Recommended Solutions for Cuyahoga South Stormwater Master Plan

Kim Colich, NEORSD, Manager of SW Design

John Aldrich, CDM Smith, Water Resource Engineer

Thursday May 9, 2:30 pm

Northeast Ohio Regional Sewer District

CDM Smith

NORTHEAST OHIO REGIONAL SEWER DISTRICT
REGIONAL STORMWATER MANAGEMENT PROGRAM

@neorsd

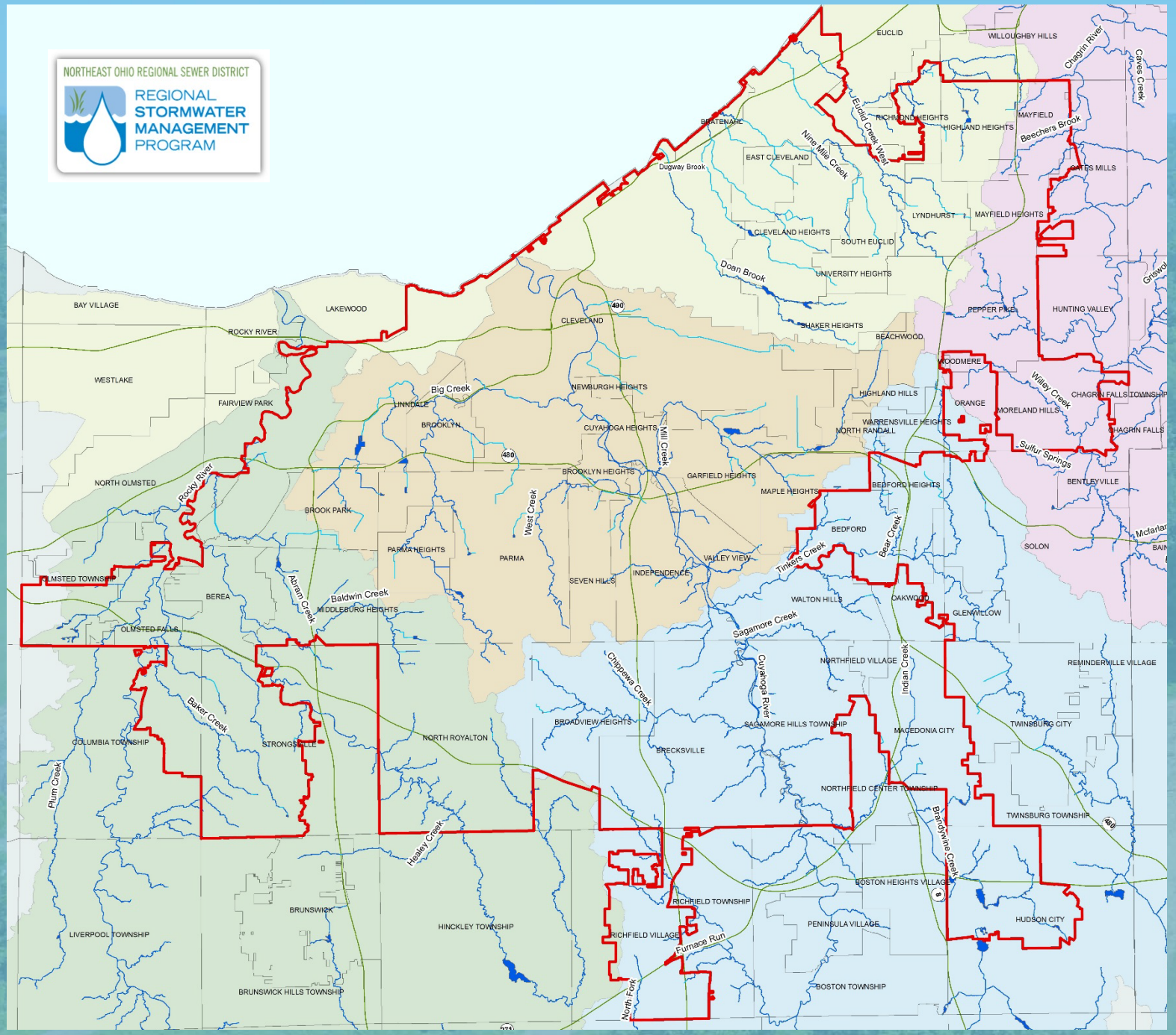
Key Topics

- 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

Northeast Ohio Regional Sewer District

NORTHEAST OHIO REGIONAL SEWER DISTRICT
REGIONAL STORMWATER MANAGEMENT PROGRAM

@neorsd



Regional Stormwater Management Program

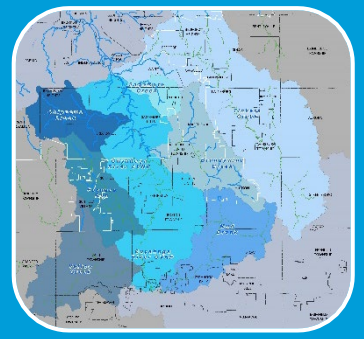
- Service Area: 355 sq. mi.
- Contributing Watershed Area: 1,524 sq. mi.
- Regional Stormwater System (RSS) in Service Area: 445+ mi.
  - 300 acre drainage
  - Intercommunity drainage

Program Goals

- Arrest stormwater-induced erosion through stabilization of stream and river banks and mitigate flood risk
- Accomplish physical, chemical, and biological water quality protection and enhancement
- Monitor, maintain, and improve the conveyance along the RSS through, debris removal and stormwater asset management

Regional Stormwater Management Program

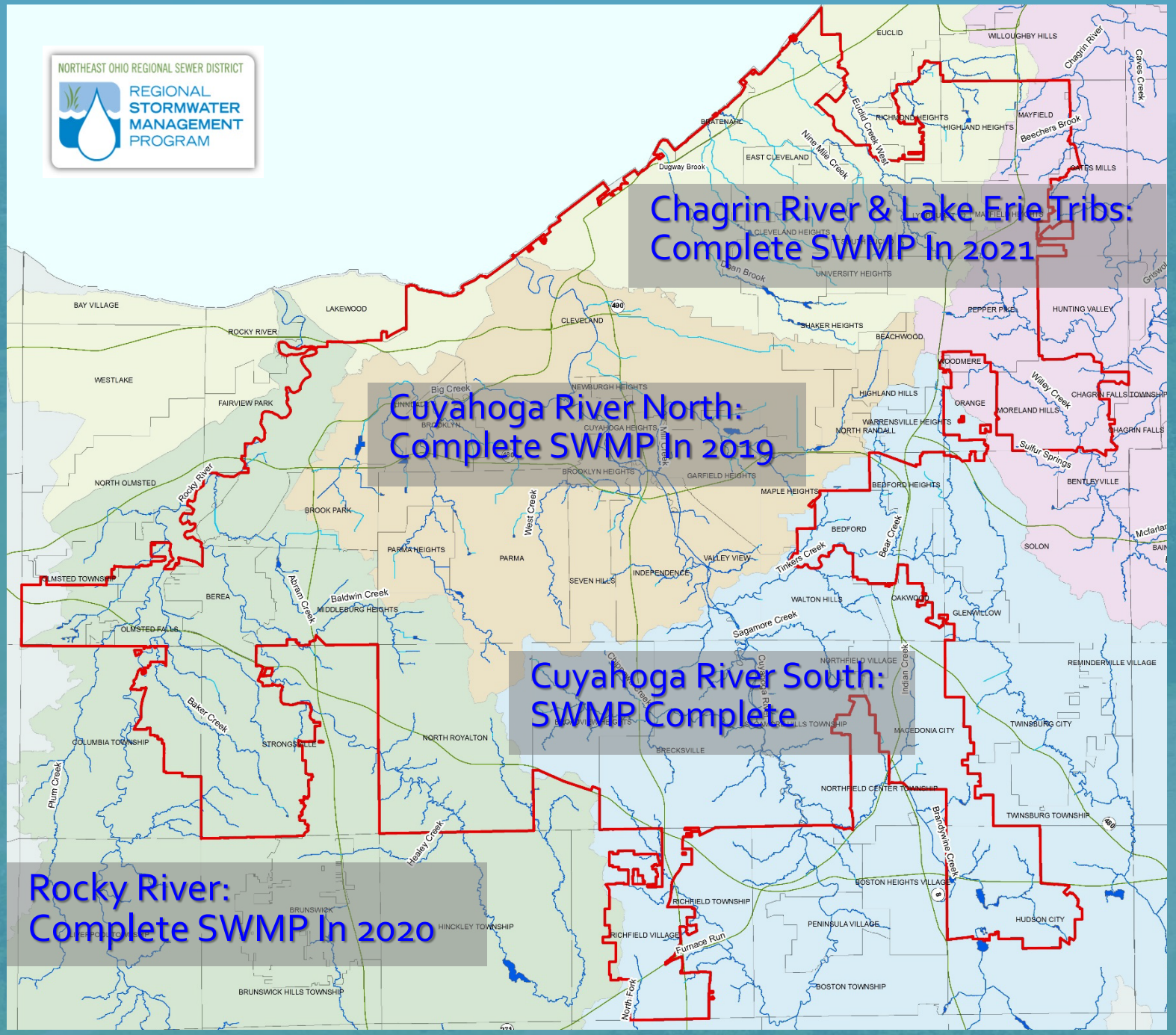
Inspect & Maintain



SW Master Plans

Construct Projects

Encourage Good Practices



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

@neorsd

Stormwater Master Planning Approach

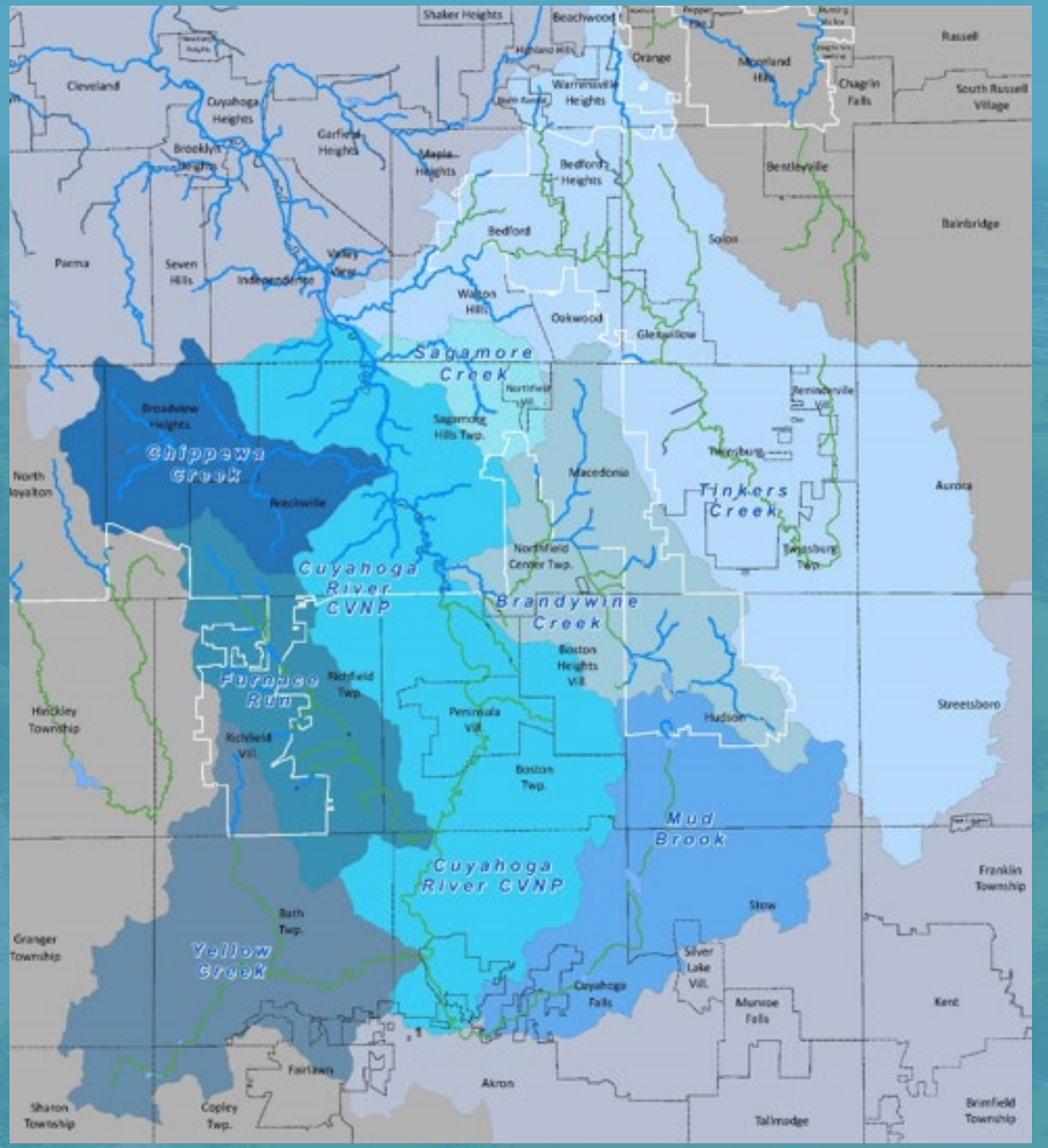
Operational Performance Evaluation	Identify areas of erosion and flooding through modeling, field assessments, and monitoring
Alternatives Development & Evaluation	Comprehensive set of solutions, incorporating stream health, function, habitat, and water quality improvements
Development of Master Plans	Recommended policies, construction projects, maintenance activities, and areas for preservation

Northeast Ohio Regional Sewer District

NORTHEAST OHIO REGIONAL SEWER DISTRICT
REGIONAL STORMWATER MANAGEMENT PROGRAM

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



Northeast Ohio Regional Sewer District

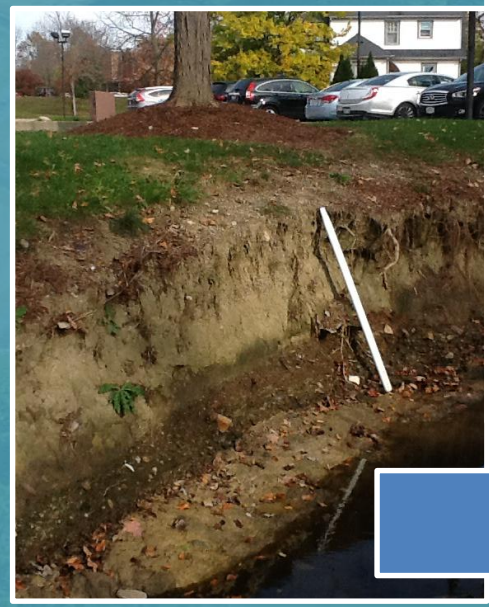
NORTHEAST OHIO REGIONAL SEWER DISTRICT
REGIONAL STORMWATER MANAGEMENT PROGRAM

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

Northeast Ohio Regional Sewer District

@neorsd

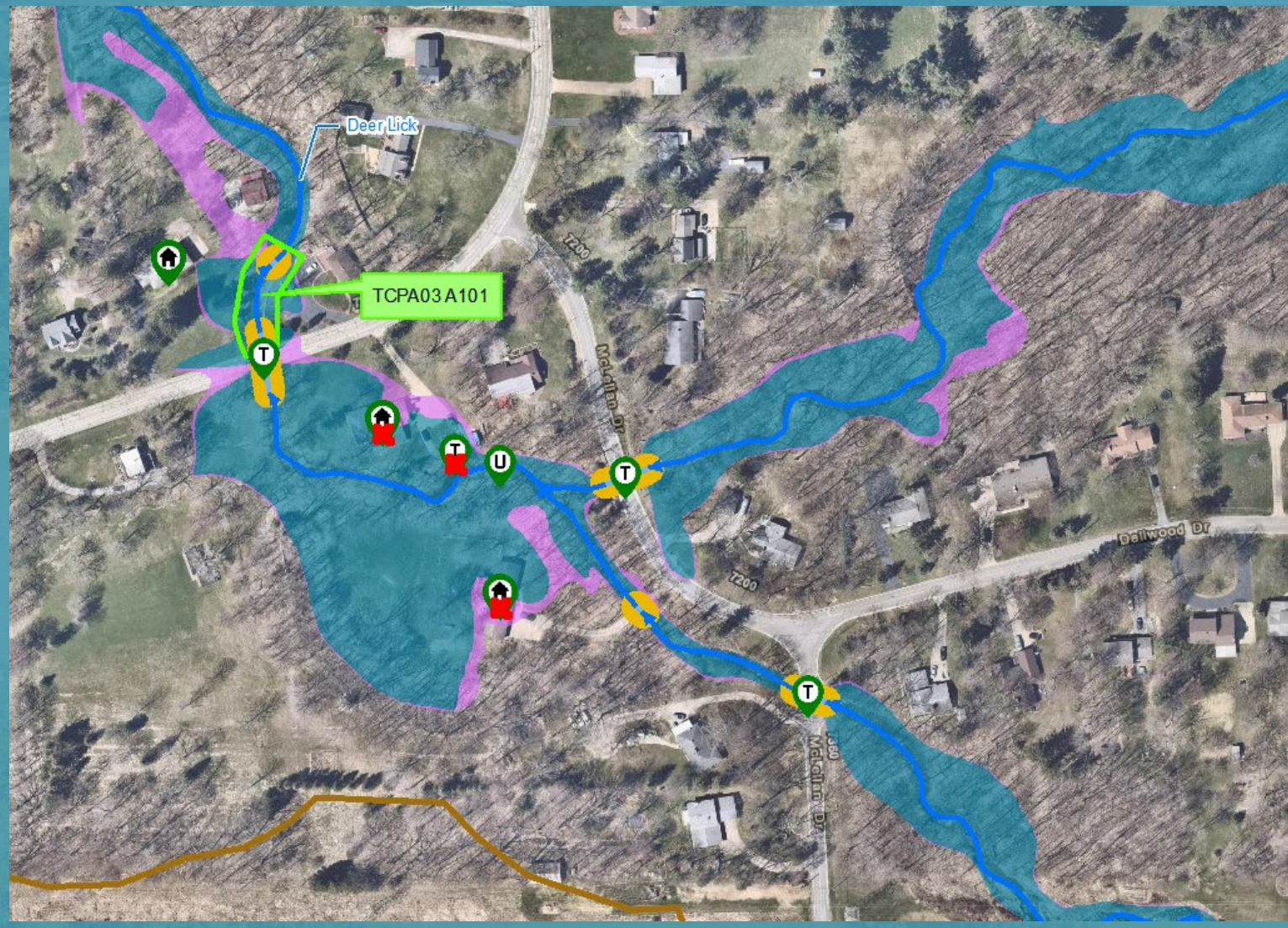
Findings and Recommendations

- ***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.

Northeast Ohio Regional Sewer District

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



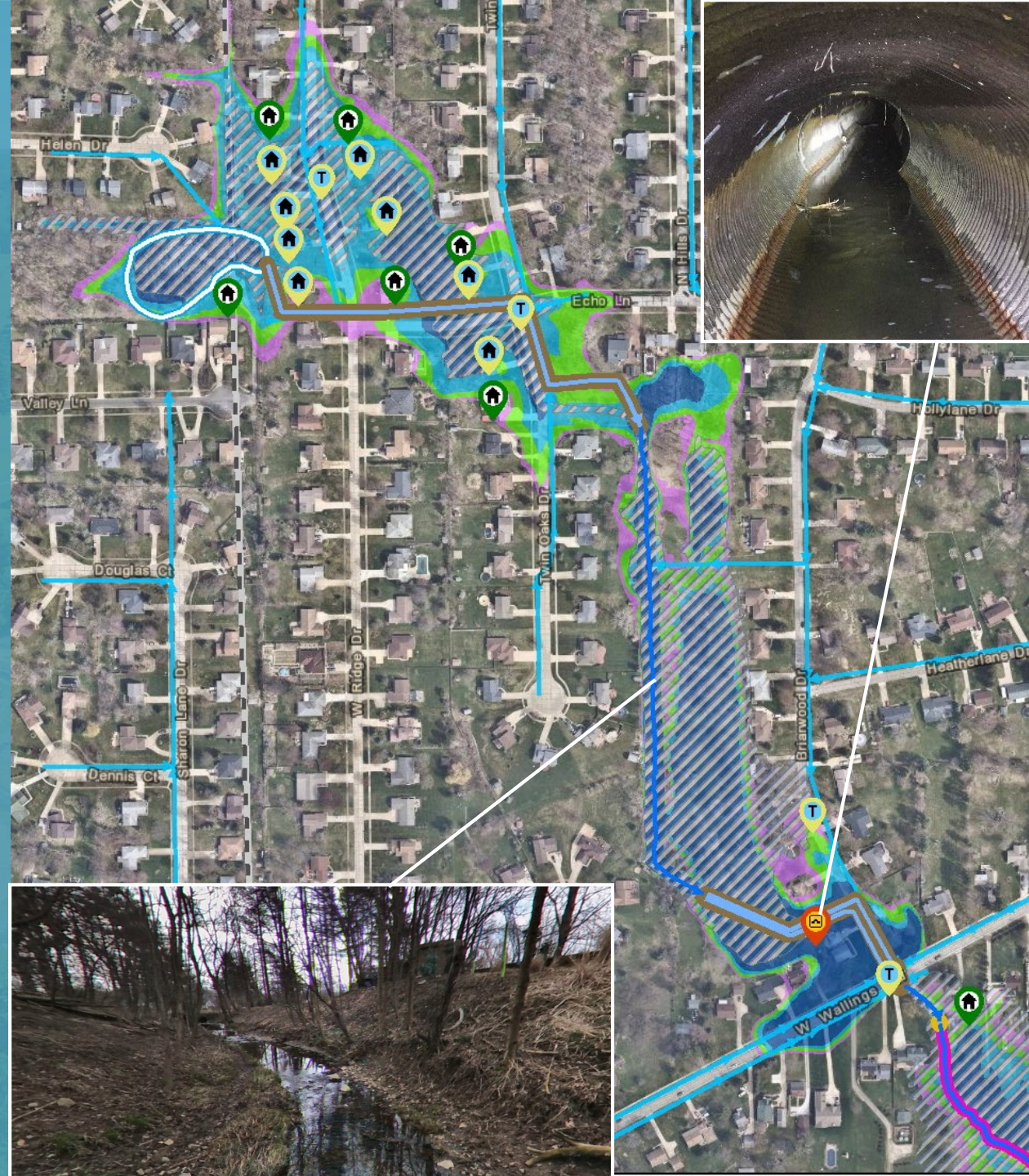
Northeast Ohio Regional Sewer District

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.

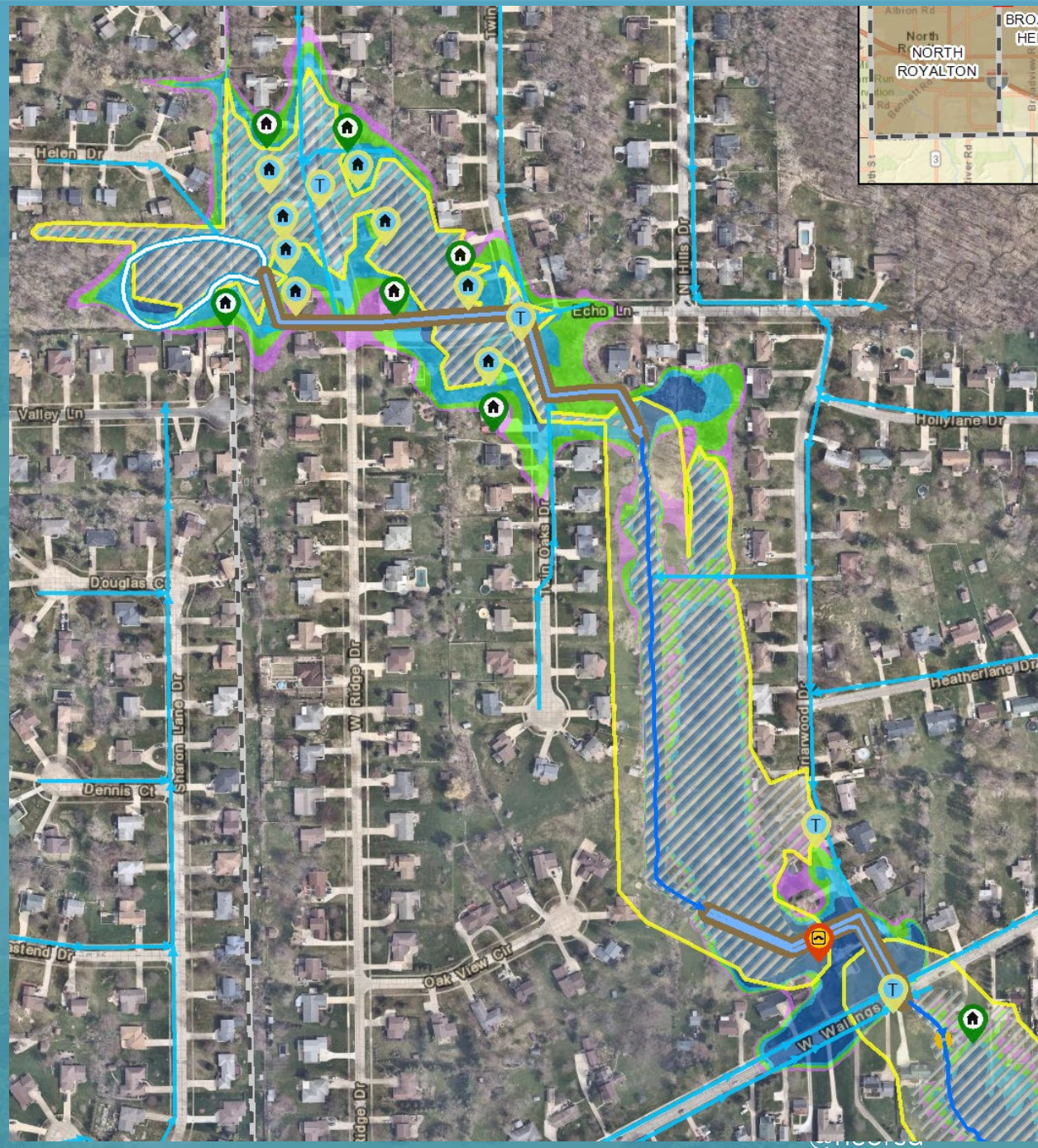


Northeast Ohio Regional Sewer District

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



Northeast Ohio Regional Sewer District

Case Study #1: Echo Lane, Broadview Heights

Opportunities and Constraints

Risk/Location / Assets	Runoff Reduction/Stream Restoration SCMs	RSS Storage/Conveyance SCMs	Land Acquisition/Risk Mitigation SCMs
Home and roadway flooding	Existing RSS basin has room to the west to enlarge to double current size. Existing stream between the two culverted streams has room to the east for floodplain creation/storage	Daylighting culverted stream at Wallings Road removes bottleneck and creates floodplain storage Existing stream between the two culverted streams has room for channel enlargement. Provides stream connectivity while reducing chronic flooding	Seven homes with higher flood risks near the upstream culverted stream could be acquired to reduce risk and restore floodplain storage.
	Floodplain creation and storage can be used in conjunction with daylighting culverted stream at Wallings Road		

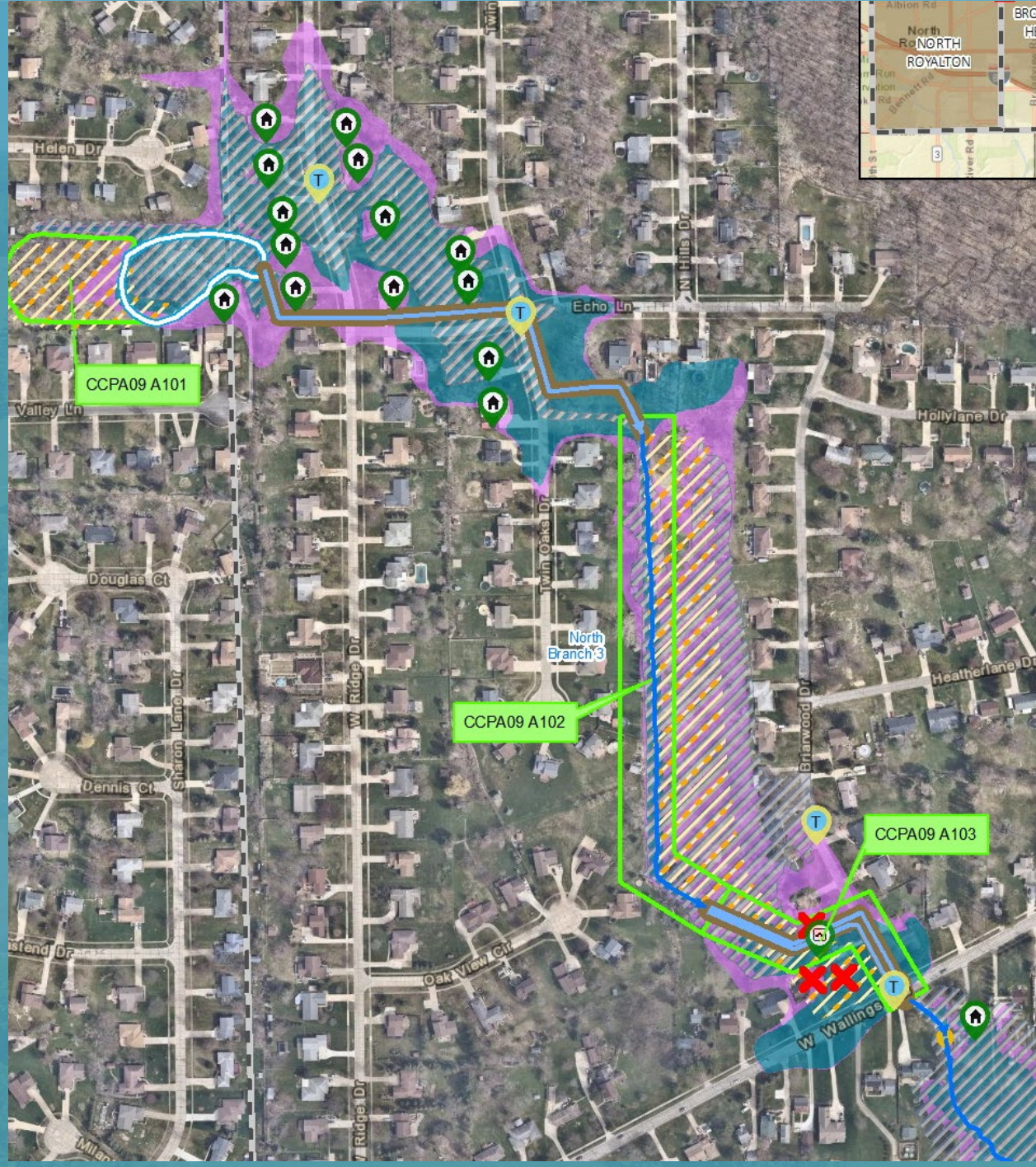
Legend	Constraint	Opportunity if done with other projects	Opportunity

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

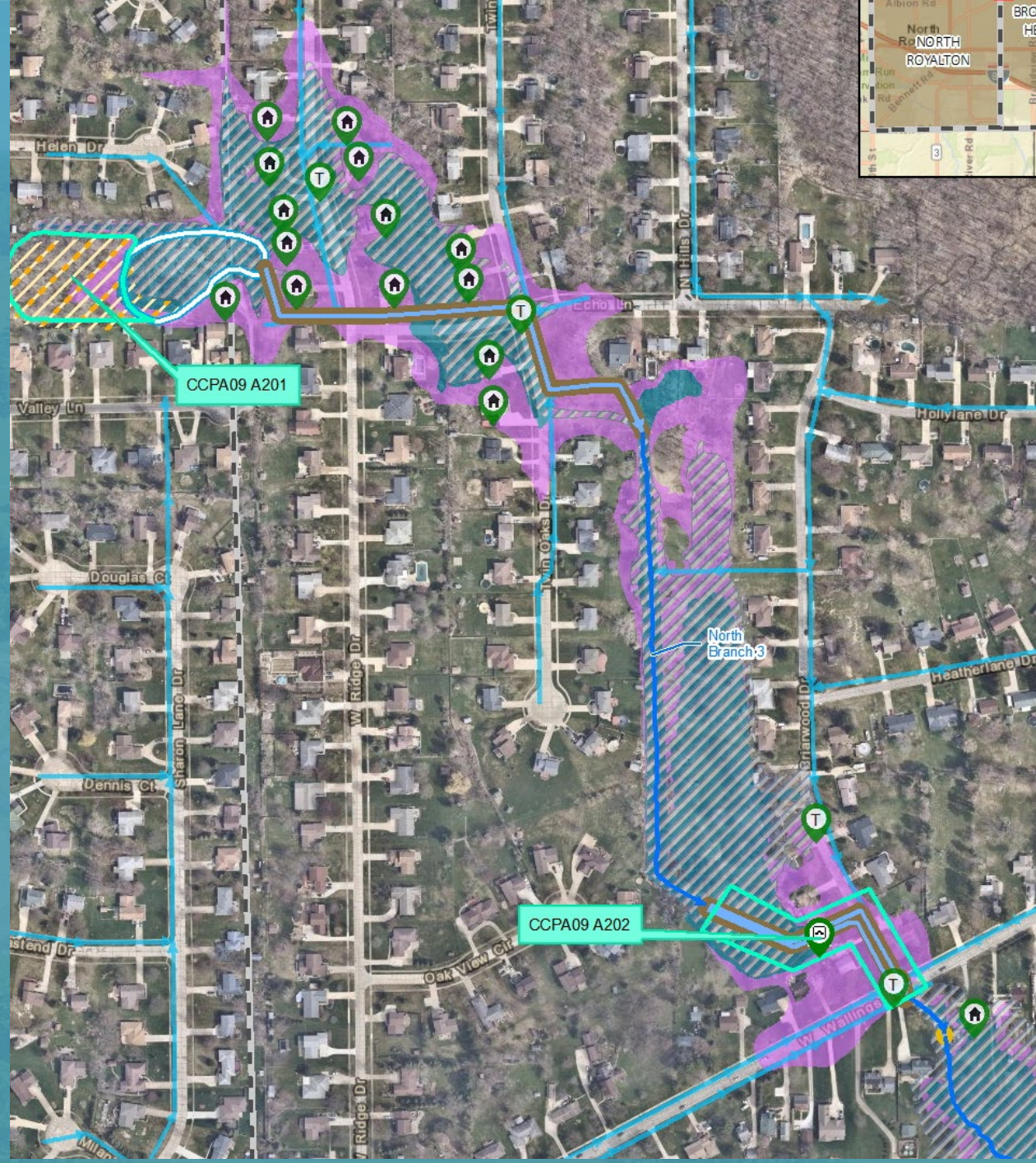


Northeast Ohio Regional Sewer District

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



Northeast Ohio Regional Sewer District

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.

Northeast Ohio Regional Sewer District

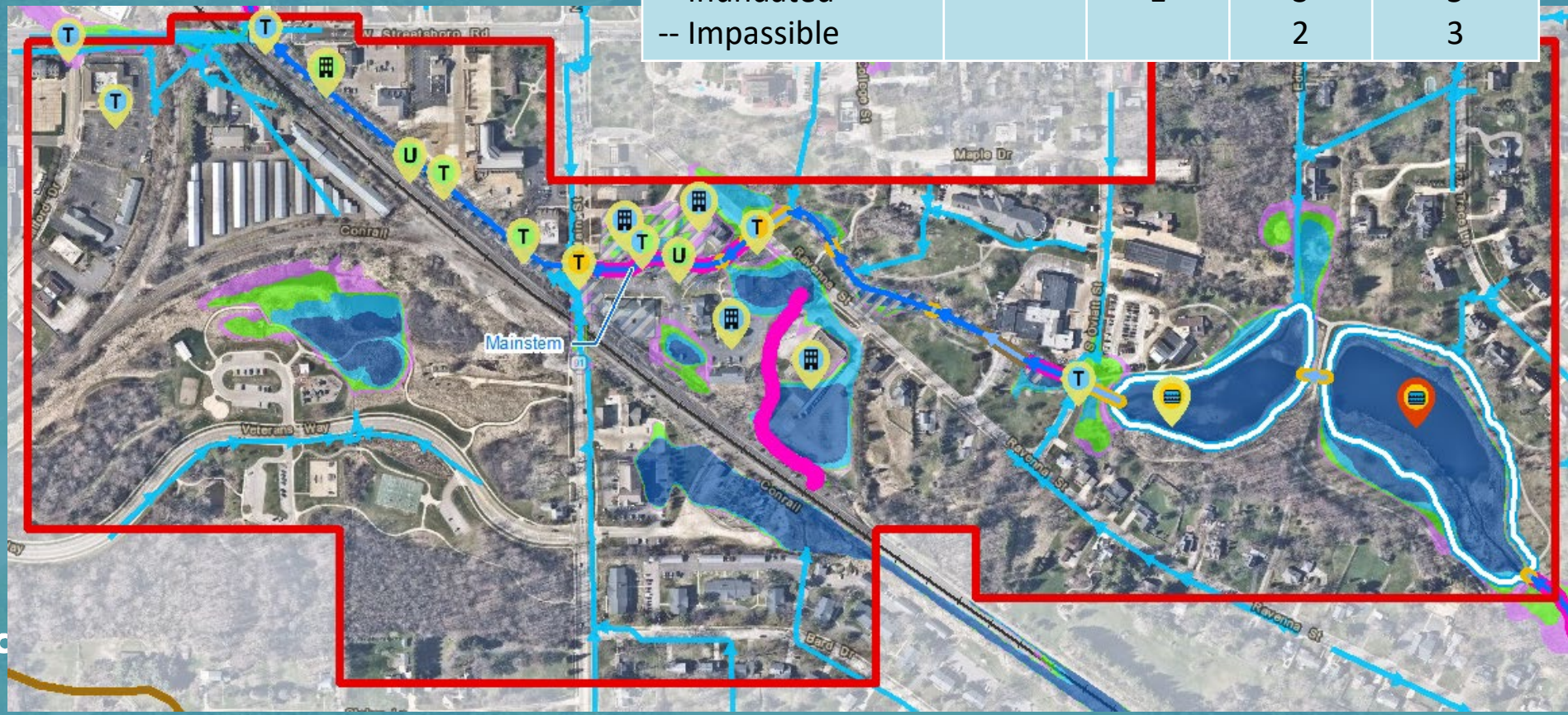
Estimated Alternative Costs			
Criteria	Alternative 1	Alternative 2	
Construction Costs (BL+Alt)	$11,696,000	$3,496,000	

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

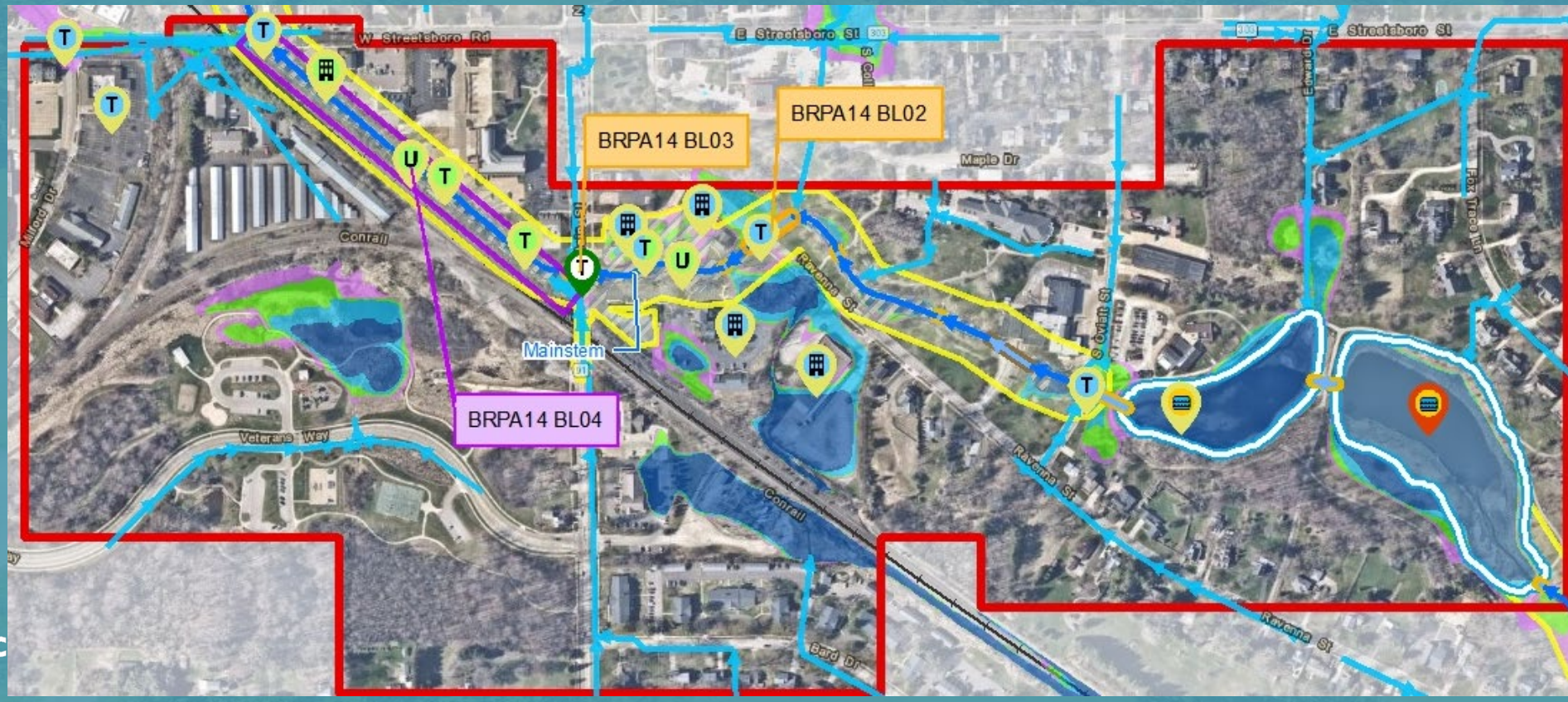


Northeast Ohio Regional Sewer District

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



Northeast Ohio Regional Sewer District

Case Study # 2: Downtown Hudson

Opportunities and Constraints

Risk/Location/Assets	Runoff Reduction/Stream Restoration SCMs	RSS Storage/Conveyance SCMs	Land Acquisition/Risk Mitigation SCMs
Flooding of commercial properties and parking lots adjacent to the stream.	Development has encroached into the floodplain. Runoff volumes have increased by the dense development of commercial area.	Some undersized crossings have worsened the flooding problem in some locations, and risk cannot be mitigated by increasing the conveyance capacity of these crossing. There are two large ponds located in Barlow Community Center that have storage available by increasing the detention storage and lowering the permanent pool levels prior to significant rain events.	Purchasing of properties adjacent to the stream is needed to mitigate the risk if other suggested SCMs are not feasible.
Eroded stream banks threatening adjacent utilities and parking lots.	Stream restoration options are feasible to resolve flooding by installing stacked rock walls along the stream banks.	Conveyance is enhanced by restoring the stream with inset compound channel combined with stacked rock walls along stream.	None.

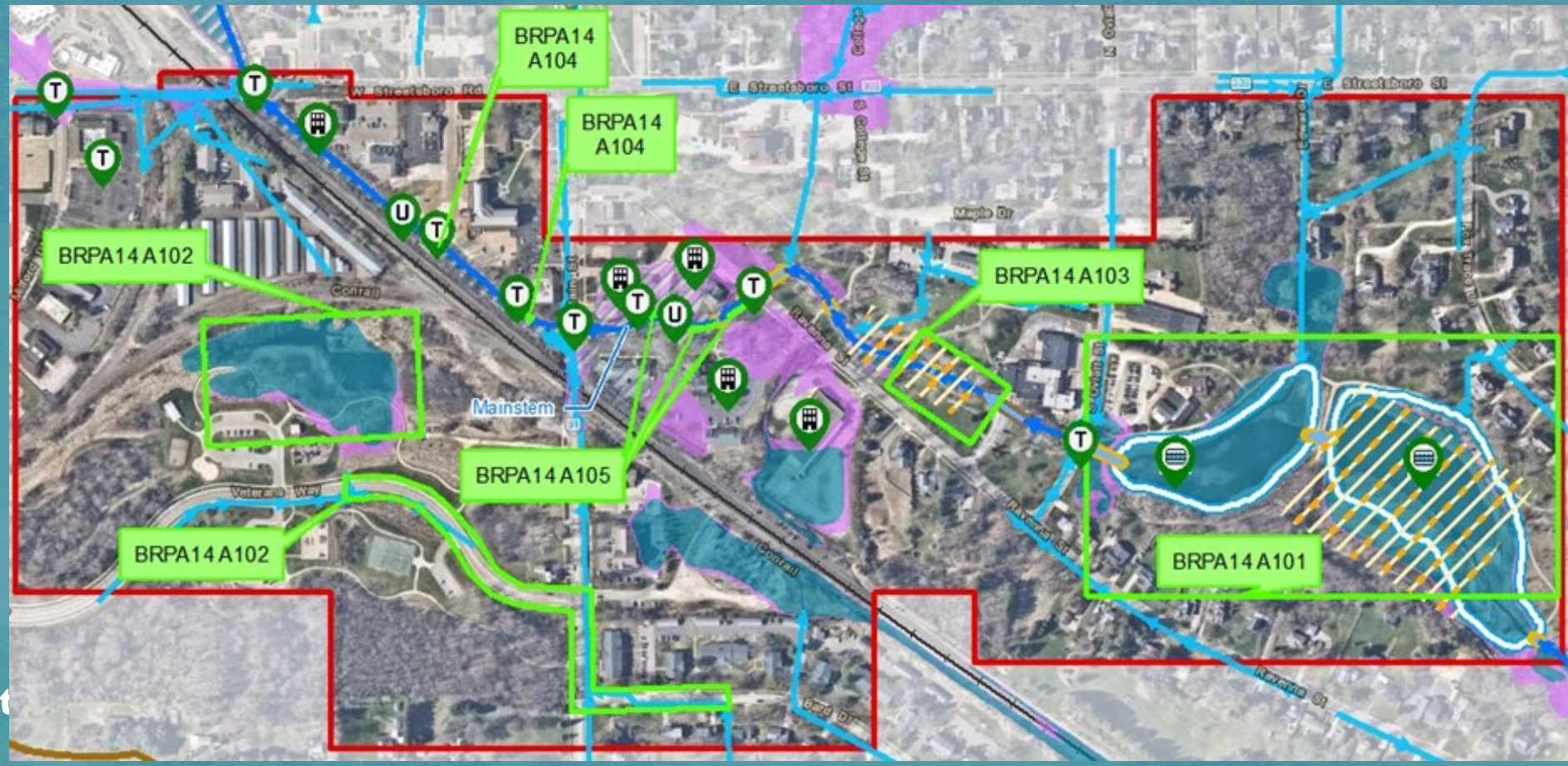
Legend	Constraint	Opportunity if done with other projects	Opportunity

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

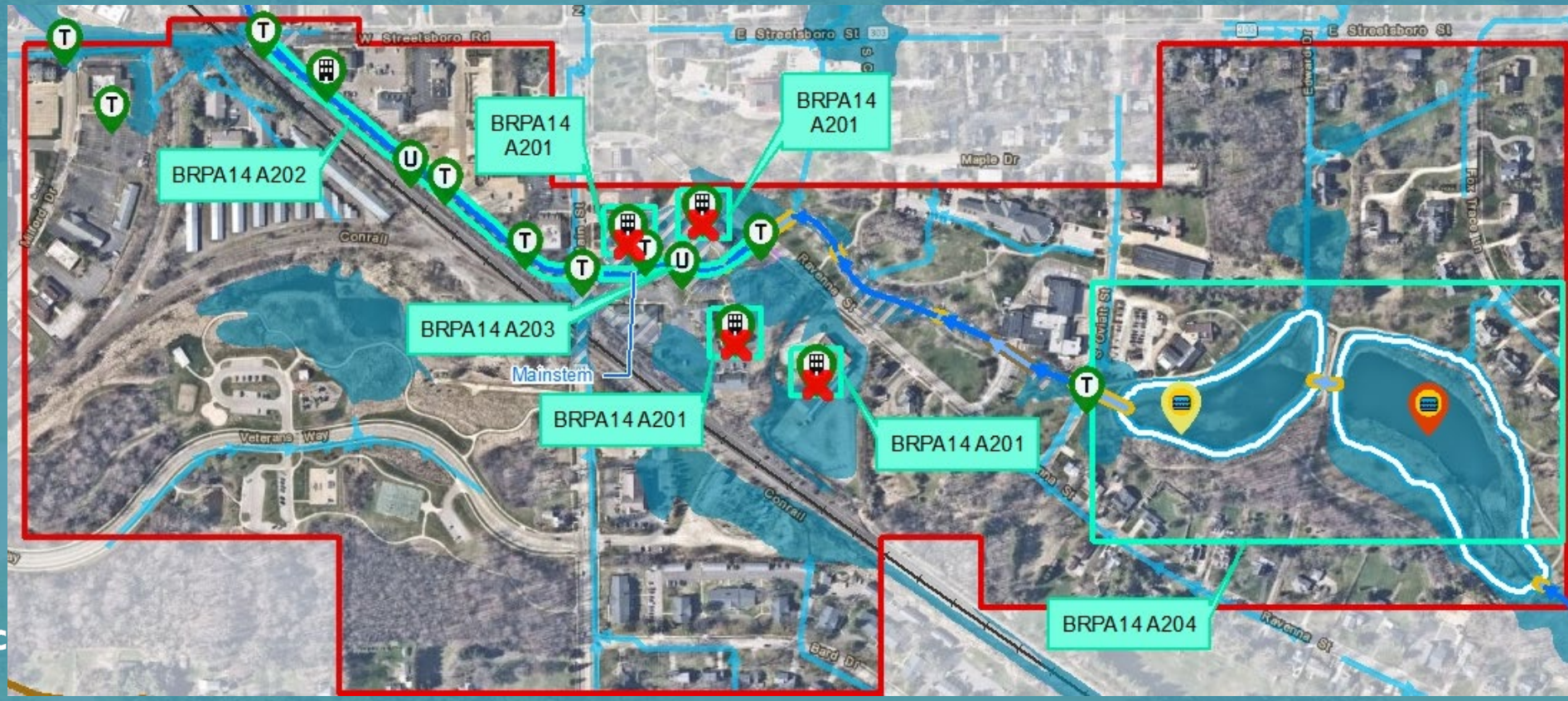


Northeast Ohio Regional Sewer District

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 with inset compound channel and microhabitat
- A204: Monitor structural condition
- Estimated Project Cost: $6,286,000



Northeast Ohio Regional Sewer District

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.

Northeast Ohio Regional Sewer District

NORTHEAST OHIO REGIONAL SEWER DISTRICT REGIONAL STORMWATER MANAGEMENT PROGRAM

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 Score*	Alternative 1 Rationale	Alternative 2 Score*	Alternative 2 Rationale	Weight
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		
	Weighted Subtotal	***41.67***		***8.33***		
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		
	Weighted Subtotal	***-20.83***		***16.67***		
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		
	Weighted Subtotal	***0.00***		***-25.00***		
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		
	Weighted Subtotal	***-6.25***		***-37.50***		
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

Northeast Ohio Regional Sewer District

NORTHEAST OHIO REGIONAL SEWER DISTRICT
REGIONAL STORMWATER MANAGEMENT PROGRAM

Questions

- Kim Colich
  Manager of Stormwater Design
  NEORSD
  216-881-6600, Ext. 6451
  ColichK@neorsd.org

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

Echo Lane Project Area, Broadview Heights

Northeast Ohio Regional Sewer District

CDM Smith

NORTHEAST OHIO REGIONAL SEWER DISTRICT
REGIONAL STORMWATER MANAGEMENT PROGRAM