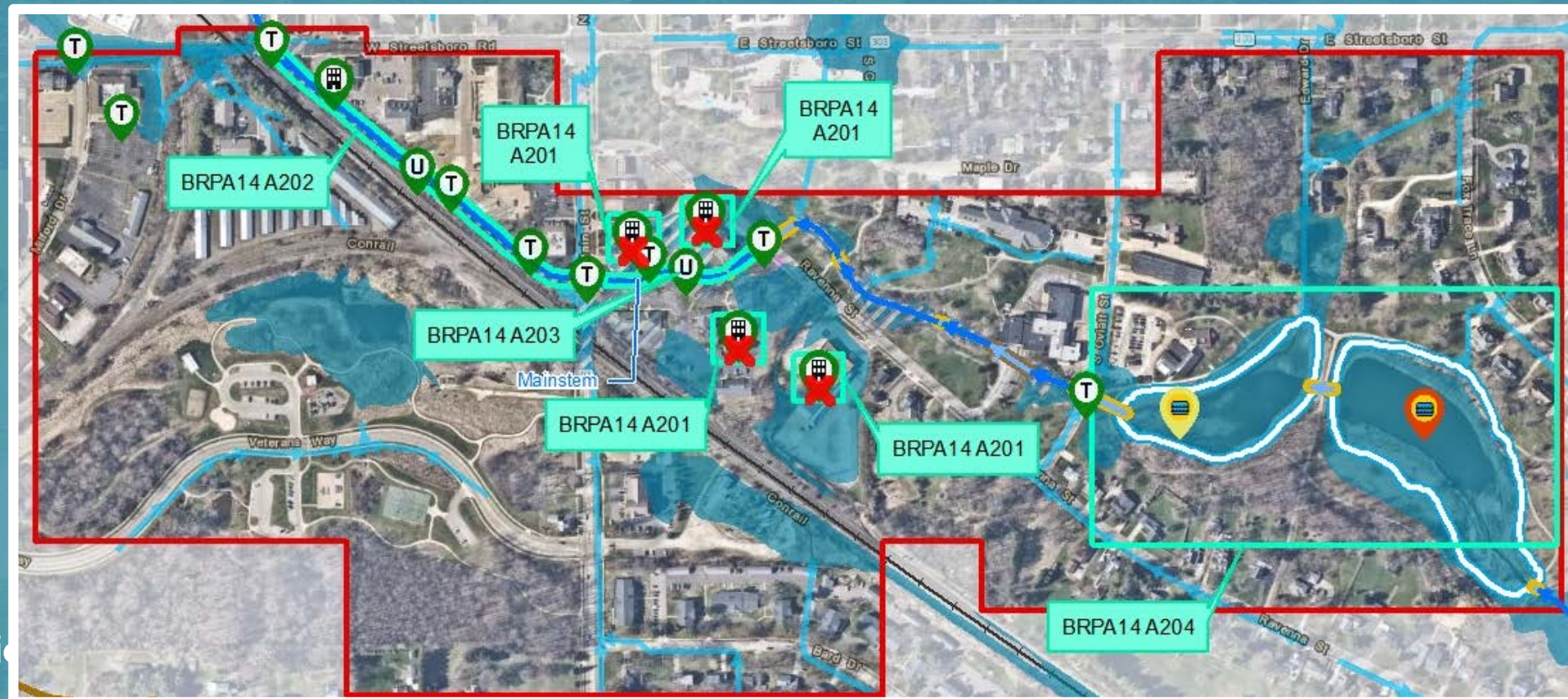
Cost: \$2,056,000



Case Study #2: Downtown Hudson

Alternative 2: Two-stage channel with rock walls, microhabitat

- A201: Acquire four flood-prone properties.
- A202 and A203: Stacked rock wall stabilization with inset compound channel and microhabitat
- A204: Monitor structural condition
- Estimated Project Cost: \$6,286,000



Case Study # 2: Downtown Hudson

Project Scorecard

- Both alternatives mitigate flooding, partially mitigate erosion
- Alternative 2 marginally improves ecologic health. Alternative 1 does not.
- Both alternatives require moderate maintenance/renewal.
- Alternative 1 is over 2 times more expensive, with significant implementation issues

Alternative 1 is the preferred alternative.

Estimated Alternative Costs						
Criteria		Alternative 1		Alternative 2		
Construction Costs (BL + Alt)		\$2,349,000		\$6,579,000		
Business Case Evaluation of Alternatives						
Criteria		Alternative 1		Alternative 2		Weight
		Score*	Rationale	Score*	Rationale	
ECONOMICS	Life Cycle Costs	2	Cost within less than half	-2	Cost more than double	25.00
	Flood Damage Mitigation	2	Achieves 100 Year ALR and reduces flood BRE > 500	2	Achieves 100 Year ALR and reduces flood BRE > 500	
	Erosion/Structural Damage Mitigation	1	ALR achieved	1	ALR achieved	
	Subtotal	5.00		1.00		
	<u>Weighted Subtotal</u>	<u>41.67</u>		<u>8.33</u>		
ENVIRONMENTAL	Vertical Stability	-1	Poor connectivity, Not in equilibrium	1	Good connectivity, in equilibrium	25.00
	Lateral Stability	-2	Frequent erosive velocities, No sinuosity	1	Infrequent erosive velocity, moderate sinuosity	
	Runoff Volume and Pollutant Loading	0	No change in runoff volumes, loads.	0	No change in runoff volumes, loads.	
	Fish Community	-1	Significant barriers to fish passage/community	1	Limited barriers to fish passage/community	
	Habitat Preservation/Restoration	0	Fair QHEI score	1	Overall good habitat and QHEI score.	
	Preserve/Restore Natural Land	-1	Maintains existing very narrow riparian area.	0	Two-stage channel provides narrow riparian area.	
	Subtotal	-5.00		4.00		
	<u>Weighted Subtotal</u>	<u>-20.83</u>		<u>16.67</u>		
O&M	Frequency	0	Routine maintenance, renewal	-1	Rock Walls require frequent renewal	25.00
	Simplicity	0	Routine maintenance, renewal	-1	Rock Walls difficult to renew	
	Subtotal	0.00		-2.00		
	<u>Weighted Subtotal</u>	<u>0.00</u>		<u>-25.00</u>		
IMPLEMENTATION	Property Acquisition	1	Located on a few contiguous parcels.	-1	Multiple properties, critical acquisitions	25.00
	Construction Impacts	-2	Multi-Season Construction	-2	Multi-Season Construction	
	Ease of Construction	0	Minimal disturbance to wetlands/streams.	-1	Moderate disturbance to wetlands/streams.	
	Regulatory	0	Routine regulatory requirements	-2	Significant regulatory requirements	
	Subtotal	-1.00		-6.00		
	<u>Weighted Subtotal</u>	<u>-6.25</u>		<u>-37.50</u>		
TOTAL SCORE		Alternative 1		Alternative 2		TOTAL
		14.59		-37.50		100.00
Comments		Alternative 1 has the higher score and is the recommended alternative.				

Key Conclusions and Lessons Learned

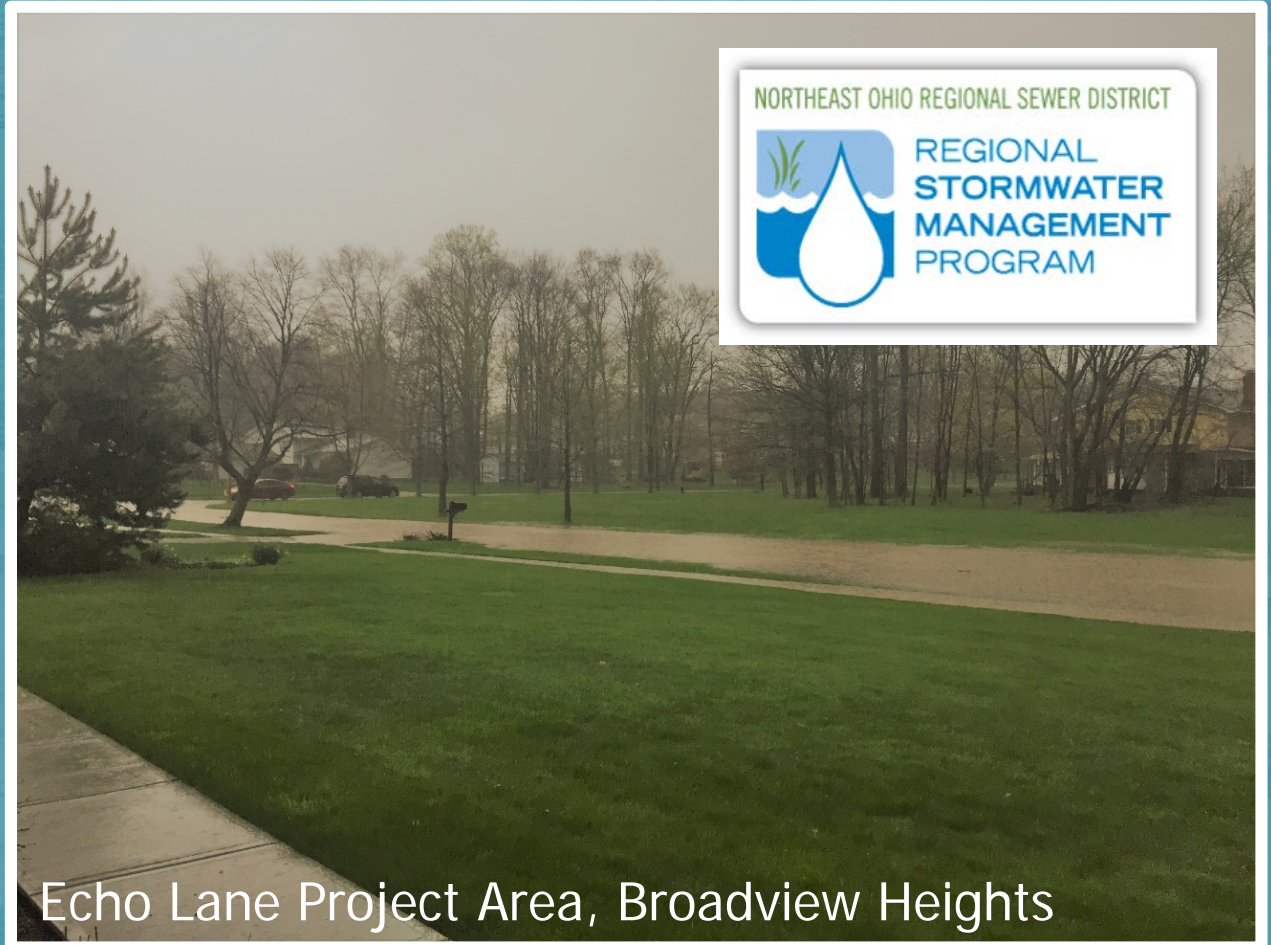
- A regional, watershed-based approach is fundamental to defining feasible, cost-effective, multi-objective controls
- Outreach to communities is critical
- Successful projects:
 - Obtain all three goals of flood reduction, erosion impacts, and water quality benefits
 - Use property acquisition to remove risk to buildings, transportation, and/or utilities
 - Solve intercommunity issues

Questions?



Rachel Webb
Senior Project Manager
NEORSD
216-881-6600, Ext. 6645
WebbR@neorsd.org

John Aldrich
Water Resources Engineer
CDM Smith
216-912-1005
AldrichJA@cdmsmith.com



Echo Lane Project Area, Broadview Heights